Income Distribution Policy in Developing Countries

A Case Study of Korea

Irma Adelman and Sherman Robinson

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Oxford

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How much can actually be done to improve the distribution of income in developing countries? In seeking an answer to this question, the authors have developed a dynamic computable general equilibrium model that provides a laboratory for investigating the potential impact of various policy instruments and programs intended to improve the relative and absolute incomes of the poor. The model is rooted in an actual economy—that of the Republic of Korea.

From their results, the authors conclude that policy instruments in current use are largely ineffective when used singly because the effects of even substantial governmental intervention are quickly dissipated over time, with few of the hoped-for trickle-down effects. However, their results also show that if a government chooses to make anti-poverty policy the major focus of its development strategy and uses a coordinated package of diverse instruments that affect a large part of total economic activity, it can do much to reduce poverty and inequality. Such coordinated packages are feasible within the existing economic structure, though they have a major impact on the relative position of different socioeconomic groups and hence on the balance of political power within the country.

Irma Adelman is Professor of Economics at the University of Maryland. Sherman Robinson was formerly Assistant Professor of Economics at Princeton University and is currently an Economist at the World Bank.

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IRMA ADELMAN & SHERMAN ROBINSON

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Foreword

In recent years the distribution of the benefits of growth has become the most debated issue in the field of economic development. The central question is whether existing policies can be modified to produce a more satisfactory distribution of benefits or whether more drastic structural changes are required. Since the postwar experience of developing countries in these matters is quite diverse, this question can be answered for individual countries only through a detailed analysis of the ways in which income is generated and of how government policies impinge on them.

Professors Adelman and Robinson have constructed a very comprehensive model of the Korean economy for this purpose and have used it as the basis for a series of experiments to simulate the effects of different policies. Their ingenuity in designing and estimating a model in which prices and incomes are endogenously determined under realistic assumptions is no small achievement in itself.

The policy experiments, which are the heart of the book, are carried out with great skill. Since the Republic of Korea has followed policies that have led to a quite equal distribution of incomes, it is hardly surprising to find that it is difficult to make large improvements, particularly in the decade over which the analysis is extended. However, the authors break new ground in identifying some of the basic trade-offs that are involved in trying to design policies of poverty redressal, such as the role of agricultural prices in balancing between rural incomes and urban incomes.

The present study was supported by the World Bank as part of a research program on the determinants of income distribution. The basic approach was discussed at the World Bank–Institute of Development Studies workshop on income distribution at Bellagio, Italy, in 1973. However, the authors' research design and its execution are entirely their own responsibility. It is our hope that a series of such country studies,

covering different economies and using a variety of analytical methods, will lead to a better understanding of the growth and distributional choices available to developing countries. The present volume makes an important contribution to this objective.

Hollis B. Chenery
Vice President, Development Policy
The World Bank

Preface

This book has its genesis in our conviction that a major intellectual effort is required to reorient development policy from a concern with economic growth and industrialization toward an explicit concern with equity and the alleviation of poverty. When we started the book, most policy makers and planners, looking at the experience of developing countries around the globe, recognized that some change of emphasis was in order, but it was not clear what direction it should take. Since then, though a certain consensus has begun to form for anti-poverty measures as an integral part of development policy, a number of important questions are still unresolved. For example, to what extent is it possible to improve the distribution of income without massive, abrupt structural change? To what extent is there a trade-off between the goals of rapid growth and equity? What are the effects on income distribution of conventional policy tools applied within the framework of the existing economic and social structure? What are the effects on income distribution of the major development strategies pursued in the past? What are the components of, and preconditions for, equitable development strategies? This book attempts to contribute to the empirical and theoretical clarification of these issues.

We have constructed an economy-wide computable general-equilibrium model as a laboratory for policy experiments with anti-poverty programs and development strategies over the short to medium run. We have put much thought and effort into the specification, parameter estimation, and validation of the model in order to make it as realistic a simulator of an actual less-developed country as possible. In addition, though we have specifically designed our model as an instrument for the planning of income distribution, we think that it represents a new technical approach to planning models that will be useful in a number of other applications.

The results of this study are amenable to diametrically opposed policy conclusions. On the one hand, they demonstrate the great difficulty of improving the distribution of income in the short to medium run through policy interventions. They thus provide intellectual ammunition both to those who would wish to ignore distributional issues and to those who argue that nothing short of revolution will suffice to bring about the requisite degree of change. On the other hand, our experiments show that a pervasive "big push" policy package can generate significant improvements. By shifting the basic growth path with the Korean model, we find that it is possible to raise the incomes of the poorest decile by up to 50 percent, to reduce the share of total households living in poverty by more than six percentage points, and to lower the Gini coefficient by more than 15 percent. Such improvements were achieved under two all-encompassing but quite different strategies, which we characterize as "market socialism" and "reform capitalism." These results lend support to those who believe that much can be achieved within the existing economic and social framework, given sufficient motivation and political will.

This study has benefited from the support and advice of a number of institutions and individuals. We are grateful to the World Bank, which provided the major financial support; and to Princeton University, which granted Professor Robinson paid leave for a semester to work on the project. We are also grateful to the Korea Development Institute and to various statistical agencies of the government of the Republic of Korea for their invaluable assistance in the collection and processing of data. For help in our dealings with various computers, we are indebted to the University of Maryland computer center and to Alice Anne Navin of Princeton University.

Since 1972, when this project was begun, a number of people have given us the benefit of their expertise and comments. In particular we would like to thank Montek Ahluwalia, Bela Balassa, Kemal Dervis, John Duloy, Dae Young Kim, Janos Kornai, Frank Lysy, Jaime de Melo, Cynthia Taft Morris, Gerald Rodgers, Byung Nak Song, Lance Taylor, Laura Tyson, Jean Waelbroeck, and Herman Wold. We must also thank Betty Kaminski, Jerri Kavanagh, and Dorothy Rieger for typing the manuscript; without their help this book would never have seen its way into print. We are also grateful to Barbara Mnookin and J. G. Bell for their patient editing, which improved the presentation of the book immeasurably.

Finally, a major real cost was borne by our spouses, Frank and Barbara, whose forbearance at our immoderate consumption of evenings and weekends over the last five years has been admirable. Truly, without their support this book could never have been written.

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CHAPTER ONE

Introduction

IN THE 1950's and early 1960's economists and planners did not consider the distribution of income a major policy problem in developing countries. The prevailing view was that rapid growth would naturally lead (perhaps with a slight lag) to improved conditions for everyone. Though many might have preferred to see more relative equality and faster improvement in the absolute incomes of the poor, even radical critics of the market economy and existing institutional arrangements were at the time much more preoccupied with failure to achieve adequate growth than with distributional issues.

By the middle 1960's it became clear that such sanguinity about the trickle-down effects of growth was misplaced. And indeed a substantial and growing body of empirical evidence now indicates that in the process of development a number of groups in fact lose ground in relative and perhaps even in absolute terms. (See Myrdal 1968; Prebisch 1962; Adelman and Morris 1973; and Chenery et al. 1974.) There is certainly extensive support for the Kuznets U hypothesis that the relative distribution of income first becomes more unequal in the course of economic development and only at the later stages becomes more equal. In a cross-section study of 43 less-developed countries, Adelman and Morris (1973: 181) found that on the average, for the longest part of the development process—corresponding to the transition from the state of development of sub-Saharan Africa to the state achieved in the least-developed Latin American countries—the primary effect of economic development on income distribution is to decrease both the absolute and the relative incomes of the poor. Though this view is still somewhat controversial, there is no question that the distribution of income—and especially the extent of poverty—has become a major policy issue both within the less-developed countries themselves and within the international community.

The major question for policy analysts has been whether or not there is a basic conflict between the goal of greater distributional equality and the goal of faster growth. The current evidence is at best mixed. Adelman and Morris (1973) found that traditional economic instruments of policy have a weak or at most a nonsystematic effect on the relative share of income accruing to the poor. They conclude that "policy instruments that are most effective in improving income distributions are different from those that are best for raising economic growth rates" (p. 185). Others have argued that there need not necessarily be any conflict with respect to policy, whether or not there has been such conflict in the past. (See Frank and Webb 1977; Stewart and Streeten 1971; and Chenery et al. 1974.) They suggest that certain changes in emphasis—for example, a shift to more labor-intensive technologies, to export promotion in trade policy, to rural rather than industrial development, or to a broad-based, skill-intensive growth strategy—might favor more equality and need not hinder rapid growth.

An even more fundamental question is raised by the genuine possibility that the distribution of income is so deeply embedded in the structure of an economy and society that it can only be affected by a major, and presumably violent, upheaval. In the event, the human costs are likely to be incredibly large, and such an approach should only be regarded as a solution of last resort. It is therefore most important to explore how much can be done to reduce inequality starting from the existing social, political, and economic framework and working gradually within an acceptable time period. It is this issue that our study explores.

To this end, we have developed a model that is designed to provide a laboratory for investigating the potential impact of standard economic policy instruments and programs intended to improve the relative and absolute incomes of the poor. The model traces out both the direct and the indirect influences on the distribution of income. Its structure is set by the nature both of the major economic forces determining the distribution of income in the relative short term and of the major policy instruments that could affect it in a reformist environment.

Real-world experience, theoretical considerations, and the failure of partial or correlation approaches to provide useful answers for policy purposes all suggest the need for a "system" approach to policy formulation. Because of the multiplicity of interdependent influences that impinge on the distribution of income—with no particular influence dominant—one cannot readily pick out through non-modeling empirical studies the critical areas of intervention or predict the probable impact of specific programs. Thus a model is needed to evaluate the multiple impacts of

various policy programs, to assess the ultimate consequences of current decisions, to facilitate comparison among alternative programs, and in general to permit intelligent and informed policy design.

MODEL STRUCTURE

The model developed in this book is in the tradition of economy-wide planning models.* We took our inspiration from the early work on price-endogenous planning models by L. Johansen. His first model (Johansen 1960) was "linearized" and solved by simple inversion for rates of change of prices and production. Our model is highly non-linear and is expressed in terms of levels. The earliest version of our model was formulated and solved in 1972. Since that time, there have been a number of Ph.D dissertations (Dervis 1973, Ahmed 1974, Zonnoor 1975, and De Melo 1975) and other projects (Lysy and Taylor 1977 and recent work on Malaysia at the World Bank by M. Ahluwalia, F. Lysy, and G. Pyatt) using the same basic type of model.

The model has five essential distinguishing features. It solves for prices endogenously in both factor and product markets. Its solution is based on achieving a measure of consistency among the results of individual optimizing behavior by a large number of actors (households, firms). It incorporates income distribution, monetary phenomena, inflation, and foreign trade. It is dynamic, with imperfect intertemporal consistency. And, finally, it allows for varying principles of market clearing and institutional behavior.

The model operates by simulating the operation of factor and product markets with profit-maximizing firms and utility-maximizing households. It can thus be characterized as a computable general-equilibrium (CGE) model and is broadly in the neoclassical tradition, though it has a number of disequilibrium, non-neoclassical features. The overall model consists of a static, within-period adjustment model linked to a dynamic, intertemporal-adjustment model. Within each period the degree of adjustment is constrained by the existence in place of capital stock of specific types; by the immobility of the self-employed in both agricultural and urban production; by rigidities in wage structures; and by government constraints on firm behavior, especially in the foreign trade sector. Between periods some flexibility for adjustment is provided by capital accumulation, population growth, migration, changes in the amount of self-employment, and changes in the size structure of production. However, because of the magnitudes involved and because we are focusing on an

* A good survey of models and techniques used in development planning is Blitzer et al. 1975.

intermediate-run period, the ability of the economy to shift factors of production around in an effort to achieve full Walrasian equilibrium is severely constrained. Our model structure thus combines elements characteristic of views held in both Cambridges. Interestingly enough, our results support a structuralist view more than they do a marginalist-reform view of the potential for policy intervention to reduce inequality.

The model is quite comprehensive in its degree of closure, i.e., the number of features of the economy that are endogenous and mutually consistent. The household and income recipient accounts are determined endogenously in accordance with behavioral specifications. The model explicitly goes from factor payments and employment to household incomes, with savings and expenditure decisions being modeled at the household level. The overall size distribution of household incomes is determined by explicit aggregation. Accounting consistency is maintained among (1) household, firm, government, and trade accounts; (2) national income accounts; (3) input-output accounts; (4) national product accounts; and (5) the composition and size of the labor force and households.

The structure of the model was dictated by four sets of considerations: the policy issues we wished to address; the potential instruments, programs, and areas of policy intervention we wished to include; the theory relating instruments to targets; and the institutional and economic characteristics of the economy being modeled (in our case, Korea).* We shall discuss in turn how each of these sets has shaped the formulation of the model.

Policy Focus

Our focus on income distribution policy within a reformist setting in the short to medium run has conditioned a number of features of the model. It has affected the manner of disaggregating productive sectors, factors of production, and socioeconomic groups. In addition, it has influenced the degree of institutional specificity, the choice of time frame, the approach taken to validation, the approach used in extrapolating exogenous variables in determining the basic dynamic solution, and even the structure of the computer program.

The model economy is disaggregated by firm size within sectors, as well as by producing sectors. There are 29 producing sectors and four firm sizes (four farm sizes in agriculture).† Disaggregation by firm size

* For convenience, we use the term Korea throughout this book for the Republic of Korea.

† Specific information on these sectors and firm sizes is given in Appendix D.

was adopted at great expense in data work because our preliminary examination of wage and profit rates by firm size indicated sharp and persistent differences within producing sectors. Disaggregation by firm size also permitted us to capture economies of scale dynamically, since investment can alter the size structure of production within sectors. On the household side, there are 15 different socioeconomic categories of income recipients, each with its own expenditure functions (dependent on both prices and income) and savings behavior.* Labor in each sector and firm size is disaggregated by six skill categories, with agricultural workers representing a seventh category. There are more than 500 labor demands and wages (by sector, firm size, and skill category) to be calculated in clearing the labor markets. There are 29 commodity prices to be determined, with some traded goods prices being tied to world prices. There are more than 100 suppliers of goods and, on the demand side, government and trade sectors are included, as well as the 15 household types.

The time frame of the model is one to nine years. This time period was chosen for essentially two reasons: first, because the combination of the increasing awareness of the problem of poverty in even rapidly growing less-developed countries, the failure of trickle-down to alleviate the problem, and the accompanying increased social tension has made the populations of many countries increasingly impatient for visible and rapid improvement; and second, because this period is long enough that the impact of the policies adopted can be felt, and yet not so long that it lies beyond the systematic planning horizon of most governments. It is thus important to examine the scope for, and potential effectiveness of, policy intervention in the short to medium run.

This time focus has profoundly affected the structure of the model. Certain factors that would be critical in the long run have been modeled rather crudely, notably technological change, institutional change, population growth, demographic effects, and changes in the quality, quantity, and distribution of human capital. The important issues in the long run are how physical and human assets are transmitted between generations and how they are monetized within different socioeconomic systems. We assume that these factors are embedded in the parameters of the economic system we describe and examine some of them only by parametric variations.

The design of the model as a laboratory for policy experiments means in particular that the model presented in this book is *not* a forecasting model. Thus, in validating the model, we have been concerned not only

* Some of the household categories are assumed to have the same expenditure functions, so the 15 household categories are aggregated into 12 different consumer types.

with comparing deviations of actual from estimated values in the historical part of the basic dynamic solution, but also with examining the ability of the model to represent realistically the response of the economy to policy interventions. In the jargon of macro-modelers, we have attempted to build a realistic structural model, not a reduced-form forecasting model. In our extrapolation of exogenous variables in the basic dynamic solution, we have purposely suppressed short-term cyclical variations or exogenous shocks. For example, we have not included the effects of the oil crisis in 1973. We have also purposely not modeled the likely government response to changes in the balance of payments, in inflation, or in the agricultural terms of trade. Our intent is to have the basic dynamic run as a pure experimental "control" for comparison with the results of policy experiments.

The focus on policy experiments led to a flexible model design so as to include a wide range of potential instruments and alternative behavioral and technological specifications. Compared with other economy-wide models, our model makes fewer compromises in the name of "simplicity" and "solvability." It incorporates optimizing responses by firms and households to a number of policy instruments (such as direct and indirect taxes) and is capable of portraying a wide variety of economic and institutional rules. For example, one can easily vary the principles of the operation of credit markets and factor markets, the degree of monopoly, the type of production functions, and even the objective functions of firms. Despite its size and complexity, the model is neither too large to solve economically nor too complex to be able to trace the major effects through the general-equilibrium system.

Policy Areas

Even though there is no satisfactory single theory of income distribution and development in less-developed countries (or, indeed, of income distribution in developed countries), it is possible to list the major variables thought to be important in determining the distribution of income. One can classify the variables and the positive policy instruments that might affect income distribution into 10 areas. These areas are not independent; rather, they reflect factors operating simultaneously in an interactive fashion.

A. Relative factor prices. These influence factor proportions, the employment of factors, and factor incomes, and hence the structure of demand and the structure of production. They are influenced by policy actions such as monetary policy, trade policy, and investment policy—the core of the country's general development strategy.

B. Relative product prices. The sectoral terms of trade are an important determinant of the distribution of income. They are influenced, directly and indirectly, by a wide range of government policies, indirect taxes and subsidies, and foreign trade policies.

C. Technology. The degree of substitutability among factors of production and the inherent labor intensity of production processes influence employment and relative factor incomes. The promotion of labor-intensive technology or small-scale industry, or both, are often advocated on distributional grounds.

D. Direct rationing of products and services. The most important policies under this heading are the allocation of government services in housing, health, and education and the rationing of scarce vital commodities.

E. Direct rationing of the factors of production. The rationing of credit (at subsidized rates) and the rationing of foreign exchange are major policy tools for influencing the structure and growth of production and incomes. We can also include under this heading direct government investment, both in infrastructure and in productive enterprises.

F. Direct transfers. In most of the less-developed non-socialist countries, direct government transfers tend to be small. However, private transfers through the extended family are important redistributive mechanisms.

G. Public works. Rural and urban employment schemes and public investment offer nonmarket mechanisms for augmenting employment opportunities and for increasing incomes of the poor.

H. Inflation. This is an instrument often used to reallocate savings, and hence wealth, among sectors and groups (particularly government).

I. The redistribution of wealth. To the layman this is the single most important influence on income disparities. Reducing inequalities in the distribution of the ownership of the primary factors of production is a fundamental goal of political activity in many developing countries. A special aspect of this issue is the distribution of ownership between domestic and foreign nationals and firms and between the private and government sectors. Perhaps the most important influence of the inequality in the distribution of wealth is not through the induced inequality in the distribution of income, but rather through the unequal distribution of political power that results, allowing those who possess it to limit or guide the use of direct income redistributing instruments.

J. Intergenerational transfers. The methods of regulating the inheritance of wealth, access to education, and access to jobs are clearly important long-run determinants of the distribution of income and wealth.

The socially, institutionally, and politically determined rules for regulating such intergenerational transfers are crucial factors in determining the transmission of income inequality over generations.

The first three areas reflect the structure of economic activity and hence the inherent nature of the development strategy chosen by a particular country. For some countries one might include the rate of inflation as reflecting the process of adapting the existing economic structure. Instruments *D*, *E*, *F*, and *G* represent the usual arsenal of marginalist anti-poverty measures and do not reflect major changes in the structure of the economy. Factors *I* and *J* are long run in nature and reflect potentially more fundamental changes. As noted, the time focus of our model is short to medium run. The distribution of wealth and its change over time are reflected in the initial conditions and parameters of the model but not, by and large, in any behavioral equations. The impact of changes in long-term factors are explored only by altering various parameters and initial conditions.

Our desire to include the entire range of variables and behavioral specifications that are potentially important in the short to medium run has led us to formulate a rather complex model. The pervasive importance for distribution of relative factor prices and product prices led us to formulate a wage- and price-endogenous CGE model. The potential importance of substitution possibilities in production and consumption led us to make the model very nonlinear in the specification of both of these activities. Including wages and prices in a nonlinear formulation also permits great flexibility in the inclusion of policy instruments directly in the model. The importance of inflation led us to include monetary variables directly in the model and to postulate behavior that is not "neutral" in real terms with respect to money. The resulting model is very different from standard linear planning models and even from the newer nonlinear models in this tradition. (See Taylor in Blitzer et al. 1975 for a survey of existing models.)

Economic Theory

A number of theoretical considerations guided the structure of the model, its degree of closure, and the strategy used to solve it.

Since in the short run the distribution of income in any economy is the by-product of its production and consumption activities, any model purporting to analyze income distribution patterns must be formulated in a framework that traces the circular flow of income and product in a mutually consistent interactive fashion. Our model therefore describes how the behavioral patterns of producers maximizing profits under

various institutional and rationing constraints, of government in its budgeting and rule setting, and of consumers maximizing utility all interact to determine the distribution of income among households.

Though market-clearing processes are important determinants of the distribution of income, income distribution is clearly also affected by institutional rigidities and imperfect adjustment to market disequilibria. We observe in Korea, for example, that the remuneration of identical skills in the same sector varies systematically with firm size. Similarly, the price of capital and the rate of return on investment differ systematically both within and among sectors, and there is no evidence of convergence. Finally, there is unemployment of various types of labor that persists over relatively long periods of time. The combination of these observations suggests that a full Walrasian general-equilibrium model will be unable to capture the essential features of reality. Our model is therefore neither a full neoclassical general-equilibrium model nor a pure disequilibrium or partial equilibrium model. Rather, the economy adjusts production decisions and various prices in an attempt to arrive at an equilibrium between supply and demand under various institutional constraints and without achieving full neoclassical equilibrium in the factor markets. There is imperfect mobility of factors; and in addition the dynamics of the model are constrained by an interaction between investment demands by firms and credit rationing by the financial system. There is no assumption of consistent self-justifying expectations in the dynamic specification. In fact, the overall dynamic model represents a kind of "lurching equilibrium" as the model continually attempts to adjust to intertemporal disequilibria. Accumulation, migration, and population growth permit changes in the structure and levels of production, but there are limits to the degree of adjustment possible in the medium term.

Until recently (with the growth of the theory of human capital), economic theory has been concerned with the functional distribution of income rather than with the household or size distribution. In a model that specifies the behavior of both producers and households the functional and household distributions must be reconciled. Accordingly, in our model we have explicitly modeled the process of household formation by which income recipients are grouped into household (and consuming) units. This is done by assuming that each category of household owns a fixed proportion of factors of production (including labor by different skill categories). Given knowledge of these proportions, of the number of workers per household, and of the total labor supplies, household incomes and the number of households in each category can then be determined from a linear model. Our attempt to integrate the household and factor

income accounts is very much in the tradition of social accounting pioneered by Richard Stone. (See United Nations 1975; and Stone 1973.) However, our particular approach has not, to our knowledge, been used in any prior planning models.*

With respect to the degree of closure, theory suggests that it is important to capture the full interaction among the structure of production, factor payments, the distribution of income, and the structure of demand. We have therefore closed the model by maintaining full accounting consistency between the production and expenditure accounts at both the micro and the macro levels. We explicitly model expenditure behavior by both households and firms, and account for the flow of funds among the various economic actors. Existing planning models are much less ambitious in their degree of closure and usually leave some set of accounts to be determined residually.

Finally, our technique for solving the model simulates market behavior. Several different techniques for solving CGE models are currently being used or are under development. Formally, the problem can be expressed as finding a solution (or fixed point) for a set of equations in prices—the well-known economic problem of finding a general-equilibrium solution for an economy. The problem can be reformulated and expressed as a maximizing problem, so that linear (or nonlinear) programming techniques can be used.† It can also be seen simply as a problem of solving a set of nonlinear equations, a special case of a general problem that has been much studied. Over the last 10 years several algorithms have been developed to solve general nonlinear systems.‡ Though we draw on such algorithms, we have chosen a solution strategy that takes advantage of our knowledge of the economic relationships inherent in the system of equations by directly simulating the operation of the markets for products and factors. Essentially, we set up the problem as one of reducing a set of market-excess demands to zero and simulate a Walrasian tatonnement process to find the market-clearing prices and wages. This direct approach of simulating market behavior permits a great deal of freedom and flexibility in the specification of how the various actors behave and of how the markets work. Apart from the usual problem of ensuring that

* The International Labor Organization has used our approach in its demographic-economic model of the Philippines, BACHUE. (See Hopkins et al. 1975; and Rodgers et al. 1976.)

† See Takayama and Judge 1964 and 1971; Goreux and Manne 1973; and Ginsburgh and Waelbroeck 1976. Chenery and Raduchel 1971 is a variant of this approach that does not explicitly model market behavior.

‡ For algorithms based on fixed-point theorems, see Scarf 1973; and Kuhn 1975. Techniques based on derivatives, which is what we have used, are surveyed in Rabinowitz 1970. See also Geoffrion 1972.

at least one solution exists, we have not been constrained in our specification of the model by considerations of solution technique. This contrasts sharply with the experience of those who work with traditional planning models.

Korea

In any economy, one can view the distribution of income as being determined by two broad sets of factors. First, the fundamental aspects of the economy (production functions, resource endowments, demand patterns, etc.) determine a first-round distribution. Second, institutional factors are brought to bear on this first-round distribution so as to adapt it to the social ends of the politically influential groups. These second-round effects can be very important and might more than counterbalance the impact of policy instruments applied to the first-round factors. For this reason an accurate description of institutional arrangements is essential for income distribution modeling.

As noted, we have rooted our model in an actual economy—that of Korea—so that we might examine and test the experimental results. As a consequence, the model reflects certain institutional and behavioral features that are specifically Korean, especially in the foreign trade sector. Korea was chosen for several reasons. First, the country has shown spectacular growth performance. Second, it has pursued an industrialization strategy that is export oriented, and thus avoids some of the negative income distribution consequences of import-substitution-led growth. Third, it combines a human resource–intensive development strategy with a highly educated, literate population. Fourth, largely because of the Korean War, the accelerated growth process was initiated starting from a relatively egalitarian distribution of wealth. Fifth, by international standards the current distribution of income in Korea is quite good. And finally, the data are very good. Korea should therefore provide a favorable test case for the proposition that rapid growth can have favorable income distribution consequences, though it may be that Korea's very success along distributional lines may make further improvements unusually difficult.

PRECIS OF THE MODEL

For convenience, we here summarize the essential shape of the model, which is fully described in the next chapter and in Appendix A.

For each period, the computation of the model is decomposed into three stages. The Stage I model describes the contracts made between firms and the financial markets to spend funds on investment goods.

Stage II describes how factor and product markets reach an equilibrium constrained by the investment commitments undertaken in Stage I, by various institutional rigidities imposed by foreign trade, and by the operation of product and labor markets. Stage III serves to generate the expectations on which the next Stage I decisions will be based, to select some of the rules of its operation (e.g., the credit regime), and to "age" the model economy. Stage II is the major simultaneous core of the model and represents the basic static portion of the model, used for comparative-statics experiments. Stages I and III are used only in the dynamic analysis.

Stage I models the loanable funds market. Producers form their demands for loanable funds on the basis of expected sales and expected prices of inputs. Credit is then rationed either by setting an interest rate and allowing the market to clear at that rate (called finance minister 1) or by setting a target rate of expansion of credit and allowing the rate of interest to adjust in order to clear the loanable funds market (finance minister 2). The output of Stage I is the allocation of loanable funds among firms and sectors, and an overall injection of credit into the economy. Stage I is diagrammed in Figure 1.

The Stage II model is a general-equilibrium model in that prices or supplies (or both) are assumed to adjust so as to clear all markets, subject to various constraints. Of the submodels, the Stage II model is the most neoclassical in spirit. Yet even in this stage there are several constraints that prevent the economy from fully adjusting by means of pure market mechanisms. Furthermore, inflation plays an important role that is certainly different from the usual general-equilibrium models, which are homogeneous of degree zero in all prices and wages.

The Stage II model is itself subdivided into a number of parts representing different computational phases: supply, demand, wage, income, and price determination. The output of this is "actual" production, employment, prices, wages, and income distribution for the period. Figures 2 and 3 portray the basic model structure. In Figure 2 the product and labor markets are pictured. The treatment of traded goods is especially important. Imports and exports that compete on the world market are assumed to sell domestically at the world price plus a fixed tariff (or subsidy). For these goods, imports and exports are determined residually after calculating domestic supply and demand at the fixed prices. For protected goods or non-traded goods, we assume that the domestic markets are insulated from the rest of the world, and prices are determined so as to clear them. For traded goods, this implies that tariffs or subsidies are determined residually to equate the world price with the market-clearing domestic price plus tariff or subsidy.

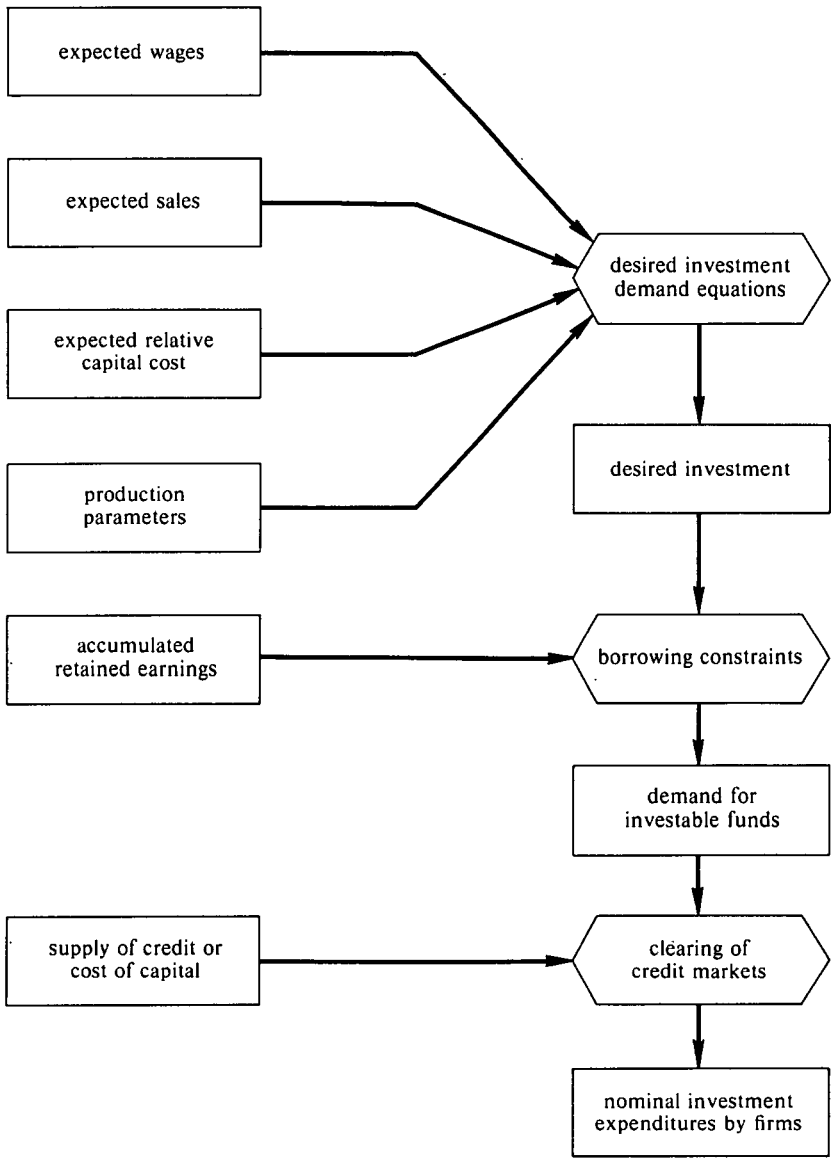

Fig. 1. Stage I: Determination of Investment

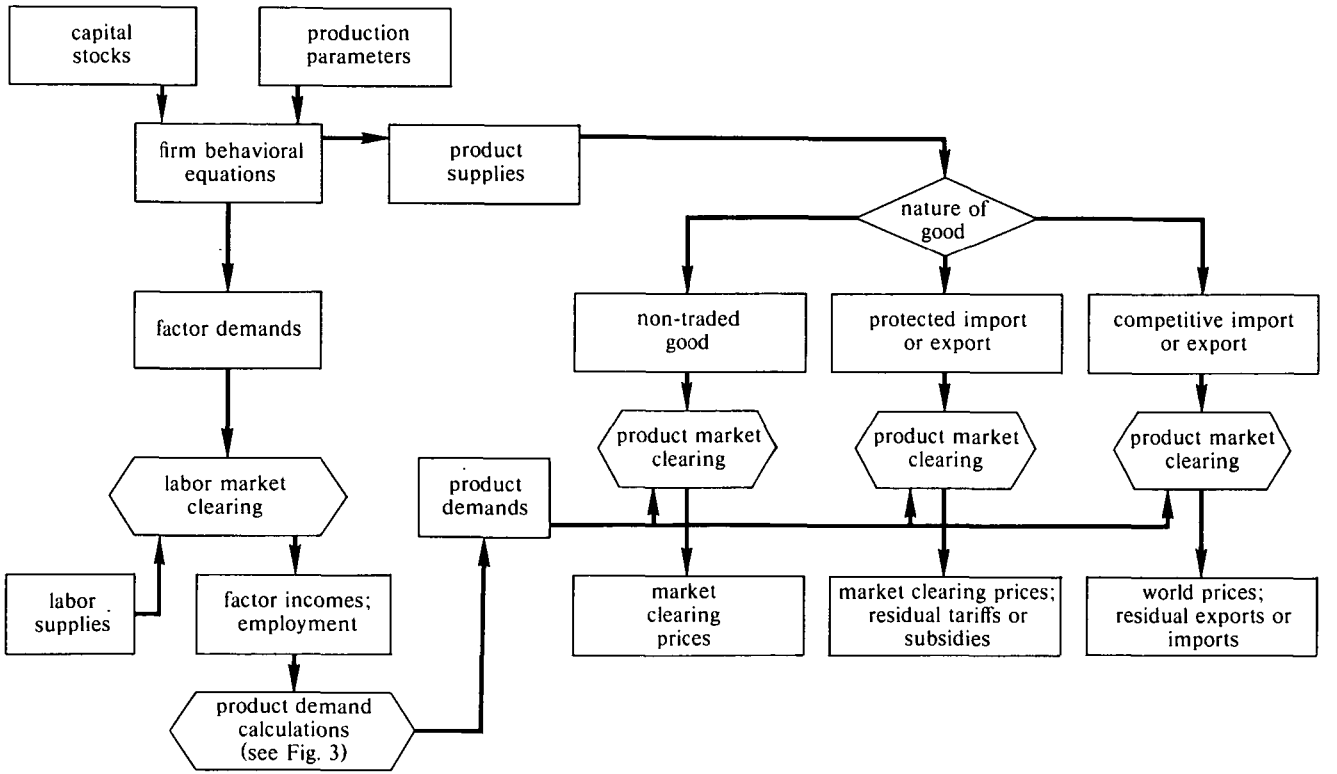

Fig. 2. Stage II: Determination of Wages, Employment, Prices, and Profits

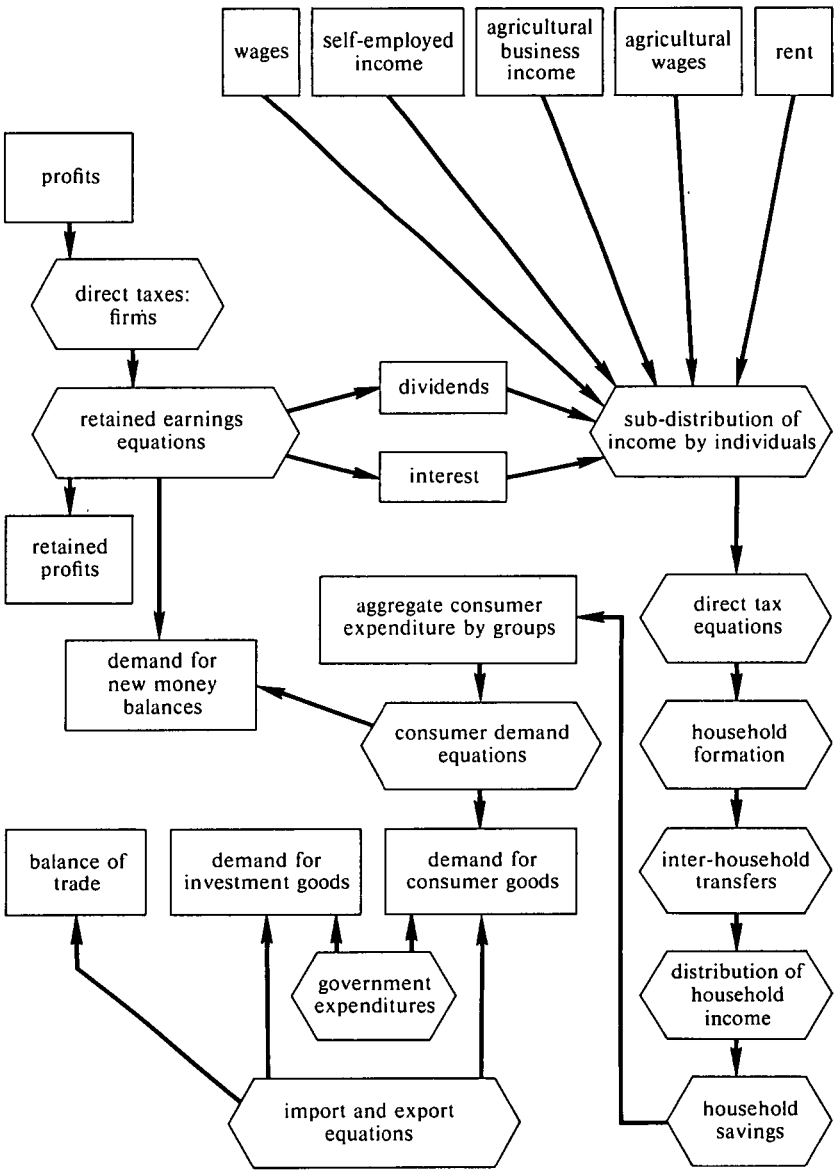

Fig. 3. Stage II: Demand for Products and Income Distribution

TABLE I
Stage III Model Summary

Stage II output	Stage III model components	Stage III output
Factor payments	Population growth	Expectations parameters for Stage I
Product prices	Education/skill	Factor supplies
Production	Exchange rate	Technological and behavioral parameters
Employment	Expected prices	
Functional distribution	Expected sales	
Household distribution	Household parameters	
	Government parameters	
	Trade parameters	
	Firm parameters	
	Technological change	
	Migration	

Figure 3 shows the income accounts and especially the steps in translating the functional distribution into the household distribution. There are 15 socioeconomic categories of income recipients for whom the model must determine income, taxes, allocation to household groups, transfers, savings, and consumption expenditure. For each category, we calculate a within-group distribution of income and derive the overall distribution by summing the 15 different group distributions.

The Stage II model reaches its solution by means of a tatonnement process that simulates market behavior. However, in both Stages I and II no actual transactions take place until the solution of each stage is reached. Thus, investment by firms is determined only at the end of Stage I; factors are hired, production takes place, and income is earned and spent only at the end of Stage II.

The Stage III model consists of a set of functions that update the relevant variables and formulate expectations that enter into the Stage I model for the next period. Stage III can be seen as consisting of a collection of submodels that specify all the dynamic adjustments and intertemporal linkages for the overall model. These components are listed in Table 1. In principle, one could specify a very complicated set of interdependent submodels in Stage III. (For examples, see Robinson 1976a; and Hopkins et al. 1975.) Our relatively short time horizon has led us to specify a fairly simple set of Stage III functions. A number of variables such as population growth are simply assumed to grow at an exogenously specified rate. Rural-urban migration is explicitly modeled as a function of rural-urban income differentials, with an upper limit on the possible annual rate of migration. There are no interactions among the various submodels, and each is specified as a self-contained set of recursive functions.

In each period the three stages are solved serially. Variables that are assumed fixed in Stage I are allowed to vary in Stage II. Thus the overall model distinguishes between expectations and realizations. In the third stage the differences between expectations and realizations are incorporated into the forecast functions for the expectational variables with which calculations are made in subsequent periods.

POLICY RESULTS

Before we turn to the details of our study, a brief word about some of the major policy conclusions reached in this book. (They are fully discussed in the last chapter.) Our major conclusion from the policy experiments is that the time path of the size distribution of income is exceedingly stable. Under a great variety of experiments, many of which involve quite sizable interventions, there is a marked tendency to return to the basic-path distribution. Even when the policy or program is sustained over time, it is quite rare that there is more than a 10 percent change in the Gini coefficient, or that a percentile's share is altered by more than 20 percent after about 10 years. Except for transfers, most single-policy interventions, even when quite large, do not have lasting effects. Transfer policies, though to some extent effective, are potentially of quite limited scope in most less-developed countries. Only when a sufficient number of different interventions are applied simultaneously, so that there is, in effect, a change in development strategy, are more sizable or lasting effects possible. These results support the view that structural change is required to affect inequality, and that equity objectives must shape the choice of basic development strategy if they are to be met.

A good dynamic development strategy, imposed on an economy in which the appropriate initial conditions are present, can have a favorable effect on distributional equity. Our experiments indicate that a labor- and skill-intensive, export-oriented development strategy can improve the distribution of income when, as in Korea, the ownership of human capital is widespread and land is reasonably equally distributed. Conversely, a wrong strategy (import substitution, for example) can do much to deteriorate the distribution of income. But even with the right strategy, there is a persistent tendency for the distribution of income to deteriorate with rapid growth, especially once possibilities for import substitution in foodstuffs are exhausted. Additional sizable and pervasive programs aimed at many different socioeconomic target groups are required to combat the tendency for deterioration.

The stability of the size distribution is associated in our experiments with relative instability in factor shares and in the functional distribution

of income. This instability indicates that the relative position of various groups is very sensitive to the choice of economic policy. By an appropriate choice of instruments, it is easy to favor or discriminate against particular socioeconomic groups. The relative degrees of poverty and wealth in the economy as a whole are little affected, but the composition of the poor and wealthy groups changes dramatically.

Particular instruments or policies often either are ineffective or have different effects than expected. Indeed, partial analyses are rarely indicative of the ultimate effects of policy interventions once their impact is allowed to permeate throughout the system. Not only magnitudes, but also directions of effect are often different. In addition, the effects of policy or program combinations are rarely equal to the sum of the effects of their individual components, indicating that interaction effects among policies are significant.

Our results emphasize the importance of the agricultural terms of trade and of the extent of rural-urban migration for anti-poverty policy. On the other hand, they indicate that such often advocated changes as the promotion of small-scale industry and changes in the labor intensity of technology in manufacturing are either ineffective or effective for reasons that are different from the grounds on which they are advocated. Population policy has relatively little effect on the size distribution of household incomes over the relatively short time period considered. Indeed, population policies that result in relatively less labor in urban areas tend to deteriorate the distribution of income.

On the whole our results underscore the difficulties of effective policy interventions to improve the distribution of income. They reinforce the need for a careful, system-wide analysis of the impact of potential policy actions—an analysis that takes account of the indirect and dynamic effects of policy intervention.

CHAPTER TWO

The Basic Model

IN THIS CHAPTER we begin with a simple wage- and price-endogeneous computable general-equilibrium (CGE) model to help the reader understand the essential structure of the full model; and present the equations in a way that will enable the reader to compare them to the more traditional formulations of multisectoral models. We then use the simple model as a framework for discussing in general terms the structure of the complete model. In Appendix A we present the static core of the complete model with a full presentation of the model equations and all extensions. The dynamic model is presented in similar detail in Appendix C.

Basically, what differentiates our model from other multisectoral models is that it solves endogenously for wages and prices in a multifactor, multiconsumer, multiproduct world in which firm and consumer behavior is based on the optimization of separate objective functions. These features are emphasized in the simple CGE model. The model we present below is static and excludes any consideration of government, foreign trade, money, labor migration, or household formation. Production is not disaggregated by firm size—in common with input-output models there is one producer for each good—and perfect competition is assumed in all markets.

The model structure evolves from the tradition of input-output models by closing the "open" Leontief model in a mutually consistent, general-equilibrium manner that allows for the substitutability of factors and commodities, wage and price interactions, and the maintenance of various accounting constraints. The core of the model structure consists of the closure of the employment-income-consumption-expenditure nexus in a way that takes account not only of changes in employment and output but also of changes in wages and prices. In the subsequent discussion we explain how the basic closure is accomplished within the framework

of a very simple model, then consider the inclusion of other aspects of the economy, such as government, foreign trade, income distribution, investment, and monetary effects.

A SIMPLE CGE MODEL

The discussion of the model is organized around the activities of firms as buyers of factors and sellers of output and the activities of consumers as suppliers of factors and buyers of output. The circular flow identities, which require that no income and no outputs be unaccounted for, is maintained in the model not only by production adjustments (as in other models), but also by price and factor income modifications. It is this feature that distinguishes CGE models from other economy-wide models.

The Producing Sector

Production functions. Output is assumed to be a function of two kinds of inputs: $R_{i\lambda}$: Resources such as labor and fixed capital that are not produced in this period; and V_{ji}, intermediate goods. $R_{i\lambda}$ is the use of resource λ in sector i, where $\lambda = 1, \ldots, m$ and $i = 1, \ldots, n$. V_{ji} is the amount of good j used by sector i, where $j = 1, \ldots, n$ and $i = 1, \ldots, n$. In general production can be seen as a function of both kinds of inputs with substitution possibilities among them. However, we assume that there are substitution possibilities only among the non-produced resources. The requirements for intermediate resources are given by fixed input-output coefficients: $V_{ji} = \hat{A}_{ji}X_i$. The demands for intermediate goods are assumed always to be met. In the system below, we use the input-output coefficient in the net-price and material-balance equations and do not explicitly use the variable V.

The production function with respect to other inputs (labor and capital) is assumed to be a neoclassical function that allows for factor substitution:

$$X_i = f_i(R_{i1}, \ldots, R_{i\lambda}) \qquad n \text{ equations.} \tag{1}$$

Net prices. Firms are assumed to maximize profits. Since they are assumed to require intermediate goods in fixed proportions, their demands for such goods are linear functions of output. In terms of the firm's behavior, the cost of intermediate goods is simply proportional to output, and net receipts are the sale price minus the fixed charge. Thus, we can define the net price as

$$p_i^* = p_i - \sum_j \hat{A}_{ji}p_j \qquad n \text{ equations.} \tag{2}$$

In terms of hiring decisions for other factors (and assuming perfect competition), the firm views the net price as the marginal revenue from the sale of one more unit of output.

Factor markets. The first-order conditions for profit maximization require that the firm hire factors until wages equal marginal revenue products:

$$p_i^* \frac{\partial f_i}{\partial R_{i\lambda}} = w_\lambda.$$

We are here assuming that wages for a given factor are equal across all sectors, and that there is perfect competition in the product markets.

The first-order conditions can be solved to give factor demands as a function of net price, wages, and the employment of other factors:

$$R_{i\lambda} = g_{i\lambda}(p_i^*; w_1, \ldots, w_m; R_{ik}, k = 1, \ldots, m \text{ and } k \neq \lambda) \qquad m \cdot n \text{ equations.} \tag{3}$$

The solution of the first-order condition for the factor demands is straightforward for Cobb-Douglas functions. For more complicated functions it may be necessary to solve for the factor demands numerically.

To calculate total demands for factors, aggregate the demands by sectors:

$$r_\lambda^d = \sum_j R_{j\lambda} \qquad m \text{ equations.} \tag{4}$$

The aggregate supplies for factors in this simple model are simply assumed to be fixed:

$$r_\lambda^s = \bar{r}_\lambda^s \qquad m \text{ equations.} \tag{5}$$

Equilibrium in the factor markets requires that factor demands equal factor supplies, or that excess demands for factors equal zero:

$$r_\lambda^d - r_\lambda^s = 0 \qquad m \text{ equations.} \tag{6}$$

Wage determination. Assume for the moment that producer prices, p_i, are given. With prices given and thus with net prices from equation (2), the excess-demand equations (6) can be seen to be a function of wages, w_λ. Simply substitute equations (3)–(5) into (6). The problem then is to find a set of wages that clears the factor markets. Formally, the problem is to find the solution of a set of simultaneous nonlinear equations. The techniques used to solve such a system are discussed in Appendix B. Since product prices were assumed given, the solution of the factor markets is only one part of the overall model solution, which involves clearing product markets as well as factor markets. The solution of the factor

markets, as well as determining wages and employment, gives product supplies from equation (1), and so can be seen as yielding the supply of goods as a function of prices.

The Consuming Sector

The demand side of the model involves first calculating total income by factors—the functional distribution of income. Aggregate income by factors is given by

$$y_\lambda = \sum_j w_\lambda R_{j\lambda} \qquad m \text{ equations.} \tag{7}$$

In this simple model, each factor type is supposed to consist of a homogeneous group of people whose consumption behavior can be represented by an aggregate expenditure function. Thus the demand for goods by each group can be written as

$$C_{i\lambda} = h_{i\lambda}(y_\lambda; p_1, \ldots, p_n) \qquad m \cdot n \text{ equations.} \tag{8}$$

The demand equations are written quite generally. The only requirement on them is that they satisfy the budget constraint, i.e., that

$$\sum_j p_j \cdot C_{j\lambda} = y_\lambda \qquad \lambda = 1, \ldots, m.$$

The literature on systems of demand equations is quite active, and the particular choices we made are discussed in Appendix A. We have assumed that the demand equations are derived from utility maximization behavior by consumers, which imposes additional constraints on them.

A simplification of this model—which we do not use but which has been employed in virtually all the current price endogenous models—is to assume that there is only one set of consumer-demand equations. For purposes of calculating consumer demand, all consumers are aggregated together. This simplification has some important implications for solution strategies that are discussed in Appendix B.

The product demands by groups can be aggregated to determine total demand for goods from each sector:

$$c_i^d = \sum_\lambda C_{i\lambda} \qquad n \text{ equations.} \tag{9}$$

The aggregate supply of each good, X_i, was determined in the solution of the factor markets. The supply of goods for final demand is determined by subtracting the demand for intermediate goods in the material-balance equations:

$$c_i^s = X_i - \sum_j \hat{A}_{ij} X_j \qquad n \text{ equations.} \tag{10}$$

TABLE 2
Variables and Equations for the Simple CGE Model

Equations	Number of equations	Endogenous variables
FACTOR MARKET		
(1) $X_i = f_i(R_{i1}, \ldots, R_{i\lambda})$	n	X_i
(2) $p_i^* = p_i - \sum_j \hat{A}_{ji} p_j$	n	p_i^*
(3) $R_{i\lambda} = g_{i\lambda}(p_i^*, w_k, R_{ik})$	$m \cdot n$	$R_{i\lambda}$
(4) $r_\lambda^d = \sum_j R_{j\lambda}$	m	r_λ^d
(5) $r_\lambda^s = \bar{r}_\lambda^s$	m	r_λ^s
(6) $r_\lambda^d - r_\lambda^s = 0$	m	w_λ
PRODUCT MARKET		
(7) $y_\lambda = \sum_j w_\lambda R_{j\lambda}$	m	y_λ
(8) $C_{i\lambda} = h_{i\lambda}(y_\lambda; p_1, \ldots, p_n)$	$m \cdot n$	$C_{i\lambda}$
(9) $c_i^d = \sum_\lambda C_{i\lambda}$	n	c_i^d
(10) $c_i^s = X_i - \sum_j \hat{A}_{ij} X_j$	n	c_i^s
(11) $c_i^d - c_i^s = 0$	n	p_i
(12) $\bar{p} = \sum_i \omega_i p_i$	one	

Equilibrium in the product markets requires that the excess demand for each good be zero:

$$c_i^d - c_i^s = 0 \qquad n \text{ equations.} \tag{11}$$

Equations (7)–(10) can be substituted into equation (11) to yield n excess-demand equations in n prices (assuming that the factor markets are solved for each set of prices). The problem is to solve a general-equilibrium system for market-clearing prices and wages. It is well known that such a general-equilibrium system can determine only relative prices since the set of equations is homogeneous of degree zero in wages and prices. Thus we are free to impose some normalization on prices and wages. We choose simply to set the level of the wholesale price index exogenously:

$$\bar{p} = \sum_i \omega_i p_i \qquad \text{one equation.} \tag{12}$$

The endogenous variables and equations are summarized in Table 2. Note that in the factor-market equations, if one assumes product prices

are given, then there are as many equations as endogenous variables. In the product-market equations, there is one extra equation because, as noted above, the entire system is homogeneous of degree zero in all wages and prices. An additional equation is necessary to set the level of absolute prices.

There are a number of different strategies and techniques that can be used to solve the model economy given by equations (1)–(12). We have chosen to iterate on prices following a kind of tatonnement procedure. First, start with an initial guess at prices. Second, solve the factor-market equations for wages, employment, and production. Third, solve the product-market equations and calculate excess demands. Fourth, raise or lower prices in sectors where there are excess demands or supplies. Fifth, normalize prices according to equation (12) and start another iteration. Stop iterating when all excess demands equal zero. Our particular method and alternate strategies are discussed in Appendix B. It is worth noting here, however, that solutions were achieved in five to 20 price iterations in virtually all of our experiments. To solve the factor markets usually required from 10 to 25 evaluations of the excess-demand equations for factors.

MODEL EXTENSIONS

We now turn to a discussion of various generalizations of the model specification that are introduced in the full model. We indicate the amendments to the simple model that need to be made to incorporate them, but leave a complete mathematical statement of the full model to Appendix A.

Money and Inflation

In an actual economy the rate of inflation—and especially any change in that rate—affects the relative real incomes of various socioeconomic groups: wage earners versus farmers, the private sector versus government, rentiers versus employees, and so on. The simple model, which determines only relative prices, cannot capture these effects. We have extended the model to include monetary variables and to solve for the absolute price level as well as for relative prices. In order to include the effects of inflation on the distribution and on other quantity variables, we have specified the model so that it is not "neutral" with respect to money—the real equations are not homogeneous of degree zero in wages and prices.

Extending the simple model to include the supply of and demand for money balances is straightforward. Assume that the recipients of factor

income desire to hold money balances as a function of their income and the price level. Their demands for money balances can be written as

$$M_\lambda^d = k_\lambda(y_\lambda, \bar{p}) \qquad m \text{ equations.} \tag{13}$$

After deciding how much of their income is to be held in money balances, the remaining amount to be spent on goods is given by

$$y_\lambda^* = y_\lambda - M_\lambda^d \qquad m \cdot n \text{ equations.} \tag{14}$$

The expenditure equations (8) are replaced by

$$C_{i\lambda} = h_{i\lambda}(y_\lambda^*; p_1, \ldots, p_n) \qquad m \cdot n \text{ equations.} \tag{8a}$$

Equilibrium in the money market requires that supply equal demand. Assuming that the supply of money is given exogenously by $\bar{M}$, equilibrium requires that

$$\sum_\lambda M_\lambda^d - \bar{M} = 0 \qquad \text{one equation.} \tag{15}$$

Equation (15) adds an extra equation to the system without adding an equilibrating variable. The traditional approach is to assume that the average price level, $\bar{p}$, in equation (12) is not fixed but is included as an endogenous variable. The average price level changes so as to equate the supply of and demand for real money balances. Nominal money demand in equation (13) is assumed to be an increasing function of the price level. In the full model velocity is assumed to be constant within periods, but to change between periods as a function of changes in the interest rate and expectations.

In general-equilibrium models, of which the simple model is an example, money is usually "neutral." Changing the money supply changes only the average price level and leaves relative prices and all real variables (employment, production) unchanged. The real system is homogeneous of degree zero in all prices, wages, and money. (See Patinkin 1965.) In the full model, however, money plays a much more complex role. First, the real system is affected by money—the real equations are not homogeneous of degree zero in wages, prices, and money. Second, the nominal supply or injection of new money is partly endogenously determined, since various sectors can hoard or dishoard money balances. As a result, the inflation rate is determined endogenously and performs a significant function.

There are several ways in which inflation affects real variables in the full-model economy. First, changing prices changes the structure of the demand for transactions balances, and so changes the demand for real goods. Second, total investment in Stage II is assumed fixed in nominal

terms from Stage I.* Thus unanticipated increases in the general price level lower the amount of capital goods demanded in Stage II. The demand curve for the aggregate capital good is a rectangular hyperbola, since price times quantity must equal a constant, specified expenditure. Third, interest payments in Stage II are specified in nominal terms. Finally, the exchange rate is usually specified in nominal terms.

The total demand for new cash balances is an endogenous variable in Stage II. The real money supply in Stage II adjusts so as to accommodate or validate the injection of new credit that was specified exogenously in nominal terms (from Stage I). The resulting inflation or deflation in Stage II can be seen as being largely determined by both the credit policy pursued in Stage I and the "cash balance" effect that is endogenous to Stage II. The mechanism that determines the price level is thus a combination of Keynes (1935) and Pigou (1949).

Functional and Household Income Generation

The simple model generates only the aggregate distribution of income by functional categories (i.e., factors of production such as labor and capital). The complete model generates the income side of the economy in great detail and treats separately the income accounts of government, firms, functional groups, and households. A fair amount of social income accounting is used to keep track of the various flows, maintain accounting consistency, and include different behavioral rules for different economic actors. A number of steps are described below that start from the income payment side of the circular flow, generate various income distributions, and finally yield the demand for goods and services. These steps are diagrammed in Figure 3 in Chapter 1 and are discussed in detail in Appendix A.

Factor incomes. For wage earners (by skill categories, including hired labor in agriculture), the model economy generates incomes through the workings of the labor markets. Given that wages differ by skill category, sector, and firm size, the model solves for seven average wages by skill category (including the skilled self-employed group) and for over 500 separate wages by skill, sector, and firm size. The self-employed (divided into two groups by type of sector) receive the net value-added accruing to the smallest firm size. A separate group, capitalists, receive all the distributed profits of private firms (government-owned firms remit profits to the government), plus most interest payments plus rent (except for imputed rent for owner-occupied houses). There are five groups receiving

* The distinction between Stages I and II is discussed below and, in more detail, in Appendix A.

agricultural income: owners of the four different farm sizes and hired agricultural laborers. Finally, government workers receive a wage that is based on the average wage of clerical workers and is thus not determined in a competitive labor market.

Distribution of income by the economically active. In the previous step, the model generates the average incomes of 15 different occupational groups. We assume that the distribution of income within each of these groups is represented by a two-parameter lognormal distribution. All of the log means and about half of the log variances are calculated from the income data that the model generates endogenously. For those groups for which the model generates only an average income, the log variance is specified exogenously. The overall income distribution by individual income recipients is generated by summing the 15 separate lognormal distributions. Note that the overall distribution need not be lognormal and, in principle, could have any shape, even bimodal. (See Robinson 1976b for a detailed description of the technique.)

Direct taxes and transfers. The direct taxes are calculated by applying the Korean tax schedules to each type of income. From the distributions, 20 representative earners are generated for each category and the appropriate tax schedule is applied to their incomes. The group tax calculated by this procedure is then corrected for the average collection ratio (which differs by group). In this step transfer payments, some rent, interest, and profit income accruing to groups other than capitalists, and income to individuals in the agricultural sectors from work in the urban sector are also accounted for.

Household formation. The model distinguishes 15 different types of households by the occupation of the head of the household. Each household can have other workers or fractional workers in occupations the same as or different from that of the household head. A special household survey yielded data on the average number of workers in each household and their occupational distribution. Assuming that the occupational distribution and average number of workers by household category remain constant and given data on the total number of workers in each category (which the model generates), it is possible to derive the number of households in each category and their average income. The derivation yields a set of linear equations based on the accounting identity between aggregate occupational income and aggregate household income. The detailed derivation is given in Appendix A.

Distribution of income by households. The household distribution is generated in the same way as the distribution by individuals. The distribution within each household category is assumed to be lognormal with

the mean household incomes being calculated in the previous step. The log variances within household categories are assumed to be the same as the log variances of the corresponding occupational categories.

Household savings and expenditure. Given household incomes, savings are calculated by assuming constant average savings rates (which differ by household category). These savings rates change dynamically in response to changes in the interest rate, inflation, and income. Household demands for money balances are also calculated. Finally, household expenditures on consumer goods are calculated as a function of both income and prices. The expenditure functions differ by household category and are described in detail in Appendix A.

Foreign Trade

Korea is a very open economy, and foreign trade has played a significant role in its development. The addition of foreign trade requires four modifications to the simple model. First, a mechanism for determining exports and imports needs to be specified. The supply equations (10) need to be defined net of exports and imports. Second, tariffs and subsidies that affect revenue must be included in the net-price equations (2). Third, the effect of the world market on domestic prices must be considered. Fourth, the balance of payments and the exchange rate must be included.

Exports have been an important source of economic growth in Korea, and exporting firms have been subject to a large battery of controls on the one hand, and direct and indirect incentives on the other. In the model we capture the mixture of incentives and controls by means of several devices. Quantitative targets for exports are fixed as a share of output for the large exporting sectors and in absolute terms for sectors only insignificantly involved in foreign trade. Whenever targets are fixed in share terms, their imposition affects the output and hiring decisions of exporting firms, since their net price (and thus marginal revenue) is the weighted average of their domestic and foreign prices. Price incentives also affect the export behavior of firms where targets are fixed by shares. There is the usual battery of direct and indirect unit price subsidies, which are considered by including them explicitly in the net-price equations. In addition, some exporters have been modeled as monopolists who, with government sanction, charge monopoly prices in the protected domestic market.

There are two kinds of imports. Noncompetitive imports are assumed to be a proportion of domestic production calculated with fixed coefficients. Competitive imports are differentiated by sector and use (intermediate, consumer, and investment); except for sectors in which the domestic price is tied to the world price (discussed below), they are

calculated with import coefficient matrices. Tariffs in Korea are ad valorem and, in the model, are included in the net-price equations.

With respect to the relationship between the world market and the domestic market, the model distinguishes between two kinds of traded goods. First, there are those goods whose prices are determined in the domestic markets. For these goods, exports and imports are determined by targets or coefficients, as noted above, and the domestic prices are determined by market clearing in the domestic markets. Tariffs or subsidies are determined residually as the difference between world prices and market-clearing prices. Second, there are those goods whose domestic prices are set by world prices plus fixed tariffs or subsidies. Domestic supplies and demands are calculated at the fixed prices, and exports or imports are determined residually so that the domestic market clears. For these goods, exports and imports are not calculated by fixed targets or coefficients. Several different experiments were done varying the sectors included in each classification.

In most of the experiments, the exchange rate is fixed in nominal terms (or varies with the average price level dynamically). Some trade experiments are reported in which the exchange rate either was set in real terms (and so varied with the price level) or was responsive to changes in the balance of payments.

Government

The addition of a government sector adds little complication to the model. The government is essentially another demander of goods and services (entering equation 10), and a transfer mechanism collecting revenues from and making transfers to households and firms (i.e., modifying y^* and p^*). It can also fix some prices, imposing rationing to maintain (10) and provide goods to households (obtaining the goods by imports, taxes in kind, rationing, etc.).

Disaggregation by Firm Size Within Sectors

Since it was found empirically that both wages for the same skill category and returns to capital vary systematically by firm size within each sector, it appeared important *a priori* to model firm sizes within sectors (not only total sectors). This feature of the model added substantially to the data problems of implementing the model and greatly increased the size of the model. It led to some modeling complications as well.

In particular, to avoid each sector tending in equilibrium to concentrate all production in a single firm size—the least-cost size—required some mechanism for fixing either labor or capital before entering the factor-

demand determination process. We chose to fix the firm's capital stock. The demand for capital is therefore not part of equation (6). The rental for capital is determined residually, after payment to other factors. In the labor-demand equations determined by the first-order conditions, w_λ is replaced by $w_{is\lambda}$ (i.e., varies by firm size and sector). Ratios of $w_{is\lambda}$ to the base wage, w_λ, are set for Stage II and updated in Stage III.

Monopoly

The amendment of the model to include monopoly behavior is quite simple. It requires only amending the factor-demand equation. The maximizing of other types of objective functions (e.g., net revenue) also impinges solely on this equation and would therefore be easy to introduce into the model.

Special Sectors

For the manufacturing sectors, we assume that the production technology can be described by neoclassical production functions, either Cobb-Douglas or two-level Constant Elasticity of Substitution (CES), and that firms behave so as to maximize profits. For certain sectors, these assumptions seem quite unrealistic as a description of actual behavior. Thus, to achieve greater realism, several special features were introduced in the treatment of the agricultural sectors, the service sectors, and the self-employed firms in all sectors.

The agricultural sectors. The agricultural production functions are assumed to be CES functions with decreasing returns to scale in capital and labor only. Land is included in the production functions (which have constant returns to scale in all factors) as part of the overall productivity term, but is fixed in Stage II. There are land transfers in Stage III as part of the migration model. Farmers are assumed to behave so as to maximize their net returns (since they own their own capital) subject to some constraints in the agricultural labor market. The agricultural labor market is completely separated from the urban labor market in the Stage II model; migration is separately modeled in Stage III.

There are two categories of agricultural labor: family workers, who may not move from their farms during the period; and hired workers, who are mobile within the agricultural sectors. There are also assumed to be upper limits on the hiring of labor by different farm sizes, so each farm is assumed to maximize net revenue subject to minimum and maximum hiring constraints. Market equilibrium occurs when all nonfamily labor is hired. When equilibrium is reached, it is entirely possible that family workers are not earning their marginal revenue products.

TABLE 3
Behavioral Rules for Service Sectors

Sector	Production function	Output rule	Employment rule
21 Construction	Fixed X/L	Supply function	Fixed L/X
22 Electricity and water	None	Supply function	Fixed L/K
23 Real estate	Fixed X/K	Fixed X/K	Fixed L/K
24 Transportation and communications	None	Supply function	Fixed L/K
25 Trade and banking	None	Supply function	Fixed L/X
26 Education	Fixed X/L	Supply function	Fixed L/X
27 Medical services	Fixed X/L	Supply function	Fixed L/X
28 Other services	Fixed X/L	Supply function	Fixed L/X
29 Personal services	Neoclassical	Profit maximization	Profit maximization

NOTE: X is output, L, labor, K, capital.

The service sectors. Very little is known about the technical and behavioral relationships in the service sectors, even in developed countries. From what we do know, however, the standard forms of the production function do not appear to be appropriate. We have assumed that the service sectors (with the exception of personal services) behave according to fairly simple rules in setting their output and employment and also are constrained by a very simple production technology. Their behavior is not based on marginal productivity calculations. The various behavioral rules for the individual sectors are presented in Table 3.

There are three types of production relationships: fixed output-capital ratio; fixed output-labor ratio; and no fixed functional relationship between output and employment. The third type of relationship is used for sectors in which increased measured output is assumed to be achieved either by reduced quality or by increased effort on the part of current employees.

In general, the output of the service sectors is assumed to vary relative to the last period's output as a function of the price of their output relative to the average price level in the non-service sectors. The exceptions are personal services (which has a neoclassical production function and behaves as a profit maximizer) and housing (whose output is a function only of its capital stock and so is fixed in Stage II).

Employment by skill types is set either by fixed labor-output ratios or by fixed labor-capital ratios. In the trade and banking sector employment is not completely independent of output; there is a fixed labor-output ratio only up to a limit, beyond which output can expand independently of employment. Furthermore, the self-employed trade sector is a residual employer and absorbs any of the self-employed category not employed

in the other nonagricultural sectors. Wages in the service sectors (except for personal services) are assumed to have a fixed relationship to the average wages of the appropriate skill categories in the non-service sectors.

The self-employed. The first firm size in the nonagricultural sectors consists of the self-employed. Self-employed firms are assumed not to compete for labor with any other firm sizes. Except for the service sectors, employment in the self-employed firms is fixed in Stage II. In the service sectors, aggregate self-employment is fixed with the trade sector serving as an employment sink.

The self-employed sectors are virtually locked-in in Stage II. This was done essentially to ensure realism. In a given period, one assumes that self-employed labor would not be mobile across different sectors—cab-drivers do not readily convert to shopkeeping or shirtmaking. The movement between the self-employed category in general and the other skill categories (and agriculture) is handled in Stage III of the dynamic model.

Wages in the self-employed sectors are set equal to the marginal revenue product of labor, exactly as in the other sectors. The average wage is calculated as a side equation since it does not affect labor allocation. Profits are defined residually after payments to all other factors.

THE DYNAMIC MODEL

To make the simple model dynamic requires the specification of intertemporal linkages. As noted in Chapter 1, the model is decomposed temporally so that each period can be solved independently with a separate set of models providing the intertemporal linkages. The Stage I model determines investment expenditure by sectors and firm sizes, and so precedes the Stage II static model. All other intertemporal submodels are gathered together in Stage III. These include a migration submodel, various expectation functions, population growth, education, technological change, policy regimes, and so forth. In general Stage III provides all the exogenous variables required for the solution of the Stage I and Stage II models for the next period.

Stage I: The Investment Model

The model of investment used here combines "real" and "financial" views of investment. Firms are assumed to have expectations concerning demand for their output, prices, and wages. Given these expectations, they demand credit for two purposes: to have sufficient working capital, and to increase their fixed capital stock. Their demand for working capital is a simple function of their expected sales and of the interest rate. Their

demand for fixed capital arises from their expectations and the assumption of profit-maximizing behavior. Given expected demand, prices, and wages, firms seek to buy capital so as to minimize the cost of producing the expected output. Their total demand for investable funds equals the sum of their demands for fixed and working capital.

The realization of the demands for investable funds depends on retained earnings and on the workings of the loanable funds markets. The Stage I model explicitly simulates these markets and determines credit allocations and interest rates. There are two loanable funds markets operating in the model: a banking sector, and the non-banking, unorganized money market, or curb market. These two markets are not entirely segmented. In any given period there are five sources of funds: accumulated earnings from the previous period; household savings; foreign capital inflow; government savings; and the financial sector. The first two sources can be funneled through either the banking system or the curb market, depending on excess demand and interest rate differentials between the two markets.

The financial sector in Stage I can affect the aggregate supply of funds through different credit expansion mechanisms. In the form of the model we call finance minister 1, we specify the absolute cost of new capital by firm size and sector and allow firms to "buy" as much as they wish at the set prices subject to "credit-worthiness" constraints. The aggregate supply of loanable funds by banks is then whatever is needed to satisfy the constrained demand. The curb market takes up some of the slack by offering to lend at a specified higher interest rate to those firms that were unable to borrow as much as they wished from the banking sector. Conversely, if there are any excess, unloaned funds in the organized market, they are assumed to flow, at least in part, to the unorganized sector.

In the second form of the model (finance minister 2) a fixed supply of loanable funds by banks is specified (from Stage III of the previous period), and the cost of new investment capital adjusts to equate the aggregate demand for loanable funds from the organized market with the fixed supply. The rate also adjusts independently in the curb market to clear that market, except that there is a lower bound on the rate differential between the two markets. If the rate in the curb market hits the lower bound, then it is assumed that any excess supply is held as idle balances.

The credit-worthiness of firms represents constraints on the ability of firms to borrow both domestic and foreign funds. The constraints are expressed as minimum self-financing ratios. In general an important role of the curb market is to permit a firm to relax its credit-worthiness constraint, and so borrow additional funds at a higher cost.

Once allocations of investment funds are made in this stage, we assume that firms carry out their investment plans in nominal terms for the period, regardless of whether or not their expectations are realized. Of course they may modify their expectations for the next period. There are two sources of discrepancy between expectations and realizations: the forecasts of sales may be incorrect, or the anticipations of prices may not be realized. In particular, the translation of demands for increases in fixed capital into demands for credit in Stage I is based on an expected price of capital goods. In Stage II the prices of capital goods that underlay the firm's demand for capital in Stage I may not be as expected, and so the firm will receive less (or more) physical capital for its money than expected.

Stage III Model

In general Stage III ages the model economy and generates the values of the dynamically updated variables required for the solution of Stages I and II. The most important behavioral submodel, the one determining migration, is discussed below. The other components of Stage III are relatively straightforward. Four general principles are used in updating variables: simple accounting, such as the updating of capital stocks given investment, depreciation, and gestation lags; the use of historical values of some exogenous variables for the early periods when such data are available; projections based on the previous period model solution; and projections independent of the model solution. A complete list of variables and a description of the techniques used to update them are given in Appendix C.

Productivity parameters are updated by assuming an exponential rate of growth that varies by sector and firm size. The exchange rate follows the historical values for three periods and then is a function of the inflation rate. Exports and imports are projected to grow at smoothly declining rates, with exports growing more rapidly. Government expenditure and employment are assumed to grow at constant rates. Household average saving rates are assumed to be an increasing function of the interest rate and income.

Several variables are required as input for Stage I. The investable internal funds available to firms are updated by simple accounting and the retained earnings from Stage II. The government allocates new foreign exchange to firms based largely on their export performance. The expected output of firms is based on the last period's output, expected sectoral growth, and an adjustment of expected market share by firm size as a function of realized relative profitability last period. The expected infla-

tion rate is based on the historical rate, but is applied to the actual Stage II average price level in each period. Expected wages and relative prices are assumed to equal the solution values in the previous period.

Migration. In Stage III migration is modeled explicitly as a function of urban-rural wage differentials. Migrants are assumed to come from the landless and the first two farm sizes, and to go into the three urban labor categories (skilled workers, apprentices, and unskilled workers). Though there is no direct migration into the self-employed categories, there are some implicit transfers because there is movement between the self-employed and other categories as a function of wage differentials. There is also some relative reshuffling of labor among urban categories as a function of wage differentials that is concomitant with migration.

Within the agricultural sector there is assumed to be a migration elasticity with respect to the differential between rural income and the average wage of the three urban categories. In addition, there is an upper limit on the amount of migration for each of the three rural migrating groups. This limit was usually set at 2 percent a year, but was increased in some experiments. The land of those migrants who owned land is assumed to be distributed to the two largest landowning groups. This is done by adjusting the productivity parameters in the production functions for both the recipient and donor farm sizes. This procedure is described in detail in Appendix C.

Intertemporal equilibrium. The dynamic path of the economy is determined by repeatedly solving Stages I, II, and III in order. The full dynamic model is an equilibrium model only in a limited sense. Its solution is not Pareto efficient in either the static or the dynamic sense. Efficiency in any one period could be improved by solving Stages I and II together, and achieving intertemporal efficiency would require a much more complex linking of the models over time than is provided by Stage III.

As noted, the model represents a kind of "lurching equilibrium." In a given period Stage II finds a market-clearing equilibrium subject to a number of constraints on factor mobility. The Stage I model and some of the parts of Stage III incorporate the movement of factors in response to the differential wages and profits that emerged from the Stage II solution. Thus, for example, in Stage I firms with higher profits will invest more than others, both because they will desire more capital and because, given larger retained earnings, they will be less constrained in the loanable funds markets. And in Stage III, as we have said, migration is modeled as a response to rural-urban income differentials, and there is also some mobility among urban labor categories as a function of wage differentials.

Over time, the model should move toward an intertemporally efficient equilibrium path. However, given differential rates of technological change, educational growth, and labor force growth, there is no reason to expect the economy to reach some efficient path. We feel that this approach represents a more realistic description of real-world dynamics than would be provided by an intertemporally efficient equilibrium growth model requiring perfect foresight by all economic agents.*

The dynamic model explicitly attempts to incorporate realistic "laws of motion" of the economy, and thus requires the specification of market rigidities and disequilibrium behavior. A full-equilibrium model is far easier to specify (though perhaps harder to solve). A model such as ours must start from the equilibrium conditions and then must specify what constraints operate, how expectations are formed, and how economic actors react to past disequilibria and unrealized expectations.† It seems to us that we ought to proceed further in the "lurching equilibrium" direction and shift away from the traditional exclusive preoccupation of neoclassical economists with equilibrium models.

* For an elegant specification and solution of an intertemporally efficient planning model, see Dervis 1975.

† For some thoughts on the dynamics of a long-run model of a developing country, see Robinson 1976a. Fair (1975) has developed a model of the United States incorporating a number of interesting disequilibrium adjustment features.

CHAPTER THREE

The Economy of Korea

THE MODEL PRESENTED in this book is not completely general. It is based on data from Korea, and so reflects certain institutional and economic characteristics that are specifically Korean. In this chapter we broadly survey the course of post–World War II economic development in Korea, focusing especially on the relationship between economic growth and income distribution. But before we discuss these postwar developments, let us set the stage with a brief look at colonial and pre-colonial Korean society.

Thanks to traditional isolationist policies, Korea entered the twentieth century as a remarkably homogeneous society with no significant ethnic minorities, no distinct military or bureaucratic classes, and no important divisive political loyalties.* It was also a remarkably fluid society, a historic characteristic that was accentuated by the general leveling process imposed by Japanese colonial rule. By the time of independence (1945) the Japanese system of government based on cooperation and merit had substantially weakened the demarcations between the social classes; even the landowning class was by then composed primarily of minor functionaries and low-ranking aristocrats. Further, as a result of Japanese colonial policies and the Koreans' own traditional drive for learning, both the general level of education and the degree of aspiration for education were unusually high for a country at Korea's level of economic development. By 1944 approximately 50 percent of the Korean children were receiving primary education, and every township had at least one primary school. Moreover, according to the census, the country had a national literacy rate of 22 percent (Henderson 1968 : 89; Cole and Lyman 1971 : 66).

* For a discussion of pre-twentieth-century Korea, see Hatada 1969; and Henderson 1968.

THE STATIC ASSET REDISTRIBUTION PHASE, 1945–1952

In the first postwar decade, years that saw the end of colonial rule, partition, and a new war, Korea underwent massive social and economic changes. The changes included substantial land reform, a significant leveling in the ownership of other forms of physical capital, and hence a major redistribution of wealth.

Land Reform

At independence and partition, the Republic of Korea was primarily an agricultural country, with three quarters of its population engaged in farming.* For the bulk of this population farming meant tenancy. More than two-thirds of the farm families were full-time tenants, and most of the others were part-time tenants; together they accounted for fully 94 percent of the rural population (Hatada 1969: 127). Subjected to exorbitant rents varying from 50 percent to 90 percent of the crop, most rural Koreans lived in abject poverty (Henderson 1968: 156). Hunger was routine, and famine common.†

A first movement toward land reform came in 1947, under American auspices, with the sale of half a million acres of confiscated Japanese lands to more than 700,000 tenant farmers (Pak 1966: 95–96). As a result the full-time tenancy rate was reduced from 70 percent to 33 percent by 1948. A law imposing a 33 percent ceiling on rents was also enacted and enforced, vastly improving tenancy conditions (Henderson 1968: 156).

Following on this there was a purely domestic land reform, redistributing Korean landlord holdings to tenants, which was adopted in 1950 after protracted wrangling in the Assembly. This program was stimulated by a combination of pressures: the demonstration effect of the North's land reform several years earlier: the traditional Korean egalitarian ideology, reinforced by both Western and Communist influences; and not least the widespread feeling against the legitimacy of large landholdings, both because of anti-prosperity principles in Confucianism and because of the collaborationist taint attached to landlordism, which had increased enormously during Japanese rule. With this reform, in which

* Henderson 1968: 75. In 1939 industrial output had accounted for 39 percent of the total output in Korea, but virtually all of the heavy industrial activity was centered in the north.

† Indeed, in 1934 the Japanese Governor General estimated that every spring saw about half of the Korean farmers scouring the countryside for bark and grass to eat (Hatada 1969: 126).

the government took over landlords' properties with nominal compensation and distributed the land to some 900,000 farm households, tenancy was virtually eliminated, and a structure of very small owner-operated farms was established. A limit of three *cheongbo* (roughly three hectares of paddy land) was imposed, but few households (less than 1 percent) in fact reached that limit (see Table 4). Indeed, in 1956 about 72 percent of all farm households were in the submarginal category (possessing less than one cheongbo), and the figure has since increased to 79 percent (in 1970).

Thus, though the second land reform set the sociopolitical conditions for the egalitarian growth of rural incomes, it also exacerbated the problems of low income and low productivity on the farm by fragmenting the countryside and drastically increasing the number of submarginal farms.

Other Physical Assets

Since Japan had monopolized virtually all entrepreneurial activity in Korea during the colonial period, the country was not characterized by great inequalities of wealth at independence. Moreover, what Korean fortunes existed in the South in 1945 were rapidly eroded by the economic dislocations and social turmoil of the partition: the disruption of commercial and other economic networks; the loss to the North of all heavy industry and major coal deposits, and almost all electric power generating capacity; rampant inflation; a wave of crimes against property; and the influx of more than 1.5 million refugees from the North (Henderson 1968: 139).

The Korean War repeated the process of the wholesale redistribution of capital and leveling of wealth. The war took the lives of more than 1.3 million Koreans and caused an estimated two billion dollars in property damage (Cole and Lyman 1971: 22). Agricultural output dropped 27 percent between 1949 and 1952, and GNP 16 percent. Prices rose 500 percent in 1951 and another 100 percent in 1952. In addition, the war had a profound impact on Korean society, obliterating social distinctions and disrupting social networks (Lee 1968: 55). The estimate that 25 percent of the population roamed the countryside as refugees for about two years suggests the magnitude of the disruption.

THE DYNAMIC ASSET REDISTRIBUTION PHASE, 1953–1963

This phase witnessed an educational explosion of major proportions. Economically, the decade can be divided into three periods characterized by reconstruction, 1953–58; import substitution and stagnation, 1958–62;

TABLE 4

Distribution of Cultivated Land by Size in Cheongbo, Republic of Korea, 1956, 1964, and 1970

Size	1956			1964			1970		
	Percent households	Percent area	Average farm size (*cheongbo*)	Percent households	Percent area	Average farm size (*cheongbo*)	Percent households	Percent area	Average farm size (*cheongbo*)
Less than .3	19.0%	5.1%	.27	19.1%	5.8%	.23	19.4%	3.4%	.19
.3– .49	20.9	10.0	.44	23.7	11.8	.42	21.4	8.0	.41
.5– .99	31.9	28.3	.83	30.7	28.5	.79	39.2	26.7	.75
1.0–1.99	21.5	36.8	1.59	20.4	36.3	1.52	32.4	40.8	1.37
2.0–2.99	6.1	17.0	2.50	5.7	16.0	2.52	6.4	13.9	2.41
3.0 or more	.6	2.8	3.71	.4	1.6	3.86	.2	7.1	4.10

NOTE: 1 cheongbo = 2.45 acres, or about 1 hectare. In our model we have aggregated the six size categories into four; they are defined in Appendix D, Table D.3.

SOURCE: Government of the Republic of Korea, Ministry of Agriculture and Forestry, *Yearbook of Agriculture and Forestry Statistics*, 1968 and 1971 (Seoul, 1969, 1972).

and a good harvest (1963). Politically, the period was one of high centralization under President Syngman Rhee, coupled with widespread corruption and rising student-led political unrest.

The Expansion of Education

By long-standing tradition education in Korea has been the major path to social status and position in the bureaucracy. The Japanese broke the pattern of Confucian schools but increased secular education dramatically, especially at lower levels, and reinforced the mobility-generating role of education by establishing educational performance as the sole means of entry into the bureaucratic elite.

Between 1953 and 1963 Korea's literacy rate rose from 30 percent to over 80 percent. Universal primary education became the rule in the countryside as well as in cities. Secondary and higher education also grew rapidly, to the point where by 1964 the country, with a per capita income of about $100, had one in every 280 citizens in college. In strictly economic terms, the Korean investment in human capital formation was enormous: between 1954 and 1964 the value-added in education averaged 3.7 percent of GNP, 33 percent of fixed capital formation, and 86 percent of non-defense government expenditures. As a result by 1965 Korea's human-resource development had exceeded the norm for a country with three times its median per capita GNP (Harbison and Myers 1964: 31–48).

The dramatic expansion of education was due only in part to government policy. Indeed, in the early 1960's a major policy goal of the government was to reduce college enrollments by one-third. The primary impetus for the expansion of education came from parents, who saw in education a necessary (though, alas, not a sufficient) condition for the social (and to a much lesser extent, economic) advancement of their children. A contemporary observation, which still holds to a large extent today, likened the financial and educational struggle to enter the best schools to near hysteria (Henderson 1968: 221):

> Many a family borrows beyond conceivable capacity to repay, mortgaging all property, skimping on food and clothing, making desperate sacrifices. The child is driven to almost constant study, and every crucial entrance examination becomes a shattering emotional crisis. Failure to obtain admission to the proper institution occasionally leads to the breakdown of child or mother or even suicide.

At the same time, by the Ministry of Education's estimate 50 percent of all college graduates were unemployed in 1964.* Moreover, Henderson (1968: 223) has estimated that only 5–10 percent of the others found

* The validity of this figure is doubtful, but it was widely believed to be correct, which psychologically is what matters.

suitable (i.e., white-collar) jobs. Despite a tradition against manual labor, in the 1960's college graduates were competing for jobs as municipal streetsweepers in Seoul, and some even signed up to mine coal in the Ruhr.

In the circumstances it is not surprising that students were in the vanguard of political protest. Their discontent was "made more dangerous by the tradition of student demonstrations, protest, and guardianship of imported values that has disturbed Korean politics for over four hundred years" (Henderson 1968: 171). Indeed, it was a student revolt that led to the toppling of the Rhee regime in 1960, and the next year there were some 2,000 student demonstrations, an average of more than five a day (Cole and Lyman 1971: 32).

The Economy

The economic recovery that marked the first part of this period saw an annual growth rate of GNP of approximately 5.5 percent and major investment in manufacturing and social overhead, financed by United States foreign assistance.* No attempt was made to install heavy industry in the South to compensate for the losses to the North. Instead, the industrialization effort started toward the end of the reconstruction period turned on import substitution centering on the development of nondurable consumer goods industries and their intermediate inputs. By 1960 opportunities for further import substitution in such industries had been virtually exhausted, with imports by then accounting for less than 10 percent of domestic consumption.

Once the import-substitution process in nondurable consumer goods was completed, production in these industries did not offer opportunities for future rapid growth. In addition, the rapid rate of inflation in the preceding years (averaging 30 percent annually in 1953–58) had led to a tight monetary and fiscal policy, which reduced the rates of growth of both consumption and investment. Foreign assistance was also reduced, leading to balance of payments difficulties, the strict rationing of exchange, shortages of imported raw materials, and increasing excess industrial capacity.† The overall result was stagnation in the years 1958–62, during which per capita GNP was essentially constant.

By 1964 the country had to choose between carrying import substitution further to intermediate and heavy industries (the capital-intensive path adopted by most other economies) and emphasizing export expan-

* The discussion in this section is based on Cole and Lyman 1971: 123–29; and Balassa 1970.

† Being poor in natural resources, Korea is highly dependent on imports for intermediate inputs; the import content of manufacturing in the 1960 input-output table was 27 percent.

sion in labor-intensive consumer nondurables. Because the second strategy offered the most rapid growth prospects consistent with Korea's comparative advantages in labor skills, the government chose to follow that path.

THE REDISTRIBUTED-ASSET VALUE-REALIZATION PHASE, 1964–

By redistributing assets and opportunities for asset accumulation, the first two phases of Korean development set the stage not only for economic growth, but, if desired, for egalitarian economic growth as well.* Assuming such equitable growth was wanted, what was required next was a set of policies that would create favorable markets for the redistributed assets or for their services, or both—in other words a set of policies that would lead to rapid labor- and skill-intensive growth.

The requisite policies were initiated in 1964, with the government's effort to reorient the country's general development strategy from import substitution to export expansion. That strategy, we should note, was chosen primarily out of purely economic growth considerations, which is to say, the favorable equity consequences, though now welcome, were not recognized at the time.

Before we look at those policies, a few words about the politico-economic climate surrounding their adoption. First and foremost, from the start President Chung Hee Park has been strongly committed to "a political strategy emphasizing economic performance" (Cole and Lyman 1971: 86). That commitment to economic development has had two important results, namely, the reorganization and centralization of both budget and planning functions in the Economic Planning Board under a strong Deputy Prime Minister in 1964, and the President's tendency since then to lean heavily on civilian experts for guidance in the management of the economy. Another point to keep in mind is that the government has consistently exercised great control over the economy, both in the direct implementation of economic decisions and in the enforcement of compliance by the private sector. Finally, a not inconsiderable factor in all this is the character of the people themselves. The ambition and drive of the Koreans, frustrated by long years of colonial exploitation, two wars, and a wardship status, should not be underestimated.

The System of Incentives

Two important changes in economic incentives were introduced in late 1964 and early 1965. The first (the interest rate reform) had the effect of dramatically altering the wage-to-capital rental ratio; the second (the

* The discussion in this section draws on Adelman 1967; Cole and Lyman 1971: Chaps. 7 and 9; Balassa 1970; and G. Brown 1973.

package of trade incentive reforms) enabled the economy to follow an outward-looking trade policy.* Together they permitted the economy to pursue a growth strategy more nearly in line with its true comparative advantage.

The interest rate reform. In early 1965 commercial bank interest rates for both savings accounts and deposits were doubled, to a nominal level of almost 30 percent (which, by reducing inflation, resulted in about a 20 percent real rate). This meant a sharp increase in the relative rental price of capital. Although there is little evidence that this increase led to the adoption of more labor-intensive technology in existing industries, the labor intensiveness of production on the whole increased substantially because of the resulting emphasis on the expansion of the more labor-intensive sectors.† The interest rate reform also resulted in an increase in savings. Household sector savings (adjusted to eliminate the effects of changes in agricultural inventories) rose from .4 percent of GNP in 1964 to 5.5 percent in 1966 and 6.8 percent in 1970. Part of this increase reflected a shift from other forms of savings, but the overall effect was to increase domestic resources available for investment.

The trade incentive reforms. Before 1960 Korea's system of trade incentives favored import substitution: tariffs and quantitative restrictions afforded substantial protection to domestic import-substitute industries, and in the absence of export subsidies, the overvalued exchange rate imparted a bias against exports.

The government attempted to rectify this situation in 1961 with a 50 percent devaluation and an easing of import restrictions, but the subsequent inflation in 1962–63 substantially nullified the effects. The concurrent balance of payments crisis led to the reimposition of import controls and the reintroduction of multiple exchange rates.

In 1964 the government again devalued the *won* by 50 percent, introduced a battery of export incentives and export promotion mechanisms; and liberalized import restrictions. (See Balassa 1970: 9, for details.) At the same time, it instituted monetary and fiscal policies that succeeded in reducing the rate of inflation.

The major results of the 1964 policy changes were (1) a phenomenally rapid expansion of exports and GNP (at average annual rates of 38 percent and 11 percent in constant prices, respectively, between 1964 and 1970), and (2) a rise in nonfarm employment of 1.6 million, accompanied

* For the best general discussion of the effects of these incentives, see G. Brown 1973. Balassa (1970) provides an excellent analysis of trade incentives.

† Between 1960 and 1968 the ratio of exports to imports increased in six of eight sectors with a below-average capital-output ratio, and decreased in all but one of those with an above-average capital-output ratio (Norton 1971).

by a drop in unemployment from 7.7 percent to 4.5 percent of the labor force (over the same period). (See G. Brown 1973 for a full discussion of these results.) Virtually all the increases in exports were in labor-intensive industries.* Indeed, between 1966 and 1970 nearly one-half of the increase in the labor force (or some 320,000 persons) was absorbed directly in export-related employment.† This large labor absorption occurred despite some evidence that between 1968 and 1970 production in general became more efficient in its use of labor.‡

Effect on the Distribution of Income

There are no acceptable data for the size distribution of income in Korea. The effects of the Korean "redistribution-cum-growth" strategy must therefore be inferred by piecing together the relevant fragmentary evidence. We reconstructed two size distributions of income by using information on distributive shares for 1964 and 1970, together with data on the distribution of wage and salary incomes and agricultural incomes for both dates (see Table 5). The results were cross checked with information from urban and rural household budget surveys, and with data on the distribution of employment.§ They were also subjected to sensitivity analyses concerning reasonable, data-consistent alternative assumptions, and proved largely insensitive to them. The size distributions obtained in this way also reproduce very closely (to within a percentage point for every decile) the size distribution obtained with more detailed and comprehensive data used for estimating the parameters and base period of our model. The base period for our model is 1968, whereas the data here refer to the years 1964 and 1970.

It should first be noted that the distribution of income in Korea is among the best in the developing world. The results of the time series analysis suggest, in addition, that there was little change in the overall size distribution of income between 1964 and 1970. However, there were changes in composition:

1. The distributions of both agricultural incomes and wage and salary incomes became somewhat more even between the two dates.
2. The gap between average income in agriculture and industry increased between the two dates (from a ratio of 1.4 to a ratio of 2).

* Five commodities accounted for 86 percent of the increase in exports. These ranked 1–3 and 5–6 in terms of the magnitude of their direct labor-output coefficients in the 1970 input-output table.

† The direct and indirect labor absorption was naturally greater.

‡ 1970 direct labor-output coefficients applied to 1968 production understate 1968 employment by nearly 20 percent.

§ The techniques used are explained in detail in Morrisson 1972. See also Renaud 1976.

TABLE 5

Distribution of Categories of Revenue by Households, Republic of Korea, 1964 and 1970

Percent

Decile	1964					1970				
	Wages and salary	Self-employment		Property income	All income	Wages and salary	Self-employment		Property income	All income
		Agriculture	Nonagriculture				Agriculture	Nonagriculture		
1	2%	4%	4%	1%	3%	2%	5%	4%	1%	3%
2	4	5	4.5	2	4	3.5	5.5	4.5	2	4
3	4.5	6	5	3	5	4.5	6	5	3	5
4	5.5	7	5.5	4	6	6	7	5.5	4	6
5	7	8	6	5	7	7	8	6	5	7
6	9	9	7	7	8	9	10	7	7	8
7	10	10	8	8	10	11	11	8	8	11
8	13	12	12	10	12	13	12.5	12	10	12
9	17	16	14	15	16	16	15	14	15	15
10	28	23	34	45	29	28	20	34	45	29

NOTE: These decile distributions have been estimated in a different manner (based on less data) from the 1968 distribution used as part of the base year of our model. See Chapter 4.

SOURCES:

Wages and salaries. Bank of Korea, *Report on Wage Survey, 1967* (Seoul, 1968), p. 43; *ibid., 1970, Summaries* (Seoul, 1971), 1: 122; 2: 220.

Self-employment in agriculture. Government of the Republic of Korea, Ministry of Agriculture and Forestry, *Yearbook of Agriculture and Forestry Statistics, 1968* (Seoul, 1969), Table 16; *1971* (Seoul, 1972), Table 122.

Self-employment in nonagricultural sectors and property income. Distributed according to the curve suggested in C. Morrisson, "Korea." Consultant report prepared for the Development Research Center of the World Bank, Washington, D.C., Aug. 1972. (Mimeo.)

3. The relative share of the most unequally distributed component of overall income, property income, rose 33 percent; at the same time, however, the share of wage and salary income increased 40 percent and the share of agricultural income dropped 32 percent.

The processes implicit in all these changes are consistent with the U-shaped hypothesis concerning the relation between the equality of the distribution of income and the development process. They are indicative of how the upturn in the U-shape can take place during the last phases of the development process, provided the appropriate economic strategies are followed and the right preconditions established. (For a discussion of these points, see Adelman 1975.)

Since the relative distribution of income remained essentially unchanged during the rapid growth phase of the Korean economy, the money incomes of the poorest 20 percent of the households rose 333 percent and their real incomes more than doubled. Between 1964 and 1970 the real wage rates of production workers in manufacturing rose more than 85 percent and those of wage earners in agriculture doubled. The real incomes of the poorest quintile of farm households increased 150 percent. These wage changes were the result of market forces, since the unionization of labor played no role; however, agricultural incomes rose in part due to the government's fixing of a high price for rice.

CONCLUSION

There is little question that the post–World War II economic history of Korea resulted in a development process that not only benefited upper and middle income groups, but also substantially raised the welfare of the poorest members of society. It is our belief that all three phases of the process described, as well as the sequence in which they occurred, were necessary to achieve the above results (as discussed in Adelman 1975). The study of the Korean experience should thus offer hints for selective and careful generalization to other developing nations.

CHAPTER FOUR

Data, Model Estimation, and Validation

CLEARLY, THE DATA requirements for a model as comprehensive and complex as ours are substantial. What created the most serious data problems, however, was not the fact that the model solves for prices and wages endogenously, but rather, the model's special focus on questions of income distribution. A simpler version of a price- and wage-endogenous model that does not require disaggregation by firm size and household types can be implemented with virtually the same data set as is required for a usual input-output or linear programming model incorporating labor force information. As is evident from the simple model discussed in Chapter 2, the minimum data requirements for a price-endogenous model are a set of input-output accounts including value-added rows; labor force information; final capital coefficients; start-up data on labor force and capital stocks; and expenditure data for the demand equations.

The major complications in our model arose because current accounting frameworks are not oriented toward providing the data base for studying distributional issues. Neither on the production side nor on the consumption side are the necessary integrated sets of accounts collected. Indeed, the accounts as currently gathered are not even defined in terms that permit such integration. (See Pyatt and Thorbecke 1976.) At the moment, serious analysts of distributional issues must themselves go through a process of revising and piecing together disparate data sets, with all the concomitant problems of reconciliation. (See, e.g., Fishlow 1972; Pyatt and Thorbecke 1976.)

DATA

The process of data gathering and manipulation that was required for our model is summarized in Table 6. The variables are listed in the order in which they are taken up in the model discussion in Appendix A; and the variable symbols are those used in the equations.

The basic principle we followed was to reconcile all data sources to the 1968 input-output accounts. In general this involved two kinds of procedures. First, sectoral compositions were derived from a number of subsidiary sources and adjusted to match the input-output totals. Second, where matrices were involved and both column and row sums had to be reconciled, an iterative adjustment procedure was used. This was done for the capital coefficient matrix and the matrix of consumption shares (by goods and households). Here we started with row sums and adjusted the row entries proportionately so that their weighted sum matched row totals known exogenously. Next, column sums were checked for their deviations from pre-specified totals. For both the capital coefficient matrix and the consumption shares, column sums had to equal unity. Column entries were adjusted proportionately to achieve the required sum. The iterations went back and forth between columns and rows until convergence was achieved (this generally happened in four to six iterations).*

For a number of variables, the input-output accounts were not the base for reconciliation either because the relevant data were not part of the input-output accounts or because the accounting conventions of the national income accounts were considered to be more relevant to behavior. Variables in the first category are obvious from the table. Variables in the second category reflect the distribution practices of firms with respect to various forms of return to capital: rent, dividends, interest payments, and depreciation. In these cases, totals were reconciled to the national income accounts.

Not counting the basic data gathering and its transcription into machine readable form, the reconciliation of the data required about one man-year of work. It is impossible for us to estimate the manpower required for basic data gathering and transcription because, except for two surveys, we obtained our data from ongoing statistical studies made by agencies of the Korean government.

Where we ran into the most serious problems was in the areas of employment ($L_{is\lambda}$), export prices (P_i^e), and household formation. In employment the major difficulty arose in accounting for the self-employed and allocating them by sector. Originally, we had intended to have only three firm sizes. However, even in manufacturing the self-employed were so important that they had to be treated separately. The government's employment survey, which collected data from establishments with 10 or more workers, omitted the self-employed. On the other hand, its survey of the economically active population, which was based on information

* This technique is a version of the RAS method. See Bacharach 1970: 4.

TABLE 6

Summary of the Data-Gathering and Manipulation Procedures Used in the Model

Symbol	Variable[a]	Source	Procedures	Code[b]
		PART I: FACTOR MARKETS		
Capital stock by firms				
K_{is}	Capital stocks (S,F)	(1) Han Kee Chun 1970 (2) *Manufacturing Census* (3) *Financial Survey* (tape)	Sectoral capital stocks from (1); (2) and (3) used to allocate by F	(3,3)
p_i	Product prices (S)	(1) I-O accounts (*Interindustry Relations Tables*)	Input-output table defines units so all prices are 1.0 in base year	(0,0)
Z_{is}	Investment expenditure (S,F)	(1) *Manufacturing Census* (2) *Financial Survey* (tape) (3) I-O accounts (4) National accounts (*National Income Statistics Yearbook*)	Basic data from (1) and (2) reconciled; totals reconciled to total by sector of destination from (4) and sector of origin from (3)	(3,3)
Z_i^r	Investment goods demand (S)	(1) I-O accounts		(0,0)
Production functions				
X_{is}	Production (S,F)	(1) I-O accounts (2) *Manufacturing Census*	Sectoral totals from (1); composition from (2)	(1,2)
$L_{is\lambda}$	Employment (S,F,L)	(1) I-O accounts (2) *Employment Survey* (tape) (3) *Survey of Economically Active*	Sectoral totals from (1); allocated by F, S, and L from (2); reconciled to (3)	(3,3)
Profits				
$\bar{E}_{is}$	Export targets (S,F)	(1) I-O accounts	Sectoral totals from (1); size allocation by production shares	(1,1)
$W_{is\lambda}$	Wages (S,F,L)	(1) *Employment Survey* (tape) (2) *Wage Survey* (3) I-O accounts	Basic data from (1) reconciled to (2); both sources with breakdown for S,F,L sectoral wage bills reconciled to (3)	(3,3)

W_{isc}	Profits (S,F)	(1) I-O accounts (2) *Manufacturing Census*	Wage bill by S and F subtracted from value-added by S and F from (2)	(2,1)
$\bar{p}^s$	Exchange rate	(1) *Economic Statistics Yearbook*		(0,0)
p_i^e	Export prices	(1) Westphal and Kim 1974		(1,1)
		PART 2: DEMAND		
The firm sector				
$\bar{r}_{is}^b$	Bank loan interest	(1) *Economic Statistics Yearbook* (2) *Financial Survey* (tape) (3) National accounts (4) Kim Pyung Joo 1975	Market rate from (1); size and sectoral differentials from (2); reconciled to total interest payments from (3); curb-market data from (4)	(2,2)
$\bar{r}_{is}^s$	Foreign loan interest			
$\bar{r}_{is}^c$	Curb-market rate			
$\bar{\beta}_{is}^b$	Share of total loans from banks			
$\bar{\beta}_{ir}^b$	Share of total loans from curb market			
K_{is}^s	Volume of foreign loans			
$\Delta\bar{M}$	Change in money supply	(1) *Economic Statistics Yearbook*	Demand deposits plus currency in circulation	(0,0)
Factors and households				
Factor incomes				
	Rent	(1) Urban household survey (*Family Income Survey*) (2) *Farm Household Survey* (3) I-O accounts (4) National accounts	Imputed and actual rent payments from (1) and (2); totals reconciled to value-added in real estate sector from (3), and to (4)	(2,3)
	Dividends	(1) *Financial Survey* (tape) (2) National accounts	Structure of dividend rates from (1); totals reconciled to (2), maintaining accounting identities for profit income	(2,3)

Table continues overleaf

TABLE 6 (continued)

Summary of the Data-Gathering and Manipulation Procedures Used in the Model

Symbol	Variable[a]	Source	Procedures	Code[b]
Direct taxes and transfers				
	Direct taxes	(1) *Tax Yearbook* (2) National accounts	Tax schedules from (1); reconciled to total collections from (2) by collection ratio	(1,1)
	Transfers	(1) Urban household survey (2) *Farm Household Survey* (3) National accounts	Data used to estimate transfer ratios	(1,1)
Household formation				
H_{ij}	Worker composition of households	(1) Adelman and Robinson 1972	Reconciliation between (1) and (2)	(2,1)
n_i	Number of "other workers" per household	(2) Urban household survey (3) *Farm Household Survey*		
Household savings and expenditure				
Y_h^c	Total expenditures household savings	(1) Adelman and Robinson 1972	Basic structure by household groups from (1), (2), and (3), plus reconciliation; also reconciled to I-O accounts for aggregates by sectors	(3,3)
C_{id}^o	Base-year consumptions	(2) Urban household survey (3) *Farm Household Survey* (4) I-O accounts		
	Trade margins	(1) I-O accounts	Used 1966 accounts that had values in both producers' and purchasers' prices	(1,1)
The government sector				
Z_i^{ex}	Government investment	(1) I-O accounts		(0,0)
G_i^{1968}	Government consumption	(1) I-O accounts		(0,0)
The foreign sector				
M_{is}^{nc}	Noncompetitive imports (S,F)	(1) I-O accounts	Assumed same ratio for all firm sizes in sectors	(0,0)

M_i^c	Competitive imports (S)	(1) I-O accounts		(0,0)
t_i^{cm}	Tariff rates, competitive imports (S)	(1) I-O accounts	Estimated from tariff collection data	(0,0)
$\hat{P}_i^{w,s}$	World prices in dollars	(1) Westphal and Kim 1974		(1,1)
t_i^e	Export subsidies	(1) Westphal and Kim 1974		(1,1)

[a] The letters in parentheses refer to the level of disaggregation. S is sector, F is firm size, L is skill level (for labor).

[b] The first number in the code entry refers to the degree of computational difficulty: 0 = virtually no computation; 1 = desk calculator, several days; 2 = computer, simple program, several days; 3 = computer, involved program, several weeks. The second number refers to the nature of the required data preprocessing: 0 = little or no preprocessing; 1 = error checks only; 2 = error checks and computer sorting of data; 3 = error checks, sorting, and data reconciliation.

SOURCES TO TABLE 6 (includes both works cited here and in Table 7 and supplementary sources used in constructing the model):

Adelman, I., D. C. Cole, R. Norton, and L. K. Jung. "The Korean Sectoral Model," in I. Adelman, ed., *Practical Approaches to Development Planning: Korea's Second Five-Year Plan* (Baltimore, 1969).

Adelman, I., and S. Robinson. "Special Integrated Household Expenditure Employment Survey." (Financed by International Bank for Research and Development, executed by Korea Development Institute, Seoul, Apr. 1972.)

Bank of Korea. *Economic Statistics Yearbook* (various years).

———. *Financial Statements Analysis* (various years).

———. *Financial Statements Analysis Survey*. Tape. (Firm balance sheet and financial flow data; data aggregated by our sector and firm size categories at the Korea Development Institute, Seoul, Apr. 1972.)

———. *Flow of Funds Accounts in Korea: 1963–1970*.

———. *National Income Statistics Yearbook* (various years).

———. *Price Statistics Summary* (various years; covers wholesale prices).

———. *Report on the Compilation of Interindustry Relations Tables for 1968* (Seoul, 1970).

———. *Report on Wage Survey: 1967*, and *Report Wage Survey: 1970* (two vols.); *Report on Wage Survey: 1970, Summary*.

Government of the Republic of Korea, Economic Planning Board. *Annual Report on the Economically Active Population* (various years).

———, ———. *Annual Report on the Family Income and Expenditure Survey* (various years).

———, ———. *Annual Report on the Price Survey* (various years; covers retail and wholesale prices).

———, ———. *Report on Mining and Manufacturing Census* (various years).

———, ———. *The Third Five-Year Economic Development Plan: 1972–1976* (Seoul, 1971).

———, ———. *Wholesale and Retail Trade Census Report: 1968*.

———, Ministry of Agriculture and Forestry. *Report on the Results of the Farm Household Economy Survey and Production Cost Survey of Agricultural Products* (various years).

———, ———. *Yearbook of Agriculture and Forestry Statistics* (various years).

———, Ministry of Labor. *Employment Survey*. Tape. (Establishment data on employment and wages; aggregated by our sector, firm size, and skill categories at the Korea Development Institute, Seoul, Apr. 1972.)

———, Ministry of Science and Technology. *Long-term Manpower Forecast and Development Policy: 1967–1986* (Seoul, 1968).

———, ———. *A Survey on Scientific and Technical Manpower* (various years).

———, ———. *The Third Five-Year Manpower Development Plan: 1972–1976* (Seoul, 1971).

———, Ministry of Transportation. *Statistical Yearbook of Transportation: 1968*.

———, Office of Fisheries. *Yearbook of Fisheries Statistics: 1968*.

———, Office of National Tax Administration. *Statistical Yearbook of National Tax* (various years).

Han Kee Chun. *Estimates of Korean Capital and Inventory Coefficients in 1968* (Seoul, 1970).

Jo Sung Hwan and Seong Yawng Park, eds., *Basic Documents and Selected Papers of Korea's Third Five-Year Economic Development Plan (1972–1976)* (Seoul, 1972).

Kim Kwang Suk. "Household Savings Behavior in Korea," Korea Development Institute Interim Report 7402, Seoul, Feb. 1974.

Kim Pyung Joo. "Does Monetary Policy Work and How: Toward a Model of Monetary Management in Korea," unpublished Ph.D dissertation, Princeton University, 1976.

Korea Development Association. *Basic Studies for Tax Reform in Korea* (Seoul, 1972).

Korea University Business Management Research Center. *Report on Research of Commercial Banking in Korea* (Seoul, 1971).

Lee Seung Yun. *A Study on Price Comparison Between Domestic Producers' Unit Prices and International Prices* (Seoul, 1971).

National Agricultural Cooperative Federation (Seoul). *Agricultural Yearbook* (various years).

Westphal, L. E., and K. S. Kim. "The Inter-Industrial Structure of Policy and Development in Korea," International Bank for Research and Development, Development Research Center, Washington, D.C., 1974. Mimeo.

provided by households, included them. The discrepancy amounted to some 2,000,000 people (out of a total nonagricultural labor force of about 5,000,000). To allocate them by sectors, we used employment data for "sole proprietors" from the 1970 input-output table, and adjusted the totals to match those from the 1968 survey of the economically active population.

Export prices, the second trouble spot, were aggregated from data at the 150-sector detail provided in Westphal and Kim 1974. The gathering of those data, supplying comparisons of world prices and Korean domestic prices on hundreds of carefully defined commodities, was plainly a monumental task.

Virtually all household surveys have the same serious deficiency: they do not provide an integrated picture of households as both consumers and suppliers of factors. It is a problem that is rooted in the fact that household expenditure data are generally gathered by talking to women in the home, whereas employment data are generally collected on men at their place of work. To deal with this problem we carried out a special survey that allowed us (1) to classify housholds by the occupation of the household head in categories consistent with our skill breakdown, and (2) to identify the skill categories and number of "other workers" in the household.

Parameter Estimation

Next to the effort that went into data gathering and reconciliation, the task of estimating the parameters of the model was moderately easy. In part, this is due to the structure of the model. Unlike macro-economic models, our model predicates behavioral relationships on the assumptions of maximizing behavior at the micro-level. We are therefore not required to estimate behavioral relationships, but need only estimate the parameters and constraints that affect those relationships.

The major behavioral relationships requiring estimation are the production functions and the expenditure equations. Most other parameters for Stage II are simply ratios or other point estimates. In Stage III of the dynamic model, however, there are some macro-economic relationships that require the use of time-series regression analysis. For example, the parameters of the money demand and savings equations are assumed to be functions of such variables as the inflation rate and the interest rate.

In Table 7 we have summarized the parameters and the procedures used in their estimation. The table speaks pretty much for itself, but again it is worth mentioning some of the special problems we encountered

TABLE 7

Summary of the Model's Parameters and the Procedures Used to Estimate Them

Symbol	Parameter[a]	Required data or source	Procedures
		PART I: FACTOR MARKETS	
The Firm Sector			
B_{is}	Capital coefficients (F,S)	Han Kee Chun 1970	Coefficients were adjusted so that investment calculated using capital coefficients agreed with actual investment (by sector of origin) from I-O accounts
g_{isr}	Gestation lags (F,S)	Adelman et al. 1969	Based on engineering estimates from Second Five-Year Plan
δ_s	Depreciation rates (S)	Jo and Park 1972	Data from Third Five-Year Plan multisectoral model; reconciled so that total depreciation matched national accounts; only two different rates by size were assumed
Production Functions			
$\bar{A}_{is}$, α_{isc}, $\alpha_{is\lambda}$, γ_{is}, ρ_i, α_{is}	Production function parameters	X_{is}, $L_{is\lambda}$, $W_{is\lambda}$, K_{is}, W_{isc}	Cobb-Douglas parameters based on share data; CES parameters γ_{is} and ρ_i based on international estimates; CES α_{is} based on share data and capital-labor ratios
Profits			
$\hat{A}_{is}$	I-O coefficients	I-O accounts	
μ_{is}	Noncompetitive import coefficients	I-O accounts	Assumed same coefficient for all firm sizes in same sector
θ_i	Indirect tax rates	I-O accounts	
θ_i^e	Export subsidy	Westphal and Kim 1974	Includes all direct subsidies for exporting sectors

[a] The letters in parentheses refer to the level of disaggregation. S is sector, F is firm size.

Table continues overleaf

TABLE 7 (continued)

Summary of the Model's Parameters and the Procedures Used to Estimate Them

Symbol	Parameter	Required data or source	Procedures
Labor Markets			
η_i	Notional price elasticity of demand		Educated guess; applies only to sectors 6, 7, and 8 (textiles; finished textile products; lumber and plywood); tuned to base-year demands
ϕ^s_λ	Labor supply elasticities		Educated guess; varied parametrically; set to zero for most experiments
$\bar{\xi}_\lambda$	Wage ratios for labor supplies	$W_{is\lambda}$, $L_{is\lambda}$	Estimated as ratio of average wage of category λ to that of "base" worker (unskilled)
$\xi_{is\lambda}$	Wage ratios to average for skill categories		See equation (17), Appendix A; estimated with base-year data
		PART 2: DEMAND	
The Firm Sector			
τ^f_{is}	Direct tax rates for firms	*Financial Survey* (tape)	Estimated only average rates, but by F and S; actual schedule is mildly progressive; reconciled with base-year aggregate national accounts
σ^π_{is}	Retained earnings rates	*Financial Survey* (tape)	See equation (20), Appendix A; reconciled to match aggregate corporate savings from national accounts
ζ^f	Firm sector's share of demand for new cash balances	*Economic Statistics Yearbook*	Used an average for three years, 1968–70
$\bar{k}$	Cambridge velocity parameter		Time-series regressions with aggregate quarterly data, 1960–70
Factors and Households			
—	Income distribution parameters, workers and households		Two parameter lognormal distributions were fit for each of the 15 categories of income recipients

—	Savings rates by households	Kim Kwang Suk 1974	Regression estimates using cross-section and time-series data from household surveys and national accounts; two sources were reconciled
ξ_k^h	Share of new money balances held by household categories		Estimated as share of household categories in aggregate household income; $\Sigma_k \xi_k^h$ is total household sector's share of new money holding
η_{iid}^y	Expenditure elasticities	Time series and household surveys	Cross-section and time-series regression analysis; two sources were reconciled
η_{ijd}	Price elasticities of demand		Frisch technique; Frisch parameters estimated from regression analysis
$\hat{Q}_{id}$	Scale parameters, demand functions	C_{id}^o, P_i	Estimated from base-year data; see equation (26), Appendix A
The Government Sector			
S_i^g	Government expenditure shares	I-O accounts	Base-year values
The Foreign Sector			
$\hat{M}_i^{(1)}$, $\hat{M}_i^{(2)}$, $\hat{M}_i^{(3)}$	Import coefficients	I-O accounts	Base-year estimates
		PART 3: MONEY AND PRICES	
ω_i	Price index weights		Equal to base-year sectoral production shares

SOURCES: See Table 6, above. The headings refer to the parts of Appendix A where the equations are presented.

We ran into problems, for example, in setting the production function parameters. At the outset, we tried to estimate production functions by sector and firm size using time-series data. However, the data series were so short (only five years) and so plagued by multicollinearity that the estimates were unusable. Attempts to estimate the change in total productivity yielded widely divergent rates by sector and firm size and were clearly dominated by cyclical phenomena. In the end, the sectoral rates of growth of productivity were estimated by first calculating what the sectoral outputs for 1970 would have been given 1968 technology (production functions) and prices but given 1970 employment and capital stocks. We then calculated the rates of growth of productivity by sectors by comparing these outputs with the actual 1970 sectoral outputs from the 1970 input-output table. There were assumed to be no negative rates of change in productivity.

Our efforts to estimate production functions from cross-section data (not categorized by firm size) by using materials at the Korea Development Institute were not successful. We therefore resorted to the use of share data for estimating Cobb-Douglas production functions with the addition of international estimates of elasticities of substitution for the CES functions. Note that share data suffice for the estimation of the Cobb-Douglas aggregation elasticities in the two-level CES functions. The use of share data for estimating the parameters of the Cobb-Douglas function rests on the assumption of marginal productivity wages and equilibrium in the factor markets. The skill category in our model for which these assumptions are the most questionable is that of the self-employed. However, the production function parameters for the self-employed firms are not very important to the model since employment by that firm size is fixed in Stage II.

To estimate money-demand equations we used quarterly national accounts data for the years 1960 to 1971 inclusive (48 observations). The dependent variable was the Cambridge k, which was defined as the money supply (currency in circulation plus demand deposits) divided by nominal national income. The final estimated regression equation we used is:

$$\begin{aligned} k = {} & \underset{(0.14)}{0.52} - \underset{(0.04)}{0.18}\,\mathrm{RPE} - \underset{(0.002)}{0.01}\,\mathrm{INTD} + \underset{(0.20)}{0.05}\,\mathrm{MON} \\ & + \underset{(0.002)}{0.005}\,\mathrm{T} + \underset{(0.03)}{0.13}\,\mathrm{D1} - \underset{(0.01)}{0.02}\,\mathrm{D2} + \underset{(0.03)}{0.04}\,\mathrm{D3}. \end{aligned}$$

In this equation the variables are:

k Cambridge velocity parameter

RPE	Average inflation rate, a weighted average of the current rate and the rates of the previous three quarters, with each rate computed on an annual basis
INTD	Nominal interest rate on time deposits
MON	Degree of monetization of the economy, defined as the share of nonagricultural production in gross national product
T	Time period
D1, D2, D3	Quarterly seasonal dummies

The equation was estimated using the Cochrane-Orcutt iteration technique for estimating the first-order autocorrelation coefficient, rho. The estimated rho was 0.38 and the R^2 for the equation was 0.91. The numbers in parentheses are standard errors of the estimated coefficients.

We tried several different forms of the equation and also used various techniques for the seasonal adjustment of the data; seasonal dummies worked best. The degree of monetization variable was significant in most of the equations tried, and we did not bother to rerun the final one without it, even though it turned out to be insignificant. In the form of this equation used in Stage III, the dummies were combined into the constant, the coefficient of T was annualized, and the coefficient of MON was assumed to be zero.

To estimate the overall income distribution, we first estimated the income distribution parameters of the 15 socioeconomic groups, as indicated in Table 7, using the lognormal form often used to characterize income distributions. We then summed the 15 income distributions to arrive at the overall distribution, which thus was not constrained to any specific analytic form. We thereby avoided a usual problem of income distribution estimates—that a lognormal overall distribution, which is the simplest distribution to estimate and to use, does not fit the tails of the distribution as well as some other forms, such as the Pareto.

The mean income and the mean of the logarithms of income (the log mean income) for each worker and household category are solved as part of the solution of the Stage II model. The log variances have been set in two different ways. For groups 1 to 7 (engineers, technicians, skilled workers, apprentices, unskilled workers, white-collar workers, and the self-employed in manufacturing), the log variances have been estimated from earnings differentials generated by the model. Given firm size and sector data, there are roughly 80 different observations for each recipient category. There are 20 observations for the manufacturing self-employed group.

The log variances for the remaining groups have been estimated from other data and are exogenous to the model. The log variance for the self-employed in commerce and personal services was estimated from frequency data in the *Wholesale and Retail Trade Census Report*. The log variance for group 8, capitalists, was estimated from frequency data on taxable incomes in the *Statistical Yearbook of National Tax*. Rental income and business income were considered separately. Government employees were assumed to have the same log variance as white-collar workers. The log variances of the five categories of agricultural labor were estimated from frequency data in the *Farm Household Economy Survey*.

We tested the log income data for normality using standard statistics for skewness and kurtosis. For two groups, engineers and, to a lesser extent, apprentices, the values of the test statistics lead one to reject the normality hypothesis. Since these two groups are very small both in number and in share of total income, we decided not to explore fitting some different distribution. Originally, we had not separated the self-employed into two categories. However, the income distribution for the combined group was bimodal. After the group was split, the hypothesis of lognormality could not be rejected for either of the two groups.

The model generates the distribution of income at four different steps:

1. The distribution by the economically active before taxes and transfers.
2. The distribution by the economically active after taxes and before transfers.
3. The distribution by the economically active after taxes and after transfers.
4. The distribution by households after taxes and after transfers.

In each of these steps, we recalculate the mean incomes of the recipient groups but assume the same log variance. In particular, we assume the log variances for the within-household category distributions are the same as the within-worker category distributions.

The demand equations we have chosen require for each demander category estimates of (1) expenditure elasticities for all goods, and (2) the Frisch parameter. (For a full discussion of this procedure, see Appendix A.)

Estimates of expenditure elasticities were obtained in three ways. First, we had the Economic Planning Board's estimated expenditure elasticities based on annual time-series regressions on sectoral consumption. The consumption categories were at the 43-sector input-output

aggregation, and there was no breakdown by different consuming groups. Second, we did cross-section regressions for each of the demander groups using the data gathered from the households in our special survey. There were 1,621 observations in all. The group sizes ranged from about 25 to 200. The expenditure observations covered household spending for one quarter, January–March 1972. We tried a number of regressions involving different functional forms and different sets of independent variables. To test each form required a set of separate regressions for each demander category and each good (about 350 regressions in each set). We finally settled on linear regressions with two independent variables: total expenditure and size of household. After consideration, we left the zero observations (for some goods in some households) in the regressions because in estimating average coefficients no consumption is a valid observation.

Our third set of estimates was based on time-series regressions of average consumption levels by household categories of the various goods. The data came from both urban and farm household surveys. There were nine observations in all, from 1963 through 1971. Several different functional forms were tried, and the independent variables were aggregate consumption and an index of own relative price. The regressions for the agricultural households were differentiated by farm size. The time-series and cross-section data could not be pooled because the definitions of groups were not compatible.

The basic estimates of expenditure elasticities by groups came from the cross-section regressions. These estimates were then adjusted so that when aggregated across groups (weighting appropriately by group consumption shares), the aggregate elasticities for each good equaled the Economic Planning Board's time-series estimate of the aggregate expenditure elasticity for that good. The adjustment required an iterative procedure (described earlier) because expenditure shares within each group had to sum to unity.

The time-series estimates from household survey data were used primarily to estimate own price elasticities of demand for a number of goods for each demander category. These own price elasticities were then used to generate a set of independent estimates of the Frisch parameter for each demander group. (See Frisch 1959; also Johansen 1960.) Our estimate of the Frisch parameter was an average of these separate estimates. In general, they tended to be fairly close, though in a few cases we discarded some extreme observations. In addition, we did not use all the price elasticity estimates for all groups.

Two recent demand studies on Korea (Lluch and Williams 1974; Lysy 1973) have proved most useful in checking our estimates. Lysy's work is particularly valuable in this respect, since he estimated the parameters for the Stone Linear Expenditure System (LES) with essentially the same time-series data from the household expenditure survey we used. One characteristic of the LES is that the Frisch parameter (which we have assumed constant for each demander group) is a function of total expenditure. Using Lysy's estimates of the LES parameters, we calculated the Frisch parameters corresponding to the total expenditures by our demander classes. The estimated parameters agreed fairly closely. Where Lysy estimated the LES parameters for a group that corresponds closely to our definition, we used his estimate of the corresponding Frisch parameter to adjust our own.

MODEL VALIDATION

For any sensible discussion of model validation one must begin by clearly specifying the purpose of the modeling effort, since the uses to which the model will be put determine the relative importance of particular criteria. As we have said, our purpose is to provide a model that can be used as a laboratory for policy experiments. This implies that the model offers a valid analogue to reality, an assumption that requires testing.

In principle, several different approaches to model testing are possible. Figure 4 gives an idealized schematic picture of the modeling process. Validation procedures can be applied at each step. (1) Is the model specification plausible? (2) Is the data base accurate? (3) Were the procedures used to estimate the model parameters technically satisfactory? (4) Is the estimated structure empirically consistent with theory and other estimates (our Bayesian prior)? (5) How closely does model behavior approximate real-world behavior? If one thinks of the model as a black box transforming inputs (exogenous variables) into outputs (endogenous variables), then the first four questions deal with internal validation, and the last one deals with external or output validation.

The first question was addressed in Chapter 2. The model is clearly more plausible theoretically than other multisector planning models and has suffered less from constraints imposed by questions of computational feasibility.

Examining the data base and the statistical estimation procedures is an indirect test of the validity of a model. Presumably, if one knew what the parameters "should" be, one would not care about data or statistical

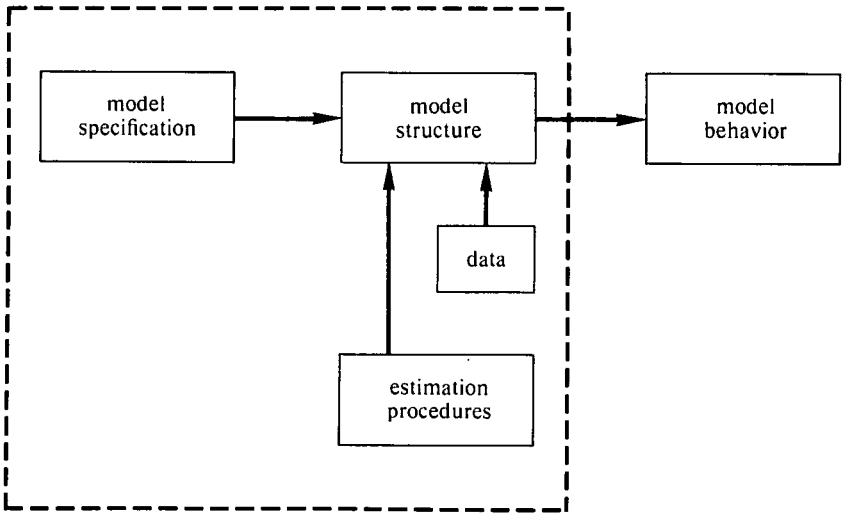

Fig. 4. The Modeling Process

procedures; one would simply insert the "correct" values. Unfortunately, economic theory is never so helpful. In the absence of "correct" values, one cannot help feeling that the use of valid procedures and the best available data offers the best chance of arriving at more or less valid estimates for the parameters. This philosophy dictated our choice of estimation techniques, particularly in view of the circumstance that the available data did not justify the use of the most sophisticated econometric techniques for many of the parameters. As can be seen from Table 7, we have used a wide variety of statistical techniques in estimating the parameters for our model. As in other planning models, many of the parameters are estimated from cross-section data for one year. However, the level of disaggregation by sector and firm size and the frequent use of large samples based on micro-data make our parameter estimates reasonably accurate. The degree of disaggregation and the attention paid to correct behavioral specification should also lessen the impact on average parameter values of certain structural changes that would affect a more aggregated macro-econometric model.

Model behavior is defined as the empirical implications of the model structure, given the input values of exogenous variables. The validation of model behavior is always empirical in nature, but the validation tests can reflect varying degrees of stringency. One might pose these questions,

for example. (1) Given input values, are the solution levels reasonable? (2) Given changes in input values, are the changes in solution values reasonable in sign? (3) Given changes in input values, are the changes in solution values reasonable both in sign and in magnitude?

How one defines reasonable in this context depends on the nature of the input values and on the degree of confidence in the expected result. For example, if the input values represent historical data, a reasonable result would find output values agreeing with historical values. If the input values represent experimental shocks (gedanken experiments), then reasonable output values are determined from purely theoretical considerations (perhaps just theoretical intuition) and from semi-intuitive comparisons with the widely composite experiments performed willy-nilly in the real world.

The formal way to relate model validation procedures to model purpose is by means of a loss function. In the case of forecasting models, the appropriate loss function is a weighted sum of a function of the deviations of forecast values from realized values. But this is not appropriate in our case. What we are interested in is a valid description of the probable effects of an array of policy changes. The loss function we would like to minimize relates to the difference between the response to policy changes traced by our model and the response that would be generated in the real economy under identical changes. Since it is obviously impossible to perform the real-world experiments required to evaluate the real-world response, we must perforce rely on indirect tests of model behavior under policy changes.

Formally, the model's performance in responding to policy changes could be validated by examining the Jacobian matrix that relates changes in endogenous variables to changes in both exogenous variables and certain policy parameters.* Instead of observing actual results, one could examine the elements of the Jacobian directly and test them against real-world (or theoretically plausible) values. Of course, all the elements are not equally important, and it would be important to weight the tests appropriately.

In general, it is impossible to determine the Jacobian matrix analytically from the model structure. However, the elements of the Jacobian can be explored numerically by perturbing the model. In this sense, all of our experiments and sensitivity tests can be seen as perturbations to explore the nature of the model's responses.

* Since the Jacobian gives only a first derivative approximation to the response, large structural changes might require higher-order approximations.

TABLE 8
Basic Solution: Wholesale Price Index and Gross National Product Deflator, 1968, 1970, and 1972

Category	1968	1970	1972
Actual			
Implicit GNP deflator	100.0	130.6	166.7
Wholesale price index	100.0	116.6	144.3
Model			
GNP deflator	99.6	123.0	145.2
Wholesale price index	99.7	123.7	148.2

SOURCE: Bank of Korea, *Economic Statistics Yearbook*, 1974 (Seoul, 1975), p. 226. GNP deflator calculated from real and nominal values, market prices. 1970 wholesale price index converted to 1968 base by division; index is based on 1970 weights.

Our validation procedure for testing the behavior of the static model involves solving the model for the base year (1968) and comparing the solution values of the endogenous variables with the actual values. Because the solution values represent the solution of a complex simultaneous model with many individual interacting elements, the comparison of base-period solution values with actual values is a strong test of both model structure and model behavior. This process should in no way be confused with econometric "goodness-of-fit" tests for single equations: roughly 3,000 solution values are involved in the one-year comparison.

Model and Economy Comparisons for 1968

Our model generates (1) aggregate income and product accounts; (2) complete input-output accounts; (3) firm output, employment, and sales by sectors and firm sizes; (4) population census specifying employment and household structure, but not age or sex structure; (5) a complete set of worker and household income accounts before and after taxes and transfers, including within-group and overall income distributions; and (6) detailed wage and price data, including consumer and wholesale price indexes, cost of living indexes by 15 income recipient groups, and various deflators. Unlike national statistics offices, in which these data are collected separately and are usually based on inconsistent definitions, our model generates a completely consistent set of price, employment, and quantity statistics. The mutual consistency of all these data, given the degree of closure of the model, implies—as noted above—that there is virtually no room for arbitrary data adjustments and no residual leakages in the system.

TABLE 9

Basic Solution: Nominal National Income Accounts, 1968, 1970, and 1972

(Billions of *won*)

Category	Actual 1968	Actual 1970	Actual 1972	Model 1968	Model 1970	Model 1972
Labor income						
Wages, nonagricultural	511	850	1,258	531	858	1,256
Self-employed	214	348	546	219	320*	574*
Agricultural income	343	557	870	348	592*	868
TOTAL	1,068	1,755	2,674	1,098	1,770	2,698
Property income						
Rent	72	103	140	73	94*	130*
Interest	97	160	194	96	165	200
Dividends	15	30	36	16	33*	37
TOTAL	184	293	370	185	292	367
Corporate savings[a]	36	45	85	39*	37**	82
Direct taxes on firms	25	43	55	26	45	37**
Government corporate savings[b]	43	54	68	41	50*	61**
Consumer interest (−)	8	13	11	8	12*	18**
Total national income	1,349	2,178	3,242	1,381	2,183	3,227

NOTE: No asterisk, solution differs by less than 5 percent from the actual value; single asterisk, solution differs by 5 percent to 10 percent from the actual value; double asterisk, solution differs by more than 10 percent from the actual value. Columns in this table and others in this chapter may not total because of rounding.

SOURCE: Bank of Korea, *Economic Statistics Yearbook, 1975* (Seoul, 1976), p. 275.

[a] Includes corporate transfer payment

[b] Net of interest on the public debt: 1.81, 4.80, and 7.75, respectively

TABLE 10

Basic Solution: Nominal Domestic Product Accounts, 1968, 1970, and 1972

(Billions of *won*)

Category	Actual 1968	Actual 1970	Actual 1972	Model 1968	Model 1970	Model 1972
Private consumption	1,205	1,884	2,844	1,208	1,821	2,746
Government consumption	175	282	438	172	281	441
Fixed investment (GDCF)	412	650	780	415	601*	693**
Inventories	16	54	25	19**	70**	108**
Exports[a]	209	381	814	220*	412*	830
Imports (−)	417	642	1,013	416	557**	951*
Statistical discrepancy (−)	25	32	13	—	—	—
Gross domestic product	1,575	2,577	3,875	1,619	2,628	3,867

NOTE: No asterisk, solution differs by less than 5 percent from the actual value; single asterisk, solution differs by 5 percent to 10 percent from the actual value; double asterisk, solution differs by more than 10 percent from the actual value.

SOURCE: Same as Table 8, p. 263.

[a] Exports are valued in domestic prices

TABLE 11

Basic Solution: Real Production by Sector, 1968 and 1970

(Billions of *won*)

Sector	1968 Actual	1968 Model	1970 Actual	1970 Model
1. Rice, barley, and wheat	280	286*	339	328*
2. Other agriculture	299	296	320	333*
3. Fishing	44	45	47	40**
4. Processed foods	174	172	232	236*
5. Mining	44	44	50	58**
6. Textiles	129	134*	159	163*
7. Finished textile products	109	115**	174	167*
8. Lumber and plywood	42	42	51	54**
9. Wood products and furniture	11	11	10	10
10. Basic chemical products	25	24	41	45**
11. Other chemical products	45	44	114	115
12. Petroleum products	40	38	77	78
13. Coal products	29	29	27	32**
14. Cement, nonmetallic mineral products	45	45	63	68**
15. Metal products	79	78	107	118**
16. Nonelectrical machinery	22	22	21	21
17. Electrical machinery	43	39**	56	50**
18. Transport equipment	67	65	76	75
19. Beverages and tobacco	100	101	145	127**
20. Other consumer products	175	172	210	221**
21. Construction	257	253	344	341
22. Electricity and water	41	41	50	59**
23. Real estate	61	60	88	72**
24. Transportation and communications	164	165	265	217**
25. Trade and banking	332	337	398	413*
26. Education	54	54		
27. Medical services	26	26	318	291**
28. Other services	34	34		
29. Personal services	99	99		
TOTAL	2,869	2,871	3,782	3,732

NOTE: No asterisk, solution differs by less than 2 percent from the actual value; single asterisk, solution differs by 2 percent to 5 percent from the actual value; double asterisk, solution differs by more than 5 percent from the actual value.

SOURCE: Bank of Korea, *Report on the Compilation of Interindustry Relations Tables, 1968* (Seoul, 1970); *ibid., 1970* (Seoul, 1972). The 1970 sectoral outputs were deflated using the wholesale price index by sectors, adjusted so that the overall index agrees with the implicit GNP deflator.

As is clear from Tables 8–20, in which we present some of the results of our basic solution, our model produced values remarkably close to the actual values. (For other results, see Appendix D.) In fact, the overwhelming majority of over 3,000 endogenous variables for 1968 come within two percentage points of the actual values. So great a degree of detailed agreement between the model results and the actual data is far

TABLE 12

Basic Solution: Employment by Sector, 1968 and 1970

(Thousands of workers)

Sector	1968 Actual	1968 Model	1970 Actual	1970 Model
1. Rice, barley, and wheat	2,307	2,381*	2,445	2,488
2. Other agriculture	2,333	2,258*	2,181	2,122*
3. Fishing	216	225*	178	150**
4. Processed foods	186	182*	188	206**
5. Mining	111	112	109	99**
6. Textiles	156	170**	145	192**
7. Finished textile products	189	209**	227	206**
8. Lumber and plywood	37	40**	34	55**
9. Wood products and furniture	31	34**	21	27**
10. Basic chemical products	11	11	14	20**
11. Other chemical products	33	32	62	83**
12. Petroleum products	3	2	4	4
13. Coal products	19	19	14	13
14. Cement, nonmetallic mineral products	53	53	57	59
15. Metal products	68	65*	69	61**
16. Nonelectrical machinery	41	40	29	21**
17. Electrical machinery	40	32**	39	23**
18. Transport equipment	53	50**	45	35**
19. Beverages and tobacco	43	45	48	24**
20. Other consumer products	215	206*	194	262**
21. Construction	290	286	329	320*
22. Electricity and water	15	15	16	19**
23. Real estate	6	6	8	7
24. Transportation and communications	232	232	320	340**
25. Trade and banking	1,044	1,049	1,131	1,064**
26. Education	229	228	—	—
27. Medical services	95	96	1,082[a]	1,023**[a]
28. Other services	147	147	—	—
29. Personal services	377	375	—	—
TOTAL	8,582	8,600	8,989	8,923

NOTE: No asterisk, solution differs by less than 2 percent from the actual value, single asterisk, solution differs by 2 percent to 5 percent from the actual value; double asterisk, solution differs by more than 5 percent from the actual value.

SOURCE: Same as Table 11. The 1970 sectoral employments were adjusted so that total employment agrees with the 1970 survey of the economically active population. To make them comparable with the model solution, the employments are given net of government workers and recipients of property income.

[a] Sum of sectors 26 to 29.

beyond anything accomplished with existing econometric models (Cooper 1972), though the different types of model are not comparable in estimating procedures.

The degree of agreement obtained is all the more remarkable in view of the very substantial room for behavioral choice embodied in the model. There is an optimization of production decisions by firm size and sector,

TABLE 13
Basic Solution: Decile Distribution of Nominal Income, 1968

Decile	Workers: Before taxes Before transfers	Workers: After taxes Before transfers	Workers: After taxes After transfers	Households: After taxes After transfers	Households: Nominal mean income (Thousands of *won*)
1	1.96%	2.03%	2.25%	2.22%	43.6
2	3.19	3.29	3.58	3.62	71.2
3	4.17	4.29	4.58	4.67	91.8
4	5.19	5.31	5.58	5.71	112.3
5	6.32	6.45	6.66	6.86	134.8
6	7.66	7.78	7.93	8.21	161.5
7	9.37	9.47	9.53	9.94	195.4
8	11.84	11.89	11.81	12.38	243.4
9	16.33	16.22	15.90	16.46	323.7
10	33.97	33.27	32.18	29.93	588.4
Gini coefficient	.440	.431	.412	.398	—

NOTE: All percent distributions are within .5 percentage point of the actual distributions except for the top decile of the household distribution, which is within 1 percentage point. The mean incomes of the deciles all differ by less than 2 percent from the actual values.

and there are great possiblities for substitution among factors in production. Hence, the distribution and the resulting consumption patterns could easily have differed from the base-year data. In addition, the degree of closure of the model does not permit the kind of arbitrary exogenous "tuning" that is common in macro-models because all the accounting flows are mutually consistent. There are no residually determined balancing items in any of the accounts; the closure of the model does not permit an "errors and omissions" item. The trade sector and even inventory investment are specified behaviorally and cannot be used as residual tuning variables.

Dynamic Model Validation

To validate the dynamic model, we have compared its solution values for 1970 and 1972 with actual data for those years. However, since 1968 is the only year for which we have comprehensive data on firm size and skill categories, the model comparison for these later years is necessarily less detailed than for the base year. We have an input-output table for 1970, so that sectoral comparisons are possible for that year; for 1972 only national accounts data are available, so the comparisons are of national aggregates only. No attempt has been made to check the model against actual data for 1974 because after 1972 the exogenous variables were extrapolated smoothly in order to give a basic run that would serve as a control for policy experiments.

TABLE 14

Basic Solution: Distribution of Nominal Household Income After Taxes and Transfers by Household Category, 1968

(Percent)

Household category	Decile 1	2	3	4	5	6	7	8	9	10	Top 5 percent
Wage earners											
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	1.0%	2.5%	2.9%
Technicians	0.6	0.8	1.0	1.2	1.4	1.6	1.9	2.2	2.6	2.9	3.0
Skilled workers	5.4*	12.2*	15.5	16.8	16.6	15.1	12.3	8.6	4.3	0.8	0.3
Apprentices	0.3	0.4	0.3	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0
Unskilled workers	15.4	13.1*	11.8*	10.8	10.1	9.3	8.5	7.5	6.0	3.3	2.5
White-collar workers	2.7	4.1	5.2	6.3	7.5	9.1	11.1	13.6	17.1	22.3	23.5*
Government workers	7.9	8.5	8.8	9.2	9.6	10.1	10.6	11.1	11.1	9.4	8.5
Self-employed											
1: Manufacturing	3.3	2.9	2.8	2.8	2.8	2.9	3.0	3.1	3.1	2.9	2.8
2: Services	5.1	7.3	8.6	9.9	11.3	12.8	14.5	16.4	18.1	17.6	16.8
Capitalists	0.0	0.0	0.1	0.1	0.2	0.4	0.7	1.2	2.8	15.1	21.4**
Agriculture											
Laborers	31.7**	13.4	7.2*	4.1*	2.4*	1.3*	0.7	0.3	0.1	0.0	0.0
Farm size 1	17.9**	20.3	18.2	15.7	12.9	10.2	7.5	4.8	2.3	0.5	0.2
Farm size 2	9.5	15.9	17.9	18.2	17.5	16.0	13.5	10.1	5.9	1.6	0.8
Farm size 3	0.2	1.1	2.6	4.7	7.4	10.7	14.5	18.2	19.6	11.9	8.5**
Farm size 4	0.0	0.0	0.0	0.0	0.1	0.4	1.0	2.6	6.0	9.2*	8.8*

NOTE: No asterisk, share differs by less than .5 percentage point from the actual value; single asterisk, share differs by .5 to 1 percentage point from the actual value; double asterisk, share differs by more than 1 percentage point from the actual value.

TABLE 15
Basic Solution: Nominal Mean Incomes, 1968
(Thousands of *won*)

Household category	Workers: Before taxes, Before transfers	Workers: After taxes, Before transfers	Workers: After taxes, After transfers	Households: After taxes, After transfers
Wage earners				
Engineers	437.4*	407.5*	434.5*	501.5*
Technicians	224.7	213.0	224.5	264.9
Skilled workers	120.8*	116.0*	108.4*	142.7*
Apprentices	59.1*	56.8*	53.3*	101.7*
Unskilled workers	121.0	116.0	108.6	145.2
White-collar workers	262.2*	246.9*	259.0*	293.9
Government workers	160.3	153.0	160.6	201.9
Self-employed				
1: Manufacturing	239.4	217.4	157.0*	197.0*
2: Services	205.3	187.3	198.4	240.3
Capitalists	788.0	732.8	729.4	773.5
Agriculture				
Laborers	48.1**	48.1**	48.8**	67.3**
Farm size 1	46.6*	46.4*	65.0*	115.0*
Farm size 2	70.5	70.2	84.8	142.4
Farm size 3	100.5	99.9	112.0	256.5
Farm size 4	118.5*	117.6*	130.6*	412.7*
Overall mean income	131.6	125.6	132.1	201.3

NOTE: No asterisk, solution differs by less than 2 percent from the actual value; single asterisk, solution differs by 2 percent to 5 percent from the actual value; double asterisk, solution differs by more than 5 percent from the actual value.

Tables 9 and 10 give the actual and model nominal national income and product accounts. The basic solution values agree quite well with the actual values, especially in the income accounts. In general, agreement is closer for 1970 than 1972, and for the income accounts rather than the product accounts. Almost all of the major aggregates in the basic solution are within 5 percent to 10 percent of the actual values, and some are within 1 percent. The close agreement in the income accounts is of course quite important in a model of income distribution.

Of all the major aggregates, fixed investment agrees least well with the actual data, differing by 1 percent to 13 percent. In comparing the GDP accounts, it should be recalled that the model investment numbers are the result of an elaborate model of the financial system: the Stage 1 model, as noted, incorporates a model of the loanable funds market, credit rationing, the derivation of desired capital stocks, and adaptive expectations. The degree of agreement between the basic solution and the actual aggregate investment numbers is therefore quite remarkable. Total

TABLE 16
Basic Solution: Worker and Household Groups, Population and Income, 1968

Household category	Numbers in thousands		Percentage share of population		Percentage share of population	
	Workers	Households	Workers	Households	Workers	Households
Wage earners						
Engineers	51.00	24.81	0.55%	0.41%	1.80%	1.01%
Technicians	120.00	99.25	1.29	1.63	2.20	2.14
Skilled workers	790.00	655.95	8.50	10.76	6.98	7.62
Apprentices	234.30	9.62	2.52	0.16	1.02	0.08
Unskilled workers	910.00	583.58	9.79	9.57	8.04	6.90
White-collar workers	667.00	603.94	7.18	9.90	14.08	14.47
Government workers[a]	673.05	587.41	7.24	9.63	8.81	9.66
Self-employed						
1: Manufacturing	211.29	180.12	2.27	2.95	2.70	2.89
2: Services	873.30	741.63	9.40	12.16	14.12	14.53
Capitalists	125.00	125.00	1.35	2.05	7.43	7.88
Agriculture						
Laborers	514.40	372.76	5.54	6.11	2.04	2.04
Farm size 1	1,190.00	672.31	12.80	11.03	6.30	6.30
Farm size 2	1,292.35	769.26	13.91	12.62	8.93	8.93
Farm size 3	1,269.05	554.17	13.65	9.09	11.58	11.58
Farm size 4	373.00	118.04	4.01	1.93	3.97	3.97
TOTAL	9,293.74	6,097.85	100.00%	100.00%	100.00%	100.00%

NOTE: All shares differ by no more than .5 percentage point from the actual values. Absolute values differ by no more than 1 percent from the actual values.

[a] Professional workers (teachers and doctors) from sectors 26 and 27 (education and medical services) are included in this category

investment, including inventories, is very close—within 1 percent to 5 percent.*

Though the nominal accounts agree closely, the real accounts are difficult to compare. As Table 8 shows, there is an odd discrepancy in the Korean price data between the implicit GNP deflator and the wholesale price index, which diverge increasingly during the period. In the model solution these two indexes move together quite closely, with the result shown in the table: good agreement with the wholesale price index, disagreement with the GNP deflator. Since it is very unusual for these two indexes to diverge so much, one is led to suspect the accuracy of one of them; of the two, the deflator seems the more likely culprit. In any event, the net result is that the solution rates of growth of GDP are higher

* The first version of the Brookings–Social Science Research Council model, we might note, tried to use a desired capital stock and adaptive expectations mechanism without success.

TABLE 17
Basic Solution: Income and Taxes by Household Category, 1968

Household category	Total income (Billions of *won*)	Direct tax rate[a]	Indirect tax rate[b]
Wage earners			
Engineers	22.16	6.9%	4.1%
Technicians	26.94	5.2	4.4
Skilled workers	85.63*	4.5	4.4
Apprentices	12.48*	4.3	4.3
Unskilled workers	98.79	4.7	4.4
White-collar workers	172.75*	5.9	4.5
Government workers	108.12*	4.5	4.4
Self-employed			
1: Manufacturing	33.17*	14.0	3.9
2: Services	173.27	9.0	4.1
Capitalists	91.18	7.6	4.1
Agriculture			
Laborers	25.10**	0.0	3.2
Farm size 1	77.29*	0.4	3.2
Farm size 2	109.56	0.4	3.2
Farm size 3	142.15	0.5	3.1
Farm size 4	48.72*	0.8	3.2
AVERAGE		4.6%	3.9%

NOTE: No asterisk, solution differs by less than 2 percent from the actual value; single asterisk, solution differs by 2 percent to 5 percent from the actual value; double asterisk, solution differs by more than 5 percent from the actual value. Asterisks refer only to the total income column.
[a] Rate is a percentage of worker income before taxes and transfers
[b] Rate is a percentage of household income

than the official rates (13 percent a year compared with 10 percent a year over the period 1968–72).

Tables 11 and 12 present production and employment data by individual sectors from the 1968 and 1970 input-output tables and from the basic solution. The agreement between the model solution and the actual data is extremely good for 1968 and quite good for 1970. Even in the latter year, the aggregates agree to within 1.5 percent, and most of the individual sectors to within 10 percent. Note that in updating the model we purposely did not change the input-output coefficients or the various import coefficients based on the 1970 input-output matrix. However, in estimating the rates of growth of productivity we did rely in part on the actual sectoral output figures for 1970.

Validation of Stage I

The operation of Stage I is evident from Tables 18–20. Table 18 gives nominal investment by sector and firm size for 1970; the distribution of

TABLE 18

Basic Solution: Nominal Investment by Sector and Firm Size, 1970

(Billions of *won*)

Sector	Firm size 1	Firm size 2	Firm size 3	Firm size 4	Total
1. Rice, barley, and wheat[a]	5.35	10.58	9.08	14.63	39.64
2. Other agriculture[a]	1.51	2.25	1.94	3.11	8.81
3. Fishing	10.35	—	—	—	10.35
4. Processed foods	0.16	—	2.95	11.37	14.48
5. Mining	—	—	0.53	2.64	3.17
6. Textiles	0.23	—	—	5.51	5.74
7. Finished textile products	3.35	1.74	0.91	3.92	9.92
8. Lumber and plywood	—	—	0.06	—	0.06
9. Wood products and furniture	—	—	—	—	—
10. Basic chemical products	0.03	—	—	6.16	6.19
11. Other chemical products	—	0.36	1.66	8.13	10.15
12. Petroleum products	—	—	—	7.40	7.40
13. Coal products	—	—	—	0.05	0.05
14. Cement, nonmetallic mineral products	0.17	0.01	—	0.52	0.70
15. Metal products	0.19	—	2.73	6.19	9.11
16. Nonelectrical machinery	—	—	0.04	—	0.04
17. Electrical machinery	0.07	0.22	0.95	2.99	4.23
18. Transport equipment	—	—	—	0.79	0.79
19. Beverages and tobacco	—	—	—	5.54	5.54
20. Other consumer products	2.02	1.54	3.98	9.96	17.50
21. Construction	0.15	2.52	2.58	2.30	7.55
22. Electricity and water	—	—	22.52	47.37	69.89
23. Real estate	65.85	14.51	—	—	80.36
24. Transportation and communications	8.07	33.64	67.79	46.76	156.26
25. Trade and banking	25.13	8.31	6.99	2.52	42.95
26. Education	—	—	25.19	—	25.19
27. Medical services	—	—	4.83	—	4.83
28. Other services	2.13	5.25	3.02	2.91	13.31
29. Personal services	6.98	17.90	8.77	9.86	43.51
TOTAL	131.74	98.83	166.52	200.63	597.72

[a] Figures in these rows refer to farm sizes. For a definition of firm and farm sizes, see Appendix D, Table D.3.

actual loans by firm size is not available. In Table 19 actual 1970 nominal investment by aggregate sectors is compared with model 1970 investment; 1970 is the first year in which Stage I operates, and its major output is nominal effective demand for investment goods. Agreement is generally good, but there is some understatement of overall investment. The lower nominal investment in the model is due in part to an underestimate of the rate of increase in prices of capital goods. It also reflects the last phase of an investment boom period in Korea, which we did not capture perfectly in the model. Table 20 indicates the binding constraints in the

TABLE 19

Basic Solution: Nominal Investment by Aggregate Sector, 1970

(Billions of *won*)

Sector	Description	Model[a]	Actual
1–3	Agriculture, forestry, fishing	58.80	52.37
5	Mining and quarrying	3.17	3.48
4, 6–20	Manufacturing	91.90	128.67
21	Construction	7.55	7.92
22	Electricity, water, and sanitary service	69.89	73.90
24	Transportation, storage, and communications	156.26	167.50
23, 25	Trade, banking, insurance, real estate, and ownership of dwellings	123.31	133.13
26–29	Services	86.84	83.23
	TOTAL	597.72	650.20

NOTE: An eight-sector classification is unique to this table and is designed to match the national accounts classification. See Appendix D for sector definitions at the 29-sector aggregation.

SOURCE: Model solution values from Table 18; actual values from Bank of Korea, *Economic Statistics Yearbook, 1975* (Seoul, 1976), p. 279.

[a] Model figures do not include inventory investment or government investment

TABLE 20

Basic Solution: Index of Binding Constraints on Investment, 1970

Sector	Firm size 1	Firm size 2	Firm size 3	Firm size 4
3. Fishing	1	0	0	0
4. Processed foods	0	0	0	4
5. Mining	0	0	4	4
6. Textiles	0	0	0	0
7. Finished textile products	1	5	1	1
8. Lumber and plywood	0	0	0	0
9. Wood products and furniture	0	0	0	0
10. Basic chemical products	3	0	0	0
11. Other chemical products	0	0	0	5
12. Petroleum products	0	0	0	0
13. Coal products	0	0	0	1
14. Cement, nonmet. min. products	0	0	0	0
15. Metal products	0	0	0	0
16. Nonelectrical machinery	0	0	0	0
17. Electrical machinery	2	1	3	3
18. Transport equipment	0	0	0	0
19. Beverages and tobacco	0	0	0	0
20. Other consumer products	0	0	1	1
21. Construction	0	0	0	0
22. Electricity and water	0	0	5	1
23. Real estate	1	5	0	0
24. Transp. and communications	0	5	1	1
25. Trade and banking	0	5	0	0

NOTE: The agricultural sectors, sectors 1 and 2, and service sectors 26–29 do not borrow in either money market. 0 = firm unconstrained in both organized and curb markets; 1 = retained earnings constraint binding in organized market; 2 = foreign exchange constraint binding in organized market; 3 = firm hits both constraints (1) and (2), (1) more binding; 4 = firm hits both constraints (1) and (2), (2) more binding; 5 = firm constrained in curb market.

financial market. About one-fourth of the firms that can borrow hit a borrowing constraint, with no one type of constraint being dominant. The most constrained sectors are the buoyant export sectors: finished textiles and electrical machinery. The nominal curb-market interest rate is extremely high, 65 percent, but this is close to the rate that actually prevails in the curb market. The volume of borrowing on the official bank market is 166 billion *won*; the volume on the curb market is 125 billion. Note for comparison that the total amount loaned by deposit, commercial, and specialized banks for equipment was 167 billion *won* in 1970. This is largely consistent with the observation that many firms meet their requirements for working capital by borrowing from the curb market. Firms with fewer than 50 employees (the first two sizes) are assumed to satisfy most of their external financial needs through the curb market. All in all, the financial sector model of Stage I behaves quite reasonably and approximates actual behavior fairly closely. In terms of the dynamics of the full model, this is important.

CONCLUSION

The degree of agreement of the model results with the actual data, coupled with the richness of behavioral specification, gives us confidence in the overall validity of the model. We feel that the model does indeed provide a valid laboratory for experiments. Though it is not our purpose to use the model to forecast the probable results of specific policy interventions in Korea itself, the close agreement between the simulator and its real-world counterpart suggests that the mathematical laboratory we have designed is a good representation of an actual economic system. In the next chapter we shall examine how the model performs on comparative statics experiments before turning to the dynamic model in Chapters 6–9.

CHAPTER FIVE

Comparative Statics Experiments

THE COMPARATIVE STATICS experiments we performed with the model are important for several reasons. They allow us to explore the eventual (i.e., equilibrium) impact of various kinds of policy interventions designed to improve the lot of the poor, and to observe the sensitivity to various parameter changes whether or not policies to achieve them are evident. They guide us in the selection of potentially desirable policy packages to be "implemented" in the dynamic version of the model. They yield useful insights into the responses to policy intervention, which can be more clearly identified when we change one policy at a time than when we change several instruments simultaneously. And they validate the model behaviorally.

DISCUSSION OF THE EXPERIMENTS

We have grouped the experiments into four sections—tax and transfer experiments, agricultural experiments, trade and industrialization experiments, and technology and manpower experiments. But there are naturally some overlaps. Tax incentives, for example, are involved in the trade experiments; changes in imports are included in some of the agricultural experiments; and changes in employment result from the technology experiments. The grouping thus serves mainly to put together experiments in which the major instruments are similar in order to facilitate comparison and discussion. Tables for these groups of experiments will be found in Appendix E.

The experiments performed involve many different instruments, some calling for substantial governmental intervention, others for a more modest effort. So that the experiments may be fairly compared, we have tried to devise an order of magnitude of intervention based on the degree of change that could actually occur in Korea over a three-to-five-year period. Since the Korean economy has developed quite rapidly in the

past decade and has adopted large policy changes during this period, the magnitudes we have used are not small. This is all to the good, because it highlights the effects of the potential policy interventions described.

Tax and Transfer Experiments

The major classical remedy for rectifying inequities in the distribution of income is to redistribute through tax and transfer policies. Such redistribution, it is claimed, will have positive secondary effects as well as the more obvious primary benefits.* The initial redistribution will shift the composition of final demand in favor of labor-intensive products, thereby raising employment opportunities and increasing the share of labor income in total production. Since labor income is more equally distributed than property income, and since the bulk of labor demand will occur in the unskilled and semi-skilled categories, the result will be a further improvement in the distribution of income.

Empirical studies of this problem, however, tend to indicate that the scope for the initial redistribution is quite limited, and that even where the initial redistribution is large, the overall induced employment effect is rather small and not always positive. The impact on the distribution of income, therefore, tends to be quite small, even when no account is taken of secondary effects occurring through induced changes in the prices of wage goods.†

We shall reinvestigate the potential of various tax and transfer policies for income redistribution within our CGE model. This model permits us to assess the ultimate extent of redistribution when the shifting of incidence through changes in product and factor prices, as well as through modifications in output mix and factor demands, is taken into account.

Tax policy is generally concerned with equity, incidence, the efficient use of private resources, output growth, and economic stability. Our experiments are designed and analyzed with these issues in mind. Included are income transfers to low-skilled workers or poor farmers, financed out of either direct or indirect taxes; a reduction in the allocative distortions of the tax system by substituting direct taxes for indirect taxes; and a policy of subsidizing labor-intensive, export-oriented industrialization. On the expenditure side, we model the effects of a human-resource upgrading program through government investment in training.

* The dynamic effects depend on how redistribution affects savings and the marginal capital-output ratio.

† It is implicitly assumed in these studies that the supply of such goods is perfectly elastic, and that all resources are perfectly mobile.

Since in our experiments even relatively drastic changes in the tax structure produce only small effects, it is possible that the primary effects are swamped by the induced secondary influences. These may depend on the exact configuration of the parameters characterizing Korea in the base period. As Harberger (1962) points out, the ultimate incidence of a tax depends on a host of characteristics of an economic system, as well as on what is allowed to adjust to achieve equilibrium in the system. Thus the precise effects of an indirect tax do not depend only on the elasticities of supply of the taxed and untaxed goods, the elasticities of substitution among factors of production, the relative factor intensities of the taxed and untaxed products, the initial factor shares, and the elasticities of demand for the products; they also depend on how these elements relate to one another in each industry and on the precise characteristics of the heavily taxed sectors as compared with the more lightly taxed ones. Theoretical analysis of more than a two-good, two-factor economy is likely to get out of hand, and regression analysis of tax incidence is likely to suffer from the confounding of too many effects that all vary at the same time (Cragg et al. 1967).

Our model, on the other hand, allows us to trace through the equilibrium effects for the configuration of parameters represented in the base-year solution and, if desired, for interesting variants thereon. Our model is well adapted to the analysis of incidence, since it allows us to follow the impact of tax or transfer changes through the product markets and to compare the various distributions of income before and after tax. Furthermore, we can compare impact effects with equilibrium effects. The model is not well suited, however, to the analysis of the influence of taxes on work incentives, since it is so constructed that the work-leisure choice is in effect demand-determined; when the worker participation rate goes up, it is because of demand considerations. In addition, since household savings rates out of disposable income are quite low and constitute only a small source of finance for investment (5 percent), changes in personal income taxes have negligible dynamic effects on investment. Finally, so far as the comparative statics experiments are concerned, no mobility of capital between firms occurs in response to changes in profitability. The savings and profitability effects are captured only in the dynamic experiments.

The Korean tax system. The development of modern tax systems has been characterized by a tendency to shift from indirect to direct taxes. In 1968, 36 percent of the taxes in Korea were direct taxes, slightly higher than the average for a country at its level of per capita GDP—32 percent.

But the share of business taxes in direct taxes was considerably higher than average, due in large part to a monopoly profits tax—30 percent compared with 6 percent.*

The country's income tax structure is quite progressive: in 1968 the top incremental tax rate, applicable to annual incomes above 5,000,000 *won*, was 60.5 percent, against a rate of 16.5 percent for incomes below 200,000 *won*.† The tax collection rate is good for a developing country (about 55 percent in the period studied, by our calculations). There is a progressive inheritance tax, but collections are very small. The taxes on farm income and on land are negligible. Government transfer payments to households are rather small. The combined result is a mildly progressive system of direct taxes and transfer payments in which the lowest decile's after-transfer, after-tax income is 15 percent above the pretax pre-transfer income, and the top decile's is 5 percent below. In the basic solution there is a deficit of 17.7 billion *won* in the government accounts (see Table 21). Table 22 presents government tax revenues for all the tax and transfer experiments.

Experiment A-1: Tax structure. The direct tax rates on households are doubled and the indirect taxes are halved.

Results. Doubling the direct household tax rates increases the tax yield by a bit more than a factor of two, the difference being due to a rise in nonagricultural incomes. Halving the indirect tax rates reduces the indirect tax take by 52 percent because the indirect taxes are ad valorem taxes and there is a 3 percent decline in the overall price level. This price level decline is due almost entirely to the halving of the difference between net and gross price. The principal impact of the tax changes on tax revenues is a reduction of tariff collections. This reduction is due primarily to the price level decline, and comes about because, in the model, tariffs are based entirely on the difference between domestic and international prices. The overall result is a very slight decrease in total taxes—from 228 billion *won* to 226 billion.

The efficiency effects of the cutting of indirect taxes are essentially negligible. Overall real gross and net production are both up by less than half a percentage point with a halving of the indirect taxes. The production effects in individual sectors are quite small (the largest change is in beverages and tobacco, where output rises 8 percent) and, in many cases, are unrelated to the changes in the sector's net price. While a partial-equilibrium analysis of the effects of general changes in indirect taxes

* Both norms are calculated on the basis of the regression functions in Musgrave 1969: 144–45.

† Note that these figures are not valid today; the direct-tax rates have since been revised.

TABLE 21
Basic Solution: Nominal Government Accounts, 1968
(Billions of *won*)

EXPENDITURES		REVENUES	
Government consumption	172.2	Government corporate income	40.8
Government investment[a]	127.7	Indirect taxes	106.8
Direct export subsidies	10.3	Direct taxes, households	56.0
Transfer payments	2.6	Direct taxes, firms	25.9
Subtotal	312.8	Tariffs	39.1
Deficit (−)	17.7	Net transfers from abroad	26.5
TOTAL	295.1	TOTAL	295.1

[a] Includes government investment in physical capital transferred to the private sector

TABLE 22
Comparative Statics Experiments: Government Tax Revenues
(Billions of *won*)

Type of taxes	Basic run	A-1	A-2	A-3	A-4	A-5
Indirect taxes	106.8	51.2	106.7	106.9	146.7	105.9
Direct taxes on households	56.0	114.4	112.0	112.1	55.7	70.1
Direct taxes on firms	25.9	26.4	25.7	25.9	26.5	28.5
Tariffs	39.1	33.8	39.9	40.4	46.7	55.1
TOTAL	227.8	225.8	284.3	285.3	275.6	259.6

would suggest that their impact is small, it appears likely that such an analysis would give misleading results regarding the sectoral pattern of the effects. There are substitution effects in production because of differences in labor intensity of output, and there are also changes in the ratio of net to gross price and in the relationships between domestic price and foreign price, all of which affect the optimal production levels of firms.

There is a slight shift in the functional distribution of income in favor of wage incomes and, as might be expected, the tax system is slightly more progressive (see Table 23). However, the overall effect on both efficiency and equity, though favorable, is quite small.

Experiment A-2: Transfer of direct taxes to urban groups. Direct taxes on households are doubled and the proceeds transferred to unskilled and skilled workers and apprentices.

Results. There are virtually no real effects other than the intended distributional ones. This reinforces the contention of fiscal specialists that income taxes tend not to be shifted. Household savings out of gross incomes decline, since there is a transfer of income from high savers to low savers; but the decline is *very* slight, from 19 billion *won* to 18.6 billion, because the average rate of household savings is low (about 1.5 percent of the after-tax and after-transfer household income), and the

TABLE 23
Comparative Statics Experiments A-1, A-2, and A-3: Average Direct Tax Collection Rate on Workers' Incomes by Deciles
(Percent)

Decile	(1) Basic run	(2) Experiments	(3) Ratio (2)/(1)	Decile	(1) Basic run	(2) Experiments	(3) Ratio (2)/(1)
1	1.1%	1.7%	1.5	7	3.4%	6.8%	2.0
2	1.5	2.6	1.7	8	4.1	8.0	2.0
3	1.8	3.4	1.9	9	5.1	9.7	1.9
4	2.2	4.2	1.9	10	6.4	12.2	1.9
5	2.5	4.9	2.0				
6	2.9	5.8	2.0	Average	4.6	8.8	1.9

transfer of income involved is only about 2 percent of household income. The effects on direct tax rates are the same as in experiment A-1.

In terms of incidence, the experiment achieves its goal: it changes the functional distribution of income in favor of low-income urban workers, whose incomes rise about 20 percent and whose proportion among the poverty households (defined as those with real incomes of less than 120,000 *won*) declines 26 percent. The decile distribution is very little affected, however: 1.14 percentage points are transferred from the top two deciles and spread downward.

Experiment A-3: Transfer of direct taxes to rural groups. Direct taxes on households are doubled and the proceeds transferred to small farmers (farm sizes 1 and 2).

Results. The results are essentially identical to those of the previous experiment except for the distributional impact. All real activities are essentially the same, and there is very little change in relative prices. Distributionally, the proportion of small farmers at the poverty level declines dramatically (their share of the poverty households declines from 33.4 percent to 20.2 percent), and their incomes rise 38 percent. The incomes and poverty status of agricultural laborers are unaffected, however. The trickle-down to the bottom decile is somewhat smaller than in the previous experiment, and the lowest decile is slightly poorer in absolute terms.

Experiment A-4: Transfer of indirect taxes to urban groups. Indirect taxes are raised one-third and the proceeds transferred to skilled and unskilled workers and apprentices.

Results. The increase in indirect tax rates was set so as to generate a transfer of comparable magnitude to the transfer in experiments A-2 and A-3. The net tax yield was somewhat less, however: 276 billion *won* compared with 284 billion.

The net real effect of the program is a slight inflation (the wholesale price index is 102.7) and a very slight decline in real production (down one-half of 1 percent in nonagricultural, non-service production). Distributionally, the results of this experiment are quite similar to those of experiment A-2, taking into account that slightly less money is transferred. The efficiency losses resulting from the use of indirect taxes seem to be quite minor.

Experiment A-5: Consumption subsidy. The six lowest income household groups—apprentices, unskilled and skilled workers, agricultural laborers, and rural households in the two smallest farm size categories—are given a 20 percent subsidy on food, housing, and medical service prices. The subsidy is financed by increasing direct taxes on households by a constant factor.

Results. The net effect is to lower the cost of living for the six target groups by 12 percent. The agricultural terms of trade improve (to 105), because the increased demand for food drives up the relative price of agricultural products. There is a small increase in the supply of the subsidized consumer goods, but agricultural output cannot expand. As a result, the prices of the subsidized goods rise and, in spite of the increased direct taxes (25 percent higher than the base-run value in nominal terms), there is some inflation (5 percent).

The real incomes of the urban target groups are 5–7 percent higher than in the basic run, and those of the rural target groups are about 17–20 percent higher. Because of the improvement in the terms of trade, all the rural groups gain, with the poorer groups gaining relatively the most. The overall distribution becomes significantly more equal, and the proportion of the total households living in poverty declines 4 percentage points.

In general, the consumption subsidy was very beneficial to the target groups, particularly the rural target groups, with relatively little (and beneficial) spillover effects. The way the program was financed—through increased income taxes—also had an equalizing effect on the overall distribution.

Conclusions. Of all the types of experiments, the tax and transfer experiments yielded final equilibrium results closest to the partial-equilibrium impact effects. The allocation and output-distorting effects of indirect taxes appear to be quite small. One might therefore infer that there would be relatively little gain from moving closer to an optimal system of indirect taxes. This conclusion assumes that the initial indirect tax rates are not too great; the average rate in Korea is about 4 percent, though there are wide variations among goods. If the average rates were 20 percent or higher, then an optimal indirect tax strategy might yield more

significant efficiency benefits. Our results indicate also that the indirect tax system in Korea is not at all regressive.

Even though the tax and transfer experiments improve the income distribution with relatively few spillover effects, their impact is limited. Even doubling direct taxes in a progressive tax rate structure (with no change in tax collection efficiency) and transferring the proceeds to the poor only produces at most a 10 percent effect on the real incomes of the poor. If the goal of national policy is to produce a major improvement in the welfare of the poor (say, a 30 percent increase in the income accruing to the poorest 20 percent of the population), these instruments can hardly serve as the major anti-poverty weapons in developing countries. The problem is that in less-developed countries the direct tax base is too small to make direct taxes the major instrument of redistribution policy, especially given the size of the necessary transfers.

Agricultural Experiments

In recent years policy interest in income distribution has focused largely on rural poverty. For most development economists, the solution to the problem lies in increasing rural employment (for example, by rural public works) and especially in increasing agricultural output (largely by increasing productivity and effective employment). It may well be true, as they have stressed for years, that agricultural development plays a crucial role in the process of economic development (see, e.g., Johnston and Kilby 1975), but, as many agricultural economists realize, there is no automatic link between increased agricultural productivity and increased rural incomes. Indeed, our experiments indicate that policies leading to increased agricultural output will cause a deterioration in the agricultural terms of trade and result in lower rural incomes unless specific steps are taken to increase the demand for agricultural products outside of the rural area. In designing rural development programs, therefore, one must take account of the linkages between the rural economy and the rest of the economy through demand for rural output, through supply of nonagricultural industrial goods to the rural sector, and finally through rural-urban migration. Any attempt to predict the effect of rural development programs on rural incomes by a partial-equilibrium analysis, that is, without considering the indirect linkages, will most likely fail; the analysis of policy effects must be carried out within a general-equilibrium framework.

Korean elements. Korean agriculture, as we have seen, is characterized by the predominance of very small holdings: only about 20 percent of the land is in plots larger than two cheongbo (roughly two hectares).

There is also some tendency for individual holdings to be divided into a number of small scattered plots. Most of the land is quite hilly, and the climatic conditions, especially in the north, are extreme. By Far Eastern standards agricultural productivity is not high: Korea is a very high cost producer of rice (with a cost price in the late 1960's three times the world price); has very little diversification into non-grain production; and, despite the government's best efforts, was still a significant grain importer in the early 1970's. Thus, though tenancy and sharecropping have been eliminated, making land tenure conditions very favorable to rural development, there is still much room for improvement in agricultural productivity. Beyond this, most farm families depend heavily on earnings from nonagricultural activities to supplement their incomes. About 20 percent of the income in the average rural household derives from nonagricultural pursuits. Even so, in 1968 about 50 percent of the households living in poverty were in the rural sector, concentrated by and large in the landless labor class (which includes 29 percent of the rural poor) and in the first two farm sizes.

Experiment B-1: Agricultural price supports. The prices of agricultural goods (sectors 1 and 2) are fixed at 25 percent above the base-year price. Exports and imports are solved endogenously so as to clear the domestic market at those prices.

Results. In order for the domestic market in agricultural goods to clear at the higher prices, the supply to the market must be reduced. Total agricultural net imports fall from 29 billion *won* in the base year to nine billion. The net change, some 20 billion *won*, represents 3.4 percent of total agricultural production.

After final equilibrium is reached, the average price level is 5 percent above the base run, and the terms of trade are raised by the full amount of the change in agricultural prices (25 percent). The real incomes of rural households go up 9–19 percent, with the richer groups gaining relatively more. Total agricultural income does not rise by the full 25 percent because the increase in relative prices of agricultural goods raises the cost of living by more than the increase in the wholesale price index, and this effect is more serious for rural households, which spend relatively more on agricultural goods. The cost of living rises about 10–12 percent for rural groups, but only 7–9 percent for urban groups. In general the rise is less for richer groups, which spend proportionately less of their income on agricultural goods.

The overall relative distribution is virtually identical to the distribution in the base run. But the composition of the deciles changes significantly, with rural households constituting a lower share of those living in poverty

and a larger share of those in the upper deciles. This result—significant changes in composition with virtually no change in the overall distribution—is interesting. It is a finding that reappears in many of our experiments, both static and dynamic.

Experiment B-2: Agricultural capital. The capital stocks of all farm sizes in the two agricultural sectors are increased 30 percent.

Results. As expected, total agricultural output is higher than in the base run—by 5 percent. The increase is rather small because the agricultural capital stock in the production functions represents fixed capital and does not include either land or livestock, and because the CES production functions have decreasing returns to scale in capital and labor, as well as relatively much larger elasticities of output with respect to labor.

A more surprising result is that the increase in production leads to slightly lower absolute agricultural incomes. The major beneficiaries of the increased output are urban groups, especially unskilled and white-collar workers. This result comes about through a dynamic process in which the impact effect or partial-equilibrium effect is as expected—initially, with prices constant, agricultural incomes rise—but the increase in supply leads to a large decline in the agricultural terms of trade (which fall 8 percentage points). This decline transfers real purchasing power to urban groups, which spend a larger share of their income on nonagricultural products, and so tends to make the terms of trade still worse.

The increase in total agricultural production is reflected in the various economic aggregates. Compared with the base run, real GDP is up slightly, real consumption is up 2 percent, real wages are up 5 percent, and total agricultural income is down 3.4 percent. The aggregate price level is 2 percent lower.

In terms of distribution, the increase in agricultural output results in a transfer of income from the bottom eight deciles to the top decile, but the change in relative shares is very small. The Gini coefficient is .401 compared with .398 in the base run. The rural group's share in the poverty population rises from an even 50 percent to 52.9 percent, and their share in the top decile falls from 23.2 percent to 19.9 percent.

All in all, the rather large increase in agricultural capital has only minor effects on the economy and on the distribution. The fact that increases in agricultural output lead to declines in agricultural incomes is a result that reappears in numerous experiments and is one of the most robust results in the entire analysis.

Experiment B-3: Agricultural productivity. Total productivity is increased 15 percent in sector 1 (rice, barley, wheat) and 10 percent in sector 2 (other agriculture). This is done by increasing the productivity parameter in the production functions.

Results. Total agricultural production rises 12 percent over the base run, causing an initial excess supply of agricultural goods. Initially, with prices constant, the excess supply is 7.4 percent of agricultural production. To get the market to absorb this requires an extremely large decline in relative prices. When final equilibrium is reached, the agricultural terms of trade are 64 percent of their initial value. This decline is large for two reasons: because the price elasticity of demand for agricultural goods is relatively small; and because as the terms of trade fall income is transferred to urban groups, which spend a smaller share of their income on agricultural goods.

A decline of this magnitude naturally leads to a disaster for farmers. Rural real incomes fall about 31 percent from the base run, in spite of the large increase in output. Urban groups benefit substantially; their incomes rise 14–41 percent, depending on the group. The overall relative distribution becomes worse, with the Gini coefficient rising to .424 compared with .398 in the base run. The group composition of the deciles changes substantially, to the detriment of rural households. The share of rural households in the poverty population rises to 66.5 percent, against 50 percent in the base run; and their share in the top decile falls from 23.2 percent to 5.5 percent.

This experiment presents, in rather pure form, a result that is a major theme of all the experiments: increases in agricultural output, ceteris paribus, hurt farmers. The results in this experiment are consistent with and even more dramatic than those from experiment B-2, where agricultural capital stocks were increased. A major challenge for policy makers, and one that we explore extensively in our experiments, is how to design policy packages that will enable farmers to capture some of the benefits from the efforts to increase agricultural output.

Experiment B-4: Agricultural productivity and price supports. Productivity in each agricultural sector is increased, as in experiment B-3, but now the prices of the output are set at the world prices, and exports are determined residually so as to provide a vent for surplus in the domestic market.

Results. By contrast with experiment B-3, where there were only productivity increases, increased exports enable farmers to capture some of the benefits of the increase in agricultural productivity. Agricultural incomes are 6–11 percent higher than in the base run. The incomes of most urban workers also rise slightly or remain constant. Thus the benefits of the increased agricultural output (up 13 percent over the base run), are shared more widely throughout the economy.

The agricultural terms of trade still decline, but much less than in experiment B-3 (4 percent compared with 36 percent). The decline is due

solely to the increase in the prices of urban goods and services; agricultural prices stay the same, and nonagricultural prices rise about 4 percent, with the total price index rising about 3 percent over the base run. The stabilization of agricultural prices leads to a significant increase in agricultural exports. In the base run there are net imports of agricultural goods of 29 billion *won*, against 14 billion *won* worth of exports in the experiment. The swing in trade is 43 billion *won*, or about 7 percent of total agricultural production.

Overall, there is some improvement in the distribution of income favoring deciles 2 to 9. However, it is very slight, with the Gini coefficient changing by only .002. The composition of the deciles changes only slightly, with some improvement in the position of rural groups. Ultimately, only four groups lose income (capitalists, engineers, government workers, and the self-employed in the manufacturing sectors), and in three cases the loss is only 1 percent. All other average group incomes either rise or remain constant. The benefits of the increase in agricultural output are thus spread throughout the economy, with the major benefits accruing to rural households.

Experiment B-5: Agricultural productivity and subsidy. Productivity is increased 15 percent in sector 1 (rice, barley, and wheat), and these products are given a 15 percent price subsidy. Productivity is increased by changing the productivity parameter in the production function, and the price subsidy is done with a negative indirect tax.

Results. The productivity increase coupled with a price subsidy causes a substantial shift of labor resources within the agricultural sector (see Table 24). The share of cereals in terms of total agricultural employment falls from 51 percent to 46 percent, but in final equilibrium the structure of agricultural output remains virtually constant (the share of cereals rises from 49.1 percent to 49.6 percent). Relative prices within the agricultural sector change substantially: the ratio of the price of these crops to those in sector 2, other agriculture, falls from 1 to 0.85.

Total agricultural output rises 5.6 percent over the base run, and the terms of trade deteriorate (by 6 percent). The fall in the terms of trade is more than compensated for, however, by the price subsidy, so that farm owner incomes rise substantially—12–16 percent. Only landowners gain; the incomes of landless laborers actually fall 2 percent.

The overall distribution hardly changes at all, and the Gini coefficient is virtually identical. Farmers gain relative to urban groups, but within the agricultural sector landless laborers lose both relatively and absolutely. Though this is the most effective rural program in reducing the extent of poverty, it still lowers the share of the households living in poverty by

TABLE 24
Comparative Statics Experiment B-5: Production, Employment, and Prices in the Agricultural Sector

Category	Basic run		Experiment B-5	
	Sector 1 Rice, barley, wheat	Sector 2 Other agriculture	Sector 1 Rice, barley, wheat	Sector 2 Other agriculture
Production[a]	285.5	295.7	304.3	309.4
Percent share	49.1%	50.9%	49.6%	50.4%
Employment[b]	2.381	2,257	2,122	2,518
Percent share	51.3%	48.7%	45.7%	54.3%
Average price[c]	.991	.997	.898	1.058

[a] Billions of *won* [b] Thousands of workers [c] 1.0 = 1968 actual price

only 3 percentage points. Moreover, the fact that within the agricultural sector it actually harms the landless laborers makes it a less desirable program than some others for helping the rural sector.

Conclusions. Above all, what the results of these agriculturally oriented experiments show is the critical importance of the agricultural terms of trade in determining whether and to what extent the sector actually benefits. Policies to increase agricultural production that do not include specific measures to maintain the agricultural terms of trade benefit urban groups and lower the absolute incomes of farmers. On the other hand, when the terms of trade are maintained (for example, by trade policy), policies to increase output are beneficial.

The course of the terms of trade depends not only on agricultural production, but also on demand for agricultural products outside of the rural sector as well as on the supply of urban goods and services. The principal lesson to come from these experiments is that the agricultural sector cannot be treated in isolation. In designing rural development strategies, it is critical to coordinate policies on agriculture with those on industrialization and trade. The results we have noted would be even stronger in economies with a larger agricultural sector than Korea's and would be weaker in economies characterized by a large, non-market, subsistence agricultural sector.

Trade and Industrialization Experiments

International trade and its consequences are best analyzed within a general-equilibrium framework, in which the effects of changes in relative prices induced by trade policy are allowed to work their way through to changes in domestic production and consumption. Our model, though

not a good one for studying the determinants of the volume of international trade, is very well adapted to investigating the effects of change in trade possibilities on the equilibrium of the economy itself.

In formulating our experiments, we have been guided by the trade-policy issues that most concern trade theorists, namely, the merits of outward-looking compared with inward-looking development strategies and the merits of complicated quantitative targets and price-incentive policies finely tuned to individual sectors compared with overall exchange-rate adjustments with or without optimal tariffs. Broadly speaking, the experiments fall into two categories. In one group the main focus is on the degree of openness of the economy; these experiments deal with such things as devaluation, an exchange-rate float, price setting, and "free trade." In the second category of experiments we explore various changes in policy or parameters that affect directly the behavior of trading sectors; for example, changes in export quotas, import coefficients, the capital stocks of trading sectors, and tax and subsidy policy.

In doing these experiments, more than with other types of experiments, we found it necessary to devise composite experiments in order to model economic behavior realistically. For example, simply changing the exchange rate in the basic model leads to rather odd results; since export and import prices in that version are all determined domestically, a simple devaluation implies all kinds of induced changes in implicit tariffs and subsidies as the model economy adjusts. A composite experiment is thus required to combine devaluation with some opening up of the economy by holding tariffs and subsidies constant and so tying the domestic price to the world price. Because composite experiments are obviously harder to interpret than simple ones, our interpretation of composite experiments also draws on information gained from subsidiary experiments in which the composite experiment is built up by successively adding one feature at a time to the experimental design. These "intermediate" experiments, though not described separately, were important in guiding our analysis of composite results.

Another general point about trade experiments is worth noting—the fact that the division between these experiments and others (such as industrialization or agricultural development experiments) is necessarily arbitrary. Experiments in these other realms must plainly be designed to provide for changes in trade policy. Many of our agricultural experiments, it will be recalled, have trade components, such as increased import substitution or export expansion.

Korean elements. Foreign trade has played a major role in shaping the pattern of growth of the Korean economy. Korea was one of the first of the developing countries to shift from import substitution to export-

propelled growth. Indeed, many trade specialists point to the country's experience in the past decade as outstanding evidence of the desirability of outward-looking trade strategies. (See, e.g., Frank et al. 1975.) As we saw in Chapter 3, the government's adoption of a package of industrialization and trade policies promoting labor-intensive, export-oriented growth resulted in absolute income gains among low-income groups and rapid economic growth for the country as a whole in the mid-1960's and early 1970's. On the trade side, the major effects of the policy package were the liberalization of quantitative controls, a substantial devaluation, and a movement toward an (initially) less-complicated structure of specialized trade incentives.

As we also saw, Korea is extraordinarily open, compared with other developing economies. In 1968 the country exported 13 percent of its GDP and 36 percent of its net manufacturing products. Employment in export sectors constituted 28 percent of total employment and 61 percent of nonagricultural employment, both excluding indirect effects. Exports have grown at a phenomenal rate (40 percent annually from 1964 to 1972), due in part to the granting of domestic monopolies in exchange for "dumping" on foreign markets and in part to a finely tuned battery of trade incentives and export quotas (Frank et al. 1975). All of these elements are captured in the model economy, either explicitly or implicitly.

The modeling of the trade experiments. In the base run of the model economy the 1968 exchange rate is fixed, and all prices are determined in the domestic markets (with implicit tariffs and subsidies determined residually). Exports are set by targets (in absolute or share-of-production terms), and imports are calculated by applying fixed import coefficients. Thus in the basic model the trade sector is rather rigid. In calculating the effects of experimental shocks on the economy, however, there is a much more open modeling of the trade sector.

Two fundamental behavioral adjustments to the basic model are made in the trade experiments. First, the exchange rate is made endogenous and responds to the balance of payments; and second, prices in various sectors are set in absolute terms by world prices, and the volume of foreign trade in those sectors becomes endogenous. Whenever the domestic price is fixed by the world price, trade is no longer set by the rigid rules of the base run, but is determined by the supply behavior of firms and by domestic demand. Furthermore, with any domestic relative price adjustment the rest of the economy adjusts around those sectors whose prices are set by the world market. The larger the number of prices pegged to world prices, the larger the burden of adjustment imposed on the economy, and the more concentrated the impact on a small number of sectors.

On the whole, therefore, the trade experiments exhibited the greatest difficulty in reaching equilibrium solutions, requiring between 20 and 30 price iterations to converge, compared with only five for the basic solution and from five to 15 for most other experiments. Also, unless severely damped,* the approach to equilibrium was oscillatory, with adjustments tending alternately to overshoot and undershoot. In general the rate of inflation in the trade experiments tended to be larger than in other experiments.

Experiment C-1: Export quotas. The export share (or export quota) of all firms is increased 25 percent.

Results. The results are thoroughly conditioned by the ceteris paribus conditions of the experiment. In particular, the overall supplies of both capital and labor are unchanged, so that whatever expansion takes place in sectoral production is at the expense of bidding away labor from other uses. As a result, the primary effect of the increase in exports is to withdraw commodities from the domestic market rather than to increase production. Real total production is essentially unaffected, though there is a slight shift in the composition of production toward sectors with higher value-added. The balance of trade improves (by 93 billion *won*), and the extra domestic purchasing power competes for a smaller volume of goods. With this development, domestic prices tend to increase, generating a 6 percent inflation.

The adjustment process to equilibrium must operate to reduce the demand for goods. This is accomplished through the inflationary process, in part by putting a squeeze on real incomes and in part through the real balance effect. Real investment also falls (6 percent) because investment expenditure is fixed in nominal terms.

The distributional effects of the policy operate through the inflationary tax imposed throughout the economy. The principal losers are engineers and government workers. Capitalists also lose because rents and interest are largely fixed in nominal terms. The self-employed, skilled workers, and apprentices are unaffected or gain slightly, while the remaining groups lose 1–3 percentage points. The overall size distribution is essentially unchanged.

Experiment C-2: Export promotion. Labor-intensive and export industries are given a 20 percent price subsidy, and their capital stocks are increased 20 percent.†

* See Appendix B for a discussion of the solution techniques.

† The affected sectors are 3, fishing; 4, processed foods; 5, mining; 6, textiles; 7, finished textile products; 8, lumber and plywood; 9, wood products and furniture; 14, cement and nonmetallic mineral products; 16, nonelectrical machinery; and 20, other consumer products.

Results. This package results in a minor boom. Total nonagricultural output rises 4 percent, output in the affected industries 7 percent, and the wholesale price index rises 26 percent. Physical exports rise 3.3 percent (though because of changes in relative prices, nominal exports deflated by the GNP deflator do not rise), but the largest trade effect is on imports, which fall 22 percent. The net effect is to raise nominal incomes much more than output, hence the inflation. Nominal aggregate household income is 44 percent higher than the base-run value. The agricultural terms of trade move dramatically in favor of agriculture (30 percent above the base run). Agricultural output does not increase at all; hence the increased demand from higher nominal incomes increases the relative price of agricultural products.

The effects on the distribution of income are determined by two sets of forces: the change in the terms of trade, and the increased demand for labor. Rural households gain the most (9–24 percent over the base run), with the large landowners gaining much more than the agricultural laborers. Urban workers gain significantly, but, except for white-collar workers and skilled labor, not as much as agricultural workers. Government workers and capitalists lose the most (about 15 percent from the base run). The effect on the relative distribution is quite small but favorable. Further, there is a significant decline in overall poverty—the share of households living in poverty declines about 5 percentage points.

Experiment C-3: Export promotion and agricultural productivity. Labor-intensive and export industries are treated as in experiment C-2, but now the productivity of cereals is increased 5 percent, and the productivity in the "other agriculture" sector is increased 15 percent.

Results. Compared with the previous experiment, agricultural output is 9 percent higher. The result is less total inflation and the complete absence of the dramatic improvement in the agricultural terms of trade seen in experiment C-2. In fact, the terms of trade show a slight deterioration relative to the base run. The net effect is that the average income is 8 percent more than in C-2, but the gains accrue more to urban groups. Compared with the basic run, the incomes of non-government urban working groups rise by 8 percent (engineers) to 40 percent (white-collar workers). Rural groups gain 6–11 percent over the base run, with the richest farmers gaining relatively the most. Both capitalists and government workers are worse off than in the base run. Since the benefits accrue more to urban groups and are spread widely, there is little effect on the overall relative distribution. However, there is some deterioration in the positions of the two lowest deciles.

Experiment C-4: Export promotion, agricultural productivity, and price supports. The same as experiment C-3 except that now the prices of

agricultural goods are fixed to world prices, and imports are determined residually.

Results. The results are interesting and somewhat perverse. Instead of providing a vent for surplus (or, in this case, for import substitution), opening the agricultural sector to the world market led to a relative decline in agricultural prices because of domestic inflation in other goods. The increased demand for agricultural goods is met by increased imports (net imports of agricultural goods increase 89 percent, from 28 billion *won* in the base run to 53 billion), without any increase in agricultural prices. The overall inflation rate is 15 percent, and the terms of trade fall to 83.8. The distributional results of this experiment are predictable. All urban groups gain (with incomes 3–52 percent higher than in the base run), and all rural groups lose (with incomes 1–6 percent lower).

A variant of this experiment was done in which the prices of *all* the subsidized sectors as well as agriculture were fixed to the world prices. The results were that the inflationary pressures could be sopped up only by trade changes and price changes in the non-affected sectors (representing about half of gross output). There were dramatic changes in relative prices, the overall inflation rate was lower (6 percent against 15 percent), and the agricultural terms of trade were better (93.2 against 83.8). The balance of trade was −286 billion *won* compared with −147 billion in experiment C-4 (and −206 billion in the base run), so much of the inflationary pressure was met by increased imports. It is interesting that attempts to subsidize and increase production in labor-intensive exports and agriculture in an open economy lead to increased imports and a decline in the balance of trade. Income effects and the existence of non-traded goods have a very significant effect empirically.

Experiment C-5: Devaluation and trade promotion. A 30 percent devaluation is coupled with (1) a freeing of trade in both export and import-substitute industries, whose prices are pegged to world prices, and (2) a 20 percent increase in the capital stocks of traded goods–producing sectors.*

Results. The affected sectors represent 38 percent of total gross output in the economy. The experiment results in a production boom, with total output in those sectors rising 10 percent over the base run. Exports rise 55 percent while imports fall 9 percent, and the balance of trade improves

* The affected sectors are 3, fishing; 4, processed foods; 6, textiles; 7 finished textile products; 8, lumber and plywood; 9, wood products and furniture; 10, basic chemical products; 11, other chemical products; 12, petroleum products; 15, metal products; 16, nonelectrical machinery; 17, electrical machinery; 18, transport equipment; 19, beverages and tobacco; and 20, other consumer products.

by 152 billion *won* (from −206 billion to −54 billion). The boom leads to a large increase in nominal household income (up 46 percent) without a corresponding increase in domestic supply. The result is a 37 percent inflation, even greater than the devaluation. In the final equilibrium, real consumption is down 3 percent from the base run, real investment is down 27 percent, and GDP is up 3 percent. The difference is absorbed by trade.

In terms of real income most of the gains are transferred abroad; average real household income is 2 percent above the base-run value. There are significant changes in relative prices, and the agricultural terms of trade improve dramatically (to 125.9). The result is that rural household incomes are above their base-run values by 9–28 percent, with the large landowners gaining relatively the most. All but two urban groups lose compared with the base run (from 3 percent to 27 percent). Unskilled workers and white-collar workers hold their ground. The overall relative distribution is changed very little, but overall poverty is somewhat reduced. Among the poor households, the share of small landowners falls relative to urban groups. All landowners increase their share in the top decile relative to urban groups, especially in the two largest farm sizes.

The broad results of this experiment are certainly in the direction that theory would predict. A devaluation in an open economy is inflationary and improves the balance of trade. The size of the effects, especially given policies to boost production, is surprising. The price rise is significantly higher than the devaluation, and most of the benefits from increased production are transferred abroad. There are significant distributional effects on the distribution of income by groups, but not on the overall size distribution.

Experiment C-6: Free trade. The exchange rate is allowed to float, with no quantitative controls on trade and with the base-year deficit.

Results. This experiment indicates what the base-year solution would have been under free-trade conditions. The results reproduce the base-year solution under quantitative controls extremely closely, indicating that for the achieved deficit and under the structure of subsidies and tariffs of the base period, the pattern of constraints imposed on the trade behavior of firms did not force them to behave in a manner inconsistent with the maximization of their profits.

In view of the very different solution path and starting points used for this flexible exchange-rate experiment, incidentally, the coincidence of the free-trade solution with the basic run is indicative of the degree of convergence and uniqueness of the solution. The equilibrium exchange rate and the dollar balance-of-payments deficit in the base run are virtually

identical to those in this flexible exchange-rate solution. There are changes in the net exports of individual sectors, but except in a few cases, these are quite minor.* All other variables are within 5 percent of the basic solution.

Experiment C-7: Import substitution. All import coefficients are lowered 20 percent.

Results. Real imports fall 24 percent, and the balance of trade improves by 104 billion *won* (a 50 percent reduction in the deficit), but forcing a greater degree of autarky on the economy inflicts real costs. Total non-agricultural production falls 1 percent due to the shifting of resources into less productive import-substitution activities. The decline in the supply of goods domestically leads to an inflation, with the wholesale price index rising to 108.2. The agricultural terms of trade decline slightly, to 97.3, and there are some dramatic price increases in import-substitution sectors. For example, price indexes for metal products, nonelectrical machinery, and electrical machinery are 119.8, 123.4, and 126.1, respectively.

Average mean group income falls 3 percent, and the decline is fairly evenly shared across all household groups. There is virtually no change in the relative distribution, and very little change in the group composition of the deciles.

In this experiment, it is clear that there are enough flexibility and substitution possibilities in the economy for it to adjust smoothly to a one-time decline in import coefficients. The dynamic effects of a continuing policy of import substitution cause much more strain on the economy and are more pernicious. The dynamic experiment is discussed at the end of Chapter 6.

Conclusions. Broadly speaking, more than in other experiments, trade policy requires not only the use of a general-equilibrium framework but also dynamic analysis. Trade policy offers a mechanism for decoupling domestic use from domestic production. Therefore, in the short run, it is the single most potent means by which an economy can dramatically alter its structure of production while still satisfying domestic demand. To take full advantage of specialization or diversification possibilities offered by trade requires shifts in the structure of production. These shifts entail concomitant changes in the economy's capital stocks as well as in its use of labor. In the very short run, in which only labor can be reshuffled in response to trade incentives, policies to improve the balance of trade are inflationary. The distributional effects in many of

* The exceptions are 4, processed foods (lower); 5, mining (lower); 7, finished textile products (higher); and 9, wood products and furniture (higher). Interestingly enough, the free-trade grain imports are 5 percent lower than the fixed-coefficient imports.

the static experiments are dominated by the results of inflation and relative price changes. Dynamically, however, changes in the structure of the capital stock can take place, even though in the short run the shifts in capital stocks are small since they are constrained by the economy's ability to accumulate and decumulate capital. Therefore, more than with the other experiments, the trade experiments yield quantitatively different results in the comparative statics and dynamic versions.

In general, successful export promotion results initially in an increase in the incomes of urban groups, especially urban workers, without a significant decline in the domestic supply of urban goods. The increased income leads to differential increased demand for goods, especially because the marginal injection gives more income to poorer urban groups, which spend relatively more of their budget on food. The result, an increased relative demand for food without an increase in supply, results in a significant shift in the terms of trade in favor of agriculture. The change in the terms of trade transfers income to rural groups, which tend to spend an even larger share of their income on agricultural goods. The ultimate outcome is that the benefits of the export promotion accrue in large part to rural groups.

Import substitution, on the other hand, occurs most in the less efficient producer goods industries, which are then led to expand output by bidding away labor from consumer goods industries. The result is a general decrease in the supply of urban goods to consumers, and hence a deterioration in the agricultural terms of trade. In the static experiment, the net result is that virtually all household incomes are lower.

On the whole price incentive policies in trade have far less real effect on quantities produced than direct controls (e.g., changing import coefficients or export quotas). In general large price changes (substantially more than can be achieved by, say, halving or doubling indirect tax rates) are required to achieve a moderate change in quantities. Therefore, policies to optimize the structure of tariffs or indirect taxes should have a very minor effect on any real variables and on income distribution.

Technology and Manpower Experiments

Much of the recent analysis of the employment problem in less-developed countries centers on the issue of technology. (See, e.g., Turnham 1971.) Relative factor prices, distorted to promote industrialization, have led to the adoption of processes that are unduly capital-intensive. The early stress of development strategies on import-substitute industrialization, for which no appropriate labor-intensive techniques exist, and the identification of modernity with capital intensity have also contributed

to this tendency (Sen 1975). The problem is best solved, it is argued, by reorienting development strategies toward outward-looking development patterns based on comparative advantage in line with existing factor proportions and by redistributing income to create mass domestic markets for labor-intensive products (Land and Soligo 1974).

The creation of employment through appropriate manpower policy has been seen both as an end in itself and as a possible means of achieving greater equity. To the extent that there is no conflict between greater output and greater employment (see, in this connection, Stewart and Streeten 1971; and Edwards 1974)—that is, so long as labor-intensive techniques are the economically efficient techniques, and/or there exist unemployed complementary factors—the increasing of employment appears as the most politically acceptable way to improve the distribution of income. But once one abandons a two-factor, one-product world, the compatibility of the two goals becomes problematical. The output consequences of an increase in employment depend not only on the techniques of production, but also on the product mix, on the elasticity of supply of factors and products, and on relative prices, and hence in the final analysis on the initial and final distribution of income. Our model is well suited to trace through all these relevant interactions.

Experiment D-1: CES technology. Two-level CES production functions are used in all non-service sectors (sectors 1–20).

Results. This is a rerun of the basic solution except for the change in technology. Note that the agricultural sectors already use CES functions in that solution. The following sectors have an elasticity of substitution between aggregate capital and labor greater than one (equal to 1.25): 3, fishing; 4, processed foods; 5, mining; 6, textiles; 7, finished textile products; 8, lumber and plywood; 14, cement and nonmetallic mineral products; 16, nonelectrical machinery; and 20, other consumer products. All the other nonagricultural sectors have elasticities equal to 0.83 except for 9, wood products and furniture (0.77), and 12, petroleum products (0.67). Agricultural sectors 1 (rice, barley, and wheat) and 2, other agriculture, have elasticities of 1.25 and 0.83, respectively.

The CES run is quite close to the basic solution. All the aggregates except employment are within a percent or two. The average labor intensity of production in manufacturing falls 4 percent, and there are some sectoral changes in output and prices, especially in the small sectors such as lumber and furniture. The changes in group incomes and in the overall size distribution are very small. All in all, this change in technology had very little effect on the solution.

Experiment D-2: Labor-intensive technology. The capital intensity of production in manufacturing is reduced 25 percent and the labor intensity for skilled and unskilled workers and apprentices is correspondingly increased. Cobb-Douglas production functions are used for all nonagricultural sectors.

Results. The average labor intensity of manufacturing output rises 5 percent, and total nonagricultural output falls 3 percent. The result is a moderate inflation of 6.3 percent led by sectors 10, basic chemicals (24 percent); 11, other chemical products (16 percent); and 14, cement and nonmetallic mineral products (14 percent). The terms of trade turn slightly against agriculture (by 2.2 percent). There is also a slight shift away from small-scale manufacturing to medium-size firms, whose share increases 2 percent.

The shift in labor intensity dramatically increases the demand for the affected skill categories and causes an increase in their incomes (up 16–27 percent over the base run). All other groups except the self-employed in services lose income. The overall distribution becomes somewhat more equal, with 1.06 percent of total income being transferred from the top two deciles and spread among the next seven deciles. There is also a reduction in overall poverty.

All in all, the ultimate effects of a rather dramatic change in technology are not very noticeable. Though the incomes of the groups directly affected (capitalists, skilled and unskilled workers, and apprentices) change, there are very few ripples in the economy as a whole.

Experiment D-3: Decreased elasticity of substitution. The elasticity of substitution outside of agriculture is lowered about 15 percent. This is done by adding 0.10 to the CES parameter ρ. The elasticity of substitution is $\sigma = 1/(1 + \rho)$. (See Appendix A.) Two-level CES functions are used in all non-service sectors.

Results. The most marked effect of the lower degree of substitution among factors is to reduce production. In effect, the lower substitutability of capital for labor makes the economy unable to generate as much output from an existing capital stock and labor force. Manufacturing production drops 10.2 percent, with the drop being most pronounced in labor-intensive industries, and total nonagricultural output drops 9.4 percent. Along with the decrease in manufacturing production, the production process becomes more labor intensive. Total employment in manufacturing rises 6 percent, and the labor-output ratio rises 18 percent.

Decreased production causes a 4.1 percent inflation and sharp changes in relative prices. The terms of trade turn against agriculture because the

decline in manufacturing output drives up the relative prices of urban goods, especially in manufactures, and because the resulting decline in rural real incomes leads to a further decrease in agricultural demand, since urban groups spend a smaller share of their income on agricultural goods.

The distributional impact is to increase the incomes of technical workers (engineers, technicians, skilled workers, and apprentices) and to lower the incomes of all other groups. Average real household income falls 4 percent. Overall poverty actually increases, but the relative distribution is hardly changed at all.

Experiment D-4: Increased elasticity of substitution. The elasticity of substitution outside of agriculture is increased about 15 percent. This is done by subtracting 0.10 from the CES parameter ρ. (See the preceding experiment.) Two-level CES functions are used in all non-service sectors.

Results. Given that capital is not mobile, the result of this experiment is to permit more efficient use of the fixed capital and hence to increase output. Nonagricultural output rises 8.6 percent. No sector produces less output, and the sectoral increases range from almost zero to over 20 percent. The sectoral pattern bears no simple relationship to either the percent change in the elasticity of substitution or the overall labor intensity of production. Rather, it seems more closely related to the shifts in the composition of consumption. The increase in output causes a slight deflation (of 3 percent) and an improvement in the agricultural terms of trade, to 111.8. The relative price changes among the nonagricultural sectors are similar in size but opposite in sign to those in the last experiment.

The shift in the agricultural terms of trade entails a transfer of real income to the rural sector. The real income of rural households goes up about 8 percent, with large farmers' income rising relatively the most, but with a considerable trickle-down to agricultural laborers. Within the urban sector some groups gain (unskilled workers, white-collar workers, the self-employed, and capitalists), but the rest lose relative to the base run. Overall, average household income rises 4 percent, and there is some reduction in the degree of poverty. There is an overall trickle-up in the relative income distribution from the deciles below the eighth to those above.

Experiment D-5: Educational change. The skill level of the labor force is upgraded by increasing the supply of engineers, technicians, skilled workers, and white-collar workers by 10 percent each and reducing the number of unskilled workers correspondingly. Cobb-Douglas functions are used in the nonagricultural sectors.

Results. Total nonagricultural output rises 2.4 percent, and GDP 1.2 percent. As might be expected, there is some induced change in the structure of production. There is an increase in the output of skill-intensive industries (3.9 percent), which together account for about two-thirds of total nonagricultural production.* Among these, manufacturing industries increase relatively more than service industries. Meanwhile, purely unskilled, labor-intensive sectors (accounting for only 6 percent of total nonagricultural production) decline.† The structure of employment changes somewhat more than the structure of production because firms substitute factors to minimize costs. Two of the nonagricultural aggregate sectors—shelter and transportation, and manufacturing—increase their shares (by 3.1 percent and 6.4 percent, respectively), while the other two—beverages and tobacco, and services—lose. The increase in aggregate output causes a slight deflation (3.6 percent), and the terms of trade move slightly in favor of agriculture (up 2.2 percent). There is very little change in relative prices in general.

Distributionally, the major changes are among urban wage earners. The household incomes of high-level manpower are down, while those of unskilled labor are up 47 percent. The total share of all urban worker groups in aggregate income, however, is essentially unchanged (see Table 25), though there are some shifts in group incomes, particularly unskilled workers (up) and white-collar workers (down). Average household income does not change at all. The overall relative distribution is very slightly more equal, with some redistribution (about one-half of 1 percent) from the top two deciles to the rest. The incidence of poverty is also reduced a bit (by 1 percentage point).

Experiment D-6: Educational change and CES technology. The same as experiment D-5, except that now two-level CES production functions are used in all non-service sectors.

Results. The results are remarkably close to those of experiment D-5. Sectoral productions are all within about 1 percent, as are national income and GDP. The wholesale price index is slightly different (99.0 in this experiment compared with 96.4 in experiment D-5), and the components of GDP differ by up to 6 percent. The allocation of labor is quite different, with a 5–12 percent difference between the two experiments in employment in the aggregate industrial sectors. Mean group incomes,

* The relevant sectors are 6, textiles; 7, finished textile products; 8, lumber and plywood; 12, petroleum products; 14, cement and nonmetallic mineral products; 15, metal products; 17, electrical machinery; 18, transport equipment; 20, other consumer products; 21, construction: 24, transportation and communications; and 25, trade and banking.

† The relevant sectors are 3, fishing, and 29, personal services.

TABLE 25
Comparative Statics Experiments D-5 and D-6: Shares of Population and Aggregate Income by Household Category

Household category	Basic run		D-5		D-6	
	Thousands of workers	Percent share of income	Thousands of workers	Percent share of income	Thousands of workers	Percent share of income
Wage earners						
Engineers	51	1.8%	56	1.7%	56	1.6%
Technicians	120	2.2	132	2.0	132	2.0
Skilled workers	790	7.0	880	7.0	880	7.3
Apprentices	234	1.0	234	1.0	234	1.1
Unskilled workers	910	8.1	766	10.3	766	10.1
White-collar workers	667	14.1	734	11.9	734	11.8
Government workers[a]	673	8.8	673	8.6	672	8.5
Self-employed						
1: Manufacturing	211	2.7	211	2.7	211	2.8
2: Services	874	14.1	873	14.3	874	14.4
Capitalists	125	7.4	125	7.6	125	7.5
Agriculture (all categories combined)	4,638	32.8	4,640	32.9	4,642	33.0
TOTAL	9,294	100.0%	9,325	100.0%	9,327	100.0%

[a] Professional workers (teachers and doctors) from sectors 26 and 27 (education and medical services) are included in this category

aggregate group shares, and the overall decile distributions are all very close.

The degree of similarity between the two experiments is quite interesting considering the very different technological specifications. Clearly, the structure of production is strongly influenced by demand considerations that do not vary between the two experiments. The relative constancy of group shares (see Table 25) and of the overall size distribution is due to the similarity in solution wages. Given fixed capital, labor mobility allows enough substitution possibilities so that equilibrium wages are very similar.

Conclusions. These technology and manpower experiments suggest that the results of deliberate efforts to alter the structure of technology and employment as such are likely to be disappointing. For reasons that varied from experiment to experiment, the ultimate effects were usually adverse or minor. In effect, it is as if the historical selection of technology embodied in the base year has some optimal properties in the sense that any deviation leads to a new equilibrium which is worse on distributional or output grounds, or both. These results imply that, at the very least,

policies aimed at affecting technology are very tricky and cannot be analyzed within a partial-equilibrium framework. Note, however, that changes in the economy-wide *effective* structure of technology through changes in product mix can have beneficial results, as can be seen by examining the trade and industrialization experiments. Changes in the structure of the labor supply do affect group incomes, but given the substitution possibilities, there tend to be as many losers as gainers.

CONCLUSIONS

The comparative statics experiments lead to a number of interesting conclusions. First, it is apparent that anti-poverty policies need to be analyzed within a general-equilibrium framework. There are strong interaction effects linking the various sectors of the economy and affecting the responses to policy interventions. Second, the design of anti-poverty policies is quite difficult, not just conceptually but also in terms of implementation. Many types of intervention have adverse effects, even though we selected only those policies that, on *a priori* grounds, would be expected to benefit the poor. Finally, as is evident from comparing the decile distributions across experiments, the size distribution of income is quite stable—in fact, the most stable of all outputs of the economic system. This implies, of course, that the distribution of income is very difficult to change. More specifically, it implies that to achieve greater equity there must be either (1) truly enormous efforts, far larger than those reflected in these experiments, that work within the given economic system or (2) structural changes in the system's distribution of assets or in its basic rules of operation, or both.

Changes in economic policy succeed in altering the composition of the deciles quite substantially, thus affecting the relative incidence of affluence or poverty among various socioeconomic groups. With the hindsight gained from our experiments, it is relatively easy to design policies favoring one group over another, even though it is very difficult to change the overall size distribution. This result is very important for those concerned with the analysis of interactions between economics and politics. Much of politics is, after all, concerned with the jockeying for economic position by various pressure groups.

All in all, the results of the comparative statics experiments are not too encouraging for policy makers seeking easy solutions to problems of equitable growth. At the very least, they point up the need for much more informed policy design than is usually forthcoming from governments and also for more concentrated and systematic efforts than can usually be achieved in a pluralistic political system.

We shall return to these themes in the discussion of dynamic policy packages. But we may note, for now, that our dynamic experiments confirm these findings in detail. They add information on how fast, after policy shocks are imposed, the economy returns to its previous equilibrium path. They also indicate how large a policy program is required to change the equilibrium path.

CHAPTER SIX

Model Dynamics: Basic Solution and Analysis of Growth

IN THIS CHAPTER we present the results of our basic dynamic run, which will acquaint the reader with the dynamic growth path that our policy package experiments seek to modify. We shall then take a look at how an economy like that of Korea would have fared if it had followed a different development strategy over the period studied.

THE BASIC DYNAMIC RUN

Our basic run solves for a nine-year period at two-year intervals, starting with the base year 1968. Through year 5 (1972), we used historical data to update several variables in Stage III in order to validate the model, notably the exchange rate; the growth rate of exports; the growth rate of imports; the growth rate of the labor force; and the expected growth rates of output, government investment, and direct tax rates on firms. We then reverted, for the last four years, to the updating principles programmed in Stage III, so that the model economy would follow a relatively smooth path rather than reproduce the cyclical behavior of the Korean economy. We thus purposely refrained from modeling the 1973 oil crisis, the general rise in world prices associated with it, and the actual course of exports and the balance of payments from 1973 on.

The basic model results discussed below are thus *not* to be viewed as forecasts. They represent the course of the economy implicit in our particular choices of rates of export growth, import substitution, labor force growth, expectations, financial regimes, and exchange-rate adjustment rules that are built into the economy.

The Basic Growth Path

Table 26 presents the real national accounts and Table 27 the rates of growth of various aggregate variables. The rate of growth of GDP starts

TABLE 26

Basic Dynamic Run: Real National Accounts

Variable	Billions of *won* (1968 prices)					Percent share				
	Year 1	Year 3	Year 5	Year 7	Year 9	Year 1	Year 3	Year 5	Year 7	Year 9
Private consumption	1,212	1,481	1,891	2,186	2,821	75.1%	70.5%	70.6%	66.8%	65.9%
Government consumption	173	228	304	381	527	10.7	10.9	11.3	11.6	12.3
Investment	435	546	552	618	889	26.9	26.0	20.6	18.9	20.8
Exports	211	294	583	924	1,503	13.1	14.0	21.8	28.2	35.1
Imports (−)[a]	417	449	651	834	1,460	25.8	21.4	24.3	25.5	34.1
Gross domestic product	1,615	2,100	2,679	3,275	4,280	100.0%	100.0%	100.0%	100.0%	100.0%
Wages, nonagricultural	533	698	865	1,077	1,665	38.5%	39.3%	38.9%	39.7%	46.1%
Self-employed	219	260	395	535	780	15.8	14.6	17.8	19.7	21.6
Agricultural income	350	482	598	627	576	25.2	27.2	26.9	23.1	16.0
Property income	186	238	253	278	315	13.4	13.4	11.4	10.2	8.7
Other	99	97	112	198	276	7.1	5.5	5.0	7.3	7.6
National income	1,387	1,775	2,223	2,715	3,612	100.0%	100.0%	100.0%	100.0%	100.0%

NOTE: Some columns in this table and others in the chapter do not total because of rounding.

[a] Valued in world prices.

TABLE 27

Basic Dynamic Run: Annualized Real Rates of Growth of Selected Variables

(Percent)

Variable	Years 1–3	Years 3–5	Years 5–7	Years 7–9
Total consumption	11.1%	13.3%	8.1%	14.2%
Investment	12.0	0.5	5.8	19.9
Exports	18.0	40.8	25.9	27.5
Imports	7.7	20.4	13.2	32.3
Gross domestic product	14.0	12.9	10.6	14.3
Wages, nonagricultural	14.4	11.3	11.6	24.3
Self-employed	9.0	23.3	16.4	20.7
Agricultural income	17.4	11.4	2.4	−4.2
Property income	13.1	3.1	4.8	6.4
National income	13.1	11.9	10.5	15.3
Gross output	14.0	14.1	11.2	14.5
Wholesale price index	11.4	9.5	11.0	5.6

TABLE 28

Basic Dynamic Run: Miscellaneous Indicators

Indicators	Year 1	Year 3	Year 5	Year 7	Year 9
Incremental capital output ratio[a]	—	2.0	1.9	2.0	1.5
Household savings rate	1.5%	4.2%	4.3%	5.8%	6.1%
Household average direct tax rate	4.6%	5.1%	4.3%	5.5%	8.1%
Agricultural terms of trade	99.7	121.3	123.4	108.5	87.3
Wholesale price index	99.7	123.7	148.2	182.7	203.9

[a] Defined as gross investment for the preceding two years divided by the change in GDP, in real terms. Investment for the two years is assumed to be twice the average of the current value and the value two years earlier.

TABLE 29

Basic Dynamic Run: Analysis of Growth

(Percent)

Components	Years 1–3	Years 3–5	Years 5–7	Years 7–9
Rate of growth				
Capital	18.3%	6.0%	4.8%	4.9%
Labor	1.9	3.0	3.1	3.1
Gross domestic product	14.0	12.9	10.6	14.3
Share in GDP				
Capital	31.2	30.0	31.5	35.2
Labor	68.8	70.0	68.5	64.8
Contribution to GDP growth rate				
Capital	40.7	13.9	14.2	11.9
Labor	9.3	16.3	19.8	14.0
Residual	50.0	69.8	66.0	74.1

high and then dips in years 3 to 7. Thereafter, the economy turns around: the rate of inflation declines, the balance of payments continues to improve, and the growth rate of GDP begins to increase.

The dip in the economy is the result of our using historical data in Stage III for the first five years. In particular, the expected outputs that affect desired investment in Stage I were set at actual historical values. The model thus reproduces the actual dip of the Korean economy in the period 1970–72.

The performance of the model economy after year 5 (1972) is very good indeed—increasing growth, a declining inflation rate, and an improving balance of payments. The balance of payments even moves to a surplus from year 7 on. But again let us stress that these optimistic results must not be viewed as forecasts; they merely reflect the impact on the economy of our particular choices of rates of growth. For both exports and imports, for example, we have assumed a very high but gradually declining growth rate. Our choices of the rate of import substitution and of the rate of growth of exports affect not only the balance of payments, but also the rate of inflation.* Lower deficits are inflationary both in theory and in the model, since they restrict the aggregate domestic supply of goods. A higher rate of import substitution in manufacturing not only increases the rate of inflation, but also turns the terms of trade against agriculture by making manufactured goods relatively more expensive. As can be seen in Table 28, the particular choices we made for the basic dynamic run result in worsening terms of trade for agriculture after year 5 (1972), finally reaching 87 in the last year.

What has in fact happened in Korea since 1972 is quite different. The change in the international environment has led to a reduced demand for exports, higher prices of imports, and sharp revisions of expectations. The economy has also moved from a system of incentives designed to promote exports to one fostering import substitution. Furthermore, in 1972, the government initiated major changes in the financial institutions, temporarily suspending the repayment and finally changing the terms of all outstanding loans on the curb market. Finally, agricultural output has not risen as fast as in the model solution, prompting the government to launch a number of public works projects in rural areas in addition to taking other steps designed explicitly to maintain the agricultural terms of trade.

* Given the export performance, virtually any reasonable choice of rate of import substitution yielded a surplus in the balance of payments by the last two periods.

In the absence of an oil crisis and a general increase in instability in world markets, the basic dynamic run indicates that the Korean economy could have continued to grow rapidly. At the same time, the results also imply a steady worsening of the distribution of income, primarily because of the steady decline in the agricultural terms of trade after 1972. In settling on the basic dynamic run, we experimented with several different sets of reasonable projections for the exogenous variables. The qualitative nature of the model dynamics is not affected by moderate variations in the assumed smooth paths for those variables.

Sources of Growth and Structural Change

Table 29 presents a very aggregated analysis of growth for the basic dynamic run. The growth rate dip in the early periods is evident in the drop in the aggregate rate of growth of productivity (the residual) followed by its subsequent rise. Productivity increases are the major source of growth, followed by capital and finally labor. In the model, changes in aggregate productivity can come either from productivity changes in the individual production functions or from changes in the structure of production (either by sector or by firm size). Changes in the structure of production by firm size can result in increasing returns to scale at the sector level.

Tables 30–33 detail changes in the structure of production and employment by firm size, aggregate sector, and skill categories through year 9. There are moderate structural changes by sector. Relative to the other sectors, agriculture declines both in employment and in output, while manufacturing gains. Services increase their share of employment but their share of output increases less than one percentage point. Thus there is some shift toward the more productive sectors of the economy.

There is also some change in the structure of production by firm size. Large farms gain relative to small and medium farms; and the largest firms gain relative to the small ones. There is thus some shifting in favor of the more productive firm and farm sizes.

In the labor force there is a relative shifting out of agriculture and services and in favor of the more highly skilled categories of labor. Agriculture's share of the labor force declines by 4.6 percentage points, or about half a point a year on the average. This rate of transfer is significantly larger than in other less-developed countries. (See Robinson 1971.)

Structural change has clearly contributed to model growth. Though such a development is more important in the long run, the shifts are significant even in the nine-year period.

TABLE 30

Basic Dynamic Run: Production by Aggregate Sector

Sector	Billions of 1968 *won*			Percentage share		
	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
Agriculture	581	788	1,081	20.3%	16.2%	13.7%
Food, beverages, and tobacco	318	530	821	11.0	10.9	10.4
Shelter and transportation	685	1,185	1,867	23.9	24.4	23.6
Manufacturing	738	1,430	2,533	25.7	29.4	32.3
Services	550	926	1,576	19.1	19.1	20.0
TOTAL	2,871	4,859	7,877	100.0%	100.0%	100.0%

TABLE 31

Basic Dynamic Run: Employment by Aggregate Sector

Sector	Thousands of workers			Percentage share		
	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
Agriculture	4,639	4,823	5,286	53.9%	50.9%	49.4%
Food, beverages, and tobacco	452	361	348	5.2	3.8	3.3
Shelter and transportation	687	799	700	8.0	8.4	6.5
Manufacturing	928	1,159	1,574	10.8	12.3	14.8
Services	1,894	2,332	2,785	22.1	24.6	26.0
TOTAL	8,600	9,475	10,694	100.0%	100.0%	100.0%

TABLE 32

Basic Dynamic Run: Production by Firm and Farm Size

Size of unit	Billions of 1968 *won*			Percentage share		
	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
Agriculture						
Farm size 1	98	132	178	3.4%	2.7%	2.3%
Farm size 2	164	213	280	5.7	4.4	3.6
Farm size 3	243	319	436	8.5	6.5	5.5
Farm size 4	76	125	187	2.6	2.6	2.4
Subtotal	581	788	1,081	20.2	16.2	13.8
Nonagriculture						
Firm size 1	347	603	1,023	12.1	12.4	13.0
Firm size 2	532	734	1,257	18.5	15.1	15.7
Firm size 3	538	894	1,529	18.7	18.4	19.5
Firm size 4	874	1,841	2,986	30.5	37.9	38.0
Subtotal	2,290	4,071	6,796	79.8	83.8	86.2
TOTAL	2,871	4,859	7,877	100.0%	100.0%	100.0%

TABLE 33
Basic Dynamic Run: Employment by Skill Category

Skill category	Thousands of workers			Percentage share		
	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
Agriculture	4,639	4,823	5,286	54.0%	50.9%	49.4%
Self-employed						
1: Manufacturing	175	201	213	2.0	2.1	2.0
2: Services	1,014	1,052	1,099	11.8	11.1	10.3
Skilled workers, unskilled workers, apprentices	1,934	2,364	2,851	22.5	25.0	26.7
Engineers, technicians, white-collar workers	838	1,035	1,245	9.7	10.9	11.6
TOTAL	8,600	9,475	10,694	100.0%	100.0%	100.0%

Distribution of Income

Though the absolute incomes of all deciles increase with time in the basic dynamic run, the decile distribution of real household income deteriorates through time at a slow but steady rate. Tables 34–37 give the relevant statistics. The share of income accruing to the lower quintile drops from 5.84 to 4.67 percent in nine years while the share accruing to the top decile rises from 29.92 to 33.01 percent. Part of the deterioration is due to the divergence over time of the mean incomes of different household categories. For example, the ratio of capitalist income to agricultural labor income rises from 11.4 to 17.3, and the percent of the log variance of total household income due to between-group variances rises from 35.1 percent to 49.1 percent. Part of the deterioration is also due to the steady decline in the agricultural terms of trade after the fifth year. The terms of trade rise in the first five years (to 123.4) and then fall steadily, reaching 87 in year 9. As a result, agricultural incomes first rise faster than urban incomes and finally fall absolutely in year 9 as the growth of urban incomes accelerates.

The steady movement in the decile distribution of income conceals very substantial changes in the composition of the deciles. This result is consistent with the results of the comparative statics experiments, where we found stability in the overall distribution but large changes in the underlying composition of the distribution.

The fact that the basic dynamic run yields a combination of overall rapid growth and a deterioration in the size distribution is consistent with the cross-section findings of Adelman and Morris (1973). One result is that the mean real incomes of the lowest quintile grow at a substantially

TABLE 34
Basic Dynamic Run: Decile Distribution of Real Household Income

Decile	Percentage share				
	Year 1	Year 3	Year 5	Year 7	Year 9
1	2.22%	2.17%	2.07%	1.99%	1.68%
2	3.62	3.55	3.47	3.40	2.99
3	4.67	4.58	4.52	4.48	4.06
4	5.71	5.61	5.56	5.56	5.16
5	6.86	6.75	6.72	6.73	6.36
6	8.21	8.11	8.10	8.11	7.78
7	9.94	9.85	9.88	9.87	9.61
8	12.38	12.33	12.42	12.38	12.29
9	16.46	16.50	16.73	16.69	17.06
10	29.92	30.55	30.52	30.80	33.01
Gini coefficient	.398	.406	.409	.413	.444

Decile	Mean income in thousands of *won*				
	Year 1	Year 3	Year 5	Year 7	Year 9
1	44	51	57	63	68
2	72	84	96	107	122
3	92	108	125	142	165
4	113	133	154	175	210
5	135	160	186	212	258
6	162	192	224	256	316
7	196	233	273	311	390
8	244	291	344	391	499
9	325	390	463	527	693
10	591	722	844	972	1,341

NOTE: In this table and in Tables 35–41, the distribution is of real household income after taxes and transfers.

lower rate than those of the upper decile: 6.4 percent a year (and only 5.6 percent in the bottom decile) compared with 10.8 percent for the richest decile. Even so, the rise in the absolute incomes of the poorest quintile leads to a dramatic reduction in the percentage of households with incomes below a fixed absolute poverty level. The share of households with incomes of less than 120,000 (1968) *won* per year falls from 38.3 percent to 14.5 percent. This reduction is in part misleading because the average income of those in the bottom deciles is not rising very fast. The use of a fixed level of absolute income implies that giving a relatively small amount of income to a number of people near the poverty level will vastly reduce the measured degree of poverty. Thus, just as the Gini coefficient is insensitive to changes in the distribution, the share of the population below a fixed poverty line is a measure that tends to be oversensitive to any shift in the distribution.

The worsening in the relative distribution involves even larger changes

TABLE 35
Basic Dynamic Run: Mean Real Household Income by Skill Category
(Thousands of *won*)

Household category	Year 1	Year 3	Year 5	Year 7	Year 9
Wage earners					
Engineers	504	537	514	561	713
Technicians	266	300	346	428	649
Skilled workers	143	161	185	247	337
Apprentices	102	115	139	193	275
Unskilled workers	146	175	185	207	280
White-collar workers	295	342	396	440	715
Government workers	203	213	242	276	369
Self-employed					
1: Manufacturing	198	167	258	367	571
2: Services	241	292	420	573	912
Capitalists	777	1,044	1,072	1,218	1,507
Agriculture					
Laborers	68	83	89	92	87
Farm size 1	116	144	166	169	162
Farm size 2	143	182	209	214	202
Farm size 3	258	331	379	384	351
Farm size 4	415	580	707	742	685
AVERAGE	202	242	283	323	418

in the range of absolute incomes of the rich and the poor, for the overall mean income, like the mean income of the top decile, grows almost twice as fast as the mean income of the bottom decile (9.5 percent compared with 5.6 percent). The ratio of the top decile's mean income to that of the bottom decile goes from 13 : 1 in the base period to 20 : 1 in the final period. What this implies is that, without special efforts, any hope for a substantial trickle-down effect from a high mean growth rate is ill-founded. The rich generally gain overwhelmingly more than the poor from high average growth rates, both relatively and absolutely.

As Table 36 shows, by year 9 the overwhelming majority of the poor are in agriculture (a little over 70 percent). Just over 81 percent of the households of agricultural laborers and well over one-third of the small farmers are below the poverty line. By contrast, at the start of the calculation the incidence of poverty is equally spread between urban and rural groups, with the urban poor accounting for about 50 percent of the total households. In year 5, when the agricultural terms of trade rise to 123.4, farm households account for about 23 percent of the rich population (see Table 37) and only 45 percent of the poor. By year 9, however, farmers account for only 3 percent of the rich population, a far smaller percentage than in year 1.

TABLE 36

Basic Dynamic Run: Composition of the Poor

(Percent composition of households with real incomes of less than 120,000 *won*)

Household category	Percentage of the poor from each household group					Percentage of group who are poor				
	Year 1	Year 3	Year 5	Year 7	Year 9	Year 1	Year 3	Year 5	Year 7	Year 9
Wage earners										
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.3%	0.7%	0.5%	0.1%
Technicians	0.9	1.0	1.1	0.9	0.4	20.6	17.7	14.3	8.9	3.1
Skilled workers	12.3	13.3	12.2	5.0	1.3	43.7	35.4	24.3	7.7	1.5
Apprentices	0.3	0.3	0.5	0.4	0.2	71.9	63.1	47.1	19.7	4.6
Unskilled workers	12.9	15.3	19.4	21.0	16.1	51.4	43.4	40.5	33.6	19.7
White-collar workers	4.5	4.4	4.2	3.5	0.8	17.3	12.3	8.9	5.6	1.0
Government workers	8.6	10.8	11.9	12.2	8.9	34.1	31.4	25.3	19.6	10.1
Self-employed										
1: Manufacturing	3.0	4.8	3.2	3.4	1.8	38.3	42.0	20.4	16.6	6.9
2: Services	7.6	5.9	2.6	1.1	0.2	23.9	16.1	6.2	2.3	0.4
Capitalists	0.0	0.0	0.0	0.0	0.0	1.0	0.3	0.3	0.2	0.1
Agriculture										
Laborers	14.6	15.9	19.1	22.7	29.1	91.4	83.2	80.0	78.1	81.2
Farm size 1	18.1	16.0	15.2	17.9	23.9	63.0	46.5	35.5	34.4	37.2
Farm size 2	15.3	11.2	9.9	11.3	16.1	46.3	28.5	20.2	18.9	22.0
Farm size 3	2.0	0.9	0.6	0.7	1.3	8.5	2.9	1.5	1.4	2.2
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
All categories combined	38.3%	29.9%	23.2%	18.4%	14.5%					

TABLE 37

Basic Dynamic Run: Composition of the Rich (Top 5 Percent)

Household category	Percentage of the rich from each household group					Percentage of group who are rich				
	Year 1	Year 3	Year 5	Year 7	Year 9	Year 1	Year 3	Year 5	Year 7	Year 9
Wage earners										
Engineers	2.9%	2.5%	1.5%	1.2%	0.9%	43.3%	29.1%	17.1%	14.8%	12.7%
Technicians	3.0	2.7	2.7	3.3	4.2	10.9	8.3	8.1	9.7	13.0
Skilled workers	0.3	0.2	0.1	0.3	0.3	0.2	0.1	0.1	0.1	0.1
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	2.5	3.2	2.3	2.0	1.9	1.5	1.6	1.1	0.9	0.9
White-collar workers	23.5	22.8	22.3	20.2	31.2	14.1	11.2	10.7	9.5	15.0
Government workers	8.5	5.7	5.1	5.3	5.4	5.3	2.9	2.5	2.5	2.4
Self-employed										
1: Manufacturing	2.8	0.5	1.9	5.3	6.9	5.6	0.8	2.7	7.5	10.5
2: Services	16.8	14.9	21.8	28.5	31.4	8.2	7.1	11.9	17.8	25.1
Capitalists	21.4	24.1	19.7	18.2	14.8	62.1	65.0	57.1	56.5	51.8
Agriculture										
Laborers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.2	0.2	0.2	0.1	0.0	0.1	0.1	0.1	0.0	0.0
Farm size 2	0.8	0.8	0.6	0.3	0.0	0.4	0.4	0.3	0.2	0.0
Farm size 3	8.5	9.8	8.3	4.7	0.5	5.6	5.8	5.0	2.8	0.3
Farm size 4	8.8	12.6	13.5	10.6	2.5	27.0	35.2	37.7	29.6	7.2
Mean real income (000 *won*)	720	925	1,070	1,235	1,692					

As we found in the comparative statics experiments, the group composition of the deciles is sensitive to the agricultural terms of trade. In the basic run the eventual worsening of the terms of trade is due almost entirely to changes in the structure of demand. As can be seen from Table 30, agriculture's share in total output declines over time. The demand for agricultural goods clearly declines even faster, essentially for three reasons. First, the income elasticity of demand for agricultural goods is quite small for virtually all the groups. It is less than one for all groups except for the demand for "other agriculture" (sector 2) by agricultural laborers and the two smallest farm sizes. Thus, as incomes rise the demand for agricultural goods will fall relatively. The fall is particularly pronounced between years 7 and 9, when the increase in absolute incomes due to the rapid overall growth rate is particularly large, and when the absolute levels of income reached are relatively high. Second, the worsening distribution transfers income from those groups that spend relatively more of their budget on agricultural goods to richer groups whose share (and income elasticity) is lower. The effect of this shift should be quite large, considering the shifts in absolute magnitudes involved in the worsening relative distribution. Finally, migration and the upgrading of skills move people out of groups whose incomes are largely expended on agricultural goods and into groups with lower shares and demand elasticities. The net result of these shifts is a rather dramatic shift in demand away from agricultural products. All groups except the self-employed actually spend proportionately less on agricultural goods per household in the final period than they did in the first period, though it should be noted that all groups spend significantly more on processed food.

SOME COUNTERFACTUAL EXPERIMENTS

In Chapter 3 we argued that the rapid-growth, labor-intensive, export-oriented development strategy followed in Korea since 1964 has contributed substantially to achieving growth with equity. Here we shall examine how other simulated strategies would have affected income distribution in Korea, specifically those of import substitution and slower growth. The experiments are pure in that we changed only a few parameters in each one to achieve the desired policy configuration. The statistical results are given in Tables 38–44.

Alternative Strategy Experiments

Slower growth. The rate of growth of productivity is reduced by 1.5 percent a year. There are two versions of the experiment. In the first,

Slow Growth 1, the rate is lowered for all sectors. In the second, Slow Growth 2, we do not lower the rate in the two agricultural sectors.

Results. Both versions of the experiment have the expected effect on real output. By year 9 total output with Slow Growth 1 is 21 percent lower than in the basic run; with Slow Growth 2 it is 12 percent lower. The effect on GDP and national income is similar. As Tables 42 and 43 show, there are no major shifts in the structure of employment and production. Real investment is significantly higher in the second version, largely because the inflation rate is lower. The unanticipated lower inflation causes investors who set their nominal investment demands in Stage I to receive more real investment when they spend the nominal amounts in Stage II. The balance of trade is more favorable under Slow Growth 1.

On the income side, the differences in the two versions are dramatic. Agricultural income falls from 22 percent of national income in year 9 in the first version to 5 percent in the second (compared with 16 percent in the basic run). The reason is the drastic difference in the terms of trade, which are 120 in the first version in year 9, but only 29 in the second version, a swing of 91 points. Under Slow Growth 1, agriculture's share of total production is 12.7 percent, and under Slow Growth 2, 15.5 percent. The shift of almost three percentage points in relative supplies causes a 90-point swing in relative prices. It is evident that the terms of trade are extremely sensitive to shifts in relative supplies.

The reason for this sensitivity is rooted in the nature of the demand for agricultural goods. First, the demand for agricultural goods is price inelastic, so large changes in prices are required to achieve moderate changes in demand, given incomes. Second, the demand for agricultural goods is income elastic. Thus, as groups become richer agricultural goods represent a significantly smaller part of their total demand. Impact effects that raise group incomes will decrease their relative demand for agricultural goods. Third, the demand for agricultural goods is sensitive to the distribution of income among groups. In general, rural groups spend a larger share of their incomes on agricultural goods, so any effect that transfers income to urban groups will cause a decline in the demand for agricultural goods.

The first and third effects interact in a destabilizing manner. An initial decline in the terms of trade leads to a decrease in rural incomes and a relative increase in urban incomes. This shifts income to urban groups that tend to spend a smaller share of their income on agricultural goods. This decline in demand leads in turn to a fall in the prices of agricultural goods and so to a second-round worsening in the terms of trade. The

TABLE 38

Alternative Strategy Experiments: Decile Distribution of Real Household Income

(Percent)

Decile	Basic run			Slow growth 1			Slow growth 2			Import substitution		
	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
1	2.22%	2.07%	1.68%	2.22%	2.09%	2.02%	2.22%	2.03%	0.61%	2.22%	2.04%	0.97%
2	3.62	3.47	2.99	3.62	3.50	3.56	3.62	3.45	1.18	3.64	3.47	1.85
3	4.67	4.52	4.06	4.67	4.55	4.69	4.67	4.53	1.92	4.70	4.55	2.79
4	5.71	5.56	5.16	5.71	5.60	5.78	5.71	5.60	3.28	5.75	5.62	4.02
5	6.86	6.72	6.36	6.86	6.77	6.93	6.86	6.78	5.42	6.89	6.79	5.62
6	8.21	8.10	7.78	8.21	8.16	8.24	8.21	8.16	7.76	8.24	8.16	7.51
7	9.94	9.88	9.61	9.94	9.95	9.90	9.94	9.92	10.29	9.96	9.92	9.78
8	12.38	12.42	12.29	12.38	12.49	12.25	12.38	12.40	13.54	12.39	12.41	12.89
9	16.46	16.73	17.06	16.46	16.73	16.30	16.46	16.59	18.90	16.45	16.64	18.28
10	29.92	30.52	33.01	29.92	30.16	30.33	29.92	30.55	37.10	29.75	30.40	36.29
Gini coefficient	.398	.409	.444	.398	.406	.402	.398	.409	.542	.396	.408	.511

spiral stops when the relative price falls enough to induce the necessary increase in demand despite the change in distribution.

In the policy experiments the sensitivity of the terms of trade to changes in relative supplies is not nearly as extreme as in this pure experiment. In those experiments there are other changes, such as changes in migration, in exports and imports, in taxes and transfers, and in the within-sector distributions, that seem to make the terms of trade more stable. Nonetheless, the terms of trade are often the most important mechanism through which the experiments affect the overall distribution of income.

In this instance, the impact is enormous, as can be seen in Tables 38–41. When the terms of trade move against agriculture, the extent of poverty vastly increases, since the groups on the border line are largely concentrated in the countryside to begin with. The overall relative distribution also deteriorates with the terms of trade. The Gini coefficient in year 9 under Slow Growth 1 (favorable terms of trade) is .402, an improvement over the basic-run value of .444. This should be compared with .542 under Slow Growth 2. The general shape of the distribution changes dramatically in both versions: the overall mean income in the first version is 70 percent of the overall mean income in the second version; and the mean incomes of the top and bottom deciles in the first version are, respectively, 58 percent and 235 percent of the figures in the second version. Under both slow growth experiments the poor suffer in absolute terms compared with the basic run. But under an unbalanced slowdown (Slow Growth 2) they suffer much more: their absolute real incomes are 43 percent of the Slow Growth 1 values, and 35 percent of the basic-run values.

In conclusion, how much worse off the Korean poor would have been with slower growth depends on how the slowdown occurred. A balanced reduction in growth, evenly shared across producing sectors, would have improved the distribution, since our experiments show that it results in significant improvement in the agricultural terms of trade. The poorest quintile, however, would have had only 82 percent of their base-run incomes by the ninth year. By contrast, slower growth achieved by reducing growth incentives in the urban sector (or the industrial sector) would have led to a significant worsening of the overall distribution and the increased impoverishment of rural households, with the poorest quintile receiving only 37 percent of base-run incomes by the end of the experiment time period.

Import substitution. The import coefficients are reduced by 20 percent initially, and the degree of import substitution is then increased systematically over time by further adjustments in Stage III.

TABLE 39
Alternative Strategy Experiments: Analysis of Poverty
(Percent composition of households with real incomes of less than 120,000 *won*)

Household category	Basic run			Slow growth 1		
	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
Wage earners						
Engineers	0.0	0.0	0.0	0.0	0.0	0.0
Technicians	0.9	1.1	0.4	0.9	1.4	1.0
Skilled workers	12.3*	12.2	1.3	12.3*	17.2*	5.0
Apprentices	0.3**	0.5*	0.2	0.3**	0.6**	0.5
Unskilled workers	12.9*	19.4*	16.1	12.9*	20.6*	23.5*
White-collar workers	4.5	4.2	0.8	4.5	7.1*	4.9
Government workers	8.6*	11.9	8.9	8.6*	11.7	12.5
Self-employed						
1: Manufacturing	3.0*	3.2	1.8	3.0*	4.7*	5.3
2: Services	7.6	2.6	0.2	7.6	3.8	0.9
Capitalists	0.0	0.0	0.0	0.1	0.0	0.0
Agriculture						
Laborers	14.6**	19.1**	29.1**	14.6**	14.3**	19.7**
Farm size 1	18.1*	15.2*	23.9*	18.1*	10.6	13.7
Farm size 2	15.3*	9.9	16.1	15.3*	7.3	11.3
Farm size 3	2.0	0.6	1.3	2.0	0.5	1.6
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.0
Percent <90,000 *won*	23.8%	12.8%	8.0%	23.8%	18.7%	12.3%
Percent <120,000 *won*	38.3%	23.2%	14.5%	38.3%	31.3%	21.6%
Mean incomes (000 *won*)						
Bottom decile	43.8	57.3	68.3	43.8	48.2	56.1
Next decile	71.5	96.0	121.5	71.5	80.6	98.6
Top decile	591.0	844.0	1,341.4	591.0	694.3	840.5
Overall	202.2	283.1	418.1	202.2	235.3	284.5

Results. The effects generally claimed for import substitution are quite evident in this experiment: a slower growth of GDP (by half a percentage point annually); a slightly higher annual rate of inflation (.3 percent higher); and a better balance of trade (by 170 billion *won* in year 9). There is also a 9 percent reduction in the production of consumer goods, with production in manufacturing becoming more capital-intensive and more devoted to producer goods. The capital stock in manufacturing is 4.6 percent larger than in the basic run, and the share of manufacturing production in large firms is slightly higher (59 percent compared with 57 percent). There is 5 percent less overall investment, though investment in manufacturing is greater.

These changes ultimately have great impact on the structure of prices (see Table 44). By year 9 the price of manufacturing goods is 30 percent

TABLE 39 (continued)

Household category	Slow growth 2			Import substitution		
	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
Wage earners						
Engineers	0.0	0.0	0.0	0.0	0.0	0.0
Technicians	0.9	0.9	0.1	0.8	0.9	0.1
Skilled workers	12.3*	7.6	0.1	12.1*	8.0	0.1
Apprentices	0.3**	0.4*	0.0	0.3**	0.4*	0.0
Unskilled workers	12.9*	16.2*	3.5	13.3*	18.2*	5.2
White-collar workers	4.5	4.0	0.3	4.5	3.8	0.2
Government workers	8.6*	10.6	2.7	9.0*	12.1	3.8
Self-employed						
1: Manufacturing	3.0*	3.2	1.2	3.2*	3.1	1.0
2: Services	7.6	2.6	0.1	7.6	2.7	0.1
Capitalists	0.1	0.0	0.0	0.1	0.0	0.0
Agriculture						
Laborers	14.6**	19.4**	15.2**	14.3**	19.8**	20.7**
Farm size 1	18.1*	19.5*	26.8**	17.8*	17.8*	30.7**
Farm size 2	15.3*	14.3	29.8**	14.9*	12.3	28.9*
Farm size 3	2.0	1.3	19.3	2.1	1.0	9.4
Farm size 4	0.0	0.0	1.0	0.0	0.0	0.1
Percent <90,000 *won*	23.8%	14.3%	28.7%	24.7%	13.4%	16.8%
Percent <120,000 *won*	38.3%	24.9%	33.9%	39.4%	23.6%	24.0%
Mean incomes (000 *won*)						
Bottom decile	43.8	53.8	23.9	42.8	55.6	43.2
Next decile	71.5	91.5	46.2	70.2	94.3	82.6
Top decile	591.0	810.8	1,446.0	573.0	827.0	1,620.8
Overall	202.2	272.0	403.8	197.1	278.5	461.6

NOTE: No asterisk, share represents less than $\frac{1}{3}$ of group population; single asterisk, $\frac{1}{3}$ to $\frac{2}{3}$ of group population; double asterisk, share represents more than $\frac{2}{3}$ of group population.

above the basic run, but the price of agricultural goods is 37 percent lower. The terms of trade move dramatically against farmers (falling eventually to 45 compared with 87 in the basic run). The changes in the terms of trade are responsible for the major changes in the overall distribution that are observed.

Like Slow Growth 2, the import-substitution strategy is vicious in its effects on both the overall distribution and the extent of poverty (see Tables 38 and 39). By year 9 the income share of the bottom decile falls 42 percent below its value in the basic run, while the top decile's is 10 percent higher. The share of households living in poverty rises to 24 percent, up almost 66 percent from the basic-run value. The strategy is also completely one-sided: it benefits urban workers, especially the more

TABLE 40

Alternative Strategy Experiments: Composition by Groups of Top Decile of the Overall Distribution

(Percent)

Household category	Basic run			Slow growth 1			Slow growth 2			Import substitution		
	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
Wage earners												
Engineers	2.5%	1.5%	1.1%	2.5%	1.2%	1.1%	2.5%	1.8%	1.3%	2.5%	1.6%	1.3%
Technicians	2.9	2.7	4.2	2.9	1.9	3.2	2.9	3.1	4.2	3.1	3.0	5.0
Skilled workers	0.8	0.5	1.0	0.8	0.2	1.1	0.8	1.4	3.9	0.8	1.0	2.4
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	3.3	3.1	3.0	3.3	1.9	2.1	3.3	4.3	4.8	2.9	3.3	3.4
White-collar workers	22.3	21.8	31.6	22.3	14.5	20.4	22.3	21.8	28.8	21.6	22.1	36.2
Government workers	9.4	6.5	7.4	9.4	6.4	9.0	9.4	7.7	8.2	8.7	6.0	6.5
Self-employed												
1: Manufacturing	2.9	2.4	6.7	2.9	1.9	6.7	2.9	4.3	9.1	2.9	3.9	7.7
2: Services	17.6	21.5	28.3	17.6	20.0	29.2	17.6	23.4	28.4	18.4	22.1	27.0
Capitalists	15.1	13.1	10.8	15.1	13.4	11.3	15.1	13.9	11.3	14.9	13.1	10.4
Agriculture												
Laborers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.5	0.5	0.0	0.5	1.4	0.6	0.5	0.2	0.0	0.5	0.4	0.0
Farm size 2	1.6	1.6	0.1	1.6	3.8	1.3	1.6	0.8	0.0	1.8	1.4	0.0
Farm size 3	11.9	12.7	1.5	11.9	20.0	6.8	11.9	7.8	0.0	12.3	10.7	0.0
Farm size 4	9.2	12.1	4.3	9.2	13.4	7.2	9.2	9.5	0.0	9.6	11.4	0.1

TABLE 41

Alternative Strategy Experiments: Mean Group Incomes as a Percent of Basic-Run Values

Household category	Basic run[a]			Slow growth 1			Slow growth 2			Import substitution		
	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
Wage earners												
Engineers	504	514	713	100%	75%	61%	100%	103%	110%	96%	104%	122%
Technicians	266	346	649	100	72	53	100	101	103	100	105	126
Skilled workers	143	185	337	100	76	67	100	115	134	99	114	139
Apprentices	102	139	275	100	77	67	100	114	131	99	113	137
Unskilled workers	146	185	280	100	73	60	100	108	125	94	103	126
White-collar workers	295	396	715	100	69	51	100	96	100	96	102	126
Government workers	203	242	369	100	84	69	100	102	111	95	98	113
Self-employed												
1: Manufacturing	198	258	571	100	73	62	100	113	128	95	115	132
2: Services	241	420	912	100	79	60	100	99	102	99	100	113
Capitalists	777	1,072	1,507	100	86	67	100	104	113	96	99	114
Agriculture												
Laborers	68	89	87	100	97	93	100	85	35	98	91	60
Farm size 1	116	166	162	100	102	109	100	83	30	99	91	56
Farm size 2	143	209	202	100	99	99	100	83	29	100	91	56
Farm size 3	258	379	351	100	95	89	100	82	29	98	89	53
Farm size 4	415	707	685	100	89	77	100	81	28	100	88	54
AVERAGE	202	283	418	100%	83%	67%	100%	96%	96%	97%	99%	109%

[a] Average real incomes of groups in thousands of *won*

TABLE 42

Alternative Strategy Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Basic run			Slow growth 1		
	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
National income accounts[a]						
Wages, nonagricultural	533	865	1,665	533	667	1,073
Self-employed	219	395	780	219	336	560
Agricultural income	350	598	576	350	625	588
Property income	186	253	315	186	231	239
National income	1,387	2,223	3,612	1,387	1,969	2,725
Gross domestic product accounts[a]						
Consumption	1,385	2,195	3,348	1,385	1,959	2,494
Investment	435	552	889	435	509	684
Exports[b]	211	583	1,503	211	500	1,100
Imports (−)[b]	417	651	1,460	417	552	932
GDP	1,615	2,679	4,280	1,615	2,416	3,346
Wholesale price index	99.7	148.2	203.9	99.7	166.2	313.9
Agricultural terms of trade	99.7	123.4	87.3	99.7	151.9	119.9
Exchange rate[c]	.277	.387	.438	.277	.387	.506
Production[d]						
Agriculture	581	788	1,081	581	678	796
Food, beverages, and tobacco	318	530	821	318	439	597
Shelter and transportation	685	1,185	1,867	685	1,080	1,481
Manufacturing	738	1,430	2,533	738	1,298	2,154
Services	550	926	1,576	550	842	1,232
TOTAL	2,871	4,859	7,877	2,871	4,337	6,260
Employment[e]						
Agriculture	4,639	4,823	5,286	4,639	4,823	5,265
Food, beverages, and tobacco	452	361	348	452	344	335
Shelter and transportation	687	799	700	687	792	614
Manufacturing	928	1,159	1,574	928	1,223	1,839
Services	1,894	2,332	2,785	1,894	2,293	2,626
TOTAL	8,600	9,475	10,694	8,600	9,475	10,678
Migration[c]	237	245		237	245	

TABLE 42 (continued)

Category	Slow growth 2			Import substitution		
	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
National income accounts[a]						
Wages, nonagricultural	533	831	1,542	506	853	1,843
Self-employed	219	371	675	214	387	761
Agricultural income	350	465	132	342	516	258
Property income	186	241	265	177	238	281
National income	1,387	2,032	2,927	1,344	2,123	3,443
Gross domestic product accounts[a]						
Consumption	1,385	1,998	2,656	1,327	2,050	3,040
Investment	435	556	861	403	537	861
Exports[b]	211	540	1,336	190	524	1,284
Imports (−)[b]	417	610	1,230	317	503	1,070
GDP	1,615	2,485	3,623	1,602	2,608	4,115
Wholesale price index	99.7	151.8	217.4	108.0	161.6	225.2
Agricultural terms of trade	99.7	96.2	28.9	97.2	107.1	45.3
Exchange rate[c]	.277	.387	.462	.277	.387	.447
Production[d]						
Agriculture	581	787	1,072	581	781	1,065
Food, beverages, and tobacco	318	502	746	316	529	837
Shelter and transportation	685	1,099	1,610	656	1,122	1,760
Manufacturing	738	1,302	2,220	764	1,503	2,782
Services	550	835	1,281	542	888	1,520
TOTAL	2,871	4,526	6,930	2,859	4,823	7,964
Employment[e]						
Agriculture	4,639	4,821	5,282	4,639	4,824	5,279
Food, beverages, and tobacco	452	395	415	433	368	348
Shelter and transportation	687	775	650	654	731	617
Manufacturing	928	1,214	1,732	978	1,258	1,729
Services	1,894	2,269	2,615	1,896	2,296	2,716
TOTAL	8,600	9,474	10,694	8,600	9,477	10,689
Migration[e]	237	245		237	245	

[a] In billions of *won*, 1968 base price
[b] In billions of *won*, valued in world prices
[c] At 1,000 *won* to the U.S. dollar
[d] Gross production in billions of *won*, real terms, 1968 base prices
[e] Thousands of workers

TABLE 43
Alternative Strategy Experiments: Total Production, Year 9, as a Percent of Basic-Run Values

Sector	Basic run[a]	Slow growth 1	Slow growth 2	Import substitution
1. Rice, barley, and wheat	475	73%	101%	98%
2. Other agriculture	606	74	98	99
3. Fishing	37	62	57	81
4. Processed foods	503	76	94	104
5. Mining	129	87	88	100
6. Textiles	409	89	88	103
7. Finished textile products	550	86	92	93
8. Lumber and plywood	46	113	109	100
9. Wood products and furniture	5	80	80	100
10. Basic chemical products	100	80	92	111
11. Other chemical products	351	82	86	101
12. Petroleum products	155	81	78	86
13. Coal products	45	80	69	84
14. Cement, nonmetallic mineral products	123	78	87	94
15. Metal products	165	84	90	152
16. Nonelectrical machinery	30	90	100	197
17. Electrical machinery	150	73	82	157
18. Transport equipment	123	85	87	123
19. Beverages and tobacco	281	68	90	100
20. Other consumer products	526	87	83	107
21. Construction	507	75	86	86
22. Electricity and water	132	81	86	100
23. Real estate	105	71	85	87
24. Transportation and communications	749	81	87	101
25. Trade and banking	821	81	82	96
26. Education	239	67	85	106
27. Medical services	80	70	76	100
28. Other services	151	79	86	94
29. Personal services	285	82	76	89
TOTAL	7,877	79%	88%	101%

[a] Gross production in billions of *won*, real terms, 1968 base prices

highly skilled, and impoverishes the already poor rural households. Rural incomes are off about 45 percent from those in the basic run. More than 70 percent of the households in the two smallest farm sizes and 97 percent of those of agricultural laborers are below the poverty line.

All in all, the import-substitution strategy has little to recommend it on either growth or distributional grounds. It appears to be a strategy designed to benefit an urban elite at the expense of the rural sector. Note that the way in which the policy is "implemented" in the experiment does not yield any special benefits to owners of factors of production. This is in contrast to the "real world," where the kinds of import-substitution

TABLE 44
Alternative Strategy Experiments: Price Indexes, Year 9

Index	Basic run	Slow growth 1	Slow growth 2	Import substitution
Agriculture	183	362	73	115
Food and beverages	175	263	175	180
Shelter and transportation	203	283	242	241
Manufacturing	219	322	285	284
Services	224	320	273	270
Overall price index	204	314	217	225
Terms of trade				
Agriculture to nonagriculture	87	120	29	45
Food to nonfood items	84	106	41	52

NOTE: All indexes use total production weights. 1968 = 100.

policies usually adopted lead to an even more unequal distribution within the urban sector. Such policies as price subsidies, high protective tariffs, and investment subsidies tend to benefit urban capitalists directly. Our experiment thus probably understates the detrimental distributive effects of such policies.

CONCLUSIONS

The counterfactual experiments indicate the importance of choosing an appropriate development strategy. They also suggest that Korea made a happy choice in this respect—one that has led not only to substantially better growth, but also to better distribution than either of the alternative strategies we have examined here. It is plain from our test results that the strategy of labor-intensive, export-led growth has produced significantly higher incomes for the poorer half of the population and a far more equal relative distribution compared with a strategy of import substitution. As for a slower growth strategy, supposing that had been Korea's choice, the government would have had to achieve it by exerting less pressure on (and offering fewer incentives to) the urban manufacturing sector to produce and to export than in the actual Korean experience. The results would probably have been in the direction of our Slow Growth 2 experiment. In this case, the poorest 60 percent would have been much worse off than their actual experience, and the impact on distribution would have been disastrous.

CHAPTER SEVEN

Rural Policy Experiments

LET US NOW turn to the analysis of the policy experiments we performed with the full dynamic model. The major results of our rural experiments are presented in this chapter; our urban and combined rural-urban experiments are discussed separately, in Chapters 8 and 9. For those interested primarily in the effectiveness of various anti-poverty measures these three chapters represent the core of the book.*

Unlike the comparative statics experiments, most of which tested single policies, the dynamic experiments are built around policy packages. In constructing these packages, we were guided by what our comparative statics experiments taught us about the impact and ultimate effects of those individual policies. We also sought to model the policies most frequently advocated for benefiting the poor. We find that some of these policies are ineffective or even harmful; that others have the predicted positive impact initially but rather quickly lose their force as trickle-up effects transfer the benefits to the rest of the economy; and that certain "big push" packages have beneficial effects on poverty reduction that persist over a span of seven to nine years, though the effects are largely eroded over time.

As we have seen, the Korean economy has grown at a spectacular rate since 1964. An extrapolation of the basic trends inherent in the operation of the economy indicates a continuation of these high growth rates. Accordingly, the trends that manifest themselves in the model economy over the span of nine years could be expected to occur in slower growing

* Our runs were performed on a Univac 1108 at the University of Maryland and on an IBM 360 at Princeton University. On the Univac 1108, each run took approximately eight to ten minutes to arrive at a solution for five periods and cost about $60. As an indication of the full volume and range of our original data, each experiment generated roughly 100 pages of printout. As with the comparative statics experiments, we have reduced this mass of material to a handful of tables organized into comparable sets; they appear as Appendix F.

countries over 15 to 25 years. A stretching out of the period over which economic change takes place would obviously allow more time for adaptive changes in behavioral patterns. Our extrapolations of behavioral and technological parameters are therefore subject to an inherently greater margin of error toward the end of the experimental period.

Before looking at the results of these experiments, we would do well to review some of the general characteristics of the agricultural sector in Korea. First, as we saw in Chapter 3, land tenure in Korea is already quite egalitarian, with no tenancy or share-cropping. At the same time, most of the farms are exceedingly small, and agricultural productivity is low compared with such neighbors as Taiwan and Japan. Multiple cropping is common, especially the cultivation of rice alongside other cereals (barley and wheat), but there is far less diversification into other farm products than in Taiwan and Japan. Korea is a very high cost producer of rice, and as of 1968 imported some food grains. But despite all this and despite a general lack of policy attention to rural development in the 1960's, Korea's agricultural productivity has increased about 1.5 percent a year over the last decade, a very high rate by international standards.

Our basic dynamic run assumes (1) a continuation of this trend in productivity to the end of the simulation period, and (2) self-sufficiency in grain production by 1972 and moderate grain exports after 1974 as part of a partial grain-price-stabilization policy. In spite of the grain exports, there is a sharp tendency for the agricultural terms of trade to deteriorate after 1972 in the basic run. As indicated earlier, this tendency is due partly to the increased supplies and partly to a substantial shift out of direct consumption of agricultural products into the consumption of urban goods and services due to the general urban prosperity induced by high growth rates. (See Table 12 in Appendix D, which shows real consumption by household categories and aggregate sectors for the basic run.) Though migration to urban areas is substantial (some 100,000 persons every two years), it is not high enough to reduce the rate of growth of agricultural output significantly. This is in part because the land of those migrants who own land is assumed to be sold to the inherently more productive farm sizes and in part because, even though farm employment in Korea is high (an average of 250 man-days is worked per man-year), there is still some underemployment.

Since in the model economy agriculture is disaggregated into two sectors (cereals and other agriculture), with four farm sizes in each sector, the income of farm households by size of farm comes in varying proportions from production in both sectors. In addition, farm households (especially among the small farms) earn a significant part of their income

from nonagricultural pursuits. This is modeled by transferring some income earned in nonagricultural sectors to farm households. A finer disaggregation of farm household activities would of course be desirable, as would a more complete specification of agricultural technology than is summarized in a CES function. The specification used probably understates somewhat the substitution possibilities open to farmers. In practice, however, because of the overwhelmingly favorable price of rice, Korean farmers tend to devote all possible resources to rice cultivation, regardless of normal price fluctuations, when they can. Their price responsiveness is thus limited to deciding how many additional resources in the way of time and land to devote to other activities.

DISCUSSION OF THE EXPERIMENTS

We conducted ten rural policy experiments in all, grouped broadly under five headings:

Land reform (experiment A-1).

Production. A set of three experiments: one centers on a system of rural cooperatives (experiment A-2); the second is a productivity-increasing package coupled with a marketing board (experiment A-3); and the third is a combination of these packages (experiment A-4).

Employment (experiment A-5).

Human resources. Another set of three experiments: the first calls for the subsidization of the consumption of the rural poor (experiment A-6); the second for the expansion of rural education, along with a slower rate of growth of the rural population (experiment A-7); and the third for a combination of these two packages (experiment A-8).

Overall rural development strategies. Under this rubric we have two combined experiments: the first includes all the components of the previous experiments (A-9); the second (A-10) omits land reform.

Land Reform Experiment

Experiment A-1: Land redistribution. Fifty percent of the land of the largest farms (farm size 4) is redistributed to the small farmers (farm sizes 1 and 2), with 35 percent of the redistributed land going to farmers in size 1 and 65 percent to farmers in size 2. The log variances of household incomes for these small farmers are reduced 50 percent under the assumption that the smallest farms in each group receive more than their proportionate share of the distributed land.

Results. The land reform is clearly quite beneficial in its distributional impact. Furthermore, the benefits are not eroded over time; indeed, the

post-reform income share of the poorest quintile is one percentage point higher in year 9 than in the last year in the basic run. The share of income accruing to the top decile dips initially and then tends to recover.

The land reform increases the size of small farms by about one-third, raises their agricultural productivity 15 percent, and lowers their per-acre employment about 20 percent. The share of total output produced in the small farms rises 13 percent. The large farms have the corresponding (opposite) results. Employment per acre increases by almost a factor of two, and both their productivity and their share of total production fall 30 percent.

There is only a 2 percent increase in total agricultural output in year 1, compared with the basic run, and virtually no change thereafter. Hence the effect of the reform on overall agricultural incomes is dominated by the course of the terms of trade. After the first year these improve slightly relative to the basic run (125 compared with 123 in year 5; 94 compared with 87 in year 9). There are three major influences on the terms of trade. First, the transfer of income from rich farmers to poor farmers should increase the demand for agricultural goods, and so be favorable to the terms of trade. Second, there is an increase of migration over the basic run, transferring people from groups that spend a larger share of their income on agricultural goods into groups that spend a smaller share on such goods. Third, in transferring workers out of the rural labor force, migration also decreases the supply of agricultural goods and increases the supply of urban goods. The effect of this increased transfer quickly erodes the initial small increase in total agricultural productivity.

The land reform initially reduces the household income of agricultural laborers by 11 percent. However, their migration rate doubles, so that by year 9 their real wages have risen 15 percent above the basic-run value.

For the urban groups, these various movements lead to a sizable decline in mean household incomes by year 9; the unskilled workers' income is 9 percent lower than in the basic run, and the white-collar workers' is 4 percent lower. Meanwhile, the mean income of small farmers has risen 21 percent. The overall effect of the land reform is a substantial reduction in the percentage of households with incomes below 120,000 *won*; they decline almost five percentage points, from 14.5 percent to 9.9 percent. Moreover, the composition of the poverty group changes. In the basic run the agricultural sector's share of poor households rises from 50 percent in year 1 to 70 percent in year 9; with land reform its share rises only 6 percentage points in the same period, going from 44 percent to 50 percent. There is thus substantial improvement over time relative to the base run.

It should be noted that our experiment does not address itself to two important effects that have marked actual land-reform programs: (1) the disruptions in agricultural commercial networks, expectations, and incentives changes that initially lower agricultural productivity, and (2) the favorable sociopolitical effects that make the adoption of future egalitarian strategies more likely, and make the design of efforts to increase rural productivity more egalitarian. In terms of the first effect, the experiment is very optimistic; there are no transition problems, and total agricultural output even rises in the first period. Our experiment ignores the second effect entirely.

It would have been possible to redistribute land to agricultural workers, rather than to small farmers as we did in this experiment. How the results would have compared with the results of the present experiment would have depended on the productivity of the landless laborers once they became landowners. Several factors would operate: (1) the relation of the agricultural laborers' net income as farmers to their marginal product as workers; if higher, their absolute incomes would go up, and distribution improve; (2) the relation of their productivity as farmers to their productivity as workers; if the output they add by farming exceeds the output they subtract by not being available for hire by larger farms, total agricultural production would increase, depressing the agricultural terms of trade, and impoverishing all farmers, including poor farmers. It is hard to predict, *a priori*, the quantitative balance among these several effects.

Production Experiments

Experiment A-2: Rural cooperatives. In our model the rural cooperatives market agricultural products, subsidize intermediate inputs, and provide low-cost credit to farmers. These functions are modeled by transferring the trade margins on agricultural products from urban wholesalers to farmers, increasing agricultural prices net of intermediate input costs by 5 percent, and reducing interest rates on production and inventory loans to farmers 50 percent.* The package is financed by tightening credit in Stage I—the interest rate is raised 10 percent, or 2 percentage points—and by raising the rate of direct taxes on large farms (sizes 3 and 4) to 5 percent.

Results. The effects on the overall distribution of income and on the degree of poverty are beneficial but not dramatic. By year 9 the income share of the lowest quintile is only .4 percentage point higher than in the

* Since farm investment is set in Stage III and is exogenous in Stage I, the interest rate change does not apply to farm investment.

basic run. The share of the top decile, as in experiment A-1, drops initially and then tends to recover, but more slowly than in A-1. The percentage of households living in poverty decreases two percentage points, half as much as in experiment A-1.

The major impact of the cooperatives is on group mean incomes. Farmers gain substantially; by year 9 their incomes are 11–24 percent higher than in the basic run. All urban groups lose, especially technicians (down 7 percent), the self-employed in services, who lose the trade margin on agricultural goods (down 13 percent), and the capitalists, who lose interest payments (down 7 percent).

The method of financing the program improves the distribution of income within the agricultural sector because it involves increased taxes on large farms. The tax rate on large farms (sizes 3 and 4) is raised from approximately .5 percent in the basic run to over 5 percent, a tenfold increase. The result is a moderate lessening of income differentials within the agricultural sector. For example, in the last period, the ratio of mean incomes of the largest farm size to those of the smallest farm size is 3.8 compared with 4.2 in the basic run. This is a rather small effect, to be sure, but if the package had been financed by an economy-wide rise in direct taxes, the net effect would have been to increase inequality within the agricultural sector.

Despite the subsidizing of intermediate inputs, agricultural production remains essentially unchanged. This is because, in our model, it is impossible to substitute intermediate inputs for other inputs, and therefore a subsidy increases net income but has little effect on production or market price.

The reduction in interest rates to farmers results in a direct transfer from interest recipients (capitalists) to farmers. The amount transferred averages 20 billion *won* per year, which represents 3 percent of agricultural income and 8.5 percent of capitalist income in the ninth year. Since production is unchanged, the income effects observed result in part from the transfers achieved by the farmers' appropriation of the trade margin, by the increase in net prices, and by the reduction in interest rates. They are also due in part to changes in the agricultural terms of trade.

The agricultural terms of trade first improve and then fall somewhat below the values for the basic run. The initial improvement comes from the transfer of income to rural households, which spend a larger share of their income on agricultural products. After year 1 the squeeze in the financial markets causes a significant decline in investment. This eventually makes itself felt in the production of manufactured goods, which

falls off slightly from the basic run. Since agricultural output does not change, there is a small deterioration in the agricultural terms of trade, which drop to 84 in year 9 compared with 87 in the basic run.

All in all, the effects of the rural cooperatives are beneficial. However, the results tend to overstate the potential of cooperatives, because the model ignores the enormous investment in effort and resources required to establish an extensive system of rural cooperatives. Moreover, in the model the cooperatives have no implementation problems, cost nothing to run, make no wrong decisions, and are completely effective in what they do.

Experiment A-3: Increased agricultural productivity with a marketing board to stabilize prices. The rate of growth of agricultural productivity is increased 2.5 percentage points (to 3.5 percent and 4 percent for sectors 1 and 2, respectively). In addition, an effort is made to maintain the agricultural terms of trade for sector 1 by means of an agricultural marketing board. This board, which buys (and exports) a share of the cereals crop whenever the terms of trade fall below parity (the 1968 terms of trade = 100), operates in Stage III, and so makes its purchase plans based on last year's terms of trade. The board buys only cereals (not "other agriculture") and cannot plan to buy more than 15 percent of the total crop. In the experiment, it hit this constraint only in year 9.

In the design of this experiment we were guided by the results of our comparative statics experiments, which showed that agricultural productivity increases alone so badly shift the terms of trade against the agricultural sector as to reduce farm incomes dramatically.

Results. The experimental results are dominated by the effects on the terms of trade. The marketing board has some initial success in keeping the terms at parity, increasing exports only slightly. After year 5, however, the board is unable to hold the line within the rules and constraints of its operation. In year 9 it buys up 15 percent of the cereals crop (7 percent of total agricultural output), but the terms of trade still fall to 73 (compared with 87 in the basic run).

The force driving the terms of trade is of course the increased productivity. Total agricultural output grows at a rate of 9.3 percent a year (compared with 7.1 percent in the basic run), and by year 9 agricultural output is 19 percent higher than in the basic run. As a result, both national income and GDP are higher: 5 percent and 2 percent, respectively, above the basic run. It is important to note, however, that this experiment assumes the increase in productivity is costless, thereby overstating the favorable impact on GDP because of the expense of increasing productivity.

But the rather significant increases in total income and product are not shared by the poor. The percentage of households living in poverty is little changed by year 9; and though by then the overall mean income is 10 percent higher than in the basic run and the top decile's mean income has risen still more, by 12 percent, the mean incomes of the bottom two deciles remain virtually unchanged. In this experiment there is no trickle-down at all!

The experiment does change the composition of the poor, as might be expected given the deterioration in the terms of trade. The agricultural groups' share of the poverty population rises. In year 9 they represent 76 percent of the households with incomes under 120,000 *won* compared with 70 percent in the basic run.

The marketing board notwithstanding, many of the gains from the increase in agricultural productivity are reaped by the urban groups. In general, technicians, unskilled workers, and white-collar workers make the greatest percentage gain in mean income, with capitalists, government workers, and the self-employed in manufacturing benefiting the least. Within the agricultural sector the large farms gain the most. But all except the smallest farmers are helped to some extent. Indeed, the package is very nearly a Pareto improvement.

This experiment emphasizes again one of the most consistent results of the entire study: any policy that increases agricultural output tends to worsen the terms of trade and so to worsen the relative situation of the rural population, especially agricultural laborers and small farmers. Even when, as in this experiment, specific steps are taken to try to maintain the agricultural terms of trade, it is an exceedingly difficult thing to do. Thus many of the benefits from increased agricultural output trickle across to the urban sectors. Even when rural groups gain, urban groups gain more, both relatively and absolutely.

Experiment A-4: Rural production package. Rural cooperatives are established as in experiment A-2, along with a marketing board, and productivity is increased as in experiment A-3.

Results. Broadly speaking, the effects of the combined rural production package lie somewhere between the results produced by each of the component programs, though closer to those for the rural cooperatives than for the productivity package. The impact on the incomes of the two poorest deciles is slightly more favorable than that of either policy alone.

As compared with rural cooperatives alone (experiment A-2), the results are generally better for most groups. In year 5 agricultural incomes are noticeably below those of experiment A-2, but by year 9 the agricultural sector as a whole is better off than with rural cooperatives alone.

Only the smallest farmers are less well off than in the cooperatives experiment, and all urban groups except government workers are better off. The success of this experiment in benefiting both urban and rural groups is due largely to the marketing board, which prevents the very large deterioration in the terms of trade that would have resulted (as indicated by our comparative statics experiments) from the productivity increase. Without the board, the results would have been a disaster for rural groups.

As can be seen by a comparison of this experiment with experiment A-3, the role of rural cooperatives as a means of transferring urban income to the rural sector permits the benefits of agricultural productivity increases to be felt in the countryside as well as in the city. Thus, the combination of marketing board and rural cooperatives allows the gains from improvements in agricultural productivity to be shared more equitably throughout the economy.

The extent of poverty is reduced somewhat, from 15 percent to 12 percent of all households. The share of agricultural households in the poverty population falls only slightly, from 70 percent to 68 percent, with agricultural laborers actually increasing their share in the (smaller) poverty population.

Rural Employment Experiment

Experiment A-5: Rural public works and rural industry. The intent of this experiment is to model a significant rural public works program coupled with policies to increase small-scale manufacturing and trade in the rural areas. The employment created by these policies is assumed to come from underemployed rural labor, and therefore to cause no decline in the labor supplied for other activities.

For the public works part of the package, government investment is increased 30 percent and is spent on construction inputs. Then, 75 percent of the net value of the government's purchases of construction inputs is transferred to the rural sector. Only a fraction of the net value of the costs of intermediate goods is transferred because (1) it is assumed that the demand for intermediate goods is satisfied from the usual sources, and (2) an allowance is made for urban managerial labor. The cost of intermediate goods represents about two-thirds of the value of construction output. The transfer is divided among agricultural laborers (half) and farm sizes 1 and 2 (one-third and one-sixth, respectively).

For the rural industry part of the package, investment in small-scale manufacturing (sectors 3-20) is increased for the first two periods so as to increase their capital stocks 30 percent. The net value of sales due to the increased capital stocks is then transferred to the rural area and distributed in the same proportions as the other transfer. The transfer

equals 5 percent of the income of the self-employed in manufacturing plus 10 percent of the income of the self-employed in services.

Finally, direct taxes on households are raised by a constant factor to finance both parts of the package.

Results. The rural public works program in year 1 costs ten billion *won* and demands about 3,000,000 man-days of labor. This labor demand is equivalent to about 2 percent of the labor supplied by landless laborers or one-half of 1 percent of that supplied by landless laborers together with family workers in the two smallest farm sizes. These numbers all increase in later years.

The added investment in small-scale industry costs about 25 billion *won*, all during the first two periods. It leads initially to a transfer of approximately four billion *won* per year from the self-employed in manufacturing and about 15 billion *won* per year from the self-employed in services. The new rural industry absorbs 2,000,000 man-days per year from the self-employed in manufacturing and 14,000,000 man-days per year from the self-employed in services. The total annual budgetary cost of the combined program is initially about 10 percent of government receipts (excluding tariffs).

The program has little effect on production. By year 9 total output is 1.5 percent above the basic-run value. The structure of production at the five-sector level of aggregation barely changes at all. This conceals some changes at the sectoral level: agriculture and textiles are down; chemicals, machinery, and most services are up. The structure of production by firm size changes slightly in the beginning. In the first year the production share of the self-employed in manufacturing is 8.2 percent higher than in the basic run, but by year 9 the shares by firm size are virtually identical to the corresponding basic-run values.

The package is ultimately somewhat deflationary relative to the basic run, since it is financed out of increased taxes and also since overall production increases slightly. Over the whole period the rate of inflation is about 10 percentage points lower than in the basic run. The increase in production is due to the greater utilization of labor.

In year 5 the distributional effects of the package are those that might have been expected from partial-equilibrium analysis. Urban groups, especially the self-employed (part of whose business receipts are transferred to rural households), are worse off, and rural groups are better off. The greatest beneficiaries are, of course, the agricultural laborers, whose real incomes are up 63 percent from the year-5 value in the basic run. After them, the most important gainers are the two smallest farm sizes, whose incomes are 19 percent and 8 percent higher, respectively. There is also a trickle-up effect to the larger farmers, whose incomes are up 4

percent due to increased food consumption. By year 9, however, the income effect for medium and large farmers is badly eroded (to 82 percent of the basic-run value) because the terms of trade turn against agriculture. The income gains of agricultural laborers and the smallest farm size are actually increased, but there is also a significant transfer of real income to urban workers.

Despite higher rural real incomes, there is no reduction in migration, since the real household incomes of agricultural workers are still substantially below those of urban workers.

The effects on the incomes of the bottom two deciles are quite favorable. By year 9 the poorest decile's mean real income is 30 percent higher than in the basic run, and the next lowest decile's is 17 percent higher. The degree of poverty is reduced very substantially: by year 9 the share of households below the poverty line is reduced by one-third, about 5 percentage points. The improvement in the absolute incomes of the poorest groups by year 9 is more favorable than that of any program analyzed that does not consist of combinations of packages.

Human Resource Experiments

Experiment A-6: Rural consumption subsidy. The prices of all agricultural goods, processed food, and medical services are lowered 20 percent for agricultural laborers and small farmers (farm sizes 1 and 2). In addition, the purchase of housing by these groups is subsidized by an income transfer based on their initial housing consumption.

Results. The major impact of the experiment, as expected, is on the cost of living and real incomes of the target groups. The cost of living is about 10 percentage points lower in every year for the three groups than for other consumers and, in year 9 is 18 percent below their cost of living in the basic run. The real incomes of the target groups are significantly higher than in the basic run: around 17 percent in year 1, 23 percent in year 5, and 5 percent in year 9. The variation with time reflects the dependence of the magnitude of the real income effect on the agricultural terms of trade. In this experiment the terms of trade, which are quite favorable to farmers in year 5, become quite adverse by year 9. The reason for this behavior is that the target groups consume relatively more agricultural products, leading to an increase in the price of agricultural goods. The resultant income improvement in the rural sector leads to increased demand for urban goods, which ultimately turns the terms of trade around.

The impact of the program on income distribution is disappointingly small and temporary. The Gini coefficient, which is .012 better in the first

year, increases by year 9 to a value actually slightly higher than in the base run. The share of the poorest two deciles is only 4 percent higher than in the base run in the first year, and by year 9 shows no improvement over the base run. The absolute incomes of the poorest 20 percent do show some improvement, compared with the base run, because the total mean income is by then 105 percent of its basic-run value. The total poverty population is 1.4 percentage points lower than in the basic run in year 9, but the share of the poverty population among the target groups, which is significantly lower in the early years of the program, is actually higher in that year than in the basic run. One reason for the rather small effect on poverty shares is that a significant percentage of some of the target groups is already above the poverty line in year 1 even without the subsidy—37 percent of the smallest farmers and 54 percent of the farms of size 2.

The subsidy program is moderately expensive—about 36 billion *won* in the first year, i.e. about 12 percent of total government expenditure or 2.5 percent of national income—and has very little effect on the rest of the economy. It is initially somewhat inflationary. In year 1 the wholesale price index is 3 points higher than in the basic run; in year 5 it is 12 points higher, but by year 9 it is about 10 points lower. All in all, the direct subsidy program appears to be an expensive way of accomplishing less than can be achieved, for example, by a combination of rural public works and the decentralization of industry (experiment A-5).

Experiment A-7: Education and demographic change. Our model does not provide specifically for demographic change or for the relationship between the skill composition of the labor force and education. This policy package is therefore modeled by changing some of the parameters exogenously so as to capture initially the partial-equilibrium effects. The effects of increased investment in education in rural areas are modeled by increasing both the migration elasticity in Stage III and the relative supply of technicians and white-collar workers. The demographic change is represented by decreasing the annual growth rate of the rural population by .25 percentage point, reflecting the results of a presumed prior birth-control program. Though this decrease in the rate of growth is high by international standards, it is consistent with the Korean experience.

Results. In 1968 Korea had a well-established family-planning program that dated back some 20 years or so. The experiment should therefore be interpreted as representing the results of a pre-existing, effective birth-control program—intensified relative to the basic run. Thus, "year 5" is really year 25 and "year 9" is really year 29.

On the whole, the results of the package are small. Initially, the changes lead to a deterioration in distribution (the Gini coefficient rises from .409 to .414 in "year 5"), and only in "year 9" do they lead to an improvement (the Gini coefficient falls from .444 to .425). Similarly, in "year 5" there is an increase in poverty (the percent of poor households rises by 1.5 percentage points), and only in "year 9" is there a decrease in poverty (1.1 percentage points fewer poor households), and a 9 percent increase in the income of the poorest decile. The beneficial effects of population reduction are thus a long time in coming, not dramatic over the medium run. There is also a deleterious transition phase.

The demographic package modeled does help the sector in which the population reduction occurs, even absolutely, but only at the cost of increasing the incidence in poverty in the rest of the economy. This is due to two effects: changes in the terms of trade, which raise the cost of living of the urban population, and increased in-migration, which lowers the wages of the not highly skilled workers. Average household incomes fall progressively and are 7 percent lower than in the basic run at the end of the period.

The package is quite favorable to farmers. As the growth rate of the agricultural labor force slows, agricultural production falls off, and the terms of trade rise. At the end of the period they stand at 122 (compared with 87 in the basic run). This is translated into substantial income gains for all farm groups over the basic run: the income of small farmers is up 30 percent, of middle farmers is up 33 percent, and of large farmers is up 36 percent. This is one of the few policy packages that also benefit agricultural workers substantially: their incomes rise 30 percent. Within the agricultural and urban sectors the distribution of income widens. But the income gap between the two sectors narrows to a notable degree, because while rural incomes rise, urban incomes fall about 20 percent under the impact of the increased in-migration from the countryside, which depresses urban wages.

The combination of education and demographic effects has an influence on the structure of employment, the pattern of production, and the composition of the labor force. By the final year the agricultural labor force is 8 percent smaller than in the basic run, the total labor force is 2 percent smaller, and rural migration to urban areas is 40 percent higher (up to an annual rate of 86,000 people by year 9). As a result, the composition of the labor force is changed: the rural proportion falls (by 3 percentage points); transportation and communications, and services (mainly education and medical) rise (by 1 percentage point). There is an overall relative decrease in employment in manufacturing of 1 percentage point.

The skill structure of the labor force is upgraded. There is a rise in white-collar workers (up 4 percentage points), skilled workers (up 9 points), and unskilled workers (up 5 points). There is a decline in the self-employed (down 7 points), reflecting the fall-off of sideline activities in the shrunken agricultural labor force. As a result of these effects, there is a slight upgrading in the overall labor productivity of 1 percent. Agriculture registers an increase of 5 percent, but this is offset to a large extent by the decline of productivity in all other sectors. Still, gross production in year 9 is virtually the same as in the basic run, and both GDP and national income are 1 percent higher.

It would appear that the beneficial effects of population reduction are not nearly as strong as generally claimed. The effects in the medium run are small, in absolute terms, and involve a transition phase that makes matters worse. Moreover, even in the end a policy that limits the growth of the rural population is more effective in improving distribution and reshifting the incidence of poverty than it is in reducing poverty as such.

Some further points should be noted. First, the reduction in population growth assumed in this experiment is costless and quite substantial by international standards. Second, the fiscal cost of providing the increased education is ignored. The student population rises 20 percent and so do private expenditures on education. In effect, the educational expansion has been financed by private expenditures. Finally, to the extent that the teacher-student ratio is lower, there is a deterioration in the quality of education. In contrast to the 20 percent increase in students, employment in education rises just 4 percent.

Experiment A-8: Social development. The rural consumption subsidies in experiment A-6 are combined with the education and demographic package in experiment A-7.

Results. In this combined package, the results are not quite the sum of the results of the component programs. By year 5 it is evident that there is a negative interaction between the two individual packages. By year 9, the end of the calculation, however, the interaction effect is reinforcing. The impact on both employment and production is closer to the results produced by the education and demographic experiment. As in experiment A-7, consideration of the long-run implications of the educational and demographic changes is essential to a proper appreciation of the implications of these policies.

The agricultural terms of trade in year 9 (110) are clearly closer to the terms in the demographic experiment (122) than to those in the rural consumption experiment (77). The distributional effects, however, surpass those of the demographic package alone. By the final year the incomes of the poor are about 2 percent above the sum of the improvements obtained

through the separate packages. This is because, in the combined experiment, the prices of the consumption basket of the poor (corrected for subsidies) are about 2 percent lower than the average prices of the subsidy (A-6) and demographic (A-7) experiments.

This combined social development package appears to represent a fairly effective way to reach the poor, even though the components were individually disappointing. At the end of nine years, the proportion of households below the poverty line has dropped to roughly 11 percent, 21 percent fewer than in the basic run, and the mean real incomes of the poorest decile are 16 percent higher. The interaction between the two packages ultimately causes the overall effect on poverty to be greater than the sum of what they accomplish as individual programs, at least so long as out-migration from rural areas remains significant. This extrapolation beyond the duration of the calculation is based largely on the argument that migration will mitigate the disastrous fall in the agricultural terms of trade that would normally develop with time. In practice, one might expect the interaction effects in the combined package to be somewhat weaker, since the drop in the rate of population growth would tend to be reduced as improved nutrition lowers infant mortality (and perhaps increases fecundity).

Overall Rural Development Experiments

Experiment A-9: Rural development including land reform. This package combines all the policies hitherto tested: land reform (experiment A-1); rural cooperatives plus increased productivity and a marketing board (experiment A-4); rural public works and industry (experiment A-5); and rural consumption subsidy plus education and demographic change (experiment A-8).

Results. This package dramatically reduces the extent of poverty, to the point where, by year 9, fewer than 4 percent of all households are living in poverty, compared with 14.5 percent in the basic run. The principal reason for this decline is a phenomenal increase in the real incomes of agricultural laborers, which have almost trebled compared with the basic run. Indeed, about 93 percent of the poverty households are now urban, against 30 percent in the basic run. These households are concentrated largely among two groups, unskilled workers and government workers. About 10 percent of the households in each of these groups are below the poverty line, and together they account for 81 percent of the poor households.

The combined package is clearly very favorable for the overall distribution of income, especially in the early periods. Even in year 9 the Gini

coefficient is .379, compared with .444 in the basic run. There is a quite general flattening of the distribution away from the top deciles in favor of the bottom deciles. Yet, interestingly, in measuring the increases in absolute incomes against the sum of the individual packages, we find that the two bottom deciles make about the same gain as the sum of the packages, whereas the top decile improves its position slightly in the combined experiment. The interaction effects in this case, unlike the combination of A-6 and A-7 to form A-8, lead to less equality in the distribution.

The initial impact is to benefit greatly the rural sector (except for the largest farmers) at the expense of the city-dwellers. As time goes on, however, the benefits of the package are distributed more evenly. In the first year all urban groups lose both relatively and absolutely; however, by year 5 almost all have gained relative to the basic run, and by year 9 the only people who are substantially worse off compared with the basic run are the self-employed in services and the largest farmers.

Some of the benefits from the rural package are transferred to the urban groups, but the rural groups are generally the prime beneficiaries. The mechanism of the transfer is through changes in the agricultural terms of trade. Initially, these rise to about 119, almost 20 points above the basic run, but by year 5 they are 28 percent below the basic run (88.6 compared with 123.4), and in year 9 they are 24 percent below (66.7 compared with 87.3). Lower agricultural prices favor the urban groups over the rural and, in general, the poor over the rich (since the former spend relatively more on food). The rural strategy is initially more favorable to agriculture than any of the individual packages, but ultimately only moderately so. Yet rural incomes as a whole are considerably higher than in any other package, even in year 9, primarily because of much higher nonagricultural receipts.

By year 9 the level and the structure of employment are very like those of the social development package (experiment A-8); likewise the rate of migration. Production levels in agriculture, on the other hand, are quite close to those of the production package (experiment A-4). In every nonagricultural sector, production is at a higher level than in any of the component packages. As a result, the productivity gains of both the social development package and the agricultural productivity package are exceeded by the combined package. By year 9 the overall rate of economic growth is higher and the rate of inflation lower than in any of the component packages.

All in all, the combined rural development package is quite successful over the period of the calculation, demonstrating excellent performance in terms of both growth and income distribution.

TABLE 45

Rural Policy Experiments: Summary

Experiment and program	Year 1					Year 9				
	Poverty	Distribution	Income of rural poor	Terms of trade	Agricultural production	Poverty	Distribution	Income of rural poor	Terms of trade	Agricultural production
A-1: Land reform	2	2	1	0	1	2	2	1	1	0
A-2: Cooperatives	1	1	2	1	0	1	1	1	−1	0
A-3: Productivity and marketing	0	0	0	0	0	1	−1	0	−2	2
A-4: A-2 and A-3	1	1	2	1	0	1	1	1	−1	2
A-5: Public works and industry	1	2	1	0	0	2	1	2	−2	−1
A-6: Consumption subsidy	1	2	1	1	0	1	0	1	−1	−1
A-7: Education and demographic change	0	0	0	0	0	1	1	2	2	−1
A-8: A-6 and A-7	1	2	1	1	0	2	2	2	2	−1
A-9: All programs combined	2	2	2	2	1	2	2	2	−2	2
A-10: All programs but land reform	1	0	2	2	0	2	2	2	−2	2

NOTES: All scores are relative to the basic run. 2 = major improvement; 1 = minor improvement; 0 = no significant change; −1 = minor worsening; −2 = major worsening. The criteria for the scoring of the five categories are as follows:

Poverty: ≥3 percentage points = 2

Distribution: ≥.010 in Gini = 2 in year 1

≥.022 in Gini = 2 in year 9

Income of rural poor: ≥20 percent change in weighted average income of agricultural laborers and farm sizes 1 and 2 = 2

Terms of trade: ≥15 percent change in terms of trade = 2

Agricultural production: ≥5 percent change in production = 2

Experiment A-10: Rural development without land reform. The same as the preceding experiment save for the omission of the land-reform measures encompassed in experiment A-1.

Results. Even without land reform, this rural development package is very effective in reducing poverty and redistributing income. It is noticeably less effective, however, than the A-9 package, and this is true consistently throughout the nine-year period. When land reform is excluded, total production and income drop off somewhat, the size of the poverty population increases substantially, and the overall distribution is more unequal. In the last year there are 29 percent more households below the poverty line than in experiment A-9, and the average incomes of the bottom two deciles are down 7 percent. In addition, the distribution of income within the agricultural sector is substantially worse: at the end of the period the income of rich farmers is 32 percent higher than in experiment A-9.

Since total agricultural output does not rise quite as much as in the other package, rural groups do somewhat better in the last period, and the income gap between the agricultural and urban sectors is narrowed. Nevertheless, in that period the Gini coefficient is significantly worse without land reform because of the better distribution within the agricultural sector resulting from the land reform. In sum, the strategy without land reform, though quite beneficial, is inferior to the strategy with land reform.

CONCLUSIONS

The general conclusion that can be drawn from the dynamic runs described in this chapter is that results derived from comparative static experiments are generally valid when tested in a dynamic framework. The essential lessons can be inferred from Table 45, which provides a brief summary of the effects of the various rural strategies on a few key variables: the degree of poverty, the degree of overall inequality, rural household income, the terms of trade, and agricultural production. The major conclusions are:

1. In the absence of pure transfer payments (as in experiment A-2 and the combined experiments that include it), the course of agricultural incomes is determined mostly by the course of the agricultural terms of trade.
2. Once self-sufficiency in food production is achieved, policies that increase agricultural production tend to hurt farmers unless they are accompanied by policies to maintain agricultural prices.
3. Eventually most rural development strategies lead to a trickle-up

to urban groups either through increases in the demand for urban goods or through cheaper food, or both.

a. In general, cheaper food benefits the poor urban groups more than the rich ones.

b. In either case, policies that help rural incomes eventually result in a deterioration in the agricultural terms of trade.

4. The terms of trade are extremely sensitive to changes in agricultural production.

a. To absorb excess supplies on the order of 1 percent requires decreases in the terms of trade on the order of 5–10 percent.

b. This is due both to distributional effects and to price effects. When the terms of trade move against farmers, there is a transfer of income to urban groups, which spend a significantly smaller share of their income on agricultural products; in addition, the demand for agricultural goods is relatively price inelastic.

5. A very effective way to benefit the urban poor is to increase agricultural production to such a point as to cause a decline in the terms of trade. This improvement occurs, however, at the cost of further impoverishing small farmers and agricultural laborers.

6. Rural development strategies designed to benefit the rural poor, improve income distribution, and reduce overall poverty generally involve integrated packages of programs addressing not only agricultural productivity and the agricultural terms of trade but, equally importantly, the generation of nonagricultural sources of income in rural areas.

CHAPTER EIGHT

Urban Policy Experiments

WE NOW TURN to the analysis of the policy experiments oriented toward helping the urban poor. Our choice of policies to try was influenced by those discussed in Chenery et al. 1974, as well as by the major recommendations of the various employment missions of the International Labor Organization.

In looking at the results of the various urban policy packages (which are in general rather disappointing), it is important to keep certain points in mind. First, Korea's basic decision to pursue an urban development strategy was a good one in that it resulted in significantly higher real incomes for the poor. As is evident from our counterfactual import-substitution experiment, the implicit gains from choosing the "right" development strategy (in the Korean case, export promotion over import substitution) can be substantial. Second, the urban poor, though poor both in absolute terms and in relation to other urban groups, are relatively well off compared with the rural poor. Moreover, the income gap between the rural and the urban poor widens throughout the simulation period. By year 9 of the basic run, only 30 percent of the households living in poverty are urban, compared with about 50 percent at the start of the period. Furthermore, because the poor are spread among a number of different urban groups, programs targeted at helping them, though initially beneficial, eventually tend to help middle-income people. That is, the extent of leakage to the non-poor is fairly large initially and becomes even larger over time.

DISCUSSION OF THE EXPERIMENTS

The urban experiments, eleven in all, are grouped under five general headings:

Human resources. A group of three experiments analogous to those conducted for the rural poor under this heading: a subsidy of consump-

tion for the urban working poor (experiment B-1); an urban education and reduction in population growth package (experiment B-2); and a combined package including, in addition, increased rural-urban migration (experiment B-3).

Employment. Another set of three experiments: the first involves the subsidization and encouragement of small-scale industry (experiment B-4); the second calls for the further promotion of labor-intensive and export industries (experiment B-5); and the third is a service industry public employment package (experiment B-6).

Technology and manpower. Also three experiments: a program increasing the labor intensity of production (experiment B-7); a program that makes labor and capital less substitutable while making investment more expensive (experiment B-8); and a combined employment and technology package (experiment B-9).

Nationalization of large industry (experiment B-10). This experiment is the urban equivalent of land reform.

Overall urban development strategy (experiment B-11). This experiment is a combined package incorporating the most promising individual packages.

Human Resource Experiments

Experiment B-1: Subsidy of consumption for urban workers. The price of food (cereals, other agriculture, and processed food), housing, and medical services is lowered 20 percent for skilled and unskilled workers and apprentices. In addition, the productivity of the medical services sector is increased, and the target groups receive a direct subsidy for the net price of medical services. Finally, direct taxes are raised by a constant factor to finance the package.

Results. The immediate effect of the package is to lower the cost of living for the target groups by 11 percent from the basic run. In the first year the real incomes of these groups are 10 percent higher than in the basic run, and this relative gain persists over time.

The package has very little effect on the overall distribution. In the final year the Gini coefficient is .005 lower than in the basic run, and the percentage of households living in poverty declines by less than half a percentage point. This result is in marked contrast to the result of the analogous package for the rural poor. The two experiments have similar effects on the real incomes of the target groups, but the rural package has much more impact on overall poverty. The reason for this difference is that the urban groups are relatively rich compared with the rural ones. In the basic run the three urban target groups represent 25 percent of the poor households in year 1, against 48 percent for the three poorest rural

groups. By year 9 the gap is even more dramatic: 18 percent against 69 percent. In year 9 the three urban groups have mean incomes roughly equal to the mean incomes of the sixth decile, whereas the rural groups fall in the three bottom deciles.

As in the comparable rural experiment, the subsidy program has very little effect on the rest of the economy. The inflation rate is similar, and in year 5 the terms of trade move slightly in favor of agriculture compared with the basic run (130 compared with 123). The program costs a bit less than the rural program (22 billion *won* in the first year compared with 36 billion in experiment A-2). But then it is also far less effective in alleviating poverty.

Experiment B-2: Education and demographic change. The relative growth rates of the supply of technicians and white-collar workers are increased one and three percentage points, respectively; and the aggregate growth rate of the urban labor force is decreased by a quarter of a percentage point annually.

Results. This package is analogous to the rural demographic and education experiment, except that the rate of migration is not changed. Its impact on the extent of poverty is quite small. In the short run, up to year 7, it improves the distribution very slightly over the basic run, but by year 9 the overall distribution has actually deteriorated. This is primarily because the terms of trade turn significantly against agriculture. Rural employment and production remain essentially unchanged from the basic run (less than 1 percent difference), while the number of urban workers decreases (by 3 percent). This has the effect of reducing the rate of increase of urban demand for food. The corresponding reduction in the supply of urban goods and services is quite small: by year 9 aggregate urban production is only 1 percent below the basic run. As a result, by year 9 the terms of trade are 10 percentage points lower than in the basic run, and rural incomes about 8 percent lower. Even the absolute incomes of the poorest three deciles are somewhat lower.

As in the corresponding rural experiment, overall labor productivity is higher, primarily because of the upgrading of the labor force. The increase in labor productivity compensates for about two-thirds of the loss in output due to the shrunken labor force. The urban labor force is about 3 percent lower and urban production about 1 percent lower than in the basic run.

Thanks to the education program, the skill differentials in the urban labor force lessen somewhat. The wages of skilled and unskilled workers increase relatively more than those of engineers and technicians, and in year 9 the wages of white-collar workers are actually 9 percent lower than in the basic run. The ratio of engineer wages to unskilled worker wages is

2.41, compared with 2.55 in the basic run. There seems to be no tendency to substitute labor for capital; sectoral capital stocks are virtually the same as in the basic run.

On the whole, the education and demographic change package results in a relative movement of income from the richest decile and the poorest four deciles to the intermediate households. It hurts the very rich relatively and the very poor both relatively and absolutely. This distributional impact is quite different from that of the rural educational and demographic program, which in general had a beneficial effect.

Experiment B-3: Urban social development. The urban consumption subsidy in experiment B-1 is combined with the education and demographic change package in experiment B-2. In addition, rural migration is increased (by 46 percent over the period).

Results. The urban social development program is more beneficial in its distributional impact than the individual components. Compared with the basic run, the bottom eight deciles gain at the expense of the top two, and the bottom four deciles gain substantially. In year 9 the average income of the bottom decile is 11 percent higher than in the basic run, while the top decile's is 9 percent lower. The average household income, however, is 4 percent lower.

By year 9 the impact on the bottom two deciles appears to be dominated by the increased migration, whose effect is discussed below. The increase in the relative incomes of deciles 3 to 5 shows the continued influence of the consumption subsidy to the poorer urban groups, and the increase for deciles 6 through 8 reflects the impact of increased education.* Thus different elements of the combined package appear to influence different parts of the distribution.

The preponderant influence of migration on the relative income of the bottom two deciles operates through its effects on agricultural incomes. The increased migration reduces agricultural production and raises the agricultural terms of trade. The lower incomes of the technicians and white-collar workers (who by year 9 earn only 77 percent and 80 percent, respectively, of their basic-run values) are due to the increased supply of these skills as a result of the educational upgrading of the labor force. Apprentices and skilled and unskilled workers improve their position relative to other urban workers, in large part because of the consumption subsidy. Their gains are also due in some part to labor supply effects operating through education, migration, and demographic

* This explanation, like many of the others in these chapters, was developed from the results of subsidiary experiments separating the individual effects.

change. But these are to some extent counteracting, since migration adds labor to the unskilled categories while education and decreased population growth subtract labor from them. The demographic and education part of the package has less net effect on worker incomes than the consumption subsidy.

On the whole, the combined urban social development package is effective in improving the distribution. But since it also lowers the growth of overall household incomes (in year 9 overall mean income is only 95 percent of the basic-run value), its impact on poverty reduction is not especially great. In year 9 the lowest decile's income is 11 percent higher than in the basic run, but the number of poor households is reduced by only 2 percentage points.

Employment Experiments

Experiment B-4: Small-scale industry. The expected market share of firms with fewer than 50 employees (the self-employed and the smallest firm size) is raised in Stage III. This raises their demand for capital in Stage I of the subsequent period. To satisfy this demand, their access to finance is subsidized in Stage I by increasing the supply of funds to these firms.

Results. The program is effective in terms of the immediate objective—that of altering the size structure of production. By year 9 the share of total manufacturing output produced in the two types of firms is 27 percent higher than in the basic run. However, the effects of the program on income levels, on the overall size distribution, on overall production, and on productivity are quite small.

At the end of the period the incomes of the self-employed in manufacturing are somewhat higher (11 percent), and there is a corresponding reduction in the real incomes of capitalists (4 percent). The decile distribution of household incomes is almost identical. There is a very slight effect on the percentage of poor households (down 4 percent); on the absolute incomes of the poor (up 2.4 percent); on mean incomes (amounting to 1 percent over the basic run for the entire period); and on the incomes of the rich (1 percent higher than in the basic run in the final year).

Though the impact on overall growth is also far from dramatic, the shift in the structure of production does not lower either total production or productivity. On the contrary, gross output by the final year even increases a tiny bit (1 percent) compared with the basic run. In manufacturing, total production increases slightly, and so does labor productivity (up 4 percent), since small-scale industry becomes more capital-intensive.

All in all, the results of the program are not impressive. Unless one attaches a social and political value to the size structure of industry (which many may well do), there is not much gain from the program in terms either of the income distribution or of overall growth. Indeed, it has little effect on any economic aggregates.

*Experiment B-5: Labor-intensive and export industries.** These industries get a direct subsidy of 20 percent on their net prices; they are charged a lower interest rate on both old and new loans, thereby lowering their interest payments 30 percent and increasing their demand for new investment in Stage I; and the export targets of exporting industries are increased 10 percent.

Results. This experiment is very similar to two of the comparative statics experiments (C-1 and C-2) and has essentially similar results by the end of the period. The initial impact of the package is highly inflationary, but the inflationary bump dissipates quickly, and by year 3 the net effect is deflationary compared with the basic run. The differences in the wholesale price index from the basic run are +24, −14, and −13 for years 1, 5, and 9, respectively.

The inflationary bump in the first year is a one-time adjustment to the changes in net prices due to the subsidy. The subsidy raises marginal revenue products, and thus wages, far more than it raises output. After the first year the increase in aggregate output compared with the basic run leads to relatively less inflation. The effect of this difference in inflation falls heavily on real investment. Because of the unexpected inflation in year 1, real investment is 19 percent lower than in the basic run. In years 5 and 9, however, investment is higher by 12 percent and 6 percent, respectively, because the inflation rate is lower than anticipated.

In year 1 the aggregate output of the affected sectors is 4 percent above the basic-run value, whereas total gross output is only one-half of 1 percent higher. The policy package clearly has some differential impact on the subsidized sectors. However, by year 5 aggregate gross output is 4 percent above the basic run, and there is little difference in the impact on production between the subsidized and non-subsidized sectors. By year 9 the subsidized sectors' share in total aggregate output is the same as in the basic run. Clearly, by year 9 the linkages through intermediate demands have spread the effect of the program throughout the economy.

* The sectors involved are 3, fishing; 4, processed foods; 5, mining; 6, textiles; 7, finished textile products; 8, lumber and plywood; 9, wood products and furniture; 14, cement and nonmetallic mineral products; 16, nonelectrical machinery; and 20, other consumer products. Together these industries account for 28 percent of total production and 67 percent of total manufacturing output.

The package's effect on the overall distribution is dominated by changes in the terms of trade, which move steadily more in favor of agriculture. The net effect is a windfall to rural households. The overall size distribution is noticeably improved, but the percentage of poor households is little changed. The group composition of poverty naturally changes as the terms of trade move in favor of agriculture. By year 9 rural incomes are 40 to 52 percent higher than in the basic run, with the rich farmers gaining relatively the most. These results are consistent with those from the comparative statics experiment C-2, in which the terms of trade also moved in favor of agriculture. The promotion of labor-intensive industry is in fact one of the most effective ways to benefit farmers.

Experiment B-6: Urban public works. Investment in real estate (sector 23) and transportation and communications (sector 24) is increased 20 percent in Stage III; this leads to increased output in these sectors and to increased demand for construction (sector 21). Direct taxes are increased by a constant factor to pay for the additional investment. The rate of migration is raised, resulting in a 46 percent increase over the entire period.

Results. By year 9 the capital stock in the housing and real estate sectors is up 3 percent from the basic run, which represents an increase in real investment of 159 billion *won* over the period. While aggregate real investment also rises, the two sectors more than absorb the gain, and by year 9 the total capital stock in the rest of the economy is about 1 percent lower than in the basic run. As Table 46 indicates, the net result is a sizable increase in output in both the real estate and the transportation sectors relative to the basic run and a moderate increase in output in the construction sector. Employment increases somewhat in the construction, real estate, and transportation sectors, showing up as a 6 percent increase in the aggregate shelter and transportation sector relative to the basic run by year 9. Since there is very little direct employment in the real estate sector, the increases are due almost entirely to increases in employment in the construction and transportation sectors.

The program costs 31 billion *won* in the first year, or about 10 percent of total government expenditure, and continues to account for about 10 percent of total government expenditure throughout the calculation. Direct taxes on households climb 33 percent in the first year, tapering off to a 4 percent rise in year 9 relative to the basic run.

The impact effect on wages is as expected—a small (1 percent) initial increase in the income of skilled and unskilled workers. There is no increase in the incomes of the lowest deciles or reduction in the percentage

TABLE 46
Urban Policy Experiment B-6: Capital Stock and Output in Construction, Real Estate, and Transportation and Communications as a Percent of Basic-Run Values

Sector	Capital stock			Output		
	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
Construction (sector 21)	100%	100%	100%	100%	105%	105%
Real estate (sector 23)	100	101	103	103	106	112
Transportation and communications (sector 24)	100	101	103	103	113	121

of poor households. The increase in wages and employment has the effect of inducing a higher rate of migration, and by year 5 the increased urban employment program leads to a decrease in urban real wages relative to the basic run. It also leads to a marked change in the terms of trade in favor of agriculture, which reach 140 at that point. This rise results from a relatively substantial reduction in agricultural production (in year 5 it is off 1.4 percent from the basic run) due to increased migration and, at the same time, a greater supply of urban goods due to the enlarged labor force and to increased investment. By year 9 nonagricultural output is up 4.2 percent over the basic run. As seems to be typical when the terms of trade change in favor of agriculture, large farmers gain substantially more, both relatively and absolutely, than small farmers.

The tendency for the benefits of the urban employment program to be transmitted to rural households is accentuated by year 9. The gap between urban and rural incomes narrows compared with the basic run, and, because of increased migration, relatively more people are in the higher income urban sector. As a result, by year 9 there is a substantial improvement in the overall distribution of income. The share of households living in poverty is slightly reduced (to 13 percent, down 1.5 points from the basic run), and the incomes of the two bottom deciles are somewhat improved (the mean income of the poorest decile is up 9 percent). This improvement is due primarily to the indirect effect of the employment program on the rural sector through the reduced output caused by migration.

A similar experiment in which migration was limited to the rate in the basic run gave diametrically opposite results: a shift in the terms of trade against farmers, a substantial reduction in their relative incomes, and a deterioration in the overall distribution of income. In that experiment (not reported in the Appendix tables) by year 9 rural incomes are about

90 percent and urban incomes about 107 percent of the basic-run values; the share of the bottom decile falls to 1.56 percent, and that of the top rises to 33.6 percent, compared with 2.06 percent and 30.54 percent in the experiment we report here; and the Gini coefficient rises from .409 in the present experiment to .452. The real incomes of the bottom two deciles are 95 percent and 97 percent of the basic-run values (compared with 109 percent and 105 percent for experiment B-6).

In experiment B-6, the final result is that rural households gain relative to the basic run, and all other households lose. This experiment is interesting in that it has a fairly significant effect on the overall distribution, with only moderate change in the bottom of the distribution. As noted, by year 9 the share of households living in poverty has been reduced by less than 2 percentage points. Migration thus transforms rural poverty into urban poverty.

Technology and Manpower Experiments

Experiment B-7: Labor-intensive technology. The coefficient on capital for the Cobb-Douglas functions for sectors 3 to 20 (all firm sizes) is reduced 35 percent, and the coefficients on labor are increased proportionately to maintain constant returns to scale. In addition, the rate of migration is increased, resulting in a 46 percent increase over the entire period.

Results. The use of more labor-intensive technology leads by year 9 to a redistribution toward deciles 4–8. Initially, the distribution within the urban sector improves, with skilled and unskilled workers gaining relative to engineers, technicians, and other high-skill categories. This effect is eroded only slightly over time by increased migration. The incomes of both groups in the final period are 30 percent higher and that of the capitalists is 6 percent lower than in the basic run. The share of urban households living in poverty drops to 20 percent, compared with 30 percent in the basic run.

The change in technology has little effect on the bottom two deciles and hence on the reduction of overall poverty. The benefits do not leak across to rural groups. In fact, quite the contrary: by year 9 the terms of trade are even less favorable to farmers than in the basic run (77 against 87). This is because the demand for agricultural products is the lowest of all the urban packages. By year 9 the consumption of agricultural goods by an average blue-collar worker household has dropped to 62 percent of its first-period value. In the basic run consumption drops to only 77 percent. Meanwhile, the consumption of processed foods rises to 20 percent of the total food consumption, the same as in the basic run.

The change in technology induces significant changes in the structure of production, employment, and growth throughout the economy. By year 9 GDP is 1.5 percent higher, consumption 5 percent higher, and investment 4 percent higher than in the basic run. The increase in investment is due to the unanticipated lower rate of inflation, which raises the real value of a given nominal investment. The balance of trade deteriorates, and where there was a 43 billion *won* surplus in the basic run, there is now a 102 billion *won* deficit because of an increase in imports and a small decline in the production of the particular labor-intensive goods that make up the major share of exports.

By year 9 nonagricultural capital stock decreases 4 percent, the nonagricultural capital-labor ratio drops about 10 percent, and overall nonagricultural labor productivity is down 3 percent. The share of all labor-intensive manufacturing industries rises, and their capital-labor ratio increases substantially as producers attempt to substitute for more expensive labor.

Though the package has significant effects on the structure of production and employment, it has only moderate effects on the overall distribution, and those effects are eroded over time. The degree of poverty is reduced only slightly by year 9, compared with the base run. Programs promoting the use of labor-intensive technology may thus be justified in terms of the efficient use of factors, but cannot be justified in terms of their effect on the income distribution.

Experiment B-8: CES functions and decreased elasticity of substitution. Two-level CES functions are used in all non-service sectors (sectors 1–20). In addition, the parameter rho is increased in the CES functions. This decreases the elasticity of substitution about 15 percent. In the basic run the CES elasticities of substitution ranged from 0.67 to 1.25; the new ones range from 0.58 to 1.11.* The rate of migration is also increased, as in experiment B-7. Finally, capital is made more expensive by tightening credit in Stage I.

Results. The design of this experiment was influenced by the results of the comparative statics experiments D-3 and D-4, in which the elasticity of substitution between aggregate labor and capital was decreased and increased, respectively. The net result in experiment D-3 (in which the elasticity was lowered) was to move the terms of trade against agriculture and so lower rural incomes. In the experiment reported here, the elasticity

* The results of a base-year run with CES functions are reported in Chapter 5, experiment D-1. The results of a dynamic basic run with CES functions are not reported but were very close to the Cobb-Douglas basic run. The agricultural sectors have CES functions in all runs.

of substitution was also decreased in the agricultural sectors, whereas in the static experiments agriculture was left unchanged.

The initial impact of the package is to lower output in all sectors. Agricultural production is only slightly affected (down 1 percent in year 1 from the basic run); but output in the other aggregate sectors declines from 8 percent to 14 percent, and total output is down 10 percent. These results are consistent with the results of the corresponding comparative statics experiment. The reason is clear: lowering the elasticity of substitution leads to a relatively less effective use of the available factors of production.

Dynamically, the decline in investment lowers the rate of growth of the capital stock by .8 percentage point a year. The aggregate capital stock in year 9 is 95 percent of its basic-run value. The average rate of growth of GDP is .8 percentage point lower per year, and in year 9 total GDP is off 13 percent from the basic run. Aggregate output and income thus start lower than in the basic run and grow more slowly.

The agricultural sectors are far less affected, and their outputs decline very little. As a result, the terms of trade are down 19 points from the start (80.2 in year 1 compared with 99.7 in the basic run), and reach only 85 at their peak, in year 5. Thereafter they decline sharply, to fall catastrophically in year 9, when they tumble to 48. At this point there was still 5 percent excess supply in the agricultural sectors when the computer program halted because it ran over its iteration limit. The year 9 results at the iteration limit can be interpreted as including a government program to buy up 5 percent of total agricultural output, and indicate that a program of this magnitude would be unable to avert an agricultural disaster. The increased migration was not enough to offset the falling terms of trade, though it helped. In an early partial run without increased migration, the terms of trade fell 3 to 4 points more than in the present experiment.

Even with the decline in the terms of trade, the overall relative distribution in year 1 is virtually unchanged. The agricultural sector's share of the total poverty households increases from 50 percent in the basic run to 55 percent. Because of the general decline in output and income, the mean of the distribution is lower, and the share of households with incomes below the fixed poverty line increases from 38 percent to 42 percent. In year 5 there is still little change in the overall relative distribution compared with the basic run, but the proportion of poor rural households rises from 45 percent in the basic run to 60 percent. In year 9 the massive deterioration in the terms of trade finally has a significant effect on the overall distribution. The Gini coefficient increases by .048 (from .444 in

the basic run to .492), and the rural share of households living in poverty rises from 70 percent in the basic run to 88 percent. The proportion of poor households overall rises from 14 percent in the basic run to 24 percent.

The initial decline in output and the slower rate of growth result in lower average household incomes. Average real household income is only 93 percent of the basic-run value in year 1 and 98 percent in year 9. The decline would have been greater in the later years if there had not been substantially more migration than in the basic run. Because of the decline in the terms of trade, most urban groups gain; only the self-employed in services and capitalists have less income than in the basic run after the first year. But even they gain enormously relative to the rural groups: in year 9 rural real incomes are just over half their basic-run values.

Overall, the change in technology by itself has virtually no effect on the relative distribution. It does lower all incomes significantly, but that effect is lessened by increased migration. It seems that significant changes in technology have a far more powerful effect through their effect on commodity supplies (and hence on the terms of trade and prices) than through their effect on factor demands.

Experiment B-9: Employment and technology. The subsidization of labor-intensive and export industries (as in experiment B-5) is combined with a public works program (as in experiment B-6), an increase in the labor intensity of the industrial sectors (as in experiment B-7), and an increase in rural-urban migration (as in experiments B-6 and B-7).

Results. This employment program has quite significant effects on the overall distribution. The Gini coefficient is lower in every year (.407 in year 9 compared with .444 in the basic run). The relative transfers come from the two top deciles; all other deciles gain in relative shares. There is also a significant effect on poverty; in year 9 the percentage of poor households falls from 14.5 percent in the basic run to 11 percent. The mean income of the two bottom deciles is up about 15 percent over the basic run, and the top decile's is down about 10 percent. The overall mean income is about 3 percent lower.

There are two separate forces working to change the distribution. First, the switch to labor-intensive technology has a significant impact on the capitalists' income, which falls to 77 percent of the basic-run value in year 9. For the self-employed in manufacturing, the fall-off is even greater (to 72 percent). Second, the terms of trade are consistently favorable to agriculture. Indeed, by year 9 they stand at 131 (compared with 87 in the basic run). Though they are somewhat lower in year 5 than in

the basic run (111 versus 123), they are higher in the first year and never fall below 100. The net effect is a transfer to rural areas. All rural groups have significantly higher incomes by year 9 than in the basic run, and except for the self-employed in services, the urban groups have lower incomes.

The improved terms of trade are due essentially to supply effects. The increased migration causes a decline in total agricultural output (down 4 percent in year 9 from the basic run) and an increase in nonagricultural output (up 10 percent from the basic run). Despite increased exports, the increase in nonagricultural production increases the supply of these goods to the domestic market, lowering the relative cost for farmers. The increase in aggregate urban output is due wholly to the increased labor supply and the technology and subsidization program. There is no change in aggregate real investment; the capital stock in year 9 is the same as in the basic run.

Overall the program is quite effective in reducing poverty and making the distribution more equal. However, it is not beneficial to urban households. Their incomes fall relative to the basic run, and by year 9 they account for about 50 percent of the poor households, compared with 30 percent in the basic run. Through changes in the terms of trade, the benefits of the program leak very quickly and substantially into the rural sector.

Nationalization

Experiment B-10: Nationalization of large-scale industry. The affected industries are the largest firm size in sectors 4–20.* To approximate the actual effects of such a program, we (1) eliminated all dividends for these firms; (2) canceled all their outstanding debts (their interest payments are thus zero); (3) raised their relative wages by increasing the ratios of sectoral wages to the overall averages 10 percent; (4) reduced their current productivity 10 percent and lowered the rate of growth of productivity 1 percent; (5) directly subsidized their net prices by 5 percent; (6) increased government employment and the government wage bill 10 percent; and (7) decreased the supply of white-collar workers in the private market by 57,000 workers to offset the increase in government employment.

Results. Despite a very substantial reduction in property income (down 23 percent in year 1 from the basic run), the impact on the overall distribution of income is very small. By year 9 there is a very slight increase

* These firms account for 57 percent of the total production in these sectors, and for 29 percent of all nonagricultural production.

in the share of the bottom two deciles (.11 percentage point) and also a very slight increase in the share of the top two deciles (.17 percentage point). The main distributional impact is the change in the composition of the elite, with white-collar workers increasing their share at the expense of the capitalists. In year 1 the white-collar workers' share in the top decile is 10.1 percent points higher than in the basic run (32.4 percent compared with 22.3 percent), and the capitalists' share is 4.1 points lower (11 percent compared with 15.1 percent). The shift is even more dramatic for the top 1 percent of the distribution (not shown in the Appendix tables). The shares are 45.2 percent compared with 23.2 percent for white-collar workers, and 21.8 percent compared with 40.7 percent for capitalists. Furthermore, the shift in favor of white-collar workers persists throughout the computation.

At the same time, the associated reduction in productivity in manufacturing has adverse effects on real income, as does the withdrawal of labor from the private market with the expanded government role. Initially, urban incomes improve somewhat and rural incomes fall. But by year 9 the slowdown in productivity reduces the real incomes of all urban groups except white-collar workers from the basic-run values. The relative reductions are substantial—from 5 percent to 37 percent. Rural incomes are slightly higher (about 5 percent) due to changes in the terms of trade, but overall average income is down 7 percent from the basic run.

In terms of growth the results of this nationalization are not impressive. By year 9 aggregate gross output is off 5 percent from the basic run. As for GDP, the annual rate of growth falls off two-thirds of 1 percent from the basic run—to 12.3 percent a year. The balance of payments is also worse. Exports grow more slowly, and by year 9 are only 86 percent of the basic-run value. In the first year imports are lower than in the basic run, but they increase at about the same rate. The net result is that the balance of trade is worse in years 5 and 9 (−68 billion *won* and +43 billion *won*, respectively, in the base run, compared with −109 billion and +28 billion in the experiment).

Under the nationalization program, there is slightly less labor available for the private sector. By year 9 total nonagricultural employment is 1 percent less than in the basic run. On the other hand, there is slightly more total real investment during the period, and the capital stock in year 9 is 1 percent higher than in the basic run. The capital-labor ratio thus increases 2 percent. The decline in productivity, however, causes a relative decline in overall productivity, and by year 9 the capital-output

and labor-output ratios are significantly lower than in the basic run (7 percent and 5 percent, respectively).

Interestingly, despite the decline in productivity, the wholesale price index in the terminal year is scarcely higher than in the basic run. This is essentially because overall incomes decline faster than output. Initially, the increased pay scales for unskilled workers in nationalized enterprises and the withdrawal of some white-collar workers from the private labor force keep wages up despite the decline in productivity. But by year 9 the productivity effects dominate, and urban real incomes are down from the basic run. This increases the proportion of income spent on agricultural products sufficiently to raise the agricultural terms of trade 4 points, to 91.7. At first glance the lower urban productivity should restrict the supply of urban goods and so turn the terms of trade against agriculture. This does not happen, however, because the worsening of the balance of international trade relative to the basic run from year 5 on maintains the aggregate supply of urban goods.

All in all, the nationalization of industry does not meet its basic goal of a significant redistribution of income away from the wealthy. Because of lower productivity, all urban groups except white-collar workers eventually lose. Farmers gain, but they would probably lose too if the balance of international trade were not permitted to deteriorate.

Urban Development Strategy

Experiment B-11: Overall urban package. The social development package in experiment B-3 (a consumption subsidy plus education and demographic change) is combined with the urban employment package in experiment B-9 (subsidization of labor-intensive and export industries plus a public works program plus increased labor intensity in the industrial sectors). In this experiment we incorporate all the packages that seemed to benefit the poorer groups. It does not include the nationalization of industry, the promotion of small-scale industry, or the CES technology (experiments B-4, B-8, and B-10).

Results. The overall urban package leads to a persistent significant improvement in the income distribution compared with the basic run. In years 1 and 9 the Gini coefficients are .398 and .444 for the basic run and .377 and .402 for the experiment. In all years almost all the lower deciles gain at the expense of the top decile. In year 9 the first eight deciles gain at the expense of the top two.

The improvement in the distribution is due primarily to the employment package, as is evident when one compares the results with experiment B-9.

The distribution becomes slightly more unequal over time, but in the last year the Gini coefficient is still very close to the Gini coefficient in the first year of the basic run (.402 here against .398 there). The massive shock induced by the total urban package seemingly moves the economy onto a different and less regressive path.

The overall urban package substantially reduces poverty, mostly through the urban employment package. There appear to be some negative interaction effects between the social development and employment packages, so that their combined effects are considerably less than the sum of their separate effects. By the last year, though, only about 10.5 percent of households are below the poverty line compared with 14.5 percent in the basic run. The urban employment package alone succeeded in reducing the number of poor households to 11 percent by year 9. As in the employment package, the urban groups' share in the poverty population increases over the basic-run value, but not by nearly as much. Poverty continues to be a predominantly rural condition, even though the terms of trade move strongly in favor of agriculture, reaching 122 in year 9 (compared with 131 in the employment package and 87 in the basic run).

The economy's growth performance is somewhat better than in the urban employment package; the annual rate is up .76 percent. The reduction in the labor force due to lower population growth is more than offset by the upgrading of the workers' skills. The structure of employment and production is similar to the urban employment package.

As in most of the urban policy packages, the ultimate impact of this overall urban development package is to raise the agricultural terms of trade, and so to pass on many of the benefits of the program to rural households. By year 9 both the rural and the urban poor are better off, but urban workers on the average are still earning over 65 percent more than the poorer rural groups. Though the rural-urban gap has narrowed, further improvement in the agricultural terms of trade would lead to a further reduction in poverty. For a continued leveling trend in distribution, however, further improvement in the terms of trade would have to be accompanied by an increased taxation of rich farmers or by some other mechanism to equalize the distribution within the agricultural sector.

From the discussion above, it is clear that to a degree the effects of the social development program counteract the urban employment package. Not only does the reduction in urban population from slower population growth subtract consumers of agricultural goods; it also results in lower urban output. Thus by year 9 the combined package has less effect on the terms of trade than the urban employment package alone.

These results lead to several conclusions. For one thing, we see that massive efforts pointed at labor-intensive growth and increased employment in the urban sector can lead to a substantial reduction in poverty and to a more equal distribution of income. At the same time, we find that the most significant impact is on rural, not urban, poverty. The indirect effects lead to a massive leakage of the benefits of the program to the rural sector. Urban workers gain absolutely during the period of the experiment, but one would expect that continued change in the terms of trade in the future would further erode the benefits of the program. And one might expect, too, that urban groups would exert enough political pressure to cause the government to try other policies to keep the terms of trade from moving in favor of agriculture. If successful, such policies would of course vitiate much of the program's overall beneficial effects on poverty.

CONCLUSIONS

Three important conclusions can be drawn from the set of urban experiments:

1. Policies aimed at helping the urban poor, when successful at all, tend initially to benefit primarily the middle deciles, not the poorest deciles.

2. Eventually, the benefits of urban anti-poverty policies tend to be transmitted to (or to trickle into) the rural sector. The initially successful policies eventually turn the terms of trade in favor of agriculture and against the urban sector. When this happens, it helps the rural households in the poorest deciles, thus improving the overall distribution of income and alleviating poverty. While the improvement in the terms of trade tends also to widen the income gap between poor and rich farmers, urban development strategies may in fact be an effective way to benefit farmers and achieve rural depauperization, provided that the initial distribution in the rural sector is not too unequal.

3. Some policies that are often suggested to improve the income distribution are clearly ineffective or even harmful. For example, in our experiments, the promotion of small-scale industry, a common policy prescription, has essentially negligible effects distributionally and, indeed, generally. The nationalization of large industries does hurt capitalists, but they are replaced by white-collar bureaucrats; it does little to change the overall distribution and clearly does not benefit the poor. The education plus demographic change experiment is dominated by the demographic effects, which, under our assumptions, are not helpful to the bottom deciles.

In general, the urban experiments are far less effective than the rural experiments in either alleviating poverty or altering the overall distribution. Essentially, this is because there is much more leakage of impact effects into the upper deciles, both urban and rural. The relatively small impact on urban poverty is due also to leakage into the rural sector. In general, the interactions among the factor markets and the product markets on the one hand and the greater substitution possibilities in both consumption and production on the other lead to the rather rapid diffusion throughout the economy of the effects of policies aimed at specific groups.

In essence, the urban economy is like a rubber toy: no matter how it is squeezed, it tends to return to its original shape. But for all that, as we shall now see, it is feasible (albeit difficult) to design combined policy packages that will close those leaks and so maintain the impact effects over time.

CHAPTER NINE

Combined Rural-Urban Experiments

IN THE PREVIOUS two chapters we saw that when policy packages are aimed specifically at the rural poor or specifically at the urban poor, there is sooner or later a leakage that tends to erode the benefits to the target group and to transmit them to other groups. Since poor rural households are much worse off than even the poorest urban groups, leakage to the urban sector (in the rural packages) represents a trickle-up to relatively richer groups, and so tends to deteriorate the overall distribution. It thus also reduces the impact of the various packages on poverty. On the other hand, urban packages that result in substantial leakage to the rural sector have a significant trickle-down effect and tend to reduce poverty and improve the overall distribution. The general improvement in the distribution occurs even though the leakage to the rural sector favors rich farmers disproportionately.

In this chapter we shall examine what happens with a more even-handed attack on poverty, one that cuts across both the rural and the urban sectors with various combinations of policy packages.

DISCUSSION OF THE EXPERIMENTS

We conducted five combined experiments, grouped under three major headings as follows:

Human resources. Two experiments: consumption subsidies for both the urban and the rural poor (experiment C-1) and an urban-rural education and demographic package (experiment C-2).

Employment. A single experiment, C-3, which is essentially a combination of our rural and urban employment experiments.

Fundamental economic and political change. Two grand depauperization strategies consistent with two very different political systems, broadly fitting the labels reform capitalism (experiment C-4) and market socialism (experiment C-5).

Human Resource Experiments

Experiment C-1: Consumption subsidy. The rural consumption subsidy in experiment A-6 is combined with the urban consumption subsidy in experiment B-1. This means that the cost of food, housing, and medical services is lowered 20 percent for six lower-income household groups: apprentices, skilled and unskilled workers, agricultural laborers, and the smallest two farm sizes. As in experiment B-1, the productivity of the medical services sector is increased, and the target groups receive a direct subsidy for the net price of medical services. Direct taxes are raised by a constant factor to finance the package.

Results. The immediate effect of the package is to lower the cost of living of the target groups by about 10 percent. As a result, their real incomes are significantly higher (5–7 percent for the urban groups, 17–20 percent for the rural groups). The increase in the real incomes of the urban target groups relative to the other urban groups is not eroded over time; an analogous statement holds for the rural groups. However, by the end of the calculation the vast majority of the gains have leaked to the urban sector, and the rural target groups are only 5 percent or less better off than in the basic run. The rest of the rural sector is worse off than in the basic run.

The program has a sizable favorable effect on the overall distribution during the early to middle years, but by year 9 the Gini coefficient is virtually identical to the basic-run value (.442 compared with .444). The effects on the overall distribution are caused mostly by changes in the terms of trade, which are higher in year 5 than in the basic run (145 compared with 123), but lower in year 9 (78 compared with 87). The behavior of the terms of trade is similar to that of the corresponding rural policy experiment (A-6), for similar reasons. The extent of poverty changes only slightly; the number of poor households is down 1.5 percent in year 5 and 1.4 percent in year 9 from the basic run. These results are similar to the results of the individual consumption experiments.

The consumption subsidy program has relatively little effect on the rest of the economy, except for a deterioration in the terms of trade and some transfer of agricultural income to the urban sector by the end of the calculation. It represents a very specific program with respect to the target groups and is certainly effective in raising their real incomes. By year 9, in spite of the decline in the terms of trade, the incomes of the three poorest rural groups are above their values in the basic run. Except for the prosperous farmers (the two largest farm sizes), all groups in the economy

gain from the program, with the urban groups—especially the target groups—gaining the most. Neither the amount of poverty nor its incidence is profoundly affected.

The relatively large cost and the relatively small impact of consumption subsidies on overall poverty do not make this tool a particularly attractive one. Though the target groups in both the rural and the urban sectors gain from the program relative to their wealthier neighbors and tend to retain these gains over time, there is a significant leakage of the benefits after a few years from the rural sector, where most of the poor live, to the urban sector, and there is no major impact on overall poverty. A consumption subsidy program would be more effective in alleviating poverty if it were designed to aid particular income groups rather than, as in our experiment, particular occupational categories of households.

Experiment C-2: Education and demographic change. The rural education and demographic experiment (A-7) is combined with the urban one (B-2). The rate of population growth, rural and urban, is reduced by .5 percent at each two-year interval and the labor force is upgraded by increasing the supply of technicians and white-collar workers. As before, the migration effects of increased investment in education in the rural areas are modeled by increasing the elasticity of migration in Stage III.

Results. This package does not do much to reduce poverty. Initially, it actually increases the percentage of poor households, but by the final year the figure is slightly below the basic run (1.7 percentage points). This result occurs even though the agricultural terms of trade are consistently more favorable to agriculture than in the basic run. In year 9 the effect is substantial: the terms of trade are up 30 percentage points from the basic run.

The initial increase in poverty is due to the decline in some urban household incomes, which by year 5 are down by about 6 percent on the average. Rural groups gain by about 5 percent. The urban poor's share of the total poor households rises from 50 percent to 63 percent, and there is a very slight decrease (2 percent) in the absolute incomes of the bottom two deciles. Through year 5 the overall distribution of income is actually somewhat worse than in the basic run. But as the agricultural terms of trade become steadily more favorable, the distribution improves, and by year 9 it is significantly better than in the basic run: the Gini coefficient drops from .444 to .419, and the average income of the bottom two deciles rises 7 percent over that in the basic run. However, by year 9 the average overall household income declines by 7 percent from the basic

run, and so, decreases in population growth and increases in education seem to do little to alleviate poverty.

By year 9 the income gap between urban and rural households has decreased substantially. Rural incomes rise almost 30 percent relative to the basic run, while urban incomes drop about 20 percent. Within the urban sector, the increases in education tend to alter income differentials by increasing the supply of technicians and white-collar workers. The incomes of white-collar workers, for example, drop 26 percent, whereas the incomes of blue-collar workers drop about 20 percent. But within the rural sector the distribution becomes worse, because the rich farmers benefit the most from the rise in the terms of trade.

The somewhat disappointing results for depauperization of the overall demographic and educational package are not explained by a tendency of the urban and rural packages to counteract each other; indeed, there is a slight reinforcement in some aspects. However, the significant decline in average household income is a major limiting factor in the depauperization potential of the package.

Despite the slowed growth rates in both the urban and the rural sectors, only the agricultural sector's total output is significantly affected. Agricultural output remains down throughout the calculation, to finish 4 percent lower than in the basic run, whereas total urban output is consistently nearly the same as in the basic run. These effects are the combined results of increased migration (which tends to lower rural output more and to add to urban output); the manufacturing sector's flexibility in adjusting to changes in the size and composition of the labor force (the structure of production and the factor proportions can be more easily changed in that sector than in others); the ability to substitute capital effectively for labor in manufacturing; and the upgrading of the labor force (which adds highly skilled labor whose productive role is important only in the urban sector).

Because, with these developments, the supply of agricultural output declines relative to the supply of urban goods and services and because the demand for agricultural goods is less price-elastic than the demand for urban goods, the terms of trade turn dramatically in favor of agriculture. In year 9 the terms of trade stand at 117 (against 87 in the basic run), and the incomes of small farmers are approaching those of urban workers.

Our experiments suggest that, contrary to popular belief, a reduction of population growth accompanied by educational upgrading, while leading to improved income distribution, cannot be a major weapon in antipoverty policy over a one-to-two-generation time span. Experiments

with BACHUE, the combined long-term economic-demographic model of the International Labor Organization (Adelman, Hopkins, et al. 1976) support this view over a 35-year time frame. This observation is consistent with the fact that the present experiments are intended to represent an intensification of policies already operating for 20 years by the beginning of the calculation.

Experiment C-3: Combined employment package. This package incorporates all of the steps to increase rural employment and agricultural productivity in experiment A-5, plus efforts to increase urban employment through public works and the subsidization of labor-intensive and export industries (experiments B-5 and B-6). In addition, all direct taxes are increased, with a proportionately greater increase in the direct taxes of large farmers; these increases were not part of any of the component packages.

Results. The combined employment program has a significant and beneficial effect on the distribution. The Gini coefficient starts .02 lower than the basic run and increases at a much slower rate; the difference between the two runs therefore widens over time. At the end of the period the Gini coefficient is only .393. This is not only .051 lower than the basic-run value in year 9; it is lower than the initial value (.398) in the basic run. The reduction in poverty is dramatic: about 8 percent fewer households live in poverty in year 9 compared with the basic run. The first eight deciles have all gained in relative shares at the expense of the top two deciles.

By year 9 the real incomes of all urban groups are lower than in the basic run, and those of all rural groups are higher. This reflects the change in the terms of trade and the impact of the rural public works program. However, most urban groups do not lose much, largely because of the booming economy. The apprentices, who lose the most, are still at 84 percent of their basic-run incomes. Moreover, in contrast to the usual pattern in the urban experiments, the leakage to the rural sector does not go disproportionately to the rich farmers. In fact, rural households gain relatively less as their landholdings increase. The incomes of landless laborers are 306 percent of the basic-run value, whereas those of the largest farmers are only 138 percent of the basic-run value. This is the result, in part, of our fixing a higher new rate of direct taxes for rich farmers than for other groups. In fact the tax rate for the top two farm sizes goes from essentially zero to between 8 percent and 13 percent. The more egalitarian rural distribution is also due in part to the migration rate modeled in the rural component package, which sends many more landless laborers to the urban areas. This means that the remaining

laborers command a significantly higher wage. Indeed, by year 9 they earn slightly more than unskilled workers (266,000 *won* compared with 255,000 *won* a year in real household income).

The terms of trade in this experiment are more favorable than in the basic run for years 1 and 9 and about the same in year 5. The improvement in year 9 over the basic run (92 compared with 87) is not nearly so great as in the urban employment packages. This is primarily because of the increase in agricultural productivity featured in the rural employment package. By year 9 agricultural output is 18 percent above the basic run. Nonagricultural output is up too, by 11 percent.

The terms of trade would have been less favorable for agriculture in year 9 were it not for the fact that real investment increases significantly. The capital stock grows at 9.1 percent a year (compared with 8.3 percent in the basic run), and by year 9 is 6 percent greater than in the basic run. The higher real investment is caused by the relatively low rate of inflation; this was generally unanticipated and so led to higher realized real investment in Stage II from the given nominal investment in Stage I, particularly in the later years of the calculation. The result is more urban investment and a greater supply of urban goods.

The combined employment package is very beneficial to the poor and rather moderate in its effect on the rich. It is the only package that makes the incomes of agricultural and urban workers comparable at a relatively high level. As a result of the increases in agricultural productivity, in real investment, and in migration, this package has the second highest growth rate in total production of any experiment, and there is in consequence significantly more income to redistribute. That fact largely explains why this package results in such a dramatic reduction in poverty.

Fundamental Change

The combined rural-urban policy packages for depauperization are divided, as we have said, into two grand strategies, a reform capitalism strategy and a market socialism (or better, social democratic) strategy. The major differences between them involve land reform and the nationalization of large-scale industry. Both are part of the socialism package; neither is used in the capitalism package. The reform capitalism development strategy is one of labor-intensive, export-oriented growth, whereas the market socialism strategy involves a mild degree of import substitution. Both packages include rural cooperatives, but only in the capitalism package is agricultural productivity increased as well. Both packages provide for consumption subsidies for poor rural and urban groups, a

massive education program, a reduction of population growth, and rural and urban public works. Both also envision the increasing of direct taxes, and those of the richer farmers in particular.

In devising the packages, we were in a sense unfair to the socialism one. Whereas the capitalism package is normative in the sense that it consists of programs that free-enterprise economies committed to depauperization *ought* to employ, the socialism package is descriptive and consists of those programs that socialist countries do in fact employ. This was done because, up to this writing, none of the nonsocialist developing countries has ever engaged in a depauperization program of the magnitude discussed here. On the other hand, there are several socialist developing countries that are now adopting or have hitherto employed depauperization strategies of the sort modeled for countries of that political bent. Examples are Israel, Singapore, Yugoslavia, China, Cuba, Ceylon, Chile under Allende, and Tanzania. The absence of examples of capitalist countries making a serious and concerted attack on poverty probably says something about the likelihood of the adoption of such policies in the future—but one can be optimistic, at least when designing experiments.

Experiment C-4: Reform capitalism package. This package combines the overall rural and urban packages in experiments A-10 and B-11, with two exclusions: the marketing board of experiment A-10 and the shift to a labor-intensive technology of experiment B-11. Note that our use of experiment A-10 rather than A-9 automatically excludes land reform. With these amendments, this experiment consists of:

1. The subsidization of consumption for selected urban and rural groups, increased education and slower population growth in both urban and rural areas, the encouragement of labor-intensive and export industries, urban and rural public works, and increased rural-urban migration.
2. Increased agricultural productivity, rural cooperatives, and the encouragement of rural manufacturing and trade.
3. A general increase in direct taxes, including an additional increase in the rate paid by the two largest farm sizes.

Experiment C-5: Market socialism package. This experiment combines the nationalization of large-scale industry (experiment B-10) and the overall rural and urban packages in experiments A-9 and B-11 with four exclusions: from B-11, the shift to labor-intensive technology and the subsidization of labor-intensive and export industries; from A-9, the increase in agricultural productivity and the marketing board. Note that this package is based on experiment A-9, and therefore includes land reform. It also provides for increased import substitution, which is set

at half the rate used in the counterfactual import-substitution experiment described in Chapter 6. Apart from these changes, this package has the several features listed above for experiment C-4, including the increases in direct tax rates.

Results. The effects of the two strategies are strongly influenced by the inclusion of the nationalization of industry in the socialist package. As we saw in experiment B-10, nationalization is at best a mixed blessing. It tends to benefit mostly the white-collar bureaucrats, and because it lowers overall productivity, after ten years or so it leaves most groups with less income than they would have had under the basic run. Nationalization is nevertheless correctly included in the socialist package as a program that socialist governments typically favor. The slower rate of growth in productivity that we have assumed for the nationalized industries seems consistent with empirical evidence, though it may in fact be too optimistic in view of the Indian and British experiences. But all that the particular differential in productivity does is determine how long it takes for everyone to be worse off in absolute terms compared with the basic run; the fact that everyone will eventually be worse off with a lower rate of productivity increase is not really in doubt.

The inclusion of import substitution in the socialist package, like nationalization, tends to load the dice against it. In an earlier experiment we saw that import substitution tends to injure farmers by restricting the supply of urban manufactured goods, thus raising their prices and turning the terms of trade against the already impoverished rural households. We have included the import-substitution policy because of the tendency of so many socialist countries to turn inward (Israel and Singapore are notable exceptions). To be sure, many capitalist countries have also adopted that policy (generally for different reasons), but there is no clear trend in this respect, and we have chosen not to include it in the capitalist package.

In view of all this, it is perhaps surprising that the socialist package comes off as well as it does. In terms of the overall distribution, it is in fact superior to any other strategy. Even in terms of absolute income levels, though the overall mean income is 9 percent lower than in the basic run by year 9, it is only the people in the top three deciles who suffer relative to the basic run (see Table 47). The six lowest deciles are better off, in absolute terms, and the two poorest substantially so, with incomes about a third higher than in the basic run. But as the table shows, in terms of absolute income, the capitalist package is still better than the socialist package for every decile, including the poorest. This is due to the higher overall growth rate of industrial production that takes place without

TABLE 47

Combined Rural-Urban Experiments C-4 and C-5: Cost-of-Living Index and Mean Income by Deciles, Year 9, as a Percent of Basic-Run Values

	Cost-of-living index			Mean incomes relative to basic run		
Decile	Basic run	C-4	C-5	Basic run[a]	C-4	C-5
1	197	131	206	68	151%	134%
2	197	130	206	122	143	131
3	196	130	206	165	136	125
4	196	130	207	211	129	118
5	195	130	208	259	125	112
6	194	131	210	317	121	106
7	194	132	211	391	117	100
8	194	133	214	500	112	93
9	193	135	217	694	105	85
10	192	139	219	1,341	94	74
Average	194	134	213	418	110%	91%

[a] Thousands of 1968 *won*

nationalization. Meanwhile, the slower growth in agricultural productivity in the socialist package is a two-edged sword: it raises farm incomes, thereby benefiting the distribution, but it also reduces overall output and so leaves less to redistribute.

As indicated above, the socialist package is clearly superior to the capitalist package in improving the distribution: in year 9 the richest decile receives only 26.2 percent of total income compared with 28.1 percent in the capitalist experiment, and the poorest deciles have significantly larger shares. Moreover, though these differences are less than one might have expected, the results hint that the future might see a continuing improvement in distribution under the socialist package. The gains made under the capitalist package, on the other hand, would surely be reduced in the future. Already by year 9, for example, we find that capitalists have recovered up to 91 percent of their basic-run income, and that wealthy farmers are substantially better off (the incomes of the households in the largest farm size are up 49 percent over the basic run). Under socialism the capitalists' incomes continue to be at about 50 percent of the basic-run values, and though rich farmers improve their relative standing, it is not clear whether their incomes would ever catch up to the average income of the economy.

In year 9 the relative distributions in these two experiments are measurably different, but they are closer to each other than they are to the distribution in the basic run—a surprising result considering the very different "economic-political" complexions of the two programs. The

TABLE 48

Combined Rural-Urban Experiments C-4 and C-5: Structure of Production and Use of Factors, Year 9

Sector	Production[a]			Capital stocks[a]		
	Basic run	C-4	C-5	Basic run	C-4	C-5
1. Rice, barley, and wheat	475	542	445	351	350	325
2. Other agriculture	606	698	576	91	92	84
3. Fishing	37	52	35	144	177	138
4. Processed foods	503	541	446	159	181	165
5. Mining	129	146	134	24	30	27
6. Textiles	409	420	377	139	175	162
7. Finished textile products	550	572	460	61	65	44
8. Lumber and plywood	46	43	46	59	61	64
9. Wood products and furniture	5	6	5	15	17	15
10. Basic chemical products	100	108	99	53	53	53
11. Other chemical products	351	342	305	82	77	81
12. Petroleum products	155	149	132	24	22	25
13. Coal products	45	59	49	13	14	13
14. Cement, nonmetallic mineral products	122	162	129	62	76	72
15. Metal products	165	188	210	71	73	77
16. Nonelectrical machinery	30	31	41	16	20	18
17. Electrical machinery	150	123	152	10	9	12
18. Transport equipment	123	147	143	34	37	39
19. Beverages and tobacco	281	298	246	76	73	73
20. Other consumer products	526	617	588	207	268	234
21. Construction	507	628	481	99	97	91
22. Electricity and water	132	148	129	590	600	510
23. Real estate	105	128	96	2,853	2,998	2,933
24. Transportation and communications	749	962	837	1,943	2,011	1,867
25. Trade and banking	821	904	777	341	336	301
26. Education	239	240	197	445	442	422
27. Medical services	80	78	65	75	75	71
28. Other services	151	171	142	168	170	158
29. Personal services	285	307	270	528	530	492
TOTAL/AVERAGE	7,877	8,810	7,614	8,733	9,129	8,566

indications are, however, that the gap between the two strategies would tend to widen over time. Similarly, the gap in absolute incomes that we see in year 9 should widen with time as a result of the differentials in the rate of growth of productivity—except, most probably, for the poorest members of society. What this comparison of socialist and capitalist packages reveals—finally—is that in each system a set of trade-offs must be made among growth, distribution, and depauperization.

The reason for the lower growth rate in the socialist package is not

TABLE 48 (continued)

Total employment[b]			Output-capital ratios			Output-labor ratios		
Basic run	C-4	C-5	Basic run	C-4	C-5	Basic run	C-4	C-5
2,555	2,297	2,319	1.35	1.54	1.36	0.19	0.24	0.19
2,730	2,476	2,454	6.65	7.59	6.86	0.22	0.28	0.23
105	154	101	0.26	0.29	0.25	0.35	0.34	0.35
223	211	236	3.16	2.99	2.70	2.24	2.56	1.89
63	64	77	5.38	4.87	4.96	2.05	2.28	1.74
275	224	249	2.94	2.40	2.33	1.49	1.88	1.51
238	271	210	9.02	8.80	10.45	2.31	2.11	2.19
24	34	21	0.78	0.70	0.72	1.92	1.26	2.19
13	17	14	0.33	0.35	0.33	0.38	0.35	0.36
32	40	50	1.88	2.04	1.87	3.12	2.70	1.98
111	115	118	4.28	4.44	3.77	3.16	2.97	2.58
4	6	4	6.46	6.77	5.32	38.75	24.83	33.25
10	12	13	3.46	4.21	3.77	4.50	3.47	3.77
72	94	81	1.97	2.13	1.79	1.69	1.72	1.59
17	21	33	2.32	2.57	2.73	9.71	8.95	6.36
16	14	25	1.87	1.55	2.28	1.88	2.21	1.64
51	36	51	1.50	13.67	12.67	2.94	3.42	2.98
28	35	40	3.62	3.97	3.67	4.39	4.20	3.58
20	24	24	3.70	4.08	3.37	14.05	12.42	10.25
744	757	1,034	2.54	2.30	2.51	0.71	0.82	0.57
275	342	261	5.12	6.47	5.29	1.84	1.84	1.84
26	29	25	0.22	0.25	0.25	5.08	5.10	5.16
4	4	4	0.04	0.04	0.03	26.25	32.00	24.00
271	287	265	0.38	0.48	0.45	2.76	3.35	3.16
999	933	992	2.41	2.69	2.58	0.82	0.97	0.78
578	622	506	0.54	0.54	0.47	0.41	0.39	0.39
252	210	174	1.07	1.04	0.92	0.32	0.37	0.37
426	447	406	0.90	1.01	0.90	0.35	0.38	0.35
530	594	516	0.54	0.58	0.55	0.54	0.52	0.52
10,694	10,375	10,303	0.90	0.96	0.89	0.74	0.85	0.74

[a] Billions of 1968 *won*
[b] Thousands of workers

hard to find. First, agricultural productivity is lower in that package than in the capitalist experiment. Thus, under capitalism, agricultural output rises and is 15 percent higher in year 9 than in the basic run, whereas under socialism output is down 6 percent (because increased migration is not offset by increased productivity). Second, productivity in the large-scale manufacturing sectors is lower in the socialist package. Large-scale firms account for over half of the total manufacturing output in year 1;

TABLE 49

Combined Rural-Urban Experiments C-4 and C-5: Structure of Production by Firm and Farm Size, Year 9

(Percent)

Aggregate sector	Size 1	Size 2	Size 3	Size 4
		BASIC RUN		
Agriculture	16.5%	25.9%	40.3%	17.3%
Food, beverages, and tobacco	6.4	5.0	9.7	78.9
Shelter and transportation	8.5	22.3	27.4	41.8
Manufacturing	3.5	23.2	16.2	57.1
Services	45.9	13.7	33.4	7.0
Total nonagricultural production	15.1%	18.5%	22.5%	43.9%
		C-4		
Agriculture	15.8%	25.1%	41.3%	17.8%
Food, beverages, and tobacco	7.5	4.0	11.2	77.3
Shelter and transportation	8.6	22.7	28.1	40.7
Manufacturing	3.7	20.0	17.0	59.3
Services	40.7	14.3	29.1	6.9
Total nonagricultural production	15.9%	17.6%	22.4%	44.0%
		C-5		
Agriculture	18.0%	28.3%	40.5%	13.1%
Food, beverages, and tobacco	7.5	9.1	12.3	71.0
Shelter and transportation	8.3	23.7	29.3	38.7
Manufacturing	3.4	25.2	24.3	47.1
Services	47.4	14.3	31.2	7.1
Total nonagricultural production	15.0%	20.6%	25.9%	38.4%

TABLE 50

Combined Rural-Urban Experiments C-4 and C-5: Industrial Production, Year 9

Industries by type and sectors	Basic run		C-4		C-5	
	Output in billions of *won*	Percent share	Output in billions of *won*	Percent share	Output in billions of *won*	Percent share
Producer goods industries Sectors 5, 8, 10, 12, 14–16, 18	871	23.3%	974	24.3%	935	26.0%
Consumer goods industries Sectors 3–4, 6–7, 9, 11, 13, 17, 19–20	2,856	76.7	3,030	75.7	2,664	74.0
TOTAL	3,727	100.0	4,004	100.0	3,599	100.0
Labor-intensive industries Sectors 3–9, 14, 16, 20	2,357	63.2	2,591	64.7	2,263	62.9
Capital-intensive industries Sectors 10–13, 15, 17–19	1,370	36.8	1,413	35.3	1,336	37.1
TOTAL	3,727	100.0%	4,004	100.0%	3,599	100.0%

TABLE 51
Combined Rural-Urban Experiments C-4 and C-5: Composition of the Nonagricultural Labor Force, Private Sector, Year 9
(Percent)

Skill category	Basic run	C-4	C-5
Engineers	1.3%	1.4%	1.3%
Technicians	3.2	3.2	3.2
Skilled workers	21.4	21.6	22.9
Apprentices	6.3	7.0	7.9
Unskilled workers	25.0	25.1	24.2
White-collar workers	18.4	18.7	17.1
Self-employed	24.3	23.0	23.4
Total share of labor force in nonagricultural production	50.6%	54.0%	53.7%

by year 9 the share of large-scale firms declines by about 10 percentage points from the basic run. Third, there is significantly less investment in the socialist package, with the result that by year 9 the aggregate capital stock is off about 6 percent from that in the capitalist package and 2 percent from that of the basic run. Finally, under the socialist package there is an increase in government employment and a withdrawal of labor from the private sector; this does not, however, make a great deal of difference, involving only 1.2 percent of the labor force in year 9.

The net result of these developments is a significant decline in total production in the socialist package relative to the basic run. In year 9 the socialist package yields 14 percent less output than the capitalist package and 3 percent less than the basic run. This compares with a rise of 12 percent over the basic run in year 9 under capitalism. The effects on national income are analogous. In terms of growth the capitalist package performs very well compared with the basic run, and the socialist package performs worse than the basic run.

Not only are there differences in aggregates between the two experiments; there are some structural differences as well. (See Tables 48–51.) There are, for example, significant changes in the structure of production by firm size and by sector. By year 9 the share of labor-intensive industry is 1.8 percentage points lower in the socialist package than in the capitalist one. The share of producer goods also rises, by 1.7 percentage points, in the socialist package, undoubtedly because of the import-substitution policy, and the supply of consumer goods, even excluding food, is 9 percent less. There are also significant differences in output-capital ratios

TABLE 52

Combined Rural-Urban Experiments C-4 and C-5: Composition of the Rich (Top 5 Percent) and the Average Rate of Taxes for Each Group, Year 9

Household category	Percentage of the rich from each household group			Percentage of group who are rich			Average direct tax rate		
	Basic run	C-4	C-5	Basic run	C-4	C-5	Basic run	C-4	C-5
Wage earners									
Engineers	0.9%	1.1%	1.1%	12.7%	13.5%	15.0%	12.7%	19.8%	21.3%
Technicians	4.2	3.6	3.6	13.0	10.7	10.5	12.5	18.2	18.7
Skilled workers	0.3	0.3	0.5	0.1	0.1	0.2	6.1	8.2	10.0
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0	3.8	5.5	5.9
Unskilled workers	1.9	3.0	3.0	0.9	1.3	1.4	6.1	9.3	10.1
White-collar workers	31.2	24.1	36.1	15.0	10.7	17.5	13.6	19.3	23.6
Government workers	5.4	3.0	5.1	2.4	1.3	1.7	7.4	8.6	9.9
Self-employed									
1: Manufacturing	6.9	2.9	4.2	10.5	4.1	7.2	13.6	23.3	25.7
2: Services	31.4	24.3	23.8	25.1	20.6	17.9	12.7	20.1	19.5
Capitalists	14.8	14.2	8.0	51.8	48.5	26.8	5.4	9.2	8.8
Agriculture									
Laborers	0.0	0.2	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Farm size 1	0.0	2.0	0.6	0.0	1.4	0.4	0.3	0.4	0.4
Farm size 2	0.0	3.0	1.5	0.0	1.8	0.8	0.3	0.4	0.4
Farm size 3	0.5	6.7	8.6	0.3	4.3	5.3	0.4	9.2	8.8
Farm size 4	2.5	11.6	3.9	7.2	34.5	11.2	0.5	13.6	13.1
Mean real income/average tax rate	1,692[a]	1,543[a]	1,209[a]				8.1%	11.7%	12.5%

[a] Thousands of 1968 *won*

and in output-labor ratios. Such differences are to be expected, considering the different component packages that make up the two experiments. The socialist package is inward-looking, putting a premium on import substitution; the capitalist package is outward-looking, promoting exports. The socialist package decreases the share of the largest firms by nationalization, with the relative gain going to the next two firm sizes; the capitalist package leaves the structure of production by firm sizes about the same as in the basic run. Finally, the capitalist package subsidizes labor-intensive industries (of all sizes), whereas the socialist package does not.

The two programs have rather different effects on the terms of trade. However, under both packages the terms are, on the average, significantly better than in the basic run, and both are thus beneficial to the poor, who are mostly rural. In all but a few of the experiments, as we have seen, it is changes in the terms of trade that most affect the overall distribution, and especially the lower end of the distribution. In these two packages, however, there are significant changes in the distribution from other sources and from interaction effects among the component packages.

Table 52 shows the composition of the richest 5 percent of the population in year 9. The differences between the two packages are significant: capitalists and rich farmers are not as well off under the socialist package, and the more highly skilled professionals—especially white-collar workers and engineers—gain. Bureaucrats and technocrats become the elites under the socialist package, compared with capitalists and rich farmers under the capitalist package. This occurs, we may note, even though the same educational program is used in the two packages. In both experiments farm households increase their shares in the rich population compared with the basic run because of the improvement in the terms of trade, but the richest farmers gain relatively much more under the capitalist package (accounting for 12 percent of the top 5 percent, compared with 4 percent under the socialist package and 2.5 percent in the basic run). The capitalist package is also significantly more favorable to the ordinary unskilled workers than the socialist package; by year 9 their mean incomes are 2 percent above the basic run under socialism. Indeed, there is only one group that is not economically better off under capitalism—the apprentices, who fare equally well (in absolute terms) under either system.

CONCLUSIONS

The results of the two grand strategy experiments imply major differences in the social stratification and indeed in the whole social and political

complexion of the countries in which these two courses may be pursued. This is true even though the socialist package under discussion is market socialism, not socialism of the Chinese or Soviet variety. The differences between the socioeconomic systems that would emerge from the adoption of our two packages are familiar, but it is very interesting to see them appear in our experiments as a consequence merely of specific differences in policy choices and in development strategies. The experiments indicate that the major social, economic, and structural differences can be seen as the result of differences in policies rather than differences in technology, economic incentives, political structure, or behavioral patterns.

The reform capitalism package is economically superior in that production and growth rates are higher and every income decile is better off than in our market socialism package. On the other hand, the benefits of economic development are less equitably distributed in the reform capitalism package, and the structure of the elites is altered. To the extent that these latter features outweigh the material advantages of the reform capitalism package, the market socialism package may be preferred. It should also be noted that the likelihood of adoption of a reform capitalism package of the magnitude of that depicted in our experiment is extremely low, and the probability that a government could successfully initiate such policies and maintain the political will to avoid a subsequent erosion of the incomes of the poor is not high either. By the same token, the adoption of a market socialism package has, as a prerequisite, a socialist political system of some sort.

The major contribution of the analysis of this chapter is to highlight the differences between the two grand strategies in both economic and social terms, to point out the economic trade-offs and policy alterations inherent in the selection of development packages aimed at achieving both growth and equity, and to hint at the long-term consequences of the policy selections. The most serious economic danger in the reform capitalism route is the possibility that the system will tend strongly to return to the status quo ante. The most serious pitfall in the market socialism route is probably a tendency to nationalize everything and at the same time to become xenophobic. For either strategy the transition process is politically difficult given the large changes in the distribution by socioeconomic groups.

CHAPTER TEN

Conclusion

IN DEVELOPING our computable general-equilibrium (CGE) model of the Korean economy and analyzing the results of experiments with it, we have learned a great deal about the modeling process, the Korean economy, and income distribution in a less-developed country. This chapter reviews the most important implications of our work, both for model builders and for policy makers. We shall first discuss two critical aspects of any attempt at drawing implications from model studies—validity and specificity—as they apply to the present model. We shall then summarize the lessons for both model builders and policy makers. Finally, we shall make some comments on the critical policy issues highlighted by our findings.

VALIDITY AND SPECIFICITY

To the extent that we attribute any general validity to the findings of our study, we make an implicit assumption that the model represents, to a greater or lesser degree of accuracy, the workings of an actual economy. Despite the extensive testing to which we have subjected our model in an effort to ensure its validity (as discussed in Chapter 4), such an assumption must remain an act of faith. However, the act of faith is substantially smaller than that required for purely theoretical models, on the one hand, and for purely econometric or programming models on the other. In purely theoretical models, the level of abstraction from the complexities of real life required to permit useful deductions is such that only purely qualitative conclusions can be inferred. This demands, as an act of faith, the *a priori* assumption that all factors treated in the theoretical model are treated correctly, and that all factors neglected or simplified are not enough to change the qualitative inferences. In the case of purely econometric or programming models, one must take it on faith that the mathe-

matical representation of behavior in the model structure applies to the real economy in the regime in which the model is to be used.

The present model structure was developed on the basis of theoretically plausible and empirically tested specifications. The model statics and dynamics reproduce the actual Korean data quite closely and in great detail, and at the same time maintain all the accounting relationships required for complete economic and demographic consistency. The model's behavior in experiments is theoretically quite reasonable, and so are the empirical results. We have found nothing in the model behavior, in any of our experiments, that conflicts with either established theory or observed economic behavior. We therefore feel justified in placing a high degree of confidence in the inferences we have drawn from our model economy about the workings of a real economy.

The detailed experimental results are of course specific to one economy in one period. However, the major interactions that are reflected in the experiments are fundamental, and both they and the consequent policy implications appear to be insensitive to rather wide variations in parameter values. There are relatively few parameters to which the major experimental results are sensitive, and the constraints they must obey in order for the qualitative results to obtain appear to be quite generally valid. On the demand side, there are three important parameter specifications: (1) there is a low income elasticity of demand for agricultural products by all groups, and so the share of household income spent on these goods declines as income rises; (2) rural households spend a larger share of their incomes on agricultural products than urban households, even the urban poor; and (3) the price responsiveness of demand tends to be fairly low and is less important in determining demand than income changes. On the supply side, there are two significant specifications: (1) the existence of capital in place seriously limits the ability of the economy to change the structure of nonagricultural production in the medium run; that is, investment and technology are such that in the medium run capital accumulation does not provide much flexibility for adjustment; and (2) labor is only partially mobile across sectors, firm sizes, and skill categories. The two supply specifications, taken together, imply that the economy is somewhat limited in its supply response to variations in prices. These features of the model economy are, we feel, generally valid and apply to virtually all market economies, developed and less developed.

In terms of income distribution, only a few of the special initial conditions imposed on the model by its specificity to Korea are really pertinent. Korea is an economy in which most of the land is owned by small

landholders, with no sharecropping. Its labor force is relatively highly skilled and the educational level of the population as a whole is very high (in the range of many developed countries). In addition, the economy has grown quite rapidly, following an export-oriented, open, labor-intensive development strategy. The country is not self-sufficient in food grains, but our basic model solution assumes the achievement of self-sufficiency toward the end of the model's nine-year time horizon. Where the initial conditions and basic development strategy impart some specificity to the experimental results, we take this into account in the conclusions below and qualify our generalizations as appropriate.

The policy conclusions drawn from the experiments are certainly valid for less-developed countries with economic structures similar to Korea's, and in fact many of the implications are probably valid for developed countries as well. The robustness and consistency of the results from the wide variety of policy experiments discussed in the preceding chapters support the validity of the model for Korea, and the fundamental character of the constraints on the critical parameters suggests that generalization to a wider class of countries may be reasonable. Finally, recent work with models of other economies, with cross-section data, and with historical information has produced results consistent with ours, both broadly and in detail. (See Lysy and Taylor 1977; Rodgers et al. 1977; Adelman and Morris 1973; and Adelman, Morris, and Robinson 1976.) In particular, a large number of paired experiments have been run on the present model and on the long-run BACHUE-Philippines model, with results that are remarkably similar both qualitatively and quantitatively (Adelman, Hopkins, et al. 1976).

LESSONS FOR MODEL BUILDERS

For model builders there are two kinds of lessons to be learned from our efforts: those directly related to models aimed at the analysis of income distribution and those applicable more generally to economic planning models. Let us take up these two classes of lessons in order.

So far as income distribution is concerned, our major finding is that, empirically, there seems to be very little connection between the distribution of income by deciles (the size distribution of income) and the distribution of income by classes of recipients (the functional distribution of income). Even though the size distribution in our model is generated from the functional distribution, our experiments indicate that the size distribution is extremely stable whereas the functional distribution varies rather widely. Dynamically, the size distribution does change, but its basic path is surprisingly insensitive to shocks or changes in parameters.

In addition, when shocked, the size distribution tends to return to the basic path over time, often quite rapidly. These observations do not appear to be limited to the time horizon of our calculations, for experiments with the 35-year BACHUE model show a similar stability (Rodgers et al. 1977).

The functional distribution, by contrast, is quite sensitive to policy interventions. As a result, there is a great deal of change in the composition of the deciles by socioeconomic categories, even while the decile shares remain stable. It follows that planners who are interested in improving the distribution of income must use models that generate both distributions. Indeed, economic theories and models that focus on the functional distribution alone have little to say directly about the size distribution. Since the functional distribution flows directly out of the workings of the economy, and is then transformed through household formation and structure into the size distribution, our results suggest that the empirical links between the two distributions must be carefully modeled. Our model pays explicit attention to such links, but clearly more empirical and theoretical work can and should be done in this area.

A second important finding is that despite the various potential interaction effects we have built into the model, relatively few are actually important in propagating the effects of experimental shocks or parameter changes to the distribution of income. This is an especially interesting result considering the size of the model and the wide range of potential interaction effects included therein. In particular, the following endogenous interactions were incorporated into the model:

1. Wage and price adjustments in factor and product markets.
2. Physical supply and demand adjustments in both product and factor markets.
3. Adjustments in the average price level (inflation) and in money-holding behavior affecting aggregate real savings, interest, foreign trade, and the government budget.
4. Substantial substitution possibilities in production by means of direct substitutability of factors in production functions, changes in the structure of production by firm size, and changes in export and import behavior.
5. Substantial substitution possibilities in consumption through changes in relative prices, absolute incomes, and the distribution of income among household categories.
6. Movement among different labor categories through rural-urban migration and through (exogenous) changes in relative labor supplies by skill category.

7. Investment behavior by firms based on financial market and investment models that are responsive to relative profitabilities, expectations, and government financial policies.

In all our experiments we found that over the experimental period quantities are much more stable than prices, with the result that the economy adjusts to policy interventions mainly through changes in wages and prices. In view of the scope for substitution in both consumption and production in our model, it is surprising that wage and price effects are so dominant.

The implications of this result are important for builders of economic planning models generally, as well as for those interested primarily in improving the distribution of income. Virtually every planning model built to date has been designed to investigate how quantities are affected by policy interventions. Both in normative models and in positive planning models, the emphasis is on real quantities: physical output, final demands, trade, investment, and employment. With the exception of a few macro models, prices, wages, and money in planning models are "veils" and are not included in any endogenous interactive feedback mechanisms. In omitting what our experiments suggest are the most important mechanisms through which economies respond to policy interventions, such models thus seem inappropriate for the very problems they seek to address.

Among the price effects, the most significant impact on the size distribution of income is due to changes in the agricultural terms of trade. The terms of trade are quite sensitive to changes in supply and demand, and in turn the relative incomes of rural and urban groups are quite sensitive to changes in the terms of trade. In most of our experiments changes in the terms of trade are the single most important factor in changing the size distribution, affecting as they do the average income in both rural and urban areas and so touching most of the population. Changes in the relative prices of urban goods are also significant, but their effect on income is diffused among all the urban groups.

Changes in the average price level are important as well. That is, inflation and money do matter, and the price level plays an important role in the economy's adjustment to shocks. The inflation rate varies substantially in our experiments, with clear effects on real variables throughout the model economy. By including monetary effects that influence real quantities, we have taken a tentative first step toward the realistic incorporation of monetary effects into empirical general-equilibrium models. In most theoretical general-equilibrium models, money is "neutral" in the sense that changes in the average price level do not affect real variables, such as

employment and output. Clearly, further efforts to extend and improve the incorporation of non-neutral monetary effects into both theoretical and empirical general-equilibrium models are worthwhile.

Though consistently small, quantity adjustments in both product and factor markets are evident in the experiments. They are relatively more significant for small sectors and over longer time periods. In the short run, even relatively slight changes in product supplies can have a significant impact on the distribution of income through their effects on relative prices and particularly on the agricultural terms of trade. In the medium run, changes in the labor supply due to migration are important, and work both directly through their effect on wages and indirectly through the consequent changes in the terms of trade to narrow the gap between rural and urban incomes. In the long run, changes in the skill composition of the labor force through education, migration, and population growth have a significant impact on wages and on the distribution of income.

Of the various substitution possibilities built into the model, some turn out to be empirically unimportant. For example, the disaggregation by firm sizes within sectors (other than agriculture) has little effect, despite substantial differences in technology and in factor earnings by firm size. In general the structure of production by firm size does not vary much among experiments. And even when it does vary in a number of sectors, the effect on total sectoral production, on the structure of wages, and on other economic aggregates is minor. The distinction between the self-employed and firms as such is important; finer distinctions are not.

As it turns out, we did not need so fine a disaggregation by sectors, either. Given our experimental results, we can now design aggregations that would simplify the model and still reflect how structural changes in production affect the functional distribution of income.

Differences in the spending patterns of various socioeconomic groups, on the other hand, are important. Even greater disaggregation by household types beyond the 15 used in our model might therefore be desirable.

Of the major building blocks in the model, the one that is least important with respect to its direct effect on either the functional or the size distribution of income is the Stage I (investment fund) model. Since variations in real investment begin to have significant impact only in the later periods, the Stage I model has more influence on financial flows and hence on inflation than on real growth or distribution. The Stage I model also realistically constrains the degree of adjustment of capital stocks permitted in the model. The Stage I model provides a rather sophisticated

explanation of real investment behavior, especially in the context of previous planning models. But that degree of sophistication was in fact unnecessary in the end because of the relatively minor role that variations in real investment play in influencing the distribution of income.

Perhaps the most important lesson from our work is a more general one: immediate effects rarely reflect the overall impact of a policy intervention, and the partial-equilibrium solution is seldom quantitatively close to the final-equilibrium solution. Indeed, in many of our experiments the ultimate effect is opposite to the initial impact or partial-equilibrium effect. In addition, the total effect of combined policy packages often differs from the sum of the results of their component packages. A nonlinear general-equilibrium framework, which permits any synergistic or interference effects that are present to manifest themselves, is thus basic. Our results underscore the importance of this type of framework for the realistic modeling of economic systems.

As is evident from the preceding discussion, a focus on income distribution clearly entails a different modeling strategy from that demanded by a focus on growth. It requires the stressing of prices and wages, not output; it requires the accurate modeling of the transition between the functional distribution of income and household income; and it requires the detailed disaggregation of consumers and households by homogeneous socioeconomic categories. By contrast, the driving forces behind traditional planning models are usually trade and investment. Such models generally emphasize manufacturing sectors over all other sectors in the economy, and intermediate demands over final demands. They do not provide an adequate description of either the agricultural sector or the service sector, and they lack a satisfactory model of the components of final demand, with the possible exception of investment. As our results indicate, this emphasis is exactly the opposite of what is needed for models focusing on income distribution, and is at least partly inconsistent with the traditional aims of planning models.

In view of the economic desirability of building nonlinear wage- and price-endogenous CGE models for planning, it is important to note that our experience with solving our model is very encouraging. The model almost always solves in five to twenty price iterations at very moderate computer costs. In solving, prices appear to converge in groups and, once converged, do not get out of equilibrium in later iterations. Typically, the iterations at the end are solving only for the last two or three equilibrium prices. If this property, which is consistent with experience from a number of smaller models, can be generalized to larger models, it suggests

that computational costs will rise approximately linearly with the size of the problem, rather than with the factorial of the size, as with programming models. This would make the empirical use of large CGE models computationally economical. Indeed, even without further algorithmic development, our experience indicates that one can already solve a model of this type far more economically than one can solve a linear programming model of even remotely comparable economic content with the most sophisticated linear programming algorithms presently available.

As the above discussion indicates, despite the arguments of many planners and modelers to the contrary, it is possible to understand the major mechanisms by which influences are transmitted throughout a large, complex, interactive system. Moreover, from our experience with the model, we are confident that we can specify a greatly simplified model structure that would capture the major influences on the distribution of income included in the larger model. But it is only on the basis of our analysis of the more complex model that we have obtained the necessary insights to determine which of the possible simplifications are reasonable to adopt and which would tend to lose some attribute of the economy that is essential for the purpose for which the model is intended. *A priori* simplification and simplification on the basis of partial equilibrium are, on the other hand, extremely dangerous, primarily because of the problem of ensuring that the simplifications do not significantly distort the results.

In conclusion, our experience with wage- and price-endogenous CGE models leads us to argue strongly for their adoption in planning. We have seen that within the customary time horizon used in planning models, wage and price effects represent the most important mechanisms by which policy shocks are transmitted throughout a market economy. Computable general-equilibrium models are the only models that capture these effects for a market economy in an economically satisfactory and flexible manner. We are convinced, therefore, that these are the only types of models that come even close to providing adequate tools for economic planning in a market economy.

The usefulness of these models is not limited to examining questions of income distribution. The general model framework is very flexible, both in the degree of closure and in the variety of behavioral specifications that can be included. In terms of closure, for example, the basic general-equilibrium structure permits as complete a specification as desired of real and money flows, including the input-output accounts and national product accounts, as well as the national income and flow of funds accounts. In terms of behavioral specification, the basic framework is flexible enough to be applicable to (and indeed is being applied to) such

different economies as those of Australia and the Netherlands, as well as that of Korea.* The range of questions that can fruitfully be approached by use of economy-wide CGE models is thus very wide and only just beginning to be explored.†

LESSONS FOR POLICY MAKERS

After validation of the model, the first step in developing its policy implications was to determine the basic dynamic path that the economy would follow if there were no changes in development strategy and no policy interventions to change the distribution of income. The basic solution is predicated on a smooth and reasonable extrapolation of present trends in a stable world environment.‡ It assumes the continuation of the strategy of export-led, labor-intensive growth initiated in Korea in 1964. The basic path is one of rapid growth and steadily deteriorating income distribution, the latter accelerating in later years because of a worsening of the agricultural terms of trade with growth. The major share of the gains from development accrue to the urban rich and professional classes, with smaller benefits falling to the urban middle class and urban poor. There is little improvement in the average absolute real income of the rural poor, and in fact a marked increase in the percentage of rural households falling below the poverty line. The very rapid real growth rate (13 percent annually) in the basic solution is consistent with Korea's performance in the late 1960's and early 1970's, and the projected steady deterioration of the distribution is consistent with the results from other studies.§

To understand better the implications of the basic solution for income distribution, it is important to be aware of the composition of the poor in Korea. Initially, half the households living in poverty are urban and

* The Netherlands model is being constructed at the Institute for Fiscal Studies, Erasmus University, Rotterdam. The one for Australia, called Project Impact, is being constructed jointly by the Australian Bureau of Statistics, the Australian Industries Assistance Commission, the Department of Labor and Immigration, and the Department of Manufacturing Industry. The literature on these projects at this writing is limited to various unpublished discussion papers.

† As noted in Chapter 1, since we formulated our model there have been a number of Ph. D. dissertations at Princeton and elsewhere using the CGE model framework to explore a wide variety of problems, as well as recent work at the World Bank. There is also an active literature based on the work of Johansen (1960) and Scarf (Scarf and Hansen 1973).

‡ That is to say, in the absence of such major shocks as the large increase in the price of petroleum. See the discussion of the basic solution and its validation in Chapters 4 and 6.

§ Which suggest that distributional inequality and rapid growth may be positively correlated. (See Adelman and Morris 1973: Chapter 4.) It is also consistent with the U hypothesis relating income distribution and economic development. (See Paukert 1973; and Kuznets 1955.)

half rural. The growth process, however, benefits the urban groups disproportionately, and by the end of the period, 70 percent of the poor households are rural. Of the urban poverty groups at the start of the calculation, roughly half are skilled and unskilled workers and the rest are distributed among a number of other worker and self-employed categories. Because the urban poor are so widely dispersed, constituting generally much less than half the households in each labor category, they represent a difficult set of targets for anti-poverty measures. It is almost impossible to help them without a significant trickle-up of the benefits to wealthier groups.

The rural poverty group consists of landless laborers and small farmers. More than 90 percent of the landless families are in poverty in the base period (1968), and the figure decreases to about 80 percent by the last period in the basic run. Clearly, assisting landless rural laborers, a difficult target group to help directly by policy actions, is critical to any successful program to reduce poverty.

In order to learn how more of the benefits of economic development might be made to reach the poor, we ran a large number of comparative statics and dynamic experiments with our model and tried a wide range of policy packages and parameter changes. Most of the experiments amounted to shocks imposed on a system whose time path is set by a development strategy that remains unchanged, and did not involve major redistributions of productive assets. Individual shocks resulted in very small changes in the time path of the distribution of income relative to the basic run. Impact effects in the early periods tended to be eroded over time even when the policies were continued. Only when enough different types of interventions were undertaken simultaneously, amounting for all practical purposes to a change in development strategy, were changes sustained over the entire nine-year period.

This remarkable stability of the basic time path of the size distribution of income is probably the most important conclusion to emerge from our study.* It is obviously a very worrisome result for those who are committed to increasing both the share and the absolute income levels of the poor as rapidly as possible. Given the deterioration in income distribution observed in the basic path, reducing poverty is most difficult. Indeed, of all the hoped-for ends of economic policy, a steady reduction of deprivation may be the hardest to achieve.

Another important general result that emerges from our study is that, unlike the overall size distribution of income, the distribution of income

* This conclusion is supported by the results of a longer-term modeling study: Rodgers et al. 1977.

to different classes of income recipients is extremely sensitive to policy intervention. In both the static and the dynamic experiments, there are substantial variations in the shares of income accruing to the 15 household groups modeled. This means that the group composition of the deciles changes dramatically, even though the overall shares by deciles remain stable. Economic policy can thus be a very powerful instrument for reshuffling the incidence of poverty (and wealth) among occupational and socioeconomic groups without doing much to increase equity. It is as if the basic course of the economy cuts the pie into slices, and policies superimposed on that course only affect who gets which slice.

These observations have several important implications. First, contrary to popular belief, increasing the share of wages does not necessarily imply either a more equitable distribution of income or a reduced incidence of poverty in the economy. Second, since the relations among socioeconomic groups are of immense political concern, the ability to manipulate the functional distribution of income is politically more significant than the inability to change the more socially neutral size distribution. Third, significant improvements in equity and reductions in the incidence and degree of poverty cannot be made without massive efforts involving programs far more sweeping than any usually contemplated in the developing nations. Finally, because of the sensitivity of the functional distribution of income to policy interventions, such programs are likely to cause substantial social unrest.

Two other empirical generalizations that emerge from our results should be of particular interest to policy makers. First, and perhaps surprisingly, we find that most anti-poverty policies eventually help the rich and middle income groups more than they help the poor. This is so even when, as in our experiments, the rich are taxed quite progressively to finance the programs, the programs are designed so that their initial impact is quite specific in favoring the lower income groups, and there is no graft, corruption, diversion, or stupidity in their execution. This trickle-up effect was evident in a great many different policy experiments and is difficult to avoid. Second, our experience with a wide range of policies indicates that it is much easier to make the income distribution worse than to improve it.

Of the individual policy instruments analyzed for improving the size distribution of income, those raising the agricultural terms of trade tend to be the most important. This is because, as we found over and over again in our experiments, the terms of trade play a crucial role in determining rural household incomes. In general, when the terms rise, so do the incomes of small farmers and, to a lesser extent, those of landless

laborers. It is true that rich farmers gain the most, and that urban groups, including the urban poor, are injured. But for all that, a substantial increase in the terms of trade reduces poverty significantly and improves the overall distribution. Another thing that makes the terms of trade so critical is their sensitivity to policies that affect the supply of and demand for agricultural goods. They thus provide a responsive mechanism that tends to subvert many of the equity-oriented policies that are often considered. Positive policy actions are required to maintain the agricultural terms of trade, since they have a natural tendency to worsen with growth, a phenomenon that is consistent with the historical experience of virtually all developed countries. This natural tendency may of course not manifest itself in an open economy in a world where the relative price of food is rising.

Other policies that have a significant influence on poverty are those encouraging rural-urban migration. In general, the incomes of the urban poor are much higher than the incomes of the rural poor, so that one would expect migration to alleviate overall poverty. This is especially true in a rapidly growing economy like Korea's, where the urban labor force can absorb the new migrants without a significant fall in wages. The relative increase in the supply of urban goods contributes to the improvement of rural incomes by raising the agricultural terms of trade. There can, of course, be too much migration, creating a Marxian "reserve army" of the unemployed and thereby keeping the wages of the unskilled urban workers at the subsistence level.*

As expected, the choice of trade policies has a significant impact on poverty and equity. However, it is not primarily the direct effects of trade policy on the urban sector that matter; those are rapidly dissipated throughout the economy. Rather it is how that policy affects the agricultural terms of trade and rural out-migration. For example, as we saw in Chapter 6, had Korea followed an import-substitution strategy rather than a labor-intensive, export-promotion policy, the resulting deterioration of the agricultural terms of trade would have produced a significantly poorer size distribution of income and significantly greater poverty than Korea actually experienced. By contrast, a stronger labor-intensive, export-promotion policy (see Chapter 8) would have had beneficial effects on both growth and equity, the latter resulting primarily from trickle-

* In one of our comparative-statics experiments that is not reported here, we managed to create such a reserve army by making about 10 percent of the agricultural labor force migrate each year. In countries growing less rapidly than Korea, one would expect the absorptive capacity of the urban labor force to be reached at a much lower rate of migration.

down to the poor farmers. These results cannot be generalized to nations that do not start out with both a reasonably equitable pattern of landownership and tenure and a relatively well-educated and skilled population.

Population reduction, a policy of great interest to decision makers, has at best a small beneficial effect on overall household poverty in the medium run. Indeed, though greater population reduction improves the size distribution of income, it does so at the cost of a significantly reduced rate of economic growth. As a result, the reduction in rural poverty due to the decreased size of the rural labor force and the consequent increased size of average landholdings is almost counterbalanced by the increased impoverishment of the urban worker. On the other hand, reducing the urban population also decreases the growth rate of the economy and increases rural poverty more than it alleviates urban poverty. The effect on rural poverty comes about because the supply of urban goods is restricted, leading to price rises in urban products and a consequent deterioration in the agricultural terms of trade. Induced increases in migration are insufficient to counteract fully the negative effects on the rural sector. A more even-handed population reduction policy, applying comparably to the urban and rural sectors, improves overall poverty somewhat, despite the reduced rate of overall economic growth. However, the reduction in poverty is far smaller than one might have expected, because urban poverty is significantly increased in the process.

Perhaps the most frequently proposed anti-poverty measures are direct transfers to the poor. We modeled two different types of very sizable transfer programs: direct income transfers, and price subsidies for the poor for the necessities of life (food, housing, and medical care). We tried out these programs on both rural and urban groups. Both types of transfers are expensive and help the specific target groups to some extent. The direct income transfers have the least leakage and the slightest market distortion effects of any of our experiments, and their effects on the target groups persist as long as the transfers are maintained. The price subsidies, in contrast, become less and less effective over time, because as incomes rise, the share spent on necessities falls. However, income transfers to functional groups are unlikely to be an effective tool of anti-poverty policy. First, the tax base for generating the necessary transfers is generally small. Second, it is hard to define recipient functional groups that do not include a significant proportion of households that are not poor. A transfer program aimed at income groups, rather than functional groups, would of course be more effective, but would be extremely difficult and expensive to administer. Finally, for any type of transfer program, the fact that

the effects do not outlast the duration of heavy programmatic expenditures means that a nation committed to direct transfers as an anti-poverty measure must be resigned to persistently large welfare budgets and to the resulting dualistic society.

To explore the nature of desirable reorientations of policy imposed over and above the basic development strategy, dynamic policy experiments for both rural and urban target groups were carried out. We investigated social development programs, production and employment programs, and programs involving varying degrees of institutional change. We also tested various combinations of these programs. Some of these combined packages are considerably more effective than the sum of their components. In general, their ultimate impact is determined largely by the extent and nature of the indirect leakage effects, which in turn are strongly influenced by the interaction of their component programs.

In evaluating the effectiveness of the various packages, we have compared their ultimate effect with the final year of the basic run using three indicators: percentage changes in the absolute income of the bottom decile of the population, changes in the share of households in poverty, and changes in the Gini coefficient. The ranges for these criteria were chosen on the basis of what our model results indicate is achievable over a nine-year period with conceivably acceptable policy interventions. Had we selected our criteria before looking at the results of the experiments, we would have selected considerably more stringent criteria, especially in the Gini coefficient. The categories are as follows.

Harmful. The bottom decile's income is lower by 5 percent or more; the percentage of households in poverty is at least one percentage point higher; the Gini coefficient is at least .010 higher. A program is deemed harmful if two or three of these criteria are satisfied.

Ineffective. There is insufficient change in the criteria to place the program in either the harmful or one of the effective categories.

Moderately effective. The bottom decile's income is higher by 5 percent or more; the percentage of households in poverty is at least one percentage point lower; the Gini coefficient is at least .010 lower. A program is deemed moderately effective if it meets two or three of these criteria but does not satisfy the criteria for a higher degree of effectiveness.

Effective. The bottom decile's income is higher by 15 percent or more; the percentage of households in poverty is more than 3 percentage points lower; the Gini coefficient is more than .022 lower. A program is effective if it meets all three criteria but is not "very effective."

Very effective. All three criteria for "effective" are doubled. A program is very effective if it meets all these doubled criteria.

The results of this categorization are shown in Table 53. It is interesting to note that only in the programs characterized as "very effective" does the rate of growth of the income accruing to the bottom decile approach (in one case) or exceed (in four experiments) the rate of growth of mean overall household income. The five "very effective" experiments are also the only ones in which the Gini coefficient is lower at the end of the ninth year than it is in either the basic run or in the experiment at the beginning of the calculation.

For a program to be "very effective," however, it appears from our experiments that a large multi-faceted intervention amounting to a major restructuring or reorientation of the basic development strategy is required. Even the criteria used for "effective" programs still benefit the poor less than they do the rest of the economy (i.e., there is a large trickle-up) and do not raise the absolute standard of living of the poor by nearly as much as do the "very effective" programs.

Among the individual rural development packages, experiment A-3, aimed at increasing agricultural production, is not an unqualified blessing. It is ineffective in reducing poverty, and it worsens the distribution once the import-substitution possiblities in food are exhausted. It tends thereafter to worsen the position of the rural poor and improve the lot of urban groups, including the urban poor, unless measures are taken to maintain prices. In general, who gains from the rural policy packages depends largely on what happens to the terms of trade. If they turn far enough against agriculture, the result is a transfer or trickle-up to the urban groups. Rural groups gain only if special steps are taken to prevent the terms of trade from deteriorating too much. A rural public works program substantially improves the real incomes of the poor, especially the landless laborers, and is a moderately effective policy. Land reform, which redistributes land to small farmers, is an effective policy that reduces poverty, improves the distribution within the rural sector, and narrows the urban-rural income gap. Rural cooperatives—which market the crop, subsidize agricultural inputs, and provide low-cost credit—have some beneficial effects and represent a moderately effective program. Of the individual policy packages, land reform has the most effect on the relative distribution, and it raises the incomes of the poor almost as much as rural public works.

A concerted rural development strategy (combining programs for increased production, public works, cooperatives, social development, and price stabilization) is very effective in alleviating poverty and improving the distribution. When land reform is included, the percentage of households living in poverty falls to about one-quarter of the number in

TABLE 53

Overall Effectiveness of Experimental Programs

Experiment number and program	Changes in indicators: Income of bottom decile	Percent of households in poverty	Gini coefficient	Rating[a]
RURAL PROGRAMS				
A-1: Land reform	+28.7%	−4.6%	−.024	E
A-2: Cooperatives	+5.7	−2.1	−.021	ME
A-3: Productivity and marketing	+3.4	−0.9	+.010	I
A-4: A-2 and A-3	+9.5	−2.7	−.014	ME
A-5: Public works and industry	+30.4	−4.7	−.009	ME
A-6: Consumption subsidy	+5.9	−1.4	+.002	ME
A-7: Education and demographic change	+7.9	−1.1	−.019	ME
A-8: A-6 and A-7	+16.1	−3.1	−.025	E
A-9: All programs combined	+77.6	−10.7	−.065	VE
A-10: All programs but land reform	+63.5	−9.6	−.057	VE
URBAN PROGRAMS				
B-1: Consumption subsidy	+1.0%	−.4%	−.005	I
B-2: Education and demographic change	−3.5	+.7	+.003	I
B-3: B-1 and B-2, with increased migration	+11.0	−2.1	−.027	ME
B-4: Small-scale industry	+2.8	−.6	−.001	I
B-5: Export promotion	+5.1	−.3	−.018	ME
B-6: Public works	+8.9	−1.5	−.035	ME
B-7: Labor-intensive technology	+1.0	−1.0	−.007	I
B-8: Decreased elasticity of substitution	−37.8	+9.9	+.048	H
B-9: B-5, B-6, and B-7	+17.6	−3.5	−.037	E
B-10: Nationalization	−2.1	+1.2	−.001	I
B-11: B-3 and B-9	+18.9	−4.0	−.042	E
COMBINED RURAL-URBAN STRATEGIES				
C-1: Consumption subsidy (A-6 and B-1)	+5.7%	−1.4%	−.002	ME
C-2: Education and demographic change (A-7 and B-2)	+10.1	−1.7	−.025	ME
C-3: Employment (A-5, B-5, and B-6)	+45.8	−7.9	−.051	VE
C-4: Reform capitalism (A-10, B-3, B-5, and B-6, with increased taxation and migration)	+51.2	−8.6	−.069	VE
C-5: Market socialism (A-9, excluding A-3; and B-3, B-5, and B-10, with increased import substitution and taxation)	+33.1	−6.7	−.098	VE

[a] VE is very effective; ME is moderately effective; E is effective; I is ineffective; H is harmful

the basic run by the final year. The rural strategy without land reform is less beneficial (there are 30 percent more households living in poverty than in the package with land reform), though it is still very effective.

At best, the individual urban programs are only moderately effective in reducing poverty and changing the overall distribution. The two individual urban packages that are moderately effective are a public works program in housing construction and transportation and a program that puts a still stronger emphasis on labor-intensive and export industries. However, these programs are successful in alleviating poverty not because of their effect on urban wages and employment, but rather because of their influence on the rural poor through changes in the terms of trade. Five individual programs are ineffective in reducing overall poverty and improving the relative distribution: consumption subsidies for urban working groups, education and demographic change, the promotion of small-scale industry, the adoption of labor-intensive technology (by changes in the production functions), and the nationalization of large-scale industry. Decreased elasticity of substitution (experiment B-8) is actually harmful. The nationalization of large-scale manufacturing industry turns out to be ineffective, with generally adverse effects, because it leads (by hypothesis) to lower productivity in the nationalized firms, and ultimately to lower output in manufacturing as a whole. This drives up the relative price of manufactures and turns the terms of trade against agriculture, thus reducing rural incomes and dragging more households into poverty.

Despite the largely disappointing nature of the individual urban programs, an urban development strategy combining public works, export promotion in labor-intensive industries, and the adoption of more labor-intensive techniques is effective in reducing poverty and improving the distribution. It is not nearly so effective, however, as the overall rural development strategies, even though some of the indirect effects improve the agricultural terms of trade and so allow the benefits to leak to the rural poor. This leakage process becomes more pronounced with time and, if allowed to operate, would continue to work to the advantage of the rural poor even after the period of the calculation.

Our experience with the separate rural and urban packages led us rather quickly to examine combined rural-urban packages. We sought an integrated approach that would ensure that leakages to urban groups of rural programs are more than counterbalanced by leakages to rural groups of urban programs (because most of the poor are rural). To this end, we designed two large across-the-board policy packages: a "reform

capitalism" package (experiment C-4) and a "market socialism" package (experiment C-5). Experiment C-5 is intended to represent those policies that are frequently adopted in non-Communist socialist countries. It emphasizes land reform, the nationalization of large-scale industry, and import substitution, but also provides for social development, urban and rural public works, rural cooperatives, and the decentralization of small-scale industry. Experiment C-4 is intended to illustrate what a capitalist economy could do if it was so set on alleviating poverty that it would be willing to make massive changes in the structure of its economy and society. This package omits land reform and the nationalization of industry. It includes the same programs for social development, urban and rural public works, rural cooperatives, and the decentralization of industry as in the market socialism package, but where that package emphasizes import substitution, this one promotes labor-intensive exports. It also introduces improvements in agricultural productivity.

Both packages are very effective by our criteria. By the end of the calculation, in spite of leakages to the rich under reform capitalism and a decline in the growth rate under market socialism, the seven lowest income deciles of the society are all better off in absolute terms than they were without any policy intervention at all. The trade-offs between the two approaches are the familiar ones. The market socialism package leads to better and improving distribution but steadily deteriorating output compared with the basic run. The reform capitalism package shows evidence of a deterioration of the distributional gains over time and of an acceleration of productive growth. By the end of the calculation, everyone (including the lowest decile) is better off under reform capitalism than under market socialism in absolute terms. Still, as noted, the seven lowest income deciles clearly do better under the socialist package than they do when, as in the basic dynamic run, a favorable growth strategy is not complemented by significant anti-poverty programs.

In comparing these two packages, one must bear in mind that the reform capitalism package comes out well because its policy makers are willing to undertake what many would consider to be "uncapitalistic" policies. In its intensity and in the way it affects the system, the program is more akin to Scandinavian socialism than to American capitalism. But then the market socialism package is clearly closer to the British design than it is to Russian socialism. It is socialism with markets and market incentives, rather than socialism with direct government control over the allocation of factors and products.

In summary, our study reinforces the view that the distribution of income is firmly rooted in the structure of the economy, and that its path

over time depends on the fundamental development strategy chosen by the society. Once the basic development strategy is chosen, single-pronged programs that do not include large direct transfers of assets or income can constitute, at best, moderately effective programs. Furthermore, to be most effective, programs to alleviate poverty and improve equity must involve an appropriate choice of basic development strategy.

Of the basic development strategies we have explored, two stand out as being potentially appropriate for equitable growth. The first is an intensification of the one that Korea has pursued, particularly in the 1964–73 decade: export-led, open, labor- and skill-intensive growth. A necessary condition for the success of this strategy in improving the income distribution and alleviating poverty is that a large proportion of the labor force be well educated or skilled workers. A second requirement for the success of this type of strategy is that the natural course of the agricultural terms of trade, when upward, should be reinforced (or at least not be impeded) and when downward should be reversed. This process needs to continue so long as the rural poor constitute the dominant portion of the poverty population. Such a policy would not be easy to maintain, however, since urban pressures for decreasing the agricultural terms of trade tend to be stronger and more highly organized than rural pressures for raising them. It is important, though, that the urban pressures be resisted, because a favorable movement in the terms of trade is the dominant process by which a labor-intensive export strategy benefits the rural poor. One may also conjecture that in a large closed economy a strategy oriented toward the production of labor-intensive goods for the domestic market would also be beneficial, so long as the agricultural terms of trade improve and the initial condition regarding the labor force is satisfied.

The second promising strategy is that of emphasizing rural development. Its success likewise depends on two conditions. The first of these is a relatively equal distribution of land and equitable tenure arrangements; the other is some kind of institutional arrangement for maintaining agricultural prices. These two strategies are not mutually exclusive. On the contrary, they might well be combined, as in the reform capitalism strategy.

The fact that the successful implementation of each of the two equitable growth strategies is predicated on the fulfillment of both a preexisting condition and a policy condition cannot be overemphasized. The application of these strategies to countries where the preexisting conditions are not met is likely to lead to the opposite result from that intended. Brazil, for example, has too low a proportion of educated labor and has, by

following a labor-intensive export strategy, managed to make the income distribution even worse than it was. And the "green revolution" areas have also gradually experienced adverse distributional effects. The moral is that before these strategies are applied where the preconditions are not met, the first efforts should be to establish the preconditions and only later should the strategies themselves be adopted. The political problems associated with establishing these preconditions, of course, must be taken into account in the process.

On the whole, our results underscore the difficulties of effective policy interventions to improve the distribution of income, and the need for a comprehensive, integrated "big push" approach. To avoid the rapid erosion of benefits requires major government intervention, with large implicit and explicit economic transfers, and with the potential for considerable social tension and political unrest. As suggested in the preceding paragraph, a regime committed to a massive attack on poverty could well expect still greater social and political stresses if it first has to create the appropriate preconditions for poverty alleviation. But even supposing the conditions were right, the implementation of a successful anti-poverty program would most likely entail a change in the ideology of the ruling classes toward explicit egalitarian concerns or a centralization of authority sufficient to overcome the resistance of the rich, or a combination of the two The typical problem with the centralization of authority, of course, is how to reduce the power of the centralized government once its basic job is done.

A POSTSCRIPT

For developing countries our results pose one overriding question: can their governments ever be sufficiently committed to the elimination of poverty to design their development strategies and mobilize their entire arsenal of policy instruments to that end? Our results indicate strongly that a lesser commitment will not suffice.

The choice of policy packages used in the attempt to eliminate poverty clearly has profound implications, not only for the structure of the economy, but also for the structure of the society and polity. To be effective, a policy package will necessarily involve substantial changes in the distribution of national income, wealth, and power. The concomitant changes in the shares of the several socioeconomic groups will almost certainly impose serious strains on the political stability of the system. On the other hand, major strains are presently being induced in the political fabric by the current trend in most less-developed countries for a steadily worsening distribution of income and an increase (or at best little decrease) in

the extent of poverty. Recall, for comparison, the political stresses and revolutions in Europe from the late-eighteenth century to the mid-nineteenth century associated with the redistribution of political and economic power from the aristocracy to the middle classes.

At present, the less-developed countries are in a dilemma. They can accept the apparent trend of increasing inequality and ratify it in their political process. The recent trend toward authoritarian government in a number of less-developed countries might be interpreted in this way. On the other hand, they can make the necessary political commitments toward the elimination of poverty and can institute the kinds of broad combined packages we have discussed. In either case, a significant period of political unrest is probable.

Under these circumstances, one can argue along the following lines. The effort required is large and the nation cannot afford it. Growth should be stressed now, and later, when the nation can afford it, the emphasis can be shifted to the necessary attack on poverty; in the meantime the unrest of the poor will be handled as well as possible, and the unrest of the more powerful will be postponed until a more propitious time.

Such an attitude has the precedent of having been adopted in most of the developed countries during their early growth phases. The authors, however, find this view unacceptable on at least two counts. First, it took a very long time (two to three generations) for the industrial revolution to begin to furnish substantial benefits to the poor. The poor in modern less-developed countries are justifiably more impatient. And second, the vast majority of the poor in developing countries are very poor indeed, with ubiquitous malnutrition, actually approaching the point of starvation in many areas.

We therefore prefer to argue that the effort required, though large, is feasible. With an integrated, well-balanced, mutually reinforcing selection of development strategy and anti-deprivation policy packages, substantial improvement is possible over relevant time periods. A nation should therefore reorient its policies in this direction and deal with the unrest of the wealthy now, as best it can.

Indeed, we urge this policy. The costs of renegotiating the social contract are never low, but they cannot be avoided in a world of dynamic change. The question is not whether there will be change; it is rather in what direction and to what extent. Will there be a relatively peaceful transition to a more equitable economy and society, with some structural change but with the essential aspects of a free market economy preserved? Or will the current trends in inequality continue or even worsen, but under

an increasingly repressive political system capable of preventing significant structural change? Or will there be a violent revolution with great costs and unpredictable outcome for the future path of the economy and society? Our results indicate that the first course is an economic possibility. Whether it is a political possibility as well is still an open question.

Appendixes

APPENDIX A

Basic Static Model Equations: Stage II

In this Appendix, we present the basic equations of the static model, Stage II of the full model. It represents the core of the full model, and its solution determines all wages, prices, production, employment, profits, and incomes, as well as consumption and the distribution of income in a given period. The Stage II equations are divided into three parts. The first part refers to product supply and factor demand; the equations describe the behavior and equilibrium conditions for the firm sector. The equations in the second part describe product demand and labor supply; they give the behavior and equilibrium conditions for households, government, and foreign trade. The equations in the third part describe aggregate supply and demand equilibrium and the determination of the aggregate price level.

Before turning to the model equations, a brief word about the system of notation used. Unless otherwise indicated, we have adhered throughout to the following general principles:

1. Greek letters refer to parameters, not to variables.
2. Roman letters without a bar or other mark are variables to be solved in the given stage.
3. Roman letters with a bar ($\bar{r}$) are fixed or exogenous in the given stage, but will be variable in another stage.
4. Roman letters with a circumflex ($\hat{r}$) are parameters, like the Greek letters.
5. Roman letters with a tilde ($\tilde{r}$) refer to money aggregates (e.g., total investment spending) and are usually not subscripted. They are generally, but not always, variables that are to be solved.
6. There is no special significance to the use of upper- or lower-case letters.
7. The subscript i always refers to sector i.
8. The subscript s always refers to firm size s.
9. The subscript λ always refers to labor category λ.
10. The same letter used with different numbers of subscripts denotes a different variable. For example, W_λ and $W_{s\lambda}$ are different variables.
11. Time subscripts are omitted for all variables except where time lags are involved. Thus, unless explicitly noted to the contrary, all variables refer to the current period.
12. Equations are numbered only if they are part of the system of equations to be solved. All derived equations and intermediate steps are unnumbered or are numbered in a different series.

PART I: FACTOR MARKETS

In this part, all the equations relating to the factor markets and the supply of goods are gathered together. If product prices are given, the equations in this part will yield a set of excess-demand equations for all factors. The solution of these equations yields employment, income, and product supplies. The equations in this part are diagrammed in Figure 2, Chapter 1. How the equations are solved is discussed in detail in Appendix B.

The important variables in this part (in order of their appearance) are

K_{is} = actual capital stock of firm size s in sector i;
Z_i^r = total demand for investment purposes of good i;
X_{is} = output of firm size s in sector i;
X_i = total output of sector i;
$L_{is\lambda}$ = labor of category λ employed in firm size s in sector i;
L_λ^s = aggregate supply of labor of category λ;
W_{isc} = profits ("wage" of capital) in firm size s in sector i;
W_λ^a = average wage of labor category λ;
$W_{is\lambda}$ = wage of labor category λ in firm size s in sector i; and
P_i = price of good i.

Part 1: Firm Behavior

Capital stock by firms. In Stage II each firm's total investment expenditure is fixed in nominal terms (from Stage I). The fixing of investment expenditure in a given period in nominal terms means that the amount of capital goods each firm actually purchases depends on the aggregate price level, which is itself an endogenous variable. This specification reflects our belief that investment plans are set in nominal terms, and that firms are constrained by the nominal investment funds they have accumulated. In our dynamic model such investment decisions are made in Stage I; if the prices as determined in Stage II were as expected in Stage I, then each firm would receive as much real capital as it desired.

To convert the investment expenditure fund into physical capital, we define the matrix B such that B_{ij} represents the fixed proportions in which any firm in sector j must acquire capital goods from sector i in order to make up one unit of real capital. In general the cost of one unit of capital is given by

$$\sum_j P_j B_{ji} \qquad \text{for all firms in sector } i.$$

Thus, given nominal investment expenditure by each firm (from Stage I), one can calculate how much real capital it receives:

$$\Delta K_{is} = Z_{is} \Big/ \sum_j P_j B_{ji} \qquad i \cdot s \text{ equations,} \tag{1}$$

where ΔK_{is} is the purchase of real capital by firm sector i, size s. This can be translated into a demand for individual capital goods by firms by using the B's, and these demands can then be aggregated into total demand for individual capital goods, Z_i^r:

$$Z_i^r = \sum_j \sum_s B_{ij} \, \Delta K_{js} \qquad i \text{ equations.} \tag{2}$$

Note that $B_{ij}\,\Delta K_{js}$ is the demand for capital good i by firm size s in sector j. Z_j^r is in physical or real units of a sector (and will enter the material-balance equations). Equation (2) converts investment demand by sector of destination to demand for capital goods by sector of origin.

Assuming that there are gestation lags, the actual capital stocks by firms are given by

$$K_{is}^{(t)} = (1 - \delta_s)K_{is}^{(t-1)} + \sum_{r=0}^{T} g_{isr}\,\Delta K_{is}^{(t-r)} \qquad i \cdot s \text{ equations,} \tag{3}$$

where t refers to time, δ is the depreciation rate, which is assumed to be the same for all types of capital goods within a given firm but different across firm sizes, and g_{isr} is the proportion of capital goods bought in time r that will have been installed by the current period for firm size s in sector i. It must be true that

$$\sum_{r=0}^{T} g_{isr} = 1$$

for all i and s. The variable T is the longest gestation lag in years. The minimum gestation lag can easily be set at one year by specifying $g_{is0} = 0$, in which case capital stock this period does not depend on investment this period.

Production functions. Given factor inputs, output is given by a production function. Two kinds of production functions are used: Cobb-Douglas and two-level CES. The equations are

$$X_{is} = \bar{A}_{is}K_{is}^{\alpha_{isc}} \prod_{\lambda} L_{is\lambda}^{\alpha_{is\lambda}} \qquad m_1^*, \tag{4}$$

and

$$X_{is} = \bar{A}_{is}[\alpha_{is}L_{is}^{-\rho_i} + (1 - \alpha_{is})K_{is}^{-\rho_i}]^{-\gamma_{is}/\rho_i} \qquad m_2^*, \tag{5}$$
$$m_1^* + m_2^* = i \cdot s.$$

The aggregate labor variable in (5) is given by

$$L_{is} = k \prod_{\lambda} L_{is\lambda}^{\alpha_{is\lambda}},$$

where k is a scale parameter set equal to the number of labor categories and where

$$\sum_{\lambda} \alpha_{is\lambda} = 1$$

for these sectors. The multiplicative term gives a geometric average labor input, which is multiplied by scale parameters to make it comparable to the labor input in the Cobb-Douglas functions. The production function in (5) is thus a two-level CES using a Cobb-Douglas aggregation function for labor. We used the two-level CES function rather than a one-level many-factor generalization of the CES function because we felt it was unreasonable to assume that the elasticity of substitution between all types of labor was the same and equal to that between labor, on the one hand, and capital, on the other. Capital is more likely to be complementary to high-level skills and to substitute for low-level ones. The production function used is CES in the labor aggregate and the capital aggregate, allowing for non-unit

elasticity of substitution between them. It is Cobb-Douglas for the various labor skills, assuming unit elasticity of substitution between them.

In the basic model the CES functions are used only for agriculture. In some experiments, CES functions were used in all sectors. We felt that in traditional agriculture in particular the elasticity of substitution between labor and capital (defined to exclude land and improvements on it) was likely to be rather low. To avoid having to include land as a separate factor of production, we lumped it into the scale parameter and deducted the returns to it from unity in setting the value of the CES return to scale parameter γ_{is}, so that in agriculture there were assumed to be decreasing returns to scale in labor and capital alone.

Aggregating to sectoral output gives

$$X_i = \sum_s X_{is} \qquad i \text{ equations.} \tag{6}$$

Profits. In the basic model each firm is assumed to maximize profits subject to technical constraints, a given capital stock, and in some cases export constraints imposed by the Korean government. In the agricultural and service sectors (as well as with the self-employed) there are other constraints or behavior rules. These sectors are discussed in Chapter 2.

Export targets are introduced because the Korean government sets minimum export quotas on Korean firms, and rigorously monitors their performance through the Ministry of Commerce and Industry. Various economic and legal sanctions, including—in the extreme—the revocation of a firm's trading license and even imprisonment of the owner, are imposed on those that fail to meet their targets. Substantial subsidies are awarded to make exporting attractive, but the need for and wide use of enforcement measures suggest that in many cases export targets are set well above the amount firms would choose to export under unconstrained profit maximization.

In addition, the government deliberately permits some exporting firms to act as discriminating monopolists. They exercise monopoly power in the domestic market through government-sanctioned trade associations and act as competitors in the world market, with the government separating the two markets by means of tariffs and quotas. Both approaches to the domestic market behavior of exporting sectors are used.

The firm's profit functions are given by

$$\pi_{is} = P^*_{is}X_{is} - (P^*_{is} - P^{*e}_{is})\bar{E}_{is} - \sum_\lambda W_{is\lambda}L_{is\lambda} - W_{isc}K_{is},$$

where P^*_{is} and P^{*e}_{is} are the net domestic and export prices, respectively, and $\bar{E}_{is}$ is the export target for the firm set by the government.

The two kinds of net prices appearing in the profit function are defined as follows. For domestic prices

$$P^*_{is} = P_i - \sum_j \hat{A}_{ji}P_j - \bar{P}^s\mu_{is} - \theta_i P_i \qquad i \cdot s \text{ equations.} \tag{7}$$

For exported goods

$$P^{*e}_{is} = P^e_i - \sum_j \hat{A}_{ji}P_j - \bar{P}^s\mu_{is} - \theta^e_i P^e_i \qquad i \cdot s \text{ equations,} \tag{8}$$

where

P_i = price of good i, in *won*;
P_i^e = export price, in *won*;
$\hat{A}_{ji}$ = input-output coefficients;
μ_{is} = noncompetitive import coefficients in dollars per unit output;
$\bar{P}^s$ = exchange rate in *won* per dollar;
θ_i = indirect tax rate, net of subsidies; and
θ_i^e = indirect tax rate for exported goods, net of subsidies. It includes any direct subsidy of exports.

The profit function as written can be used for all sectors since those sectors that do not export will have $\bar{E}_{is} = 0$.

The parameters θ_i and θ_i^e include *all* per-unit-value direct taxes and subsidies (including tax benefits, credit benefits, duty-free import of machinery, preferential transport rates, and wastage allowances). They differ from the more usual effective rate of protection measures in that they *exclude* indirect effects through intermediate inputs but *include* indirect taxes.

For those goods in which the export target represents a constraint set by the Korean government, we assume $P_i^e \leq P_i$. If, in fact, the model solved so that $P_i^e > P_i$, then unless quotas are set in the world market, the domestic price will be assumed to be determined by the world price. For goods for which there are export quotas set in the world market (e.g., textiles and knit goods), one would expect $P_i^e > P_i$, and would not adjust the domestic price. The modeling of monopolistic behavior by export sectors in the domestic market is discussed at the end of this part.

Actual profits, or the returns to capital, are defined residually. They are defined as what is left over after payments for intermediate goods, taxes, and wages. The profits per physical unit of capital, or "wages" of capital, are given by

$$W_{isc} = \frac{1}{K_{is}}\left[P_{is}^* X_{is} - (P_{is}^* - P_{is}^{*e})\bar{E}_{is} - \sum_{\lambda} W_{is\lambda} L_{is\lambda}\right] \quad i \cdot s \text{ equations.} \tag{9}$$

This equation holds also for firms not operating under an export constraint, since in that case $\bar{E}_{is} = 0$.

Note that the profit rate is not assumed to be the same across firms or to be an equilibriating variable in Stage II, thus introducing a non-neoclassical element. The allocation of capital is essentially determined exogenously to Stage II, and the profit functions are really, from a behavioral point of view, side equations that do not affect intraperiod equilibrium. They do affect market share expectations in Stage III and the ability to borrow in Stage I of the dynamic model.

Part 1: Labor Market

Just as there are λ different skill categories of labor in the model, so there are also λ different labor markets. In addition, the agricultural labor market is treated separately; no sector other than agriculture is permitted to hire agricultural labor. In each nonagricultural sector the self-employed firms are assumed to consist only of the self-employed, and hence demand no labor in any of the skill categories. This simplification was necessary for data reasons: there is no information available on skill breakdowns in the self-employed category. The number of nonagricultural self-employed workers in each sector is constant in Stage II.

Labor demand, nonagricultural sectors. The firm chooses the level of employment to maximize profits. In principle, the first-order conditions for labor are the same regardless of any export constraint. The export constraint is seen as a fixed charge (or windfall profit) and does not change hiring decisions at the margin so long as there is some production for the domestic market.

The first-order conditions do depend, however, on marginal revenue, which in turn depends on the nature of the market, i.e., the degree of monopoly power. It is here that specifying domestic monopoly power for certain export sectors affects firm behavior.

The labor-demand equations differ depending on the type of production function assumed for the sector. For sectors with Cobb-Douglas functions, the labor demand equations are given by

$$L_{is\lambda} = \frac{1}{W_{is\lambda}}[\alpha_{is\lambda}X_{is}]P^*_{is}\left(1 + \frac{1}{\eta_i}\right) \qquad m^*_1 \cdot \lambda, \tag{10}$$

where $W_{is\lambda}$ is the wage of labor category λ in firm size s, sector i, and η_i is the notional price elasticity of demand (assumed to be infinite for competitive sectors).

For sectors with two-level CES functions, the labor-demand equations are more complicated. They are given by

$$L_{is\lambda} = \frac{1}{W_{is\lambda}}[(MPL)_{is}\alpha_{is}L_{is}]P^*_{is}\left(1 + \frac{1}{\eta_i}\right) \qquad m^*_2 \cdot \lambda; \tag{11}$$

$$m^*_1 \cdot \lambda + m^*_2 \cdot \lambda = i \cdot s \cdot \lambda.$$

L_{is} is the labor aggregate, and $(MPL)_{is}$ is the derivative of the CES function with respect to the labor aggregate:

$$(MPL)_{is} = \alpha_{is}\gamma_{is}\bar{A}_{is}^{-\rho_i/\gamma_{is}} X^{1+(\rho_i/\gamma_{is})},$$

so

$$\frac{\partial X}{\partial L_{is\lambda}} = \frac{\partial X}{\partial L_{is}}\frac{\partial L_{is}}{\partial L_{is\lambda}} = (MPL)_{is}[\alpha_{is}L_{is}/L_{is\lambda}].$$

Labor supply, nonagricultural sectors. The markets for different categories of nonagricultural labor are divided into two types: those for which the supply is fixed and those for which the supply is a function of the wage. The higher-skill categories of labor are assumed to be in fixed supply during the period. The supply of low-skill labor to the nonagricultural sectors is not fixed; in general it should be affected by migration from the rural sector, and thus be a function of urban and rural wages. The basic model incorporates this fact by specifying elastic supply functions for certain low-skilled labor categories. An explicit migration model, discussed in Appendix B, is specified in Stage III.

All labor supplies are also defined net of the government demand for labor. The government is assumed to demand fixed quantities of labor, and so does not have a wage-sensitive demand curve for labor. Its demands can thus simply be subtracted from the labor available to the private sector. The supply equations are

$$L^s_\lambda = \bar{L}^s_\lambda \qquad m_1 \text{ equations,} \tag{12}$$

and

$$L_\lambda^s = \bar{L}_\lambda^{*s}[1 + \phi_\lambda^s(W_\lambda^a/W_\lambda^n - 1)] \qquad m_2 \text{ equations,} \tag{13}$$

$$m_1 + m_2 = \lambda,$$

where

$\bar{L}_\lambda^s$ = fixed supplies for m_1 categories;
$\bar{L}_\lambda^{*s}$ = the "normal" labor supply at wage W_λ^n for m_2;
ϕ_λ^s = elasticity of supply of labor category;
W_λ^n = normal wage of m_2 categories; and
W_λ^a = average wage of category λ.

The elasticity ϕ_λ^s in equation (13) gives the response of supply relative to "normal" supply $\bar{L}_\lambda^{*s}$ with respect to a change in the wage relative to the "normal" wage W_λ^n.

The normal wage, W_λ^n, can be thought of as a base wage for those categories of labor for which there are aggregate supply functions. It might be considered a reservation wage, a lower limit necessary for attracting relatively low-skilled workers from the agricultural sector. It is defined in real terms:

$$W_\lambda^n = \hat{\xi}_\lambda \bar{W} \left(\sum_j P_j C_j^0 \Big/ \sum_j P_j^0 C_j^0 \right) \qquad m_2 \text{ equations,} \tag{14}$$

where $\hat{\xi}_\lambda$ represents the ratio of the wage of category λ to that of the "base" worker. $\hat{\xi}_1 = 1$. The term in parentheses is the price index of the consumption bundle of the "base" worker, and $\bar{W}$ is his wage in the base period. Thus W_λ^n is a nominal wage whose value is fixed in real terms, and $\bar{W}$ is the real wage of the "base" worker.

The labor-supply functions given in (13) permit a great deal of flexibility. For example, setting the supply elasticity very high is equivalent to specifying a Lewis or Keynesian model with unlimited supplies of labor at the normal wage, and the normal wage becomes a wage floor. Of course, specifying a very low supply elasticity makes equation (13) approach the fixed-supply version given in equation (12). One assumes the existence of a pool of labor that represents an absolute upper bound on L_λ^s. The difference between the labor supply—given by either equation (12) or equation (13)—and the size of the pool either defines unemployment or comes from migration from the agricultural sector. In most experiments we used fixed labor supplies within the period, with migration modeled in Stage III.

Wage determination. The determination of wage levels outside of agriculture proceeds in two steps. First, we determine the average wage rate for a given skill category, W_λ^a, by equating the aggregate demand for labor with its aggregate supply. Next, we apply a set of ratios, calculated from base-period conditions, defining the relationship between wage rates (by skill) in each industry and sector to the average wage for that skill. In neoclassical labor markets, these ratios should all be unity. The extent of this departure from unity reflects both the results of market imperfections restricting labor mobility among sectors and firm sizes, and the extent to which labor quality differs among sectors and firms.

More specifically, equilibrium wages are determined by equating the aggregate demand for labor with aggregate supplies. The demand is given by

$$L_\lambda^d = \sum_i \sum_s L_{is\lambda} \qquad \lambda \text{ equations,} \tag{15}$$

and the equilibrium conditions are

$$L_\lambda^s = L_\lambda^d \qquad \lambda \text{ equations.} \tag{16}$$

In equations (10) and (11) the wage is denoted by $W_{is\lambda}$ and is assumed to be different for the same categories of labor working in different sectors and firm sizes. In equation (16) the labor market operates to equilibriate the aggregate supply and demand for labor by categories without regard to sector or firm size, and in equation (13) the aggregate supply of labor is assumed to be a function of one wage, W_λ^a. The relationship between wages of the labor of the same skill category in different sectors and firm sizes is given by

$$W_{is\lambda} = \xi_{is\lambda} W_\lambda^a \qquad i \cdot s \cdot \lambda \text{ equations.} \tag{17}$$

It is useful to interpret W_λ^a as an average wage, so it follows that

$$\sum_i \sum_s \xi_{is\lambda}(L_{is\lambda}/L_\lambda^s) = 1$$

for all λ. In fact, the average is defined excluding the service sectors. The $\xi_{is\lambda}$ are the appropriate weights defining the average wage in the base period. They embody our assumptions about labor market institutions and their imperfections, and are assumed to change over time (in the dynamic model).

TABLE A.1
Variables and Equations for Stage II, Part 1

Variables	Number of equations	Equation number
ΔK_{is}	$i \cdot s$	(1)
Z_i^r	i	(2)
K_{is}	$i \cdot s$	(3)
X_{is}	$i \cdot s$	(4), (5)
X_i	i	(6)
P_{is}^*	$i \cdot s$	(7)
P_{is}^{*e}	$i \cdot s$	(8)
W_{isc}	$i \cdot s$	(9)
$L_{is\lambda}$	$i \cdot s \cdot \lambda$	(10), (11)
L_λ^d	λ	(15)
L_λ^s	λ	(12), (13)
W_λ^a	λ	(16)
$W_{is\lambda}$	$i \cdot s \cdot \lambda$	(17)
W_λ^n	m_2	(14)

Part 1: Equation Summary

Table A.1 summarizes the endogenous variables appearing in Part 1 and indicates the equations that are most closely related to the variables. Note that, assuming product prices are given, there are as many equations as endogenous variables. Economic theory tells us that given product prices and factor supplies, one should be able to solve for factor prices, employment, and profit-maximizing product supplies. This is exactly what we do in the solution strategy discussed in Appendix B.

PART 2: PRODUCT DEMAND AND INCOME DISTRIBUTION

There are four sectors that demand goods: (1) firms; (2) households; (3) government; and (4) exports (the foreign sector). On the demand side, household demand, government demand, part of the firms' demand (that for investment goods), and some exports are assumed to be a function of prices.

In addition to the demand for goods, each sector has a demand for new cash balances. Our modeling of these demands follows Patinkin. We assume that households want to hold some part of the expected value of their total purchases in the form of money. These cash balances are included explicitly in the model to permit real balance effects to occur, and so enable the model to determine the absolute as well as the relative price levels.

The equations in this part are summarized in Figure 3, Chapter 1.

Part 2: The Firm Sector

Define by firms the pre-tax profits available for distribution:

$$PR_{is} = W_{isc}K_{is} - \bar{r}^b_{is}\bar{B}^b_{is} - \bar{r}^c_{is}\bar{B}^c_{is} - \bar{r}^s_{is}\bar{P}^s\bar{B}^s_{is} - \delta_{is}K_{is} \qquad i \cdot s \text{ equations,} \tag{18}$$

where

δ_{is} = depreciation rate for firm i, s;
W_{isc} = "wage" of capital defined in equation (17), $W_{isc}K_{is}$ equals gross profits;
$\bar{r}^b_{is}$ = interest rate on bank loans;
$\bar{r}^c_{is}$ = interest rate on curb-market loans;
$\bar{r}^s_{is}$ = interest rate on foreign loans;
$\bar{B}^b_{is}$ = total outstanding loans borrowed from banks;
$\bar{B}^c_{is}$ = total outstanding loans borrowed from the curb market;
$\bar{B}^s_{is}$ = volume of foreign borrowing, in dollars; and
$\bar{P}^s$ = exchange rate in *won* per dollar.

The profits of firms in equation (18) depend on interest payments, which in turn depend on the structure of debt by sources of loans, on the interest rates, and on the exchange rate. It is through this equation that the "foreign debt burden" problem affects the model. Interest payments do not directly affect production decisions in Stage II, since they are seen as fixed costs—though they do affect production indirectly by changing dividends and income distribution, and so the pattern of demand. The most serious direct effect of increasing debt burden is to decrease the investment fund available to the firm in Stage I of the next period.

Note that depreciation charges are defined in terms of purchase price rather than current replacement cost. It makes more sense economically to define them with respect to replacement cost, but we have followed the accounting practice of depreciating only book value in order to be consistent with Korean national accounts.

Direct taxes on firms are given by

$$T^f_{is} = \tau^f_{is}PR_{is} \qquad i \cdot s \text{ equations,} \tag{19}$$

where τ^f_{is} is the direct-tax rate on firms.

The direct-tax rate on firms in Korea is in fact mildly progressive. We approximate it with a proportional rate that differs by sectors and firm sizes. This approach should cause no serious distortion. The treatment of personal income taxes is much more complex.

Total capital income to be distributed to the household sector in the form of dividends is given by

$$\tilde{Y}^{\pi} = \sum_i \sum_s (1 - \sigma^{\pi}_{isc})(PR_{is} - T^{f}_{is}) - \Delta\tilde{M}^{f} \qquad \text{one equation,} \tag{20}$$

where σ^{π}_{isc} is the retained earnings or "savings" rate by firms. It is applied to gross profits net of depreciation, taxes, and interest payments.

The variable $\Delta\tilde{M}^{f}$ in equation (20) is the firm sector's demand for new cash balances and is given as a share of the total demand for new cash balances, $\Delta\tilde{M}$:

$$\Delta\tilde{M}^{f} = \xi^{f}\,\Delta\tilde{M} \qquad \text{one equation.} \tag{21}$$

The total demand for new cash balances is given by the Cambridge quantity equation

$$\Delta\tilde{M} = \bar{k} \sum_i P_i X_i - \tilde{M}_{t-1} \qquad \text{one equation,} \tag{22}$$

where $\bar{k}$ is the Cambridge k and is assumed to be a function of the interest rate and the inflation rate (in Stage III; it is fixed in Stage II). By updating $\bar{k}$ in accordance with these variables our demand for money becomes more Keynesian.

Part 2: Factors and Households

The levels and distribution of household incomes are calculated in six steps, which are discussed in full in sequence below. These steps, briefly, are (1) average factor incomes by 15 occupational groups are calculated, plus the size of each group; (2) the size distribution of personal factor income within each of the 15 groups and overall is estimated; (3) calculate direct taxes and transfers; (4) calculate number of households in each of 15 categories classified by occupation of the head of household and the mean household incomes by groups; (5) estimate the size distribution of income both within household groups and overall; and (6) calculate household savings and expenditure.

Factor incomes. There are 15 different categories of income recipients in the model. The first six are skill categories of labor who receive wage income: engineers, technicians, skilled labor, apprentices, unskilled labor, and white-collar workers. The model economy generates the wages for these groups through the workings of the labor markets. The seventh group, government workers, also receive a wage; their wage and employment is exogenous to Stage II (though it is updated in Stage III of the dynamic model). Teachers and doctors are added to government workers when taxes and consumption are calculated.

There are two categories of self-employed who receive the net returns (or net value-added) accruing to the smallest (self-employed) firm size. A separate group—capitalists—receive all the distributed profits from the other firm sizes.

Finally, there are five groups who receive agricultural income: owners of the four different farm sizes and landless labor. The wage of agricultural labor is determined in the agricultural labor market.

Rental income is treated specially. About three-fourths of total rental income is imputed rent from owner-occupied housing. This imputed income is distributed to the groups in proportion to their base-period consumption of housing. The rest of the rental income goes to the capitalist group (which thus includes landlords).

Size distribution: personal income. From the previous calculations, we have the number of people in, and average income of, each of 15 occupational groups. We then assume that the size distribution within each of these groups can be represented by a two-parameter lognormal distribution. These parameters are estimated for each of the groups.

The method of estimating the parameters and our reason for choosing the lognormal distribution are discussed in Chapter 4. We simply note here that the lognormal distribution is used for each of the subgroups separately and is never used to represent the overall size distribution. Our tests indicate that the two-parameter forms fit the within-group distribution very well.*

The overall size distribution is calculated numerically by simply adding the group distributions. The quantiles (for example, deciles) of the overall distribution are determined by guessing an income quantile, adding the distributions, and refining the guess iteratively.† Note that the overall distribution need not be lognormal or have any tractable form. It might even be multimodal (though in practice it never was). Note also that the central-limit theorem has no application here, since we are summing distributions, not random variables. All overall distribution statistics such as quantiles, quantile means, and Gini coefficients are computed numerically from the sum of the separate distributions rather than from some approximation of the overall distribution.

Direct taxes and transfers. Direct taxes are calculated by applying the appropriate Korean tax schedules to each type of income. Using the size distribution function, average income recipients representing the mean incomes of successive twentieths of the distribution were constructed for each group of agents. The appropriate tax schedules were applied to the 20 average incomes to get the total group tax. The total group tax was then adjusted for such things as evasion by applying a group collection ratio. The process was repeated for each group.

At this point some transfer payments are programmed to account for government transfer payments; some rent, interest, and profit income that accrues to groups other than capitalists; and the income of individuals in the agricultural sector from work in nonagricultural sectors. The need for the last type of transfer arises because the model economy completely separates the agricultural and nonagricultural labor forces when in fact there are clearly some agricultural sector workers who work part-time in nonagricultural jobs.

Household formation. We define 15 household groups categorized by the occupation of the head of the household. Each household can have other workers (or fractional workers) who work in occupations different from that of the head of the

* We used tests for skewness and kurtosis developed by Geary. See Aitchison and Brown 1957: 34. The only group for which lognormality could be rejected (by one of the two tests) was engineers. The group is so small that it did not seem worthwhile to try any other distribution.

† Formally, the problem is to find the unique root of an algebraic equation. We used the standard Newton method, using a numerical estimate of the first derivative. See Jarratt 1970; or Arden and Astill 1970. See also Robinson 1976b for a detailed description of the approach and the associated computer algorithm that we have used.

household. From a special urban household survey, we have data on the average number of other workers in each household category and their occupational distribution.* Given this information and the total number of workers in each category, it is possible to derive the total number of households and the average household income in each category.

In the derivation we use some matrix algebra, and so deviate slightly from the notational conventions used elsewhere. The equations are also numbered differently since they are really side equations in the overall model and will be netted out of any equation and variable counting.

We define the following matrices and column vectors:

H = matrix such that H_{ij} is the share of "other workers" of category j in household category i (note that $\Sigma_j H_{ij} = 1$ for all i);
n = column vector such that n_i is the average number of "other workers" in households of category i;
N = diagonal matrix such that $N_{ii} = n_i$ and $N_{ij} = 0$ if $i \neq j$;
w = column vector such that w_i equals the average income of workers in category i;
y = column vector such that y_i equals the average total income of households in category i;
h = column vector such that h_i is the total number of households in category i; and
p = column vector such that p_i is the total number of workers in occupational category i.

Note that $n_i H_{ij}$ is the number of "other workers" in category j in household i. The total income of a household is the sum of the income of the head and of the incomes of all "other workers." Thus

$$y = w + NHw$$

or

(i) $$y = Qw,$$

where $Q = I + NH$. Q_{ij} is the total number of workers in category j in household i.

It must be true that total household income must be identically equal to total worker income. Therefore, where (′) indicates the transpose,

(ii) $$h'y \equiv p'w.$$

Substituting from (i):

$$h'Qw \equiv p'w.$$

Since this must be true for any w, it follows that

(iii) $$h'Q = p',$$

and

(iv) $$h' = p'Q^{-1}.$$

* These data were gathered in a special survey commissioned by the World Bank.

We estimate Q from survey data, and given equations (i) and (iv), we can calculate both average incomes and household numbers by household category.

Note that there is no restriction on the sign of the elements of Q^{-1}, and it is theoretically possible to have negative elements in h (though it did not happen in practice). This implies that so many workers of a given category are needed as "other workers" that the household category must generate such workers ex nihilo by having a negative entry.

Household income distribution. The size distribution of income within household categories is estimated by the size distribution within occupational categories. A separate lognormal distribution is fit for each category of households, and the overall distribution is calculated numerically by adding the group distributions.

Household savings and expenditure. Household savings are calculated using savings equations for each household category (estimated by regression analysis of household survey data). After savings (and taxes) are subtracted, households use their remaining income either to purchase goods or to hold as new money balances. The amount of new money balances held by each household category is given by

$$\Delta\tilde{M}_k^h = \xi_k^h \Delta\tilde{M} \qquad k = 1, \ldots, h \qquad h \text{ equations.} \tag{23}$$

The result of all the steps outlined above is to calculate the aggregate consumption expenditure of each household category, Y^c. For later counting purposes, we number and list the variables as if they were equations.

$$Y_k^c \qquad k = 1, \ldots, h \qquad h \text{ equations.} \tag{24}$$

Y_k^c is defined net of the households' demand for new cash balances.

In order to calculate the demand for individual goods, households are first grouped into several "demander classes." These demander classes are defined as groups of households whose collective demand for goods can be described by one aggregate function. We define 12 such classes.

Aggregate total household consumption expenditures into d demander classes:

$$Y_d = \sum_{k \in d} Y_k^c \qquad d \text{ equations.} \tag{25}$$

Each demander class is assumed to have a different set of demand functions for goods as a function of its total expenditure and prices. Following much of the recent literature in demand analysis, we assume that each demander class behaves as if it were a single individual maximizing an additively separable direct utility function. (For a recent survey, see Brown and Deaton 1973.) The assumption of direct additivity simplifies the problem of parameter estimation, but has its costs. It implies that there are no specific substitution effects, no inferior goods, and no Hicks-Allen complementary goods.

In the empirical literature there are currently only two commonly used additively separable direct utility functions: Houthakker's direct addilog function and the Stone-Geary generalized Cobb-Douglas function (Brown and Deaton 1973: 227–32, 241–43; Houthakker 1960; Stone 1954). For reasons discussed below, we have chosen the Houthakker approach. His direct addilog function is (with notation only used in this section)

$$u = \sum_i \alpha_i C_i^{-\rho_i},$$

where α_i and ρ_i are parameters and C_i is consumption of good i.

Sato (1972) has rewritten this as a generalized CES function:

$$u = \left[\sum_i \alpha_i C_i^{-\rho_i}\right]^{-1/\rho}$$

As a working hypothesis in many empirical applications, one often assumes that the income elasticities and all price elasticities are constant. Houthakker (1960) and Sato (1972) have both shown that the constancy of these parameters is implied approximately by the generalized CES (direct addilog) utility function. Thus double-log demand functions with constant price and income elasticities can be seen to be associated with the generalized CES (addilog) utility function.

Frisch (1959) has shown that given estimates of all income elasticities and one other parameter (which he calls the "money flexibility of the marginal utility of income" and which we shall simply call the "Frisch parameter"), one can derive all own and cross price elasticities. Sato shows that the Frisch parameter is a simple function of his overall elasticity of substitution parameter, ρ. The implication of Frisch's approach is that one need not estimate price elasticities directly but can calculate them from estimates of the income elasticities and the Frisch parameter. Frisch's approach is very powerful and has been used in one form or another in many empirical studies. It is the approach we have chosen.

The most common alternative approach is the Stone-Geary linear-expenditure system. The demand equations are derived from a generalized Cobb-Douglas utility function and have the property that the Engel functions are linear; i.e., the marginal propensity to consume particular goods does not change with income. This approach has been used in a number of empirical studies and has recently been applied to Korea at a relatively aggregated level. (See Lluch and Williams 1974.) We have not used this approach because the problems of estimating the necessary parameters for 12 subgroups and 29 goods proved too difficult with currently available data. We have, however, tested for the sensitivity of the model to our specification.

We assume constant income and price elasticities, and so have chosen to use the simple double-log form approximation for the demand functions. The aggregate demand for each good is determined by summing up the equations for each demander group. The resulting equations are

$$C_i = \sum_d \hat{Q}_{id} Y_d^{\eta_{id}^y} \prod_j P_j^{\eta_{ijd}} \qquad n_1^* \text{ equations,} \tag{26}$$

and

$$C_i = 0 \qquad n_2^* \text{ equations.} \tag{27}$$

Here n_1^* is the number of goods that enter consumer demand functions, and n_2^* is other goods (pure intermediate and investment goods); $n_1^* + n_2^* = i$. The $\hat{Q}_{id}$ are parameters. Given that all P_j equal 1 in the base period, then they are defined as

$$\hat{Q}_{id} = C_{id}^o / Y_{Od}^{\eta_{id}^y}.$$

The parameters η_{ijd} and η_{id}^y are respectively price and income elasticities of demand for demander class d.

As noted above, these demand equations with constant price and income elasticities are implied approximately by the generalized CES (direct addilog) utility function. There are two problems with using the functions as written. First, they are

an approximation and do not in general satisfy the budget constraint. Second, they give consumer demands as a function of producer prices, not retail prices.

As concerns the first problem, Sato, Houthakker, and others have noted that the income elasticities can be assumed to remain constant if and only if they all equal 1. To see this, note that the expenditure elasticity can be written

$$\eta_i^y = MPC_i/S_i,$$

where MPC_i is marginal propensity to consume good i, $P_i(\partial C_i/\partial Y)$; S_i is expenditure share on good i, P_iC_i/Y; and η_i^y is expenditure elasticity, $(Y/C_i)(\partial C_i/\partial Y)$.

If the budget constraint is to be satisfied, it must be true that the marginal propensities to consume must add to 1 over all goods. They thus must remain constant, and if the elasticities are also to remain constant, then so must the shares. However, the shares will remain constant if and only if all the elasticities equal 1.

We have not bothered to try to correct the demand functions directly for this approximation. Instead, we have used equation (26) to calculate the demands and have then adjusted all demands (by each demander group) proportionately so as to impose the budget constraint

$$\sum_i P_iC_i^d = Y_d,$$

where C_i^d is the consumption of good i by demander group d. Empirically, we found the correction to be trivial.

In the dynamic version of the model, we in fact adjust the elasticities. It must be true that

$$\sum_i S_i\eta_i^y = \sum_i MPC_i = 1.$$

Given the shares that are determined in solving Stage II, we adjust all the elasticities proportionately so that the weighted sum still equals 1. Given these adjusted elasticities, we then recalculate all the price elasticities (assuming the same values for the Frisch parameters). Finally, we recalculate the constants $\hat{Q}_{id}$, so that the new demand equations will replicate the Stage II quantities demanded given the solution prices and total expenditures. All these adjustments are done as part of the updating procedure in Stage III.

The second problem with the demand equations as written is that the model is based fundamentally on input-output data and is thus formulated in terms of producer prices. The demand equations, however, are expressed in terms of retail prices. All the parameter estimates were made with data based on retail prices. However, we do have data on the trade margins (the ratio of wholesale to retail prices) for each sector.

Faced with the identical problem, Johansen (1960) assumed constant trade margins and adjusted the various demand parameters so that the demand functions were expressed in terms of wholesale prices. We have used a slightly different approach with similar effect. Assuming constant trade margins, we estimate demand in the following steps:

1. Using the trade margins, convert producer prices to retail prices. Total expenditure of course remains unchanged.

2. Given retail prices and total expenditure, use the demand equations to estimate demands for each good. Pure producer goods for which $C_i = 0$ and trade services

are excluded from the demand equations. The procedure discussed above is used to ensure that the budget constraints are met.

3. Given the solution quantities demanded, the value of total consumption in terms of producer prices is calculated. Since producer prices are always less than or equal to retail prices (all trade margins are greater than or equal to zero), the value of total expenditure in producer prices is always less than the value in retail prices.

4. The demand for trade services is calculated as the difference between total expenditure valued in consumer prices and total expenditure valued in producer prices.

Part 2: The Government Sector

The government is assumed to undertake investment projects, and so provide an exogenous demand for investment goods, $\bar{Z}_i^{ex}$. In the basic static model, aggregate government consumption expenditure is specified exogenously in real terms. Nominal aggregate government consumption is calculated by applying a price index to the real value, so that at current prices nominal aggregate government expenditure is such that it would purchase the base year (1968) bundle of government consumption.

$$\tilde{G} = \tilde{G}^r \left[\sum_i P_i G_i^{1968} \Big/ \sum_i P_i^{1968} G_i^{1968} \right] \qquad \text{one equation,} \tag{28}$$

where $\tilde{G}$ is the nominal value of total government consumption; $\tilde{G}^r$ is the real value of total government consumption; G_i^{1968} is government consumption of good i in 1968; and P_i^{1968} is the price of good i in 1968.

The allocation of government consumption by sectors is calculated by assuming constant expenditure shares, S_i^g. Thus

$$P_i G_i = S_i^g \tilde{G} \qquad i \text{ equations.} \tag{29}$$

In the basic run no balanced budget or specified government deficit is introduced, so that $\tilde{G}^r$ is exogenous.

Part 2: The Foreign Sector

Exports have been an important source of growth in Korea, and the behavior of exporting firms is subject to a large battery of controls on the one hand, and direct and indirect incentives on the other. In the model we capture the mixture of incentives and controls by means of several devices. As indicated earlier, all firms have been allocated minimum export targets. In addition, however, the big export sectors (textiles, finished textiles, and lumber) have been modeled as monopolists, which make their production decisions on the basis of a marginal revenue calculation, and charge monopoly prices on the domestic market. There is also the usual battery of direct and indirect unit-price subsidies. Firms that achieve their export targets are given substantial indirect subsidies in the form of low-interest loans, wastage allowances, preferred access to foreign exchange, etc. These subsidies are represented in the model by various parameters in the net-price equations and elsewhere, but their magnitudes are specified exogenously to the model.

On the import side, there are two categories of importers: those whose domestic prices are set by world prices and those who are protected by tariffs as infant industries, so that their domestic price is allowed to rise to whatever level is necessary to allow profitable domestic operation. Though the distinction between these two

types of importers is important, in the base-year run of the basic model all importing sectors (basic and consumer chemicals, petroleum products, metal products, machinery, and transportation equipment) were assumed to be protected infant industries.

We distinguish among five types of goods that enter foreign trade: noncompetitive imports; competitive imports whose prices are determined in the domestic market; exports whose prices are determined in the domestic market; competitive imports of goods whose domestic prices are set by the world price; and exports whose domestic prices are set by the world price. Given the aggregation in the model, most sectors both export and import. We allow for this, but categorize sectors by their primary behavior. See Figure 2, Chapter 1.

Noncompetitive imports. Such imports are assumed to be in fixed proportions to gross output:

$$M_{is}^{nc} = \bar{P}^{\$}\mu_{is}X_{is} \qquad i \cdot s \text{ equations,} \tag{30}$$

where the μ_{is} are fixed coefficients (they also appear in the net-price equation, equation (7) in Part 1). $\bar{P}^{\$}$ is the exchange rate, *won* per dollar. Noncompetitive imports enter only the balance-of-payments equations; they are not used in the material-balance equations. They can be thought of as foreign exchange required for production and are not identified by sector of origin. They are of course excluded from the intermediate input-output coefficients.

Competitive imports whose prices are determined in the domestic market. In this case competitive imports are assumed to be proportionate to the various components of final demand.

$$M_i^c = \bar{P}^{\$}\left[\hat{M}_i^{(1)}(C_i + G_i) + \hat{M}_i^{(2)}(\bar{Z}_i^{ex} + Z_i) + \sum_j \hat{M}_{ij}^{(3)}X_j\right] \qquad n_1 \text{ equations,} \tag{31}$$

where $\hat{M}^{(1)}$ and $\hat{M}^{(2)}$ are vectors of import coefficients for the different components of final demand; and $\hat{M}^{(3)}$ is the matrix of import coefficients for intermediate goods.

The implicit tariff rate, defined as the rate that equates the domestic and world prices, is

$$t_i^{cm} = [P_i/(\bar{P}^{\$} \cdot \hat{P}_i^{w,\$})] - 1 \qquad n_1 \text{ equations,} \tag{32}$$

where t_i^{cm} is the tariff rate on competitive imports of good i; $\bar{P}^{\$}$ is the exchange rate in *won* per dollar; and $\hat{P}^{w,\$}$ is the world price in dollars of import i.

Exports whose prices are determined in the domestic market. For all sectors, these exports are specified exogenously as government-imposed export targets, and are given by $\bar{E}_{is}$. Monopolists take the $\bar{E}_{is}$ into account in estimating their marginal revenues and, hence, in deciding how much to produce for the domestic market.

One can estimate, analogous to imports, the implicit subsidy, i.e., the gap between the domestic and world prices:

$$t_i^e = [P_i/(\bar{P}^{\$} \cdot \hat{P}_i^{w,\$})] - 1 \qquad n_2 \text{ equations.} \tag{33}$$

This would be the per-unit subsidy necessary for firms to be indifferent to whether they export or sell domestically.

Competitive imports whose domestic prices are set by the world price. Competitive imports of these goods are determined as a residual in the material-balance equations. Domestic prices for these goods are assumed fixed and are given by

$$P_i = \bar{P}^s(1 + \hat{t}_i^{cm})\hat{P}_i^{w,s} \qquad n_3 \text{ equations,} \tag{34}$$

where $\hat{t}_i^{cm}$ are exogenously specified tariffs, ad valorem.

Exports whose domestic prices are set by the world price. These exports are also determined residually by the material-balance equations. Essentially, we assume that producers supply the domestic market first and export the rest of their goods. The residual exports are calculated *after* export targets, $\bar{E}_{is}$, are met. If any are negative, this indicates the target was not met.

As in the case of competitive imports, domestic prices are assumed fixed and are given by

$$P_i = \bar{P}^s(1 + \hat{t}_i^e)\hat{P}_i^{w,s} \qquad n_4 \text{ equations,} \tag{35}$$

where $\hat{t}_i^e$ is the exogenously specified export subsidy for good i (and may be zero). Equations (41) and (42) determine the number of prices that must be solved for in the model. The model must solve for $i - n_3 - n_4$ prices in all. Let

$$n^* = i - n_3 - n_4 = n_1 + n_2 + n_5.$$

Note that

$$i = n_1 + n_2 + n_3 + n_4 + n_5,$$

where n_5 is the number of non-traded goods.

Part 2: Material-Balance Equations

The material-balance equations are different for each category of traded good and for non-traded goods. Define the total of intermediate and exogenous demands for goods as

$$X_i^{ex} = \sum_j \hat{A}_{ij}X_j + \bar{Z}_i^{ex} + Z_i^r + G_i.$$

For non-traded goods, the material balances are given by

$$C_i^s = X_i - X_i^{ex} \qquad n_5 \text{ equations.} \tag{36}$$

For competitive imports whose prices are determined in the domestic market:

$$C_i^s = X_i - X_i^{ex} + M_i^c \qquad n_1 \text{ equations.} \tag{37}$$

For exports whose prices are determined in the domestic market:

$$C_i^s = X_i - X_i^{ex} - \sum_s \bar{E}_{is} \qquad n_2 \text{ equations.} \tag{38}$$

For imports whose domestic prices are set by the world price:

$$M_i^c = C_i + X_i^{ex} - X_i \qquad n_3 \text{ equations.} \tag{39}$$

For exports whose domestic prices are set by the world price:

$$E_i^c = X_i - C_i - X_i^{ex} \qquad n_4 \text{ equations.} \tag{40}$$

Since in practice many sectors both export and import, these equations collapse to two types: those in which net trade is calculated residually—equations (39) and

TABLE A.2
Variables and Equations for Stage II, Part 2

Variables	Description	Number of equations	Equation number
PR_{is}	Retained earnings	$i \cdot s$	(18)
T_{is}^{f}	Firm direct taxes	$i \cdot s$	(19)
$\tilde{Y}^{\pi}$	Distributed profits	one	(20)
$\Delta\tilde{M}^{f}, \Delta\tilde{M}_{k}^{h}, \Delta\tilde{M}$	New transactions balances	$h + 2$	(21), (22), (23)
Y_{k}^{c}	Household expenditure	h	(24)
Y_{d}	Aggregated expenditure	d	(25)
C_{i}	Consumption of good i	i	(26), (27)
$\tilde{G}$	Aggregate government consumption	one	(28)
G_{i}	Government consumption	i	(29)
M_{is}^{nc}	Noncompetitive imports	$i \cdot s$	(30)
M_{i}^{c}	Competitive imports	$n_1 + n_3$	(31), (39)
t_{i}^{cm}	Tariffs: competitive imports	n_1	(32)
t_{i}^{e}	Implicit export subsidies	n_2	(33)
P_{i}	Domestic prices set by world prices	$n_3 + n_4$	(34), (35)
C_{i}^{s}	Supply of consumer goods	n^*	(36), (37), (38)
E_{i}^{c}	Exports	n_4	(40)

DEFINITIONS:
n_1 Competitive imports, prices determined in domestic market
n_2 Exports, prices determined in domestic market
n_3 Competitive imports, prices determined by world price
n_4 Exports, prices determined by world price
n_5 Non-traded goods
n^* Number of prices to be determined in domestic market ($n_1 + n_2 + n_5$)

(40)—and those in which it is not—equations (36) to (38). Both exports and imports appear in all the material-balance equations, since almost all sectors, no matter how categorized, actually had some exports and imports.

Part 2: Equation Summary

In equations (36), (37), and (38) we solve for C_i^s, which is the supply of goods for consumption. It is assumed that non-household demands for goods (which are not related to prices in Part 2) are met first, and the residual represents the supply of consumer goods. There are $n_1 + n_2 + n_5 = i - n_3 - n_4 = n^*$ such supplies. This number, n^*, is exactly the number of prices that need to be determined in the system, and there will also be n^* excess-demand equations. Equations (39) and (40) do not contain C_i^s. Instead, M_i^c and E_i^c are calculated so that consumption demand, C_i, is met exactly.

Table A.2 summarizes the variables and equations in Part 2.

PART 3: MONEY AND PRICES

The problem of solving Stage II is to find a set of prices such that all markets are in equilibrium. The solution approach we take is inherent in the way the system has been described. First, assume a given set of absolute prices, not the equilibrium set. Part 1 can be solved for production of all goods, and Part 2 can be solved for the demands. The solution of Part 2 yields a set of demands, (C_i), and, from the material-balance equations, a set of supplies, (C_i^s). From these, one can specify a set of excess-demand equations for goods, and the equilibrium conditions are that these excess demands all equal zero.

(41) $$ED_i = C_i - C_i^s = 0$$ n^* equations.

For those sectors for which the world price determines the domestic price, it will be true that $ED_i = 0$ in every iteration, since imports and exports are determined residually for those goods. Thus there are only n^* prices to be determined in the domestic market and n^* excess-demand equations.

In model economies in which each of the transacting sectors obeys a balanced-budget constraint even when out of equilibrium, or in economies in which there is always a residual transactor, Say's law must always hold regardless of whether or not the economy has reached equilibrium. That is, the total value of goods supplied must always equal the total value of goods demanded, and there can be no hoarding or dishoarding of money. In virtually all existing CGE models, aggregate consumption has been calculated residually, thus satisfying Say's law. (See, e.g., Johansen 1960; Taylor and Black 1974; and Dervis 1973.) All such models solve only for relative prices, since they have no mechanism for setting the aggregate price level.

In our model there is no residual transactor, since every transacting sector is modeled separately. Aggregate household consumption is determined in various steps involving the generation of household income, taxes, and savings. Furthermore, we do not impose balanced budgets for government, the foreign sector, or even the firm sector. The excess-demand-for-money equation is therefore a genuine equation in our system.

Our treatment of money balances and the determination of the rate of change of the price level follows Patinkin. The desire to hold cash balances in the framework of the model economy of Stage II can be rationalized by means of the arguments of Clower, though there are enough disequilibrium elements and divergences between expectations and realizations in the full dynamic model represented in Stages I–III to create the uncertainties and market imperfections required to rationalize money holdings even without the Clower considerations. (See Clower 1965; and Clower and Leijonhufvud 1975.)

The excess demand for new cash balances is the net balance of changes in the supply of and demand for new balances. The change in money supply occurs from two sources: the injection of new money (from Stage I), which appears in Stage II as exogenous investment spending by the firm sector; and net dishoarding (excess supplies) of money from firms, households, government, and the foreign sector. The second source is endogenous to Stage II. The aggregate demand for new cash balances is given by the Cambridge quantity equation, (22), and is allocated to firms and households. Note that the quantity equation determines the demand for real balances, since increasing prices will increase the demand for nominal balances.

Our model economy satisfies Walras's law, namely, the net value of all excess demands, including the excess demand for money, must equal zero. This is always true even when the economy is not at equilibrium. One can use this fact to calculate the excess demand for money at any iteration, since it must be true that the excess demand for money must equal the sum of the values of the excess supplies of goods:

(42) $$ED_M = -\sum_i P_i \cdot ED_i$$ one equation.

If our model economy is to achieve monetary equilibrium, imbalances in the real sector must call forth equilibriating adjustments in money-holding behavior. These equilibriating adjustments could, in principle, center around the interest rate, firm

investment behavior, and household-savings behavior in a Keynesian model. Alternatively, one could follow Pigou and have the adjustments center on cash balance-holding behavior. In our model the interaction between investment and the interest rate is modeled in Stage I. In Stage II this results in an exogenous cash injection to the firm sector for the purpose of investment spending. Within Stage II the adjustment mechanism centers around real balance effects and the adjusting variable is the average price level. The model solves for that average price level that makes households and firms satisfied to hold the net supply of new balances from all sources.

To see how the monetary adjustment process works, consider a disequilibrium situation in which there is an aggregate excess demand for goods, and so a corresponding excess supply of new money balances. This situation will lead to a general rise in commodity prices, which will lead in turn to an increased demand for nominal balances as well as to a reduction in the demand for goods. These adjustments simultaneously reduce the excess demands for goods and the excess supply of money, and so tend to lead the economy to an equilibrium.

The excess-demand-for-money equation is of course not independent of the product-excess-demand equations. Thus all the excess-demand equations together represent n^* independent equations in n^* prices. If we wished, we could ignore equation (42) in the solution algorithm. However, as we discuss in Appendix B, it is efficient to keep equation (42) as part of the system and define a new variable, the average price level, P_a, in the system. The average price level is given by

$$P_a = \sum_i \omega_i P_i, \tag{43}$$

where the parameters ω_i are the base-year weights in the wholesale price index.

Assuming an initial set of prices is given, all the endogenous variables in Parts 1 and 2 can be solved. The solution problem, then, reduces to finding a set of solution prices for the excess-demand equations of Part 3. How these equations are solved is discussed in Appendix B.

MATHEMATICAL PROPERTIES: EXISTENCE, UNIQUENESS, AND HOMOGENEITY

In the discussion above we have indicated how we derive a set of numerical excess-demand equations with as many endogenous prices as equations. Equation counting is not, of course, sufficient to prove either the existence or the uniqueness of a solution. However, the model economy is a member of the family of economies studied by many general-equilibrium economists (see, e.g., Arrow and Hahn 1971), and so should have at least one equilibrium point. The model economy is not Hicksian in the sense that the demand equations cannot be considered to come from one aggregated consumer, and so there is no guarantee that the solution prices are unique. The system is also not homogeneous in all prices and wages. One suspects, however, that the system will display what might be called "strong local uniqueness." That is, for reasonable variations in the initial guesses of prices, the solution technique will find the same set of solution prices. Many runs with the model indicate that it does converge on a single solution.

In the usual representation of general-equilibrium models, the set of equations for real (rather than nominal) quantities is homogeneous of degree zero in all prices and wages. Money is "neutral" in such a system in the sense that changing the money

supply will only affect the aggregate price level and not change real production and employment. Our model economy does not have this homogeneity property: the level of absolute prices does affect real variables.

There are a number of ways in which nonhomogeneity is manifested in the model economy. These are discussed in Chapter 2. They can be seen in the equations concerning demand for transactions balances, nominal investment expenditure, interest payments, government expenditures, and the exchange rate.

APPENDIX B

Solution Techniques for the Stage II Model

In solving any general-equilibrium model, one must find market-clearing prices for two sets of markets: product markets and factor markets. In theory, one could consider all markets together and seek to solve for all prices and wages simultaneously. Though often theoretically convenient, such an approach is probably computationally inefficient. It is always possible to use our knowledge of the economic structure of the model to separate the two markets and, essentially, solve them seriatim.

It is important, at the outset, to keep in mind the distinction between a solution strategy and a solution algorithm. The purpose of a solution strategy is to establish numerically a set of nonlinear functions (generally excess-demand equations) whose simultaneous solution is desired. A solution algorithm is a computation technique for solving the set of simultaneous nonlinear equations numerically. All iterative solution algorithms consist of two parts: (1) a set of rules for generating new values for the endogenous variables given the past values, and (2) convergence criteria to determine when the solution is reached. The solution strategy sets up the problem; the solution algorithm finds the answer.

SOLUTION STRATEGIES: AN OVERVIEW

There are essentially two types of solution strategies. First, one can solve numerically for excess-demand equations in the factor markets, and so substitute out the product markets. This is the factor-market strategy, and has two variants depending on how one treats the product markets. The second approach is to solve numerically for a set of excess-demand equations in the product markets—the product-market strategy. The two approaches are diagrammed in Figs. B.1–B.3. Note that the "solution algorithm" box is included to represent the rules for generating the new values of the endogenous variables given the appropriate excess demands.

In both approaches, the factor markets and the product markets are treated separately. This is reflected in the presentation of the model equations in Appendix A. The Part 1 equations refer to the factor markets and depict the supply behavior of workers and the factor-demand behavior of firms. The Part 2 equations refer to the product markets and depict the product-supply behavior of firms and the demand behavior of households, government, firms, and trade. The Part 3 equations refer to the demand of new money balances and, for the discussion of solution strategies, can be grouped with the product-market equations.

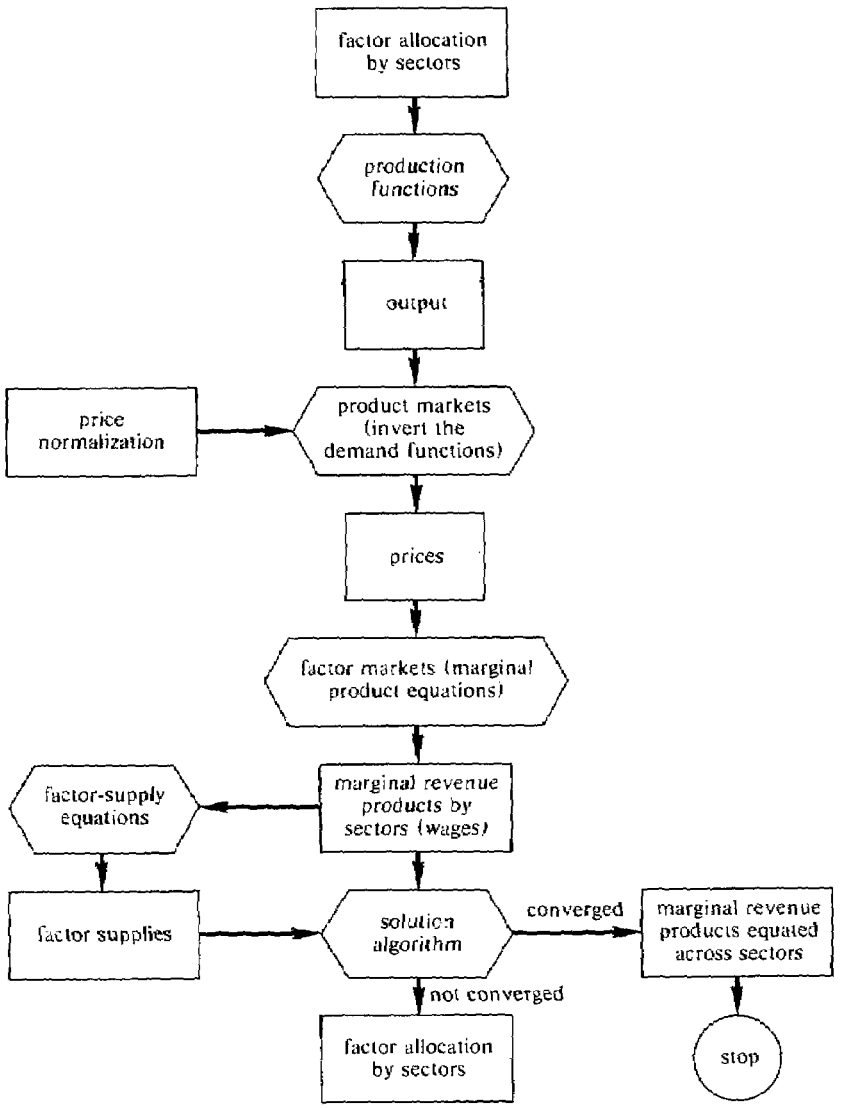

Fig. B.1. Factor-Market Strategy: Variant 1

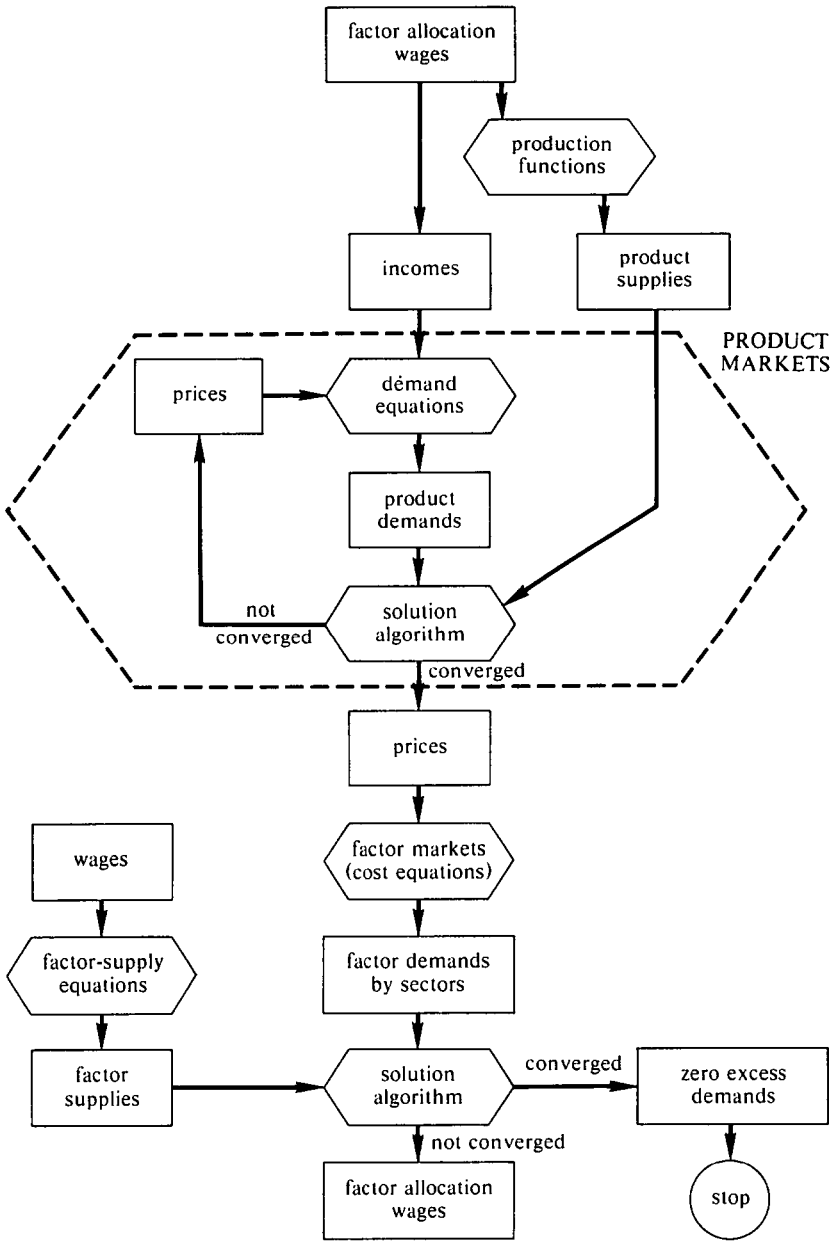

Fig. B.2. Factor-Market Strategy: Variant 2

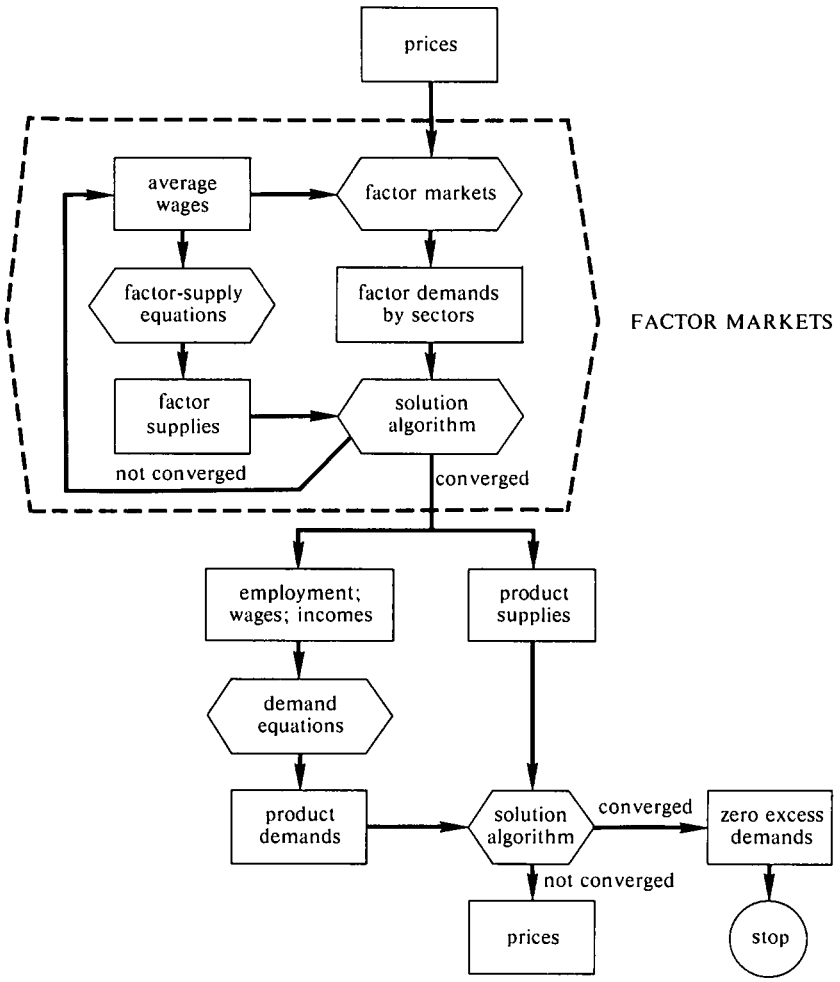

Fig. B.3. Product-Market Strategy

In the first factor-market category (Fig. B.1), one starts from an initial allocation of factors. This yields product supplies. One then inverts the set of demand functions, given a price normalization rule, to find a set of prices yielding product demands equal to the given supplies. This inversion may be straightforward if one assumes there is only a single consumer in the economy. With more than one consumer the problem of inverting the demand system becomes much more difficult. This step yields prices that, given marginal-product equations and factor allocation, are used to calculate the marginal-revenue products for all factors in all sectors. The solution algorithm reallocates the factor supplies so as to equate the marginal revenue products for the same factors across sectors.

This first solution strategy is efficient when there is only one consumer, the demand system is simple, and there are relatively few factors and sectors so that the reallocation procedure is relatively easy. It seems to be quite inefficient when there are a large number of factors or a more complicated demand system. This approach, with variations, has been used by Dervis (1975), De Melo (1975), Zonnoor (1975), and Ahmed (1974).

The second factor-market strategy (Fig. B.2) involves the explicit calculation of excess demands in the factor markets. Given wages and employment, both factor incomes and product supplies are generated. Given incomes, a set of prices is sought that equates product demands and product supplies. The technique shown is iterative and does not require the direct inversion of the demand equations. Of course, if direct inversion is possible, the iterations are not necessary. Given prices, wages, and outputs it is possible to calculate the factor demands by sectors. Given these demands and aggregate factor supplies, the solution algorithm changes wages so as to make all the excess demands for factors equal zero. This approach is used in Lysy and Taylor 1977.

An important advantage of both factor-market strategies is that since there are usually fewer factors than products, the major (or outer) solution problem involves fewer variables. However, the product-market excess demands do not disappear in either variant of this strategy, but are included implicitly when the demand system is solved. In both variants, the strategies include a price adjustment mechanism to clear the product market with the supply responses occurring in the factor-market solution. In general, if the product supplies are very sensitive to changes in factor prices, these strategies might well be difficult to implement numerically. Reducing the number of variables is not necessarily helpful if the resulting equations are more difficult to solve.

We have chosen the product-market strategy (Fig. B.3). Our approach is to establish and solve numerically a set of excess-demand equations in the product and money markets as a function of output prices. As a subproblem, however, one must solve for market-clearing wages in the labor markets given output prices and total labor supplies, making this in fact a two-tier approach.

First, one must solve the equations in Part 1 (Appendix A). Given output prices, determine each firm's demand for labor of all categories. Given the labor supplies, set up the nonlinear excess demand for labor equations and solve them (with a nonlinear solution algorithm) for market-clearing wages. This solution yields wages, profits, employment, and output by sectors and firm sizes.

Second, the Part 2 equations are solved in a straightforward manner to yield the distribution of income, taxes, savings, exports, imports, and the demands for investment goods, consumer goods, and new cash balances. Given the supplies solved

earlier, the result is a set of excess-demand equations for real goods (from the Part 3 equations). The demand for new money balances is given by the Cambridge aggregate money-demand equation. The supply is partly exogenous (from Stage I) and partly endogenous (the net imbalance of the firm, government, and foreign trade sectors). The result is an excess-demand equation for money.

The system as a whole has excess-demand equations for all goods and money, and must determine all prices. The sum of all excess-demand equations, including that for money, must be zero, since Walras's law applies to the model economy in equilibrium. Thus there are exactly as many independent excess-demand equations as there are prices. The solution problem reduces to finding a set of prices that makes all excess demands equal zero or, more generally, to finding a numerical solution to a set of nonlinear excess-demand equations.

The second factor-market strategy and the product-market strategy are really quite similar. Both require the numerical solution of both product and factor market excess-demand equations and approach the two sets of markets in much the same way. Where they differ is in which markets represent the outer and inner loops of the iteration procedure, a difference that can have significant consequences depending on the structure of the particular model being solved.

The product-market strategy appealed to us on two counts. For one thing, given the size and structure of our model, this strategy is simply numerically more convenient to use. Working with the first variant of the factor-market strategy, for example, which requires the inversion of the demand functions, would have been very difficult in our model, with its 12 distinct consuming groups. Similarly, in the second variant of the factor-market strategy, one must assign production levels to each sector given the solution of the demand side. With four firm sizes in each sector in our model, this assignment problem itself would require a sub-solution.

Convenience was also a consideration owing to the role that cash balances play in the model economy. Given the aggregate money supply, the general price level adjusts so that the economic agents desire to hold the appropriate cash balances. In the factor-market strategy, the average price level can only be adjusted by changing the average level of all wages. Since the model economy is strongly affected by changes in the average price level—the real equations are not homogeneous of degree zero in all prices and wages—it seemed more sensible to work in the product markets directly. With the product-market strategy, it is easier to adjust the average price level directly to achieve monetary equilibrium.

SOLUTION ALGORITHMS

In the product-market strategy, two sets of nonlinear excess-demand equations must be solved. In recent years various techniques have been developed to solve such systems, but all are based essentially on one of three different approaches. The first approach is to rework the economic specification so that it can be expressed as a maximization problem, which is then solved using programming techniques. This approach has been taken by Takayama and Judge (1964) and (1971); Goreux and Manne (1973); and Ginsburgh and Waelbroeck (1976). The second is to express the problem as one of finding a fixed point for a set of equations and then use an algorithm based on fixed-point theorems. For examples, see Scarf 1973; and Kuhn 1975. Finally, one can use numerical techniques that treat the equations directly in searching for solution values for prices and wages; this is the approach we have taken.

Within the general strategy of directly attacking the system of nonlinear equations, one also has a choice of approaches, which are broadly divided into two groups: those that use information about derivatives and those that do not. (For a survey of various approaches, see Murray 1972.) In solving our model, we use both types of algorithms. To solve for product prices (the outer loop), we simulate a tatonnement procedure of price adjustment. This technique can be considered a rather special version of a Gauss-Seidel iteration procedure and does not require any evaluation of derivatives of the excess-demand equations.

In solving for wages so as to clear the factor markets (the inner loop), we use an algorithm developed by M. G. D. Powell. (For a complete description, see Powell 1970a and 1970b.) This technique requires the numerical evaluation of the derivatives of the excess-demand equations. Algorithms that use derivatives in general require the specification (either numerically or analytically) of the entire Jacobian matrix. They are thus more efficient when the number of endogenous variables is fairly small (as in the case of the factor markets, where there are seven average wages to be determined).

So that the reader may see why we chose the Powell algorithm and, in general, may understand how such alogrithms work, the basic approach is set out below. The notation used is unique to this section. Let

$$f(X) = \text{vector of excess-demand equations};$$
$$X = \text{vector of wages};$$
$$J(X) = \text{Jacobian matrix}, J_{ij} = \frac{\partial f_i}{\partial X_j}.$$

When an expression is evaluated at the kth iteration, we write $f_k = f(X^{(k)})$ and $J_k = J(X^{(k)})$.

A classic approach to finding the solution of $f(X) = 0$ is to use the linear Taylor series expansion:

$$f(X) \approx f_k + J_k(X - X^{(k)}).$$

Setting $f(x) = 0$ and solving for $X = X^{(k+1)}$ yields

$$X^{(k+1)} = X^{(k)} - J_k^{-1} f_k.$$

This is the Newton method. One tests for convergence by substituting back to $f(x)$ and stops when the functions are near enough to zero.

Powell's approach, which we use, is to set up the problem as a minimization problem of a special kind. Let

$$F(X) = \sum_{i=1}^{n} [f_i(X)]^2 = [f(X)]'f(X);$$
$$H(X) = \text{Hessian matrix}, H_{ij} = \frac{\partial^2 F}{\partial X_i \, \partial X_j};$$
$$H_k = H(X^{(k)}).$$

Now $F(X)$ has a minimum when $f(X) = 0$, so minimizing $F(X)$ will yield a solution to $f(X) = 0$.

One approach to minimizing $F(X)$ is to use linear approximations of $f(X)$. From the Taylor series

$$f(X) \approx f_k + J_k(X - X^{(k)}).$$

Thus

$$F(X) \approx \hat{F}(X) = [f_k + J_k(X - X^{(k)})]'[f_k + J_k(X - X^{(k)})];$$
$$\hat{F}(X) = f_k'f_k + 2(X - X^{(k)})'J_k'f_k + (X - X^{(k)})'J_k'J_k(X - X^{(k)});$$

further,

$$\frac{\partial \hat{F}}{\partial X} = 2J_k'f_k + 2J_k'J_k(X - X^{(k)}),$$

and

$$\frac{\partial^2 \hat{F}}{\partial X^2} = 2J_k'J_k = H_k.$$

Note that in this case the Hessian of F can be calculated from the first derivatives of f (and is positive definite or at least non-negative definite).

Given knowledge of the Hessian, it is logical to approximate $F(X)$ by a Taylor series expansion with a second-order term:

$$\tilde{F}(X) = F_k + \left[\frac{\partial F(X^{(k)})}{\partial X}\right]'[X - X^{(k)}] + \tfrac{1}{2}(X - X^{(k)})'H(X - X^{(k)}).$$

Minimizing this, set $\partial \tilde{F}/\partial X = 0$:

$$\frac{\partial \tilde{F}}{\partial X} = \frac{\partial F(X^{(k)})}{\partial X} + H_k(X - X^{(k)}) = 0.$$

Replacing $\partial F(X^{(k)})/\partial X$ with $\partial \hat{F}/\partial X$ evaluated at $X^{(k)}$, thus using the linear approximation for the $f(X)$, one gets

$$2J_k'f_k + H_k(X - X^{(k)}) = 0.$$

Thus

$$X^{(k+1)} = X^{(k)} - 2H_k^{-1}J_k'f_k.$$

This is the Gauss-Newton (or just Gauss) method using the second derivatives.

Note that if one uses the $\hat{F}$ approximation for F, then $H_k = 2J_k'J_k$, and the method yields

$$X^{(k+1)} = X^{(k)} - J_k^{-1}f_k,$$

which is again just the classical Newton iteration.

In general, the iteration procedure can be viewed as changing $X^{(k)}$ in a direction given by vector $d^{(k)}$ and by a step size $\alpha^{(k)}$ where $\alpha^{(k)}$ is a scalar. Thus

$$X^{(k+1)} = X^{(k)} + \alpha^{(k)}d^{(k)}.$$

For Gauss-Newton, $\alpha^{(k)} = 1$ and $d^{(k)} = -2H_k^{-1}J_k'f_k$.

Another technique is to define the direction vector $d^{(k)}$ by the gradient of $F(X)$ at $X^{(k)}$. This is the method of steepest descent. Define the gradient $\nabla F(X)$:

$$\nabla F(X) = \frac{\partial F}{\partial X} = 2J'(X)f(X).$$

Then

$$\nabla F(X^{(k)}) = 2J_k' f_k.$$

Note that this term appears in the definition of $d^{(k)}$ for Gauss-Newton above, but not times a scalar. Marquardt (1963) devised an algorithm in which the direction is biased toward the steepest descent direction. For some non-negative $\lambda^{(k)}$, let

$$d^{(k)} = -2[H_k^{-1} + \lambda^{(k)} I]^{-1} J_k' f_k.$$

When $\lambda^{(k)} = 0$, we have the usual Gauss-Newton method. Using the $\hat{F}$ function and the fact that then $H = 2J'J$, this reduces to the simple Newton method with direction vector $-J_k^{-1} f_k$. If $\lambda^{(k)}$ is large, the H term becomes relatively unimportant, and the direction vector approaches the steepest descent vector, $-J_k' f_k$.

A number of algorithms have been devised using this basic approach. They vary in how they choose $\alpha^{(k)}$ and $\lambda^{(k)}$, and in how they calculate the Jacobian and Hessian matrices. We have chosen the Powell algorithm primarily because it does not require the analytic specification of any derivatives. Since it is designed to solve a set of nonlinear equations, it uses the specific form

$$F(X) = \sum_i [f_i(X)]^2.$$

With the linear approximation of the $f(X)$ equations, it calculates the Hessian using only the Jacobian. It estimates the initial Jacobian by numerical approximation (requiring $n + 1$ function evaluations) and then updates the approximation using a technique that does not involve additional function evaluations. It seems to be the best algorithm currently available for solving the excess-demand equations using knowledge of the derivatives.

SOLUTION STRATEGY: DETAILED DISCUSSION

We come now to the details of exactly how we derive the product excess demands given an initial set of prices, a subject that is best explained by discussing the equations in each part separately. We shall accordingly first consider the labor market and indicate how, given an initial set of prices, one derives the product supplies and clears the labor markets, then discuss income and product demand (the Part 2 equations), and finally, examine the excess-demand equations in Part 3, along with the overall solution algorithm.

Factor Markets: Part 1

The Part 1 equations from Appendix A appear in Table B.1; and the solution strategy for this part is summarized in a flow chart in Fig. B.4. Note that assuming prices are given, there are $2 \cdot i \cdot s \cdot \lambda + 6 \cdot i \cdot s + 2 \cdot i + 3 \cdot \lambda + m_2$ equations in as many unknowns. In our model, with 29 sectors, four firm sizes, and seven labor markets, there are in all some 2,400 equations and variables. This reduces to a set of seven simultaneous nonlinear excess-demand-for-labor equations as a function of average wages.

First, solve equations (1)–(3) to get the sectoral capital stocks. Note that hereafter the capital stocks are fixed. In Stage II there is no movement of capital in response to differences in profitability between sectors. Next, solve for the labor demands given prices and wages. The solution differs for sectors with Cobb-Douglas or CES production functions.

Labor demands: Cobb-Douglas production functions. For those sectors with Cobb-Douglas production functions, the labor demands are derived by eliminating X_{is} from the first-order conditions for labor. To do this, first substitute the first-order conditions (10) into the production function (4):

$$X_{is} = \bar{A}_{is} K_{is}^{\alpha_{isc}} \prod_{\lambda} \left[\frac{1}{W_{s\lambda}} \alpha_{is\lambda} MR_{is} X_{is} \right]^{\alpha_{is\lambda}},$$

TABLE B.I

Equations for Stage II, Part I

Equation	Number of equations
Capital stocks	
(1) $\Delta K_{is} = Z_{is} \Big/ \sum_j P_j B_{ji}$	$i \cdot s$
(2) $Z_i^r = \sum_j \sum_s B_{ij} \Delta K_{js}$	i
(3) $K_{is}^{(t)} = (1 - \delta_s) K_{is}^{(t-1)} + \sum_{r=0}^{T} g_{isr} \Delta K_{is}^{(t-r)}$	$i \cdot s$
Production functions	
(4) $X_{is} = \bar{A}_{is} K_{is}^{\alpha_{isc}} \prod_{\lambda} L_{is\lambda}^{\alpha_{is\lambda}}$	$i \cdot s$
(5) $X_{is} = \bar{A}_{is} [\alpha_{is} L_{is}^{-\rho_i} + (1 - \alpha_{is}) K_{is}^{-\rho_i}]^{-\gamma_{is}/\rho_i}$	
(6) $X_i = \sum_s X_{is}$	i
Net prices and profits	
(7) $P_{is}^* = P_i - \sum_j \hat{A}_{ji} P_j - \bar{P}^s \mu_{is} - \theta_i P_i$	$i \cdot s$
(8) $P_{is}^{*e} = P_i^e - \sum_j \hat{A}_{ji} P_j - \bar{P}^s \mu_{is} - \theta_i^e P_i^e$	$i \cdot s$
(9) $W_{isc} = \frac{1}{K_{is}} \left[P_{is}^* X_{is} - (P_{is}^* - P_{is}^{*e}) \bar{E}_{is} - \sum_{\lambda} W_{is\lambda} L_{is\lambda} \right]$	$i \cdot s$
Labor market	
(10) $L_{is\lambda} = \frac{1}{W_{is\lambda}} [\alpha_{is} X_{is}] P_{is}^* \left(1 + \frac{1}{\eta_i}\right)$	$i \cdot s \cdot \lambda$
(11) $L_{is\lambda} = \frac{1}{W_{is\lambda}} [(MPL)_{is} \alpha_{is} L_{is}] P_{is}^* \left(1 + \frac{1}{\eta_i}\right)$	
(12) $L_\lambda^s = \bar{L}_\lambda^s$	m_1 λ
(13) $L_\lambda^s = \bar{L}_\lambda^{*s} [1 + \phi_\lambda^s (W_\lambda^a / W_\lambda^n - 1)]$	m_2 λ
(14) $W_\lambda^n = \bar{\xi}_\lambda \bar{W} \left(\sum_j P_j C_j^0 \Big/ \sum_j P_j^0 C_j^0 \right)$	m_2
(15) $L_\lambda^d = \sum_i \sum_s L_{is\lambda}$	λ
(16) $L_\lambda^s = L_\lambda^d$	λ
(17) $W_{is\lambda} = \xi_{is\lambda} W_\lambda^a$	$i \cdot s \cdot \lambda$

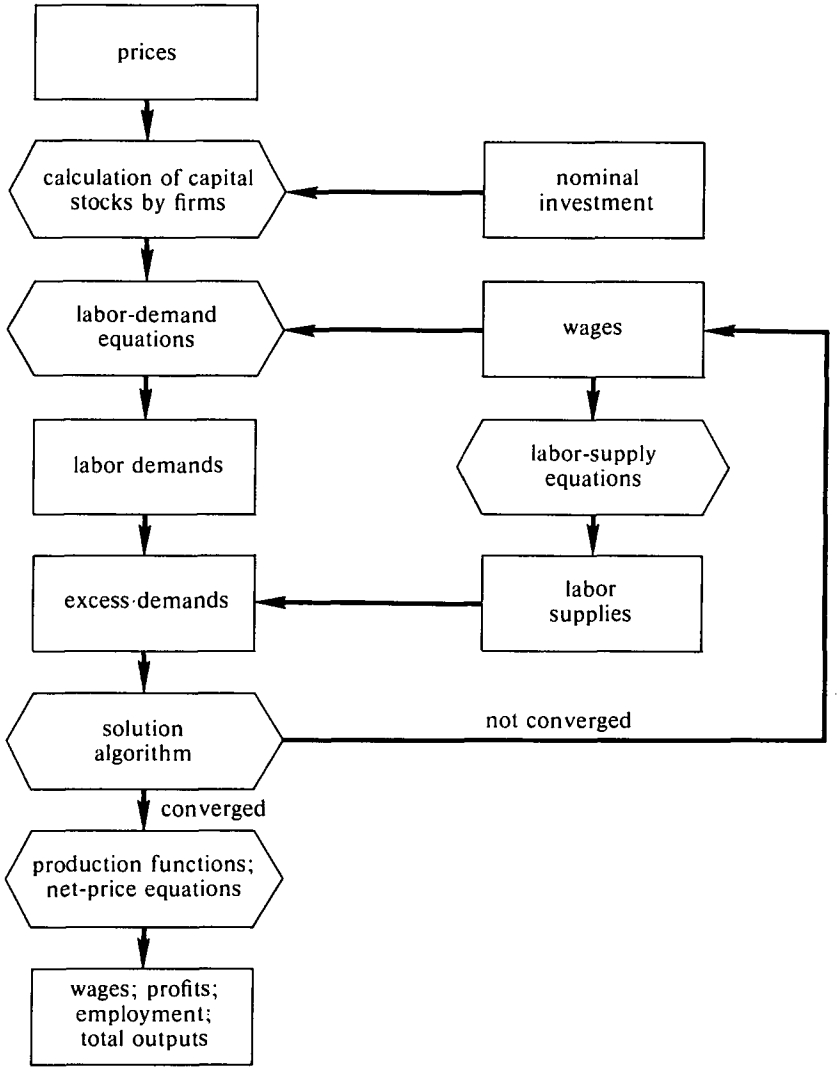

Fig. B.4. Part 1: Factor Markets

where

$$MR_{is} = P^*_{is}\left(1 + \frac{1}{\eta_i}\right).$$

Factoring X_{is} and MR_{is} from the product, noting that

$$\alpha_{isc} + \sum_{\lambda} \alpha_{is} = 1,$$

and using equation (17), we obtain

$$X_{is} = \left[D_{is} \prod_{\lambda} \left(\frac{\alpha_{is\lambda}}{\xi_{s\lambda} W^a_{\lambda}}\right)^{\alpha_{is\lambda}}\right]^{1/\alpha_{isc}} \qquad \text{i} \cdot \text{s equations,}$$

where

$$D_{is} = \bar{A}_{is} K_{is}^{\alpha_{isc}} MR_{is}^{(1-\alpha_{isc})}.$$

This yields an expression for X_{is} that does not involve labor. It is a function only of parameters, prices, and capital, which are all known or fixed at this point.

Substituting (17) and (11) into (15) yields the aggregate demand for labor:

$$L^d_{\lambda} = \sum_i \sum_s \frac{1}{\xi_{s\lambda} W^a_{\lambda}} (\alpha_{is\lambda} MR_{is} X_{is}).$$

Given the expression for X_{is}, these equations can be solved for labor demands.

Labor demands: CES production functions. The demand for labor equations are more complicated when there are CES production functions. For the sake of clarity, drop the i and s subscripts. Then, equation (5) becomes

$$X = \bar{A}[\alpha L^{-\rho} + (1 - \alpha)K^{-\rho}]^{-\gamma/\rho},$$

where

$$L = k \prod_{\lambda} L_{\lambda}^{\beta_{\lambda}}.$$

Here k is a scale parameter and is set equal to the number of labor categories and $\sum_{\lambda} \beta_{\lambda} = 1$. The marginal product of the labor aggregate is given by

$$MPL = \frac{\partial X}{\partial L} = \frac{\alpha\gamma \bar{A}^{(-\rho/\gamma)} X^{(1+\rho/\gamma)}}{L^{(1+\rho)}},$$

and the marginal product of a particular type of labor is

$$\frac{\partial X}{\partial L_{\lambda}} = MPL \frac{\partial L}{\partial L_{\lambda}} = MPL \frac{L\beta_{\lambda}}{L_{\lambda}}.$$

This yields the labor-demand equation given in equation (11). By substitution, it is possible to derive a polynomial expression for L_{λ} (with fractional exponents). We experimented with solving this polynomial, but it turned out to be scaled very badly.

We finally simply used the marginal-product equation directly in a Gauss-Seidel iteration technique. With an initial allocation of labor, solve for output from the production function. Given the output, solve for the marginal product of the labor aggregate. Then, given the wage, use (11) to solve for the new demands for labor, go back to the production function, and start again. Stop when the labor demands have converged with a given wage. This procedure converges very quickly.

Labor excess-demand equations. With either (or both) CES and Cobb-Douglas functions, we end up with a set of demands for labor. Given the labor-supply equations, (12) and (13), one gets λ excess demands for labor as a function of λ average wages, W_λ^a.

In solving for market-clearing average wages, we used the Powell algorithm described earlier. From the initial set of wages, the algorithm calculates a new guess of the solution wages (and updates the Jacobian). Given wages, the program solves the labor-demand and labor-supply equations, and calculates a new set of excess demands. Every solution for a set of excess demands gives a set of wages and is known as a "function evaluation" for the algorithm. Note that given seven endogenous variables, it takes eight such function evaluations simply to make an initial estimate of the Jacobian matrix. In our experience, we virtually never required more than 20 function evaluations to solve for market-clearing wages. Ten to 15 function evaluations per solution was more usual.

Product Markets: Part 2

The Part 2 equations from Appendix A are shown in Table B.2. The solution strategy for this part is straightforward. All the equations are simply evaluated: there are no roots of nonlinear equations to be solved. The flow chart for evaluating the equations has already been presented in Chapter 1. Assuming prices are given, there are about 265 equations (depending on the classification of traded goods). Equation (24) represents the result of the several steps required to go from factor incomes to household consumption. Those steps involve generating the distribution of personal income, calculating taxes, forming households, generating the distribution of household income, and estimating household savings and expenditures. Counted separately, these steps greatly increase the number of variables solved in Part 2.

Product and Money Excess Demands: Part 3

From the solution of the Part 2 equations, we have the supply and demand for consumer goods in all sectors. We can thus define the product excess-demand equations

$$ED_i = C_i - C_i^s = 0 \qquad n^* \text{ equations.} \tag{41}$$

For those sectors whose domestic price is set by the world price, exports and imports are determined residually so that $ED_i = 0$ without price adjustment. There are thus only $n^* = n_1 + n_2 + n_5$ product prices to be determined in the domestic market and the same number of excess-demand equations.

As discussed in Appendix A, the excess demand for new money balances must equal the sum of the money value of the excess demands for all goods:

$$ED_M = -\sum_i P_i \cdot ED_i \qquad \text{one equation.} \tag{42}$$

To equilibriate the supply and demand for new money balances, one could introduce variables such as the interest rate, exchange rate, and tax rate to achieve balance between expenditure and receipts by each spending sector (households, firms, government, trade). However, we have chosen instead to specify cash-balance equations for households and firms—equations (21), (22), and (23)—and so use the inflation rate to equilibriate the demand and supply of money balances.

TABLE B.2
Equations for Stage II, Part 2

Equation	Number of equations
Demand for new cash balances	
(22) $\Delta\tilde{M} = \bar{k}\sum_i P_i X_i - \tilde{M}_{t-1}$	one
(21) $\Delta\tilde{M}^f = \xi^f \Delta\tilde{M}$	one
(23) $\Delta\tilde{M}_k^h = \xi_k^h \Delta\tilde{M} \qquad k = 1, \ldots, h$	h
Business income	
(18) $PR_{is} = W_{isc}K_{is} - \bar{r}_{is}^b\bar{B}_{is}^b - \bar{r}_{is}^c\bar{B}_{is}^c - \bar{r}_{is}^s\bar{P}^s\bar{B}_{is}^s - \delta_{is}K_{is}$	$i \cdot s$
(19) $T_{is}^f = \tau_{is}^f PR_{is}$	$i \cdot s$
(20) $\tilde{Y}^\pi = \sum_i\sum_s (1 - \sigma_{isc}^\pi)(PR_{is} - T_{is}^f) - \Delta\tilde{M}^f$	one
Households	
(24) $Y_k^c \qquad k = 1, \ldots, h$	h
(25) $Y_d = \sum Y_k^c$	d
(26) $C_i = \sum_d \hat{Q}_{id} Y_d^{\eta_{id}^y} \prod_j P_j^{\eta_{ijd}}$	i
(27) $C_i = 0$	
Government	
(28) $\tilde{G} = \tilde{G}^r \left[\sum_i P_i G_i^{1968} \Big/ \sum_i P_i^{1968} G_i^{1968}\right]$	one
(29) $P_i G_i = S_i^g \tilde{G}$	i
Foreign sector	
(30) $M_{is}^{nc} = \bar{P}^s \mu_{is} X_{is}$	$i \cdot s$
(31) $M_i^c = \bar{P}^s\left[\hat{M}_i^{(1)}(C_i + G_i) + \hat{M}_i^{(2)}(\bar{Z}_i^{ex} + Z_i) + \sum_j \hat{M}_{ij}^{(3)} X_j\right]$	n_1
(32) $t_i^{cm} = [P_i/(\bar{P}^s \cdot \hat{P}_i^{w,s})] - 1$	n_1
(33) $t_i^e = [P_i/(\bar{P}^s \cdot \hat{P}_i^{w,s})] - 1$	n_2
(34) $P_i = \bar{P}^s(1 + \hat{t}_i^{cm})\hat{P}_i^{w,s}$	n_3
(35) $P_i = \bar{P}^s(1 + \hat{t}_i^e)\hat{P}_i^{w,s}$	n_4
$n_1 + n_2 + n_3 + n_4 =$ total number of traded goods	
Material-balance equations	
(36) $C_i^s = X_i - X_i^{ex}$	n_5
(37) $C_i^s = X_i - X_i^{ex} + M_i^c$	n_1
(38) $C_i^s = X_i - X_i^{ex} - \sum_s \bar{E}_{is}$	n_2
(39) $M_i^c = C_i + X_i^{ex} - X_i$	n_3
(40) $E_i^c = X_i - C_i - X_i^{ex}$	n_4
$n_1 + n_2 + n_3 + n_4 + n_5 = i$	

This yields one more variable, P_a, the average price level:

$$P_a = \sum_i \omega_i P_i. \tag{43}$$

We thus again have as many variables as equations.

SOLUTION ALGORITHM

The solution technique is based on a tatonnement procedure to adjust, in each iteration, both relative and absolute prices. That procedure, as we have said, is really a special case of a Gauss-Seidel iteration method. Start with an initial set of prices, $P_i^{(1)}$, and do the following steps.

1. Solve Part 1 for production and factor prices. The convergence criteria for the solution in the factor markets is very coarse at first and is made progressively finer in later price iterations.
2. Solve Part 2 for the various demands for goods, C_i, and for $\tilde{M}$. Given the supplies of goods from Part 1 and the material-balance equations, calculate the excess demands for goods, $ED_i^{(1)}$.
3. Adjust relative prices for the next iteration according to the following rules:

If $ED_i^{(1)} > 0$, set $P_i^{(2)} > P_i^{(1)}$.
If $ED_i^{(1)} < 0$, set $P_i^{(2)} < P_i^{(1)}$.
If $ED_i^{(1)} = 0$, set $P_i^{(2)} = P_i^{(1)}$.

4. Adjust the average price level by changing all variable prices proportionately according to the following rules:

If $\sum_i P_i^{(1)} ED_i > 0$, set $P_a^{(2)} > P_a^{(1)}$.

If $\sum_i P_i^{(1)} ED_i < 0$, set $P_a^{(2)} < P_a^{(1)}$.

If $\sum_i P_i^{(1)} ED_i = 0$, set $P_a^{(2)} = P_a^{(1)}$.

5. Redo steps 1–4 using the new prices. Continue this procedure until it converges on a set of equilibrium prices and quantities.

Note that in step 3, there is automatically zero excess demand for goods whose prices are set in the world market because trade is a residual for those goods. Thus their prices will not change in step 3. In step 4, their prices must be kept constant while other prices are being changed proportionately.

The rules for changing prices given the set of excess demands are the heart of the solution procedure. First, note that the supply behavior of firms is based on net prices (or marginal revenue), and so is affected by the entire set of changes to product prices. Second, the question of how much to change each price is crucial, since it is possible to generate cycling behavior. Our procedure is as follows.

First, calculate the desired change in net prices by assuming the response elasticity of excess demand with respect to changes in the net price equals 1. This, in effect, specifies a derivative, which is refined later. Thus, we get:

$$\Delta P_i^* = P_i^* \frac{ED_i}{XS_i},$$

where

$$P_i^* = \text{net price of good } i;$$
$$ED_i = \text{excess demand of good } i;$$
$$XS_i = \text{total supply of good } i;$$
$$\Delta P_i^* = \text{desired change in net price.}$$

Second, we estimate the desired changes in product prices from the desired changes in net prices:

$$\Delta P^{(1)} = (I - \hat{A}')^{-1}\, \Delta P^*,$$

where $\Delta P^{(1)}$ is the column vector of desired changes in prices and $(I - \hat{A}')^{-1}$ is the inverse of the identity matrix minus the matrix of input-output coefficients.

Third, to reduce the possibilities of cycling, we damp the desired change in prices by multiplying it times a damp factor, DAMP:

$$\Delta P_i^{(1)} = \text{DAMP}_i \cdot \Delta P_i^{(1)}.$$

This damp factor is itself set according to various rules and can vary by sectors. It is always true that $0 < \text{DAMP}_i \leq 1$. It is initially set to values between 0.5 and 1.0 for all sectors. The small-scale sectors get the lower damp factors (lumber gets 0.5, agriculture gets 1.0). The factor is adjusted further according to the following two rules. (1) No price is allowed to change more than 20 percent in a given iteration; if the desired change is greater than 20 percent, it is set equal to 20 percent. (2) If the desired price change in this iteration has a different sign from the desired change in the last iteration, then the damp factor is cut in half.

The trick is to set the damp factors high enough for rapid convergence but not so high as to induce cycling. For most experiments, we initially set the damp factors at 0.85 for most sectors, 0.50 for a few small sectors, and 1.00 for the two agricultural sectors. In some experiments, especially trade experiments in which there were many prices set by the world prices, it was necessary to reduce the initial damp factors. Instead of 0.85 we used 0.65 or even lower.

Fourth, the average price level is changed by first assuming that only the demand for new real balances is relevant:

$$\Delta P_a^{(1)} = P_a \cdot \frac{ED_M}{\bar{k} \sum P_i X_i},$$

where $\bar{k}$ = Cambridge k from equation (22).

Fifth, this desired change in average prices is damped:

$$\Delta P_a^{(1)} = \text{DAMP} \cdot \Delta P_a^{(1)}.$$

The damp factor is initially specified (usually equal to 0.85) and then adjusted in each iteration according to the following two rules. (1) The average price level is not allowed to change by more than 10 percent in any iteration. (2) If the sign of the excess demand for money, ED_M, is different in the current iteration from the last iteration, the damp factor is cut in half. This is to prevent cycling.

Finally, all prices, P_i, are adjusted proportionately so that their weighted sum in the average price equation equals the new P_a. In this process some prices—those for which the domestic price is set by the world price—are not changed at all from their initial values. Only the variable prices can be changed to change the average price level.

This solution procedure simulates price-adjusting market behavior. Step 3, the adjustment of relative prices, is straightforward. The effect of step 4 is to change the total demand for real goods by changing the demand for nominal cash balances. Assume, for example, that in a given iteration there is an aggregate excess demand for goods. The effect of step 4 on the next iteration will be to increase prices and so, through the quantity equations, increase the demand for nominal money balances. The intent is to induce firms and consumers to hold the nominal value of total excess demand in the form of new money balances, and so reduce their nominal demand for goods. Since the real system is not homogeneous of degree zero in all prices, step 4 will also have some effect on real variables in the succeeding iteration.

APPENDIX C

Basic Dynamic Model Equations: Stages I and III

This appendix describes the full dynamic version of our model. To make the model dynamic requires the generation over time of all the exogenous variables and parameters in the static Stage II model. We update or age the model economy in two separate submodels, Stages I and III. Stage I models the operation of the financial markets, both organized and informal, and is required because our Stage II model represents a complete monetary economy in which the inflation rate plays an important role. The Stage I model determines nominal investment and its allocation; Stage II converts this into real investment. The Stage III model updates the exogenous parameters and real variables and also generates the required expectational variables for the solution of the Stage I model of the next period.

STAGE I MODEL

The primary purpose of this stage is to determine investment, given institutional features characteristic of Korea. The view of the world we take is that producers formulate their demands for investment on the basis of expected sales. The realization of these demands depends on the workings of the market for loanable funds—on the cost of capital and credit rationing both by the financial system and by the unorganized money market (the curb market).

Once allocations of investment funds are made in this stage, we assume that firms carry out their investment plans for this period regardless of whether or not their expectations are realized.* The product and factor markets must adjust to these investment expenditure decisions this period (in Stage II).

Theoretically, the role of financial markets as a disequilibrating mechanism in the model derives from Wicksell and Schumpeter in the sense that a combination of expectations and credit market operations continually imposes shocks in the system. The specific investment model on the demand side is an accelerator model (for a specified interest rate). On the supply side, however, various liquidity and "credit-worthiness" constraints are applied to ration the available credit.

The demand for investment in Stage I is determined given a target output (or sales). It thus represents the view of investment of Eisner and Strotz 1963. However, since investment realizations depend in the model on the firm's liquidity position, and the firm's liquidity in turn depends on past profits, the realized investment is

* Of course, they may modify their expectations for the next period.

clearly a function of "profitability" as well. Thus, the investment theory used in the model contains elements of the Jorgenson (1963) view as well as of the Duesenberry (1958) and Meyer and Kuh (1957) views of the role of liquidity.

The Stage I model determines the allocation of funds spent on fixed capital goods by firms. Though the real demand for investment goods is generated in Stage II, the capital stocks of firms in Stage II are effectively fixed, and each firm will thus have an upward sloping short-run marginal cost curve. Since we assume constant returns to scale production functions for each firm size in every sector, the long-run cost curves within each firm size are all horizontal. Note that the existence of production functions with constant returns to scale for each firm size implies nothing about the returns to scale in each sector, since the structure of production by firm size is not fixed in the Stage II model.

In Stage I we assume that firms have expectations concerning (1) the overall demand for the output of their sector, (2) wages by skill category and firm size, and (3) the structure of capital costs. These expectations guide the entrepreneurs in the formulation of their demand for funds. In the Stage II model all the variables that are taken as given (in the expected sense) for the current calculations become variable, and the variables for which we solve the current stage of the model are taken as fixed. The Stage I model is shown schematically in Figure 1, Chapter 1.

Firms demand credit for two reasons: to increase their fixed capital stock; and to obtain working capital. Given the expectations of sales and factor prices, firms determine the profit-maximizing (or equivalently, cost-minimizing) fixed capital stock with which they desire to produce their expected output. They also determine their needs for working capital as a function both of expected sales and of the interest rate.

The principle of firm behavior for determining the demand for fixed capital goods in the Stage I model is profit maximization. Firms start with output targets, the wage structure, and the structure of expected capital costs, and then seek to hire capital so as to minimize the cost of producing the specified sectoral outputs. The firms will bid for capital until the ratio of wages to marginal products is equated across all factors for each firm. This process determines the firms' demands for fixed capital goods (and so part of their demands for loanable funds).

Implicit in the Stage I model is the view that capital is merely the real value of money spent on capital goods. When moving to the general-equilibrium part of the model (Stage II), it is necessary to translate this demand for capital into demands for physical capital goods. In Stage I the nominal investment demand is based on a forecast of the rate of inflation. In Stage II the prices of investment goods that underlay a firm's demand for capital in Stage I may not be as expected, and so the firm will receive less (or more) physical capital for its money than expected. So the capital stock actually employed in Stage II may differ from that entering the production functions in Stage I.*

In any given period, there are five sources of loanable funds: accumulated retained earnings from the previous period; household savings; foreign capital inflow; government savings; and the financial sector. The first two sources can be funneled through either the banking system or the curb market. Clearly, the structure and

* This statement is reinforced by the existence of gestation lags in investment realizations, incorporated into Stage II. In fact in all the experiments reported we used a gestation lag of one period (two years).

degree of financial intermediation and the possible changes in the relative importance of the curb market influence both the cost and the ultimate total volume of credit.

The financial sector in Stage I can affect the aggregate supply of funds through different credit expansion mechanisms. In the finance minister 1 form of the model, we specify the absolute cost of new capital by firm size and sector and allow firms to "buy" as much as they wish at the set prices subject to credit-worthiness constraints. The aggregate supply of loanable funds by banks is then whatever is needed to satisfy the constrained demand. The curb market takes up some of the slack by offering to lend at a specified higher interest rate to firms that were unable to borrow as much as they wished from the banking sector. Conversely, if there are any excess, unloaned funds in the organized market they are assumed to flow, at least in part, to the unorganized sector.

In the finance minister 2 form of the model, a fixed supply of loanable funds by banks is specified (from Stage III of the previous period), and the cost of new investment capital adjusts to equate the aggregate demand for loanable funds from the organized market with the fixed supply. The rate also adjusts independently in the curb market to clear that market, except that there is a lower bound on the rate differential between the two markets. If the rate in the curb market hits the lower bound, then it is assumed that any excess supply is held as idle balances.

The behavior of a third kind of finance minister was formulated and programmed but was not used in any of the reported experiments. In this version loanable funds by the banking system are rationed, and so are directly allocated to firms by the government. In this case the curb market is much more important, since it is the only equilibrating mechanism available. All three of these alternatives have some empirical appeal in Korea.*

The credit worthiness of firms represents constraints on the ability of firms to borrow both domestic and foreign funds. The constraints are expressed as minimum self-financing ratios. In general an important role of the curb market is to permit a firm to relax its credit-worthiness constraint, and so borrow additional funds at a higher cost.

The equations are presented in three parts. The first part gives the basic profit-maximizing model, which determines the demand for capital goods (plant and equipment) by firms; the second part gives the rules by which firms determine their demand for working capital; and the third part discusses the various borrowing constraints. The solution technique follows.

Stage I Equations

Part 1: Demand for fixed capital. The variables for this part are as follows:

$\bar{X}_i$ = expected output of sector i (exogenous in this stage);
X_{is} = expected output of firm size s in sector i;
$L_{is\lambda}$ = labor of skill category λ employed in firm size s in sector i;
K_{is} = capital stock of firm size s in sector i;
MC_{is} = marginal cost for firm size s in sector i;
$\bar{W}_{is\lambda}$ = wage of labor of skill category λ employed in firm size s in sector i;
W_{isc} = shadow cost of capital in firm size s, sector i;

* See Cole and Lyman 1971 and P. J. Kim 1976 for a discussion of the workings of Korean monetary institutions. Kim was especially helpful, both for data and for analysis.

$\bar{R}_{is}$ = relative cost of capital by firm size and sector (exogenous except when the firm hits a borrowing constraint);
r = average cost of new capital;
$\tilde{K}$ = real value of aggregate capital.

The production functions by firm size and sectors are

$$X_{is} = \bar{A}_{is} K_{is}^{\alpha_{isc}} \prod_{\lambda} L_{is\lambda}^{\alpha_{is\lambda}} \qquad i \cdot s \text{ equations.} \tag{1}$$

We assume Cobb-Douglas functions with parameters α_{isc}, $\alpha_{is\lambda}$, and $\bar{A}_{is}$. Exogenous technical change will be specified by changing $\bar{A}_{is}$ in Stage III. When CES functions are used, only the equations for the first-order conditions change (see Appendix A).

Total exogenous output for sector i equals the sum of outputs by firm size:

$$X_{is} = \bar{S}_{is}^{f} \cdot \bar{X}_i \qquad i \cdot s \text{ equations.} \tag{2}$$

In this equation $\bar{S}_{is}^{f}$ is the expected share of sectoral output for firm size s in sector i. The actual shares will be solved in Stage II, and the expected shares will be updated for the next period in Stage III.

First-order conditions for cost minimization are

$$MC_{is} = \frac{\bar{W}_{is\lambda} L_{is\lambda}}{\alpha_{is\lambda} X_{is}} \qquad i \cdot s \cdot \lambda \text{ equations,} \tag{3}$$

and

$$MC_{is} = \frac{W_{isc} K_{is}}{\alpha_{isc} X_{is}} \qquad i \cdot s \text{ equations.} \tag{4}$$

These equations state that the ratio of wages to marginal products must be equal for all factors in a firm. This ratio, MC_{is}, is the marginal cost of producing one more unit of output assuming all factors are variable. It will generally be different for firms of different size in the same sector.

Capital goods are

$$W_{isc} = \bar{R}_{is} \cdot r \cdot \bar{P}_i^c \qquad i \cdot s \text{ equations,} \tag{5}$$

where

$$\bar{P}_i^c = \sum_j B_{ji} \bar{P}_j.$$

Here $\bar{P}_j$ is the output price (assumed fixed in Stage I) and B is the capital coefficients matrix in relative terms:

$$\sum_i B_{ij} = 1 \qquad \text{for all } j.$$

Thus $\bar{P}_i^c$ is the price of a unit of aggregate capital to sector i. These equations relate sectoral rates of user costs of capital to the average cost of new capital in the system. One might identify the average (opportunity) cost of new finance with the average rental rate of new capital goods. (This average is the average over the economy for incremental borrowing, *not* the average cost of all borrowing for a given firm.) In this case W_{isc} will be the expected marginal efficiency of investment by firm size and sector, and r will be a weighted average of borrowing rates from the banking system.

The weights $\bar{R}_{is}$ incorporate various institutional factors, such as government subsidies, the identification of "infant industries" and "key sectors," and the favoring

of large-scale firms. They reflect the relative cost a firm faces in borrowing for new investment. They are probably more related to firm size than to relative profitability, so they are a function of the firm's relative employment of the total capital stock (its relative share of total physical assets). The weights $\bar{R}_{is}$ are important in determining a firm's ability to borrow, but are only one factor. An unprofitable firm will find that its credit-worthiness constraint limits its ability to borrow, regardless of its size (and hence low $\bar{R}_{is}$).

If one ignores the possibility of capital gains on the existing capital stock (due to changes in the price of capital goods), then the firm's marginal profit rate on investment is equal to $W_{isc}/\bar{P}_i^c$ and is thus equal, in equilibrium, to the firm's cost of borrowing new capital. The financial mechanisms working in Stage I and the way firms determine their desired investment would lead, ceteris paribus, toward an equalization of rates of return on investment (excluding capital gains), subject to the structural variation imposed by the $\bar{R}_{is}$. More profitable firms will both desire more capital and be less constrained in the loanable funds markets. This tendency toward equalization is, of course, modified by the way in which various dynamic trends, such as technological change and educational growth, affect each sector.*

Solution of Part 1. The first set of equations is to be solved for the allocation of capital by sectors and firm size. If one assumes fixed and known wages and cost of capital, then each firm faces a cost-minimizing problem (given target output) that it must solve independently of all other firms. In this case, we can simply solve the system represented by equations (1), (3), (4), and (5) for each firm separately. Dropping the i and s subscripts, this reduces to solving the following very familiar system of equations for each firm:

$$X = \bar{A}K^{\alpha_c}\prod_{\lambda} L_{\lambda}^{\alpha_\lambda} \qquad \text{one equation;}$$

$$MC = \frac{\bar{W}_\lambda L_\lambda}{\alpha_\lambda X} \qquad \lambda \text{ equations;}$$

$$MC = \frac{\bar{W}_c K}{\alpha_c X} \qquad \text{one equation.}$$

This is a system of $\lambda + 2$ equations to be solved for K, L_λ, and MC. Given constant returns to scale, this system solves very easily. Solve the first-order conditions for L_λ and K, and then substitute into the production function. This yields

$$X = \bar{A}\left[\frac{\alpha_c}{W_c}\cdot X\cdot MC\right]^{\alpha_c}\prod_{\lambda}\left[\frac{\alpha_\lambda}{\bar{W}_\lambda}\cdot X\cdot MC\right]^{\alpha_\lambda}$$

Since $\alpha_c + \Sigma_\lambda \alpha_\lambda = 1$, this reduces to

$$X = \bar{A}\left(\frac{\alpha_c}{W_c}\right)^{\alpha_c}\prod_{\lambda}\left(\frac{\alpha_\lambda}{\bar{W}_\lambda}\right)^{\alpha_\lambda}\cdot X\cdot MC,$$

and so

$$MC = \left[\bar{A}\left(\frac{\alpha_c}{W_c}\right)^{\alpha_c}\prod_{\lambda}\left(\frac{\alpha_\lambda}{\bar{W}_\lambda}\right)^{\alpha_\lambda}\right]^{-1}.$$

* Dervis 1973 and 1975 present a dynamic CGE model in which capital gains are accounted for and profit rates are equalized across all sectors.

Given MC, solve for K and L_λ in the first-order conditions. The solution is intuitive—given a Cobb-Douglas production function and factor prices, marginal cost is solvable and, given constant returns to scale, is independent of output. Analogous equations are easily derived when the production functions are CES functions (see Appendix A).

All but one of the service sectors are treated specially and do not have Cobb-Douglas or CES production functions. (See Chapter 2 for a discussion of how they are treated.) Their demands for investment goods thus cannot be calculated from simple marginal productivity equations. Instead, their demands for fixed capital are calculated in Stage III by assuming they have a desired rate of growth of their capital stock (which varies by sector and firm size). Their nominal demand for investment finance is thus just the expected price of capital goods times their desired real investment. Their demand for finance is assumed not to vary with the interest rate.

Part 2: Demand for working capital. The demand for working capital is divided into two parts. The first part is assumed to be an essential minimum requirement that must be satisfied if the firm is to operate at all. It is given as a fixed proportion of sales:

$$WC^b_{is} = \beta^b_{is}\bar{P}_i\bar{X}_{is} \qquad i \cdot s \text{ equations,} \tag{6}$$

where $\bar{P}_i$ is the expected product price.

Since these demands must be met if the firm is to produce, they are assumed to have first priority in entering the firm's demand for funds from the banking system and, indeed, to have first claim on the firm's internal funds.

The second part of the firm's demand for working capital is assumed to be interest elastic and enters into the firm's demand for funds from the curb market. It is given by:

$$WC^c_{is} = \beta^b_{is}\bar{P}_i\bar{X}_{is} \cdot \left(1.0 - \varepsilon^c\frac{\delta^r}{r}\right), \tag{7}$$

where δ^r is the spread between the banking system and curb market average interest rates, r is the average borrowing rate in the banking system, and ε^c is the elasticity of demand. The interest elastic part of the firm's demand for working capital, WC^c_{is}, is assumed not to enter into the firm's demand for funds from the banking system. It must be financed either from internal funds or from loans from the curb market. This was done to ensure that there was a demand for working capital from the curb market and is necessary given the priority for funds of this demand. Demands for working capital are quite large and would otherwise have swamped the demand for new fixed capital goods.

Part 3: Borrowing constraints by firms. Additional variables in Part 3 are as follows:

$\bar{K}_{is}$ = initial or received capital stocks—capital stock at end of last period for firm size s, sector i, net of depreciation;
$\overline{TF}_{is}$ = investment fund for firm size s, sector i (it represents accumulated retained earnings from previous periods);
$\overline{FL}_{is}$ = foreign exchange allocation for firm size s, sector i;
Z_{is} = total investment by firm size s, sector i;

K_{is} = desired capital stocks by firms (as in Part 1);
LF^b = loanable funds supply from the banking sector;
LF^c = loanable funds supply from the curb market.

Desired fixed investment by firms (sector of destination) is given by

$$Z_{is} = [K_{is} - \bar{K}_{is}]\bar{P}_i^c \qquad i \cdot s \text{ equations,} \tag{8}$$

where $\bar{P}_i^c$ is the expected price of a unit of capital for all firms in sector i, and $\bar{K}_{is}$ is the depreciated capital stock left over from the previous period. The investment in equation (8) is gross, including replacement. Since Z_{is} is assumed non-negative, by hypothesis the rate of disinvestment is limited to the value of depreciation per period. Equation (8) also implies that firms desire (though do not necessarily achieve) full adjustment to the desired capital stock during each period. Implicitly, the lack of full adjustment is reflected in a lower forecast of expected output.

Total desired borrowing in the two markets is given by

$$DB_{is}^b = Z_{is} + WC_{is}^b \qquad i \cdot s \text{ equations} \tag{9}$$

and

$$DB_{is}^c = Z_{is} + WC_{is}^c \qquad i \cdot s \text{ equations.} \tag{10}$$

We assume the financial sector imposes certain constraints on the ability of firms to borrow. In particular, it requires that the marginal ratio of new equity to new debt not fall below certain limits. These limits differ between the organized and unorganized money markets, the curb market being more lenient in its self-financing requirements.

The borrowing constraints are given by

$$\overline{IF}_{is}/DB_{is}^b \geq \chi_{is}^b \qquad i \cdot s \text{ equations} \tag{11}$$

and

$$\overline{IF}_{is}/DB_{is}^c \geq \chi_{is}^c \qquad i \cdot s \text{ equations,} \tag{12}$$

where χ_{is}^b is the self-financing ratio by firm size s, sector i, imposed by the banking sector, and χ_{is}^c is the self-financing ratio by firm size s, sector i, imposed by the curb market.

Second, there is a rationing of foreign exchange; to the extent that more foreign exchange is required than is available, investment simply cannot take place. This constraint can be expressed as

$$\left[\sum_j B_{ji}M_j^{(2)}\right] Z_{is} \leq \overline{FL}_{is}, \tag{13}$$

where B_{ji} is the fixed proportion in which any firm in sector i must acquire capital goods from sector j in order to make up one unit of real capital, and $M_j^{(2)}$ are import coefficients for investment goods. (Used again in Stage II.) Units are dollars per unit output of sector j. The lefthand side of equation (13) gives the total demands for imported investment goods by firms.

Financial market equilibrium. Finance minister 1, it will be recalled, specifies an average rate of interest, r, on new lending from the banking system and stands ready to satisfy all credit-worthy demands for investment loans. For this form of

the model, equations (11) and (13) define the credit-worthiness constraint, and each firm's total demand for funds is given by equation (9). If a firm hits a borrowing constraint (not a foreign-exchange constraint), it may then borrow from the curb market with credit worthiness defined by equation (12). It must, however, pay a higher interest rate, $r + \delta^r$, where δ^r is the interest premium on the curb market and is affected by supply and demand in the curb market.

The firm must resolve its cost-minimizing problem using $r + \delta^r$ instead of r to determine whether and how much it wishes to borrow on the curb market. If the amount desired under $r + \delta^r$ is smaller or equal to the amount the firm can borrow from the banking system (given equation 11), the firm will not enter the curb market. If the amount desired under $r + \delta^r$ exceeds the amount the firm can borrow from the banking system, it will enter the curb market subject to constraint equations (12) and (13).

If the aggregate desired borrowing from the curb market exceeds the total available supply of funds in that market, it will be necessary to raise δ^r and resolve, iterating until the curb market clears. If the desired borrowing is less than supply at the minimum δ^r, we then assume that the excess supply is deposited in the banking system or held as idle balances.

Finance minister 2 sets the aggregate supply of loanable funds from the banking system and allows r to adjust so as to clear the market. In this situation both markets operate separately with their separate aggregate supplies of funds, credit-worthiness constraints, and interest rates (with a minimum spread).

Under both finance ministers, firms may have extra retained earnings after satisfying their needs. A fraction of these extra funds is assumed to be available as an additional supply of funds to the curb market. The fraction available is assumed to be interest elastic but with an upper limit.

TABLE C.1

Variables and Equations for Stage I

Variables	Number of equations	Equation number
X_{is}	$i \cdot s$	(2)
W_{isc}	$i \cdot s$	(5)
$L_{is\lambda}$	$i \cdot s \cdot \lambda$	(3)
K_{is}	$i \cdot s$	(4)
MC_{is}	$i \cdot s$	(1)
WC^b_{is}	one	(6)
WC^c_{is}	one	(7)
Z_{is}	$i \cdot s$	(8) or (13)
DB^b_{is}	$i \cdot s$	(9) or (11)
DB^c_{is}	$i \cdot s$	(10) or (12)
δ^r	one	

Solution of Stage I and Operation of Credit Markets

Table C.1 summarizes the variables being solved for in the Stage I model and indicates the equations most closely related to them.

Equations (11), (12), and (13) represent additional constraints and will affect DB_{is} or Z_{is}. If one of the constraints is binding for a given firm, it will replace equation (8), (9), or (10) for that firm.

The interest rate differential, δ^r, is solved so as to clear the curb market, subject to the various constraints. The solution technique is an iterative one. First, specify the average cost of new capital from the banking system, r, and solve the equations in Part 1 for desired capital stocks by firms (K_{is}). Equations (6) and (7) give the demands for working capital. The borrowing constraints and the curb market are taken into account by using the following steps. For finance minister 1:

1. Z_{is} is estimated from equation (8). If it is negative, then Z_{is} is set to zero and K_{is} is set to $\bar{K}_{is}$.
2. DB^b_{is} is calculated from equation (9). Equations (11) and (13) are calculated. If either constraint is not satisfied, then DB^b_{is} is set to the maximum permissible value given both constraints.
3. Calculate the desired borrowing from the curb market from equation (10). There is a demand for fixed capital investment in the curb market only for those firms that hit a borrowing constraint—equation (11)—in the banking system. For those firms the demand for fixed capital must be recalculated in Part 1 using $r + \delta^r$ instead of r. If the recalculated demand for fixed capital is larger than the previously constrained value of Z_{is}, the difference represents a demand for funds from the curb market.
4. Calculate the extra supply of funds to the curb market from those firms possessing excess funds. Along with exogenous supply, this determines the aggregate supply of funds to the curb market.
5. Calculate the aggregate desired borrowing from the curb market and compare it with the aggregate supply. If there is excess demand, increase δ^r and redo steps 3 and 4. If there is excess supply *and* if δ^r is greater than the minimum permitted differential, lower δ^r and redo steps 3 and 4. Continue until either δ^r is at its minimum or there is no excess demand.

Under finance minister 2, the banking system and the curb market reach separate equilibria, though the demand for funds in the curb market depends on the solution in the organized market. Thus, one must insert a step after 2:

2′. Calculate the aggregate desired borrowing from the banking system and compare it with the aggregate supply. Adjust r upward or downward depending on the sign of excess demand and repeat steps 1, 2, and 2′ until excess demand is zero.

For finance minister 3, step 2 is altered. Instead of adjusting r, the borrowing constraints in equation (11) are adjusted to achieve equilibrium.

Conclusion

The Stage I model just discussed is in the spirit of the "temporary equilibrium" models of Drèze (1974) and others. As in those models actions in this period (Stage I) are based on anticipations of the state of the economy in the next period (Stage II). In both periods, there is no true "intertemporal" equilibrium, since expectations and realizations may (and usually do) diverge. The two-period optimum for temporary-equilibrium models will generally not be the same as for the two temporary equilibria solved individually in each of the two periods (or, in our case, Stage I and Stage II). As in the temporary-equilibrium models, under finance minister 1 our Stage I model is purely a quantity-rationing model with prices and production fixed. And as in those models, bounds are imposed to limit the range of the feasible current action space. In our case, the bounds are provided by the credit-worthiness constraints.

The disequilibrium possibilities that underlie the combined operation of Stages I and II provide a strong rationale for the existence of a monetary economy in Stage II,

and introduce the major elements of nonhomogeneity in the design and operation of the Stage II model.

STAGE III MODEL

The function of the Stage III model is to update certain parameters and variables in Stages I and II. Three different types of parameters and variables are involved: (1) those that depend on the solution of Stage II; (2) those that are exogenous to Stage II but are set in Stage III; and (3) those that reflect expectations for the next period and for which there are expectation functions in Stage III.

The Updating of Stage II Variables

The Stage II variables that require updating and the principles and procedures used to update them are given in Table C.2. Before elaborating on some of the procedures, we should emphasize that our choices in this respect, as in all others, were conditioned by the use for which the model is intended. As indicated in Table C.2, we set most exogenous variables of type 2 at their historical values up to 1972, and projected them at smooth exponential rates thereafter. Actual values were used up to 1972 to enable comparison with actual Korean growth, thereby permitting model validation. Smooth exponential growth was assumed thereafter to generate smooth paths, so that we could more clearly evaluate the effects of various policy instruments.

Stage III also includes a migration model as an independent influence on rural and urban labor supplies. The migration model, which incorporates a land-transfer submodel, will be discussed later.

Productivity parameters. We have assumed an exponential rate of growth of productivity that varies by sectors and by firm sizes. The rates are mostly in the range of 5 percent to 10 percent a year, with agriculture and some services having lower rates. Productivity in the two agricultural sectors is assumed to grow at a rate of 1.5 percent a year.

Labor supplies and migration. The labor supply is assumed to grow at a steady exponential rate of 2.9 percent a year. For the two years 1970 and 1972 (years 3 and 5 of the model) actual data have been used. Later projections are based on past average growth rates (estimated from a log-linear regression on time) and have been adjusted by skill categories according to the projections given in the Third Five-Year Plan. The urban population is assumed to grow at a slightly faster rate than rural groups, especially in the early periods. The higher urban rate includes some implicit migration, which thus occurs independently of our migration model.

Interest rates and loans by types. Two types of borrowing are modeled in Stage I: that for plant and equipment and that for working capital. In Stage I we treat the two kinds of loans differently, but we do not explicitly model the term structure of the different loans. We have instead assumed that total outstanding debt grows roughly with output and have set the average interest rate exogenously. In virtually all of the dynamic experiments, we have used finance minister 1, which maintains a fixed interest rate in the organized money market, with that rate also being set exogenously in Stage III.

Exchange rate. The exchange rate is set equal to the actual rate in the first three periods (1968, 1970, and 1972) and then is a function of the actual inflation rate. We have chosen this fairly smooth adjustment procedure rather than have changes in the exchange rate be a function only of the balance of payments because we believe it is more realistic and appropriate in a model intended for short-term policy

TABLE C.2

Summary of the Updating of Variables and Parameters Used in Stage II

Symbol	Variable	Equation reference[a]	Updating code[b]	Updating procedure
$\bar{A}_{is}$	Productivity parameters	4, 5	3	Exponential growth
K_{is}	Capital stock	3	2	Depreciation and investment flows (with gestation lags) accounted for
$\bar{L}^s_\lambda$, $\bar{L}^{*s}_\lambda$	Labor supply	12, 13	1, 2, 3[d]	Exponential growth and migration[c]
$\bar{r}^b_{is}$, $\bar{r}^c_{is}$, $\bar{r}^\$_{is}$	Interest rates on outstanding loans	18	3	Set exogenously
$\bar{B}^\$_{is}$, $\bar{B}^b_{is}$, $\bar{B}^c_{is}$	Outstanding loans by types	18	3	Exponential growth
$\bar{k}$	Cambridge k	22	2	Regression equation[e]
$\bar{P}^\$$	Exchange rate	7, 8	1, 2	Function of inflation rate
$\bar{E}_{is}$	Export targets	9	1, 2	Exponential growth, declining rate
$\hat{M}^{(1)}_i$, $\hat{M}^{(2)}_i$, $\hat{M}^{(3)}_{ij}$	Import coefficients	31	1, 2	Adjusted to maintain relation with export growth rate
θ_i	Indirect tax rates	7	1, 3	Match historical values in 1970, then assumed constant thereafter
	Direct tax rates[f]		1, 3	Match historical values, then assumed constant
	Government value-added[f]		1, 3	Exponential growth
	Government employment[f]		1, 3	Exponential growth
$\bar{Z}^{ex}_i$	Government investment	31	1, 3	Exponential growth, declining rate
$\bar{G}^r$	Government expenditure	28	1, 3	Exponential growth
$\hat{Q}_{id}$, η^y_{id}	Expenditure equation parameters	26	2	Consistency adjustment[g]
	Household savings rate[h]		2	Regression equation

[a] All equation references are to Appendix A

[b] The code is (1) historical values used for periods 2 and 3 (1970 and 1972); (2) projection based on Stage II solution values; (3) projection independent of Stage II solution.

[c] Migration is a function of the Stage II solution wages; the natural rate of growth is independent of the Stage II solution.

[d] See equation (3) in Appendix A

[e] See discussion of velocity equation in Chapter 4

[f] See discussion of factor incomes in Appendix A

[g] See discussion of equation (26) in Appendix A

[h] See discussion of household savings and expenditure in Appendix A

experiments. Note that we have likewise imposed rather smooth changes in exports and imports.

Exports and imports. Both exports and imports are projected to grow at smoothly declining exponential rates, with exports growing faster. We assume the decline in the growth rate of exports because it seems unreasonable to project real export growth continuing at a 40 percent annual rate for very long. In the basic run, there is a moderate surplus in the balance of trade by the end of the period. In Stage III the export targets are set to match the target aggregate growth. Imports are not fixed in quantitative terms in Stage II, and so have to be changed in Stage III by adjusting the import coefficients. To adjust them in relation to the export growth, it is necessary to use the projected output figures calculated in Stage III for use in Stage I. Insofar as these projections are wrong, imports in the subsequent period might not have the desired relationship with exports.

Government variables. The indirect tax rates have been set in the second period (1970) to rates calculated from the 1970 input-output table and are assumed not to change thereafter. For direct taxes, we have left the rate structure unchanged but have adjusted the average collection ratio in the second and third periods (1970 and 1972) so that total collections in the model roughly equal actual collections. The collection ratio is assumed not to change thereafter.

Government employment, government consumption, and government value-added (the government wage bill) are assumed to grow at constant rates after being set to their historical values in the second period (1970). Real government investment is assumed to grow at a declining rate.

Household savings rate. The household average savings rate is assumed to be an increasing function of the interest rate and of income. We have used a regression equation estimated by G. T. Brown (1974:195), adjusted to correspond to our units and definitions. We have adjusted the constant so that in the base year, 1968, the equation yields our actual 1968 average savings rate. Savings rates by different types of households are assumed to have a proportional relationship to the average savings rate.

Migration and land transfer. In Stage III migration is modeled explicitly as a function of urban-rural wage differentials. Migrants are assumed to come from the landless laborers and the first two farm sizes; and are assumed to go directly into the three urban labor categories (skilled workers, apprentices, and unskilled workers). Though there is no direct migration into the self-employed categories, there are some implicit transfers because there is movement between the self-employed and other categories as a function of wage differentials. There is also some relative reshuffling of labor among urban categories as a function of wage differentials that is concomitant with migration. Note that employment in the service sectors is treated specially in Stage II (see the discussion in Chapter 2). In any case, there is evidence from Korea that migrants do not first move into the urban traditional sector but are directly recruited by factories in a process reminiscent of nineteenth-century New England (Cohen 1977).

Within the agricultural sector, there is assumed to be a migration elasticity with respect to the differential between rural income and the average wage of the three urban categories. In addition, there is an upper limit on the share of each of the three rural labor categories that migrate. We usually set this limit at 2 percent a year, but increased it in some experiments. The land of those migrants who owned land is assumed to be distributed to the two largest landowning groups. This is done by

adjusting the productivity parameters, $\bar{A}_{is}$, in the production functions for both the recipient and donor farm sizes. The share of land released is assumed to be equal to the share of total landowners who migrate, thus assuming that migrants are average landholders within the two farm sizes.

The effect of the transfer on the two recipient farm sizes (the two largest sizes) is calculated by assuming that the transferred land is of the same quality as the old land. Thus we calculate the percent increase in land input directly, given data on initial acreage of land holdings by size from the *Agricultural Yearbook* (published annually by the Korean National Agricultural Cooperative Federation, Seoul).

The production functions for the agricultural sectors are CES functions in labor and capital with decreasing returns to scale:

$$X = \bar{A}[\alpha L^{-\rho} + (1 - \alpha)K^{-\rho}]^{-\gamma/\rho}.$$

The scale parameter, γ, is assumed to be significantly less than 1, since there are decreasing returns to scale with respect to labor and capital. The productivity parameter, $\bar{A}$, is assumed to include land as an input and can be written

$$\bar{A} = A^*(\mathrm{LND})^{1-\gamma},$$

where LND is the land input. Thus the production function is assumed to be a Cobb-Douglas function of land and "other factors" where the "other factors" is a CES aggregation of labor and capital. The effect on $\bar{A}$ of a given rate of increase of land, LND, is thus that rate raised to the power $1 - \gamma$. In general, $1 - \gamma$ equaled about .3, so a 10 percent increase in land leads to a 3 percent increase in $\bar{A}$.

The Updating of Stage I Variables

Since the Stage I model bases current demands for finance on anticipated values of subsequent period variables, they must be forecast in Stage III. The variables for Stage I that are updated in Stage III are given in Table C.3. Most of the variables depend on the solution of Stage II for the previous period either as arguments in various expectation functions or as part of accounting equations.

Expected sectoral output and shares by firm size. In each year sectoral outputs are expected to grow at the same rate across manufacturing sectors, but with different aggregate rates from year to year. For the second period, actual 1970 outputs are used, implying that firms correctly forecast their expected outputs. The expected market share by firm size is a function of relative profitability. Those firm sizes whose profit rate is greater than the sectoral average do increase their market share according to an elasticity. No firm is allowed to change its market share by more than 20 percent, and of course the shares are constrained to sum to 1.

For the service sectors, the firms determine their desired capital stocks, and hence desired demand for investable funds, in Stage III directly. Since their output decisions are not based on profit-maximizing behavior, they are not assumed to determine their desired investment based on sales expectations. Instead, they are assumed to have an expected growth of capital stock, which differs by sector and firm size and is modified as a function of the relative profitability of different firm sizes within sectors. The agricultural sectors also do not form sales expectations, since their investment is exogenous.

Expected prices. The expected inflation rate is based on the historical inflation rate, and expected prices are assumed to grow at that rate throughout the period. Errors in expectations are corrected in Stage III of the following period, since the

TABLE C.3
Summary of the Updating of Variables and Parameters Used in Stage I

Symbol	Variable	Equation reference[a]	Updating code[b]	Updating procedure
$\bar{X}_i$	Expected sector output	2	1, 2	Expectation function
$\bar{S}^f_{is}$	Expected output shares by firm size	2	2	Expectation function
$\bar{W}_{is\lambda}$	Expected wages	3	2	Equal to Stage II solution
$\bar{R}_{is}$	Relative user cost of capital	5	3	Assumed constant
$\bar{P}^c_i$	Expected price of capital goods	5	2	Expectation function
$\bar{P}_i$	Expected output price	7	2	Expectation function
$\bar{A}_{is}$	Productivity parameter	1	3	Exponential growth (see Table C.2)
$\overline{IF}_{is}$	Investment fund	11, 12	2	Accounting equation
$\overline{FL}_{is}$	Foreign exchange allocation	13	2	Allocation equation
$\bar{K}_{is}$	Previous period capital stock	8	2	Accounting equation (see Table C.2, K_{is} entry)
r	Average cost of capital	5	1, 3	Under finance minister 1, assumed constant
	Exogenous supply of funds to curb market		3	Set exogenously

[a] All references are to the equations in this appendix
[b] The updating code is (1) historical value used for second period (1970); (2) projection based on Stage II solution values; (3) projection independent of Stage II solution.

growth rate is always applied to the last period's prices. The prices of capital goods are assumed to grow at the same rate as the general price level except in the first period, when they grow somewhat faster.

Investment fund. The investment fund is updated by a simple accounting equation that keeps track of new retained earnings, investment expenditure, and net previous borrowing. In some experiments the government encourages investment by exogenously increasing the investment fund of various firms.

Foreign exchange allocation. The government is assumed to allocate a share of total export earnings to the firm sectors to finance imported capital goods. The allocation is based partly on import requirements (which vary by sectors) and partly on export performance. In some experiments the government exogenously increases the foreign exchange allocation to encourage investment.

Average cost of capital. In the basic run and most of the experiments, finance minister 1 is assumed to operate. Thus, the average cost of capital is set in Stage III and remains constant throughout the period. The exogenous supply of funds to the curb market is also set exogenously, though the total supply is endogenous to Stage I.

APPENDIX D

Basic Solution Data

In this appendix we present a set of tables showing some of the results of our basic run. In addition, we have included three tables that show how we have defined the sectors and firm (farm) sizes for the model. Columns in the tables that follow may not total because of rounding.

TABLE D.I

Definition of the 29 Sectors Used in the Model

Model sector	Based on Bank of Korea classification
1. Rice, barley, and wheat	Rice, barley, and wheat, *1*
2. Other agriculture	Other agriculture, *2*; Forestry, *3*
3. Fishing	Fishery, *4*
4. Processed foods	Processed foods, *7*
5. Mining	Coal, *5*; Other minerals, *6*
6. Textiles	Fiber spinning, *10*; Textile fabrics, *11*
7. Finished textile products	Finished textile products, *12*
8. Lumber and plywood	Lumber and plywood, *13*
9. Wood products and furniture	Wood products and furniture, *14*
10. Basic chemical products	Basic chemicals, *19*; Chemical fertilizer, *21*
11. Other chemical products	Other chemical products, *20*
12. Petroleum products	Petroleum products, *22*
13. Coal products	Coal products, *23*
14. Cement, nonmetallic mineral products	Glass, clay, and stone products, *24*
15. Metal products	Iron and steel, *25*; Steel products, *26*; Nonferrous metals and primary products, *27*; Finished metal products, *28*; Scrap, *42*
16. Nonelectrical machinery	Nonelectrical machinery, *29*
17. Electrical machinery	Electrical machinery, *30*
18. Transport equipment	Transport equipment, *31*
19. Beverages and tobacco	Beverages, *8*; Tobacco, *9*
20. Other consumer products	Paper products, *15*; Printing and publishing, *16*; Leather and leather products, *17*; Rubber products, *18*; Miscellaneous, *32*; Unclassifiable, *43*

Table continues overleaf

TABLE D.1 (continued)
Definition of the 29 Sectors Used in the Model

Model sector	Based on Bank of Korea classification
21. Construction	Building and maintenance, *33*; Other construction, *34*
22. Electricity and water	Electricity, *35*; Water and sanitary services, *37*
23. Real estate	Real estate and ownership of dwellings, *100*
24. Transportation and communications	Communications, *38*; Transportation and storage, *39*
25. Trade and banking	Trade and commerce, *40*; Banking and insurance, *99*
26. Education	Education, *107*
27. Medical services	Medical and health services, *108*
28. Other services	Religion and social services, *109*; Agricultural services, *110*; Business services, *111*; Office supplies, *114*
29. Personal services	Recreation and entertainment, *112*; Personal services, *113*

NOTE: Model sectors 23 and 26–29 and the banking and insurance data used in model sector 25 were based on the Bank of Korea's 117-sector classification. All the other model sectors were based on the Bank's 43-sector classification.
SOURCE: Bank of Korea, *Report on the Compilation of Interindustry Relations Tables for 1968* (Seoul, 1970).

TABLE D.2
Definition of the Five Aggregate Sectors Used in the Model

Aggregate sector	Based on model sectors as defined in Table D.1
Agriculture	Rice, barley, and wheat, *1*; Other agriculture, *2*
Food, beverages, and tobacco	Fishing, *3*; Processed foods, *4*; Beverages and tobacco, *19*
Shelter and transportation	Lumber and plywood, *8*; Wood products and furniture, *9*; Petroleum products, *12*; Coal products, *13*; Cement, nonmetallic mineral products, *14*; Construction, *21*; Electricity and water, *22*; Real estate, *23*; Transportation and communications, *24*
Manufacturing	Mining, *5*; Textiles, *6*; Finished textile products, *7*; Basic chemical products, *10*; Other chemical products, *11*; Metal products, *15*; Nonelectrical machinery, *16*; Electrical machinery, *17*; Transport equipment, *18*; Other consumer products, *20*
Services	Trade and banking, *25*; Education, *26*; Medical services, *27*; Other services, *28*; Personal services, *29*

TABLE D.3

Definition of the Model's Firm and Farm Sizes

Size	Firms (*Number of workers*)	Farms (*Number of cheongbo*)
1	Fewer than 5[a]	Less than .5
2	5–49	.5–1.0
3	50–199	1.0–2.0
4	200 or more	More than 2.0

NOTE: 1 cheongbo = 2.4 acres.

[a] All references to this firm size in the text and various tables are to the self-employed

TABLE D.4

Basic Solution: Consumption, Investment, Trade, and Prices, 1968

(Billions of *won*)

Sector	Consumption	Investment	Trade: Exports	Trade: Competitive import	Prices: Domestic	Prices: Net[a]
1. Rice, barley, and wheat	237.0	0.0	0.1	29.6	.991	.799
2. Other agriculture	158.0	0.0	3.1	1.9	.997	.658
3. Fishing	29.4	0.0	4.3*	0.2	1.000	.703
4. Processed foods	118.3	0.0	12.2	14.2	.995	.206
5. Mining	0.0	0.0	8.6	2.7	1.009	.551
6. Textiles	27.0*	0.0	17.6	18.0	.995	.209
7. Finished textile products	67.0**	0.0	37.3**	1.2	.990	.262*
8. Lumber and plywood	0.0	0.0	19.0*	0.1	1.000	.164
9. Wood products and furn.	4.5	1.5	0.4	0.8	1.000	.264
10. Basic chemical products	0.7	0.0	0.7	13.6	.994	.380
11. Other chemical products	24.4	0.0	0.2	24.6	.996	.292
12. Petroleum products	2.8	0.0	2.0	18.5*	1.000	.138
13. Coal products	20.6	0.0	0.0	0.4	1.003	.097
14. Cement, nonmetallic prod.	1.8	0.0	1.9	3.5	1.007	.324
15. Metal products	3.6	0.0	3.7	42.0	.998	.271
16. Nonelectrical machinery	2.6	42.1	0.6	50.8	1.005	.325
17. Electrical machinery	10.5*	51.6	4.7	56.3	1.010	.267*
18. Transport equipment	7.1	67.3	0.4	41.6	.998	.209
19. Beverages and tobacco	61.6	0.0	2.7	0.2	.995	.146
20. Other consumer prod.	53.9	2.6	43.8	37.8	.996	.265
21. Construction	7.0	214.0	8.0	0.0	.998	.346
22. Electricity and water	11.0	0.0	1.1	0.0	.998	.491
23. Real estate	54.2	5.5	0.0	0.0	.998	.760
24. Trans. and comm.	76.3	0.5	29.8	2.2	.998	.583
25. Trade and banking	149.2	20.1	10.7	2.7	.998	.770
26. Education	55.7	0.0	0.0	2.6	.998	.815
27. Medical services	25.5	0.0	0.0	0.0	.998	.617
28. Other services	23.8	0.0	4.3	0.0	.998	.424
29. Personal services	71.8	0.0	4.3	0.5	.997	.632
TOTAL	1,305.3	405.2	221.2	336.1	—	—

NOTE: No asterisk, solution differs by less than 2 percent, or one billion *won*, from the actual value; single asterisk, solution differs by 2 percent to 5 percent, or less than two billion *won*, from the actual value; double asterisk, solution differs by more than 5 percent from the actual value.

[a] Net prices represent sales price minus intermediate goods costs, indirect taxes, noncompetitive import costs, and any subsidies. See Appendix A.

TABLE D.5

Basic Solution: Production by Firm Size and Sector, 1968

(Billions of *won*)

Sector	Firm size 1	Firm size 2	Firm size 3	Firm size 4	Total
1. Rice, barley, and wheat[a]	37.81	77.78	124.81*	45.06**	285.46
2. Other agriculture[a]	59.79	86.44	118.58*	30.89**	295.70
3. Fishing	14.13	0.00	31.21	0.00	45.34
4. Processed foods	18.89	34.38	26.72	92.13	172.13
5. Mining	0.32	3.75	6.54	33.85	44.46
6. Textiles	1.08	21.08	25.94*	86.01	134.10
7. Finished textile products	17.75	60.32*	9.22*	28.03*	115.32*
8. Lumber and plywood	1.35	12.09	2.28	26.52	42.25
9. Wood products and furniture	3.94	7.01	0.00	0.00	10.96
10. Basic chemical products	0.07	1.90*	1.07**	21.25	24.28
11. Other chemical products	0.22	3.24	6.34	34.57	44.37
12. Petroleum products	0.00	0.00	0.00	38.26	38.26
13. Coal products	1.45	13.28	8.38	5.52	28.63
14. Cement, nonmetallic mineral products	0.93	9.27	4.75	30.16	45.12
15. Metal products	3.25	16.62	18.88	38.88	77.64
16. Nonelectrical machinery	1.39	10.16	5.31	4.99	21.84
17. Electrical machinery	0.51	5.19*	8.44*	24.82**	38.97*
18. Transport equipment	1.17	12.47*	8.98	41.84	64.46
19. Beverages and tobacco	1.90	16.71	10.25	71.75	100.61
20. Other consumer products	10.90	30.61	35.75	94.90	172.16
21. Construction	5.07	84.50	86.72	77.04	253.33
22. Electricity and water	0.00	0.00	13.67	27.75	41.41
23. Real estate	43.27	16.45	0.00	0.00	59.72
24. Transportation and communications	7.97	43.80	66.96	46.19	164.93
25. Trade and banking	190.17	74.94	52.90	19.10	337.11
26. Education	0.00	0.00	53.66	0.00	53.66
27. Medical services	0.00	0.00	26.07	0.00	26.07
28. Other services	5.51	13.56	7.79	7.50	34.37
29. Personal services	15.91	40.52	19.81	22.51	98.75
TOTAL	444.76	696.08	781.03	949.53	2,871.40

NOTE: No asterisk, solution differs by less than 5 percent from the actual value; single asterisk, solution differs by 5 percent to 10 percent from the actual value; double asterisk, solution differs by more than 10 percent from actual value.

[a] Figures in these rows refer to farm sizes. The self-employed in agriculture (Firm size 1) include agricultural laborers as well as landowners.

TABLE D.6

Basic Solution: Employment by Sector and Skill Category, 1968

(Thousands of workers)

Sector	Engineers	Technicians	Skilled workers	Apprentices
1. Rice, barley, and wheat	0.00	0.00	0.00	0.00
2. Other agriculture	0.00	0.00	0.00	0.00
3. Fishing	2.31*	6.21	11.55	3.43
4. Processed foods	3.19	5.91	71.24	19.37
5. Mining	1.90	6.37	52.73	6.49
6. Textiles	1.69**	4.74**	112.37*	27.99*
7. Finished textile products	0.17**	1.92**	119.45**	49.93*
8. Lumber and plywood	0.29*	1.90*	20.48*	5.94*
9. Wood products and furniture	0.00	0.00	13.02*	7.15**
10. Basic chemical products	0.56	1.35*	4.06*	1.31*
11. Other chemical products	1.36	1.58	12.18	3.79
12. Petroleum products	0.10**	0.13**	0.74**	0.18**
13. Coal products	0.00	0.00	6.38*	1.07*
14. Cement, nonmetallic mineral products	1.06	1.91	24.19	7.23
15. Metal products	1.29	3.74	31.10	12.93
16. Nonelectrical machinery	0.88	2.17	20.40	7.76
17. Electrical machinery	0.98**	1.62**	17.02**	6.47**
18. Transport equipment	1.33	4.33	23.33*	8.72*
19. Beverages and tobacco	0.44	1.57	15.93	4.53
20. Other consumer products	1.99	5.91	104.84	39.45
21. Construction	26.41	28.93	66.29	7.19
22. Electricity and water	1.81	3.24	3.07	0.20
23. Real estate	0.00	0.00	0.08	0.01
24. Transportation and communications	0.60	1.44	6.69	1.82
25. Trade and banking	0.00	0.00	4.32	0.45
26. Education	0.00	0.00	0.00	0.00
27. Medical services	0.00	32.73	0.00	0.00
28. Other services	1.16	1.92	11.29	4.69
29. Personal services	1.48	0.38	37.25	6.24
TOTAL	51.00	120.00	790.00	234.30

Table continues overleaf

TABLE D.6 (continued)

Basic Solution: Employment by Sector and Skill Category, 1968

(Thousands of workers)

Sector	Unskilled workers	White-collar workers	Self-employed	Total
1. Rice, barley, and wheat	0.00	0.00	2,381.03[a]	2,381.03
2. Other agriculture	0.00	0.00	2,257.77[a]	2,257.77
3. Fishing	95.97*	41.05	64.70	225.23
4. Processed foods	39.48	23.14	19.51	181.85
5. Mining	34.01	8.32	2.46	112.28
6. Textiles	10.77**	10.15*	2.56	170.26
7. Finished textile products	18.03**	8.04**	11.39	208.93
8. Lumber and plywood	6.14**	4.05*	1.21	40.00
9. Wood products and furniture	4.45**	1.29*	8.00	33.91
10. Basic chemical products	1.30	1.84*	0.15	10.58
11. Other chemical products	4.41	7.63	0.50	31.44
12. Petroleum products	0.07**	0.32**	0.00	1.55
13. Coal products	6.73	3.21	1.03	18.41
14. Cement, nonmetallic mineral products	9.56	6.54	2.84	53.33
15. Metal products	5.34	7.05	3.95	65.40
16. Nonelectrical machinery	2.85	4.11	2.24	40.40
17. Electrical machinery	1.60**	3.75**	0.47	31.90
18. Transport equipment	3.54	7.78	1.29	50.33
19. Beverages and tobacco	13.28*	6.72	2.18	44.65
20. Other consumer products	22.57	20.79	10.84	206.40
21. Construction	85.96	59.50	11.80	286.09
22. Electricity and water	1.77	5.15	0.00	15.24
23. Real estate	0.48	0.42	5.48	6.47
24. Transportation and communications	172.29	27.05	22.45	232.34
25. Trade and banking	58.87	220.58	765.08	1,049.29
26. Education	25.35	132.48	69.74	227.57
27. Medical services	33.72	0.00	29.31	95.76
28. Other services	67.14	19.00	41.71	146.90
29. Personal services	184.33	37.03	108.23	374.94
TOTAL	910.00	667.00	5,827.93	8,600.24

NOTE: No asterisk, solution differs by less than 5 percent from the actual value; single asterisk, solution differs by 5 percent to 10 percent from the actual value; double asterisk, solution differs by more than 10 percent from the actual value. There are, in addition to these, 574,000 government workers and 125,000 capitalists making the total number of income earners 9,299,240.

[a] Includes both agricultural laborers and landowners

TABLE D.7

Basic Solution: Production and Employment by Firm Size and Aggregate Sector, 1968

Aggregate sector	Firm size 1	Firm size 2	Firm size 3	Firm size 4	Total
Production (billions of *won*)					
Agriculture[a]	96.6*	164.2	243.4**	75.9**	581.2
Food, bev., & tob.	34.9	51.1	68.2	163.9	318.1
Shelter & transp.	64.0	186.4	182.8	251.5	684.6
Manufacturing	36.7	165.3	126.5	409.2	737.6
Services	211.6	129.0	160.2	49.1	550.0
TOTAL	444.8	696.0	781.1	949.6	2,871.5
Employment (thousands of workers)					
Agriculture[a]	1,193.00**	1,391.72	1,679.84**	374.24**	4,638.80
Food, bev., & tob.	86.39	78.78	207.17*	79.39	451.73
Shelter & transp.	52.81	196.99	221.17	216.37	687.34
Manufacturing	35.86	238.49*	168.63	484.94	927.92
Services	1,014.07	355.22	401.56	123.60*	1,894.45
TOTAL	2,382.13*	2,261.20	2,678.37**	1,278.54**	8,600.24

NOTE: No asterisk, solution differs by less than 2 percent from the actual value; single asterisk, solution differs by 2 percent to 5 percent from the actual value; double asterisk, solution differs by more than 5 percent from the actual value.

[a] Size categories for agriculture are by farm size. The self-employed in agriculture (firm size 1) include laborers as well as landowners.

TABLE D.8

Basic Solution: Employment by Skill Category and Aggregate Sector, 1968

(Thousands of workers)

Aggregate sector	Engineers	Technicians	Skilled workers	Apprentices
Agriculture	—	—	—	—
Food, bev., & tob.	5.94	13.69	98.73*	27.33*
Shelter & transp.	30.28	37.55	140.93	30.77*
Manufacturing	12.15	33.73	497.48	164.82
Services	2.64	35.03	52.86*	11.37*
TOTAL	51.00	120.00	790.00	234.30

Aggregate sector	Unskilled workers	White-collar workers	Self-employed	Total
Agriculture	—	—	4,638.80[a]	4,638.80
Food, bev., & tob.	148.73**	70.91	86.39	451.73
Shelter & transp.	287.46	107.54	52.81	687.34
Manufacturing	104.41**	79.46	35.86	927.92
Services	369.40	409.09	1,014.07	1,894.45
TOTAL	910.00	667.00	5,827.93	8,600.24

NOTE: No asterisk, solution differs by less than 2 percent from the actual value; single asterisk, solution differs by 2 percent to 5 percent from the actual value; double asterisk, solution differs by more than 5 percent from the actual value.

[a] Includes agricultural laborers as well as landowners

TABLE D.9

Basic Solution: Employment in Aggregate Sectors (Excluding Agriculture) by Skill Category and Firm Size, 1968

(Thousands of workers)

Skill and sector	Firm size 2	Firm size 3	Firm size 4	Total
Engineers				
Food, bev., & tob.	.35	3.38*	2.21	5.94
Shelter & transp.	12.56	9.28	8.44	30.28
Manufacturing	.72*	2.25	9.18	12.15
Services	.94	1.23	.47	2.64
TOTAL	14.57	16.14	20.30	51.00
Technicians				
Food, bev., & tob.	2.02	8.24*	3.43	13.69
Shelter & transp.	12.23	10.69	14.64	37.55
Manufacturing	4.60	6.45	22.68	33.73
Services	1.37	33.17	.49	35.03
TOTAL	20.22	58.55	41.24	120.00
Skilled workers				
Food, bev., & tob.	26.85*	29.02	42.86*	98.73*
Shelter & transp.	48.71	33.26	58.97	140.93
Manufacturing	124.29*	89.05	284.15	497.48
Services	36.07*	11.12*	5.66	52.86*
TOTAL	235.92	162.45	391.64	790.00
Apprentices				
Food, bev., & tob.	8.64*	9.78	8.91*	27.33*
Shelter & transp.	14.03**	5.92	10.82	30.77*
Manufacturing	53.97	30.39	80.46	164.82
Services	9.13*	2.14	.10	11.37*
TOTAL	85.77	48.23	100.29	234.30
Unskilled workers				
Food, bev., & tob.	30.85*	105.25**	12.63	148.73*
Shelter & transp.	68.21*	123.38	95.87	287.46
Manufacturing	34.89**	19.89*	49.64*	104.41**
Services	181.90	138.46	49.04	369.40
TOTAL	315.85	386.98*	207.18	910.00
White-collar workers				
Food, bev., & tob.	10.07	51.49*	9.35	70.91
Shelter & transp.	41.26	38.64	27.64	107.54
Manufacturing	20.03	20.61	38.82	79.46
Services	125.81	215.45	67.83	409.09
TOTAL	197.17	326.19	143.64	667.00

NOTE: No asterisk, solution differs by less than 2 percent from the actual value; single asterisk, solution differs by 2 percent to 5 percent from the actual value; double asterisk, solution differs by more than 5 percent from the actual value. Agricultural employment by farm size is given in Table D.7. There is no breakdown of employment by skill category for firm size 1 (self-employed).

TABLE D.10

Basic Solution, Five Periods: Consumption by Aggregate Sector and Year

(Billions of *won*)

Aggregate sector	Year 1	Year 3	Year 5	Year 7	Year 9
Agriculture	1,030.5	1,135.7	1,231.3	1,225.0	1,137.0
Food, bev., & tob.	669.6	835.2	1,055.4	1,258.6	1,575.0
Shelter & transp.	445.6	567.7	759.8	1,020.3	1,579.7
Manufacturing	595.7	735.1	1,056.4	1,497.8	2,653.5
Services	337.3	395.7	524.1	666.3	972.6
TOTAL	3,078.7	3,669.4	4,627.0	5,668.0	7,917.8

TABLE D.11

Basic Solution, Five Periods: Consumption Shares by Aggregate Sector and Year

(Percent)

Aggregate sector	Year 1	Year 3	Year 5	Year 7	Year 9
Agriculture	33.5%	30.9%	26.6%	21.6%	14.4%
Food, bev., & tob.	21.7	22.8	22.8	22.2	19.9
Shelter & transp.	14.5	15.5	16.4	18.0	19.9
Manufacturing	19.3	20.0	22.8	26.4	33.5
Services	11.0	10.8	11.3	11.8	12.3

TABLE D.12

Basic Solution: Expenditure Shares by Aggregate Sector and Household Category, 1968

(Percent)

Household category	Agriculture	Food, bev., & tob.	Shelter & transp.	Manufacturing	Services
Wage earners					
Engineers	26.75%	23.21%	16.81%	22.11%	11.13%
Technicians	31.93	24.52	17.45	15.86	10.24
Skilled workers	35.58	23.37	15.59	16.98	8.48
Apprentices	36.69	21.86	14.85	17.93	8.67
Unskilled workers	39.19	22.23	13.75	18.10	6.73
White-collar workers	31.00	24.58	16.43	18.84	9.16
Government workers	30.86	25.27	14.95	18.36	10.56
Self-employed					
1: Manufacturing	35.27	24.80	15.07	15.73	9.12
2: Services	35.27	24.80	15.07	15.73	9.12
Capitalists	30.71	24.28	17.31	18.25	9.46
Agriculture					
Laborers	47.20	15.79	8.87	15.01	13.13
Farm size 1	47.20	15.79	8.87	15.01	13.13
Farm size 2	47.20	15.79	8.87	15.01	13.13
Farm size 3	39.68	12.97	7.81	25.64	13.89
Farm size 4	39.24	12.91	7.88	22.08	17.89

TABLE D.13

Basic Solution: Expenditure Elasticities by Aggregate Sector and Household Category, 1968

Household category	Agriculture	Food, bev., & tob.	Shelter & transp.	Manufacturing	Services
Wage earners					
Engineers	.455	.914	1.190	1.559	1.092
Technicians	.573	1.047	1.184	1.554	1.049
Skilled workers	.606	1.074	1.286	1.438	1.048
Apprentices	.717	1.061	.959	1.393	1.303
Unskilled workers	.647	1.123	1.369	1.343	.972
White-collar workers	.762	1.064	1.052	1.011	1.519
Government workers	.405	.783	1.300	1.728	1.569
Self-employed					
1: Manufacturing	.748	1.214	.954	1.132	1.243
2: Services	.748	1.214	.954	1.132	1.243
Capitalists	.576	1.000	1.150	1.430	1.271
Agriculture					
Laborers	.863	.920	1.241	1.404	.963
Farm size 1	.863	.920	1.241	1.404	.963
Farm size 2	.863	.920	1.241	1.404	.963
Farm size 3	.702	1.027	1.630	1.115	1.260
Farm size 4	.604	1.322	1.395	1.264	1.136

APPENDIX E

Comparative Statics Experiments

Below we give a brief description of the experiments discussed in Chapter 5. Columns in the related tables that follow may not total because of rounding.

Tax and Transfer Experiments

A-1: Tax structure. Double direct tax rates on households and halve indirect tax rates.

A-2: Transfer of increase in direct taxes to urban groups. Double direct tax rates on households and transfer the proceeds to apprentices and skilled and unskilled workers.

A-3: Transfer of increase in direct taxes to rural groups. Double direct tax rates on households and transfer the proceeds to small farmers (farm sizes 1 and 2).

A-4: Transfer of increase in indirect taxes to urban groups. Raise indirect tax rates by one-third and transfer the proceeds to apprentices and skilled and unskilled workers.

A-5: Consumption subsidy. Subsidize the consumption of food, housing, and medical services for households in the six lowest income household categories.

Agricultural Experiments

B-1: Price supports. Fix agricultural sector prices at 1.25 of base-year values.

B-2: Capital. Increase agricultural capital stocks 30 percent.

B-3: Productivity. Increase agricultural productivity 15 percent in sector 1, 10 percent in sector 2.

B-4: Productivity and price supports. Increase agricultural productivity and fix agricultural prices at world prices.

B-5: Productivity and subsidy. Increase productivity in sector 1 (cereals) and subsidize the price.

Trade and Industrialization Experiments

C-1: Export quotas. Increase export targets.

C-2: Export promotion. Subsidize labor-intensive and export industries.

C-3: Export promotion and agricultural productivity. Subsidize labor-intensive and export industries and increase productivity in agricultural sectors.

C-4: Export promotion, agricultural productivity, and price supports. Same as C-3 plus agricultural prices pegged to world prices.

C-5: Devaluation and trade promotion. Devaluation coupled with free trade at world prices for export and import-substitute industries, and increased capital stocks.

C-6: Free trade. Flexible exchange rates with no quantitative controls on trade.

C-7: Import substitution. Lower import coefficients.

Technology and Manpower Experiments

D-1: CES technology. Use two-level CES production functions in all non-service sectors.

D-2: Labor-intensive technology. Reduce capital intensity of production in manufacturing.

D-3: Decreased elasticity of substitution between labor and capital outside of agriculture.

D-4: Increased elasticity of substitution between labor and capital outside of agriculture.

D-5: Educational change. Upgrade the skill composition of the labor force.

D-6: Educational change and CES technology. Upgrade the skill composition of the labor force and use CES functions in all non-service sectors.

TABLE E.1

Tax and Transfer Experiments: Decile Distribution of Real Household Income

(Percent)

Decile	Basic run	A-1	A-2	A-3	A-4	A-5
1	2.22%	2.24%	2.26%	2.23%	2.23%	2.36%
2	3.62	3.65	3.71	3.76	3.68	3.83
3	4.67	4.71	4.81	4.88	4.76	4.91
4	5.71	5.75	5.89	5.98	5.84	5.96
5	6.86	6.90	7.06	7.17	7.01	7.10
6	8.21	8.25	8.43	8.53	8.37	8.43
7	9.94	9.97	10.13	10.22	10.07	10.10
8	12.38	12.39	12.47	12.53	12.44	12.41
9	16.46	16.44	16.34	16.29	16.36	16.23
10	29.92	29.69	28.90	28.41	29.24	28.66
Gini coefficient	.398	.395	.387	.382	.391	.381

TABLE E.2

Tax and Tranfer Experiments: Analysis of Poverty

(Percent composition of households with real incomes of less than 120,000 *won*)

Household category	Basic run	A-1	A-2	A-3	A-4	A-5
Wage earners						
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	0.9	0.9	1.0	1.1	1.0	1.1
Skilled workers	12.3*	11.8*	8.3	15.4*	9.1	12.2*
Apprentices	0.3**	0.3**	0.3*	0.3**	0.3*	0.3**
Unskilled workers	12.9*	12.6*	10.3*	15.2*	10.8*	13.1*
White-collar workers	4.5	4.4	5.2	5.5	5.1	5.3
Government workers	8.6*	8.6*	9.6*	10.1*	9.6*	10.4*
Self-employed						
1: Manufacturing	3.0*	3.3*	3.4*	4.3*	3.1*	3.8*
2: Services	7.6	8.4	9.0	9.8	8.1	9.1
Capitalists	0.0	0.1	0.1	0.1	0.1	0.1
Agriculture						
Laborers	14.6**	14.6**	15.4**	15.8**	15.4**	15.1**
Farm size 1	18.1*	18.1*	19.1*	11.9*	19.2*	15.8*
Farm size 2	15.3*	15.1*	16.1*	8.3	16.2*	11.9
Farm size 3	2.0	2.0	2.2	2.2	2.2	1.9
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.0
Percent <90,000 *won*	23.8%	23.7%	22.5%	21.7%	22.5%	20.5%
Percent <120,000 *won*	38.3%	38.2%	36.5%	35.6%	36.5%	34.7%
Mean incomes (000 *won*)						
Bottom decile	43.8	44.0	44.7	44.3	44.6	47.8
Next decile	71.5	71.8	73.5	74.5	73.4	77.5
Top decile	591.0	583.5	572.0	563.4	583.7	579.3
Overall	202.2	201.1	202.2	202.4	204.1	206.4

NOTE: No asterisk, share represents less than $\frac{1}{3}$ of group population; single asterisk, share represents $\frac{1}{3}$ to $\frac{2}{3}$ of group population; double asterisk, share represents more than $\frac{2}{3}$ of group population.

TABLE E.3

Tax and Transfer Experiments: Composition by Groups of Top Decile of the Overall Distribution

(Percent)

Household category	Basic run	A-1	A-2	A-3	A-4	A-5
Wage earners						
Engineers	2.5%	2.6%	2.3%	2.4%	2.3%	2.3%
Technicians	2.9	3.1	2.8	2.7	2.7	2.7
Skilled workers	0.8	1.0	2.6	0.6	2.0	1.1
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	3.3	3.6	6.4	2.6	5.6	4.1
White-collar workers	22.3	23.0	20.7	20.3	20.8	20.3
Government workers	9.4	9.5	8.7	8.5	8.5	8.0
Self-employed						
1: Manufacturing	2.9	2.5	2.5	1.6	3.0	2.2
2: Services	17.6	16.0	15.7	14.7	17.4	15.9
Capitalists	15.1	14.8	14.5	14.3	14.8	14.5
Agriculture						
Laborers	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.5	0.5	0.5	2.8	0.5	1.2
Farm size 2	1.6	1.7	1.7	7.5	1.6	3.8
Farm size 3	11.9	12.3	12.3	12.6	11.7	13.8
Farm size 4	9.2	9.4	9.3	9.4	9.1	10.1

TABLE E.4

Tax and Transfer Experiments: Mean Group Incomes as a Percent of Basic-Run Values

Category	Basic run[a]	A-1	A-2	A-3	A-4	A-5
Wage earners						
Engineers	504	100%	93%	92%	93%	93%
Technicians	266	101	96	93	95	96
Skilled workers	143	102	121	92	117	105
Apprentices	102	101	116	91	114	105
Unskilled workers	146	102	122	92	118	107
White-collar workers	295	101	95	93	96	95
Government workers	203	100	95	94	96	94
Self-employed						
1: Manufacturing	198	92	92	77	101	89
2: Services	241	95	94	91	99	96
Capitalists	777	96	93	91	97	94
Agriculture						
Laborers	68	102	100	100	99	117
Farm size 1	116	101	100	138	99	119
Farm size 2	143	101	100	138	99	120
Farm size 3	258	100	99	100	99	104
Farm size 4	415	100	99	99	100	105
AVERAGE	202	99%	100%	100%	101%	102%

[a] Average real incomes of groups in thousands of *won*

TABLE E.5

Tax and Transfer Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Basic run	A-1	A-2	A-3	A-4	A-5
National income accounts[a]						
Wages, nonagricultural	533	568	534	532	508	516
Self-employed	219	227	219	219	215	216
Agricultural income	350	354	350	351	347	369
Property income	186	193	186	185	181	183
National income	1,387	1,447	1,386	1,387	1,346	1,387
Gross domestic product accounts[a]						
Consumption	1,385	1,382	1,386	1,388	1,395	1,409
Investment	435	448	435	435	424	414
Exports[b]	211	221	220	220	220	214
Imports (−)[b]	417	431	417	416	405	395
GDP	1,615	1,620	1,625	1,627	1,634	1,642
Wholesale price index	99.7	96.6	99.7	99.8	102.7	104.7
Agricultural terms of trade	99.7	101.0	99.8	99.9	98.7	104.7
Exchange rate[c]	.277	.277	.277	.277	.277	.277
Production[d]						
Agriculture	581	581	581	581	581	581
Food, beverages, and tobacco	318	325	318	318	313	318
Shelter and transportation	685	694	685	685	678	680
Manufacturing	738	733	737	737	741	740
Services	550	549	550	551	551	554
TOTAL	2,871	2,883	2,870	2,872	2,864	2,874
Employment[e]						
Agriculture	4,639	4,639	4,640	4,640	4,640	4,640
Food, beverages, and tobacco	452	456	452	451	452	436
Shelter and transportation	687	699	690	688	679	681
Manufacturing	928	916	926	925	934	925
Services	1,894	1,891	1,894	1,896	1,897	1,919
TOTAL	8,600	8,600	8,602	8,602	8,601	8,602

[a] Real values in billions of *won*, 1968 prices
[b] In billions of *won*, valued at world prices
[c] At 1,000 *won* to the dollar
[d] Real gross production in billions of *won*, 1968 prices
[e] By thousands of workers

TABLE E.6

Agricultural Experiments: Decile Distribution of Real Household Income

(Percent)

Decile	Basic run	B-1	B-2	B-3	B-4	B-5
1	2.22%	2.22%	2.19%	1.92%	2.22%	2.17%
2	3.62	3.61	3.59	3.23	3.64	3.61
3	4.67	4.63	4.63	4.29	4.69	4.68
4	5.71	5.67	5.68	5.38	5.73	5.74
5	6.86	6.81	6.83	6.60	6.88	6.90
6	8.21	8.19	8.19	8.03	8.24	8.26
7	9.94	9.96	9.92	9.83	9.98	10.00
8	12.38	12.47	12.36	12.36	12.43	12.45
9	16.46	16.67	16.47	16.66	16.53	16.55
10	29.92	29.77	30.14	31.71	29.65	29.65
Gini coefficient	.398	.399	.401	.424	.396	.397

TABLE E.7

Agricultural Experiments: Analysis of Poverty

(Percent composition of households with real incomes of less than 120,000 *won*)

Household category	Basic run	B-1	B-2	B-3	B-4	B-5
Wage earners						
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	0.9	1.0	0.8	0.6	0.9	0.9
Skilled workers	12.3*	16.2*	11.3*	6.5	13.0*	12.9*
Apprentices	0.3**	0.3**	0.3**	0.2*	0.3**	0.3**
Unskilled workers	12.9*	14.6*	12.3*	9.1*	13.5*	13.4*
White-collar workers	4.5	5.1	3.9	2.6	4.2	4.2
Government workers	8.6*	9.6*	8.3	6.8	9.4*	9.6*
Self-employed						
1: Manufacturing	3.0*	3.8*	2.8*	2.0	3.4*	3.4*
2: Services	7.6	8.1	7.3	5.8	7.7	7.6
Capitalists	0.0	0.1	0.1	0.0	0.1	0.1
Agriculture						
Laborers	14.6**	14.0**	15.1**	15.3**	15.3**	16.1**
Farm size 1	18.1*	14.8*	19.2**	23.3**	17.2*	17.2*
Farm size 2	15.3*	11.4*	16.3*	22.1*	13.5*	12.9*
Farm size 3	2.0	1.0	2.3	5.7	1.4	1.4
Farm size 4	0.0	0.0	0.0	0.1	0.0	0.0
Percent <90,000 *won*	23.8%	24.1%	22.9%	24.9%	21.7%	21.3%
Percent <120,000 *won*	38.3%	38.7%	37.1%	37.9%	35.7%	35.0%
Mean incomes (000 *won*)						
Bottom decile	43.8	43.9	44.5	40.2	45.9	45.3
Next decile	71.5	71.2	72.8	67.7	75.1	75.4
Top decile	591.0	588.1	612.0	665.2	611.8	619.3
Overall	202.2	201.8	208.0	215.7	210.9	213.5

NOTE: No asterisk, share represents less than $\frac{1}{3}$ of group population; single asterisk, share represents $\frac{1}{3}$ to $\frac{2}{3}$ of group population; double asterisk, share represents more than $\frac{2}{3}$ of group population.

TABLE E.8

Agricultural Experiments: Composition by Groups of Top Decile of the Overall Distribution

(Percent)

Household category	Basic run	B-1	B-2	B-3	B-4	B-5
Wage earners						
Engineers	2.5%	2.2%	2.6%	2.8%	2.3%	2.3%
Technicians	2.9	2.4	3.2	3.8	2.9	2.8
Skilled workers	0.8	0.2	0.9	2.5	0.6	0.6
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	3.3	2.1	3.7	5.6	3.0	3.2
White-collar workers	22.3	19.1	24.0	28.2	22.1	21.9
Government workers	9.4	7.3	9.6	11.1	8.1	7.8
Self-employed						
1: Manufacturing	2.9	1.4	3.1	5.3	2.4	2.4
2: Services	17.6	15.5	17.9	19.7	16.8	16.8
Capitalists	15.1	14.2	15.1	15.5	14.5	14.4
Agriculture						
Laborers	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.5	1.0	0.4	0.1	0.6	0.6
Farm size 2	1.6	3.1	1.2	0.2	2.1	2.3
Farm size 3	11.9	19.3	9.9	2.3	14.3	14.1
Farm size 4	9.2	12.2	8.4	2.9	10.3	10.8

TABLE E.9

Agricultural Experiments: Mean Group Incomes as a Percent of Basic-Run Values

Household category	Basic run[a]	B-1	B-2	B-3	B-4	B-5
Wage earners						
Engineers	504	92%	105%	120%	99%	98%
Technicians	266	92	106	123	103	103
Skilled workers	143	84	105	131	100	102
Apprentices	102	85	105	131	100	102
Unskilled workers	146	88	107	129	102	104
White-collar workers	295	93	107	123	104	105
Government workers	203	92	104	116	99	99
Self-employed						
1: Manufacturing	198	78	106	141	96	97
2: Services	241	96	104	114	102	104
Capitalists	777	93	103	114	99	99
Agriculture						
Laborers	68	109	100	87	106	98
Farm size 1	116	116	98	77	110	112
Farm size 2	143	116	98	77	111	115
Farm size 3	258	118	98	73	111	112
Farm size 4	415	119	99	73	111	116
AVERAGE	202	100%	103%	107%	104%	105%

[a] Average real incomes of groups in thousands of *won*

TABLE E.10

Agricultural Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Basic run	B-1	B-2	B-3	B-4	B-5
National income accounts[a]						
Wages, nonagricultural	533	491	558	625	542	547
Self-employed	219	212	223	236	222	224
Agricultural income	350	422	338	241	384	384
Property income	186	182	188	192	187	188
National income	1,387	1,403	1,406	1,404	1,438	1,448
Gross domestic product accounts[a]						
Consumption	1,385	1,393	1,406	1,400	1,423	1,432
Investment	435	402	445	475	422	424
Exports[b]	211	227	222	237	224	218
Imports (−)[b]	417	383	427	453	369	403
GDP	1,615	1,638	1,646	1,659	1,701	1,671
Wholesale price index	99.7	104.9	97.6	93.0	103.1	103.3
Agricultural terms of trade	99.7	125.3	91.7	64.1	96.3	93.8
Exchange rate[c]	.277	.277	.277	.277	.277	.277
Production[d]						
Agriculture	581	581	611	649	654	614
Food, beverages, and tobacco	318	311	324	347	328	322
Shelter and transportation	685	682	691	699	685	686
Manufacturing	738	728	734	736	732	735
Services	550	565	553	541	561	563
TOTAL	2,871	2,868	2,913	2,971	2,959	2,920
Employment[e]						
Agriculture	4,639	4,640	4,640	4,640	4,640	4,640
Food, beverages, and tobacco	452	439	456	486	451	435
Shelter and transportation	687	692	688	677	677	674
Manufacturing	928	901	916	919	909	916
Services	1,894	1,929	1,902	1,880	1,925	1,936
TOTAL	8,600	8,602	8,602	8,602	8,602	8,602

[a] Real values in billions of *won*, 1968 prices
[b] In billions of *won*, valued at world prices
[c] At 1,000 *won* to the dollar
[d] Real gross production in billions of *won*, 1968 prices
[e] By thousands of workers

TABLE E.11

Trade and Industrialization Experiments: Decile Distribution of Real Household Income

(Percent)

Decile	Basic run	C-1	C-2	C-3	C-4	C-5	C-6	C-7
1	2.22%	2.21%	2.19%	2.14%	1.98%	2.21%	2.21%	2.22%
2	3.62	3.63	3.64	3.57	3.37	3.64	3.62	3.64
3	4.67	4.69	4.71	4.65	4.47	4.70	4.67	4.70
4	5.71	5.74	5.78	5.73	5.57	5.76	5.71	5.75
5	6.86	6.89	6.94	6.90	6.78	6.92	6.86	6.89
6	8.21	8.25	8.30	8.27	8.19	8.31	8.22	8.24
7	9.94	9.98	10.05	10.01	9.97	10.07	9.96	9.96
8	12.38	12.40	12.50	12.44	12.45	12.57	12.41	12.39
9	16.46	16.46	16.60	16.52	16.62	16.70	16.51	16.45
10	29.92	29.74	29.29	29.75	30.61	29.13	29.82	29.75
Gini coefficient	.398	.397	.394	.399	.412	.394	.398	.396

TABLE E.12

Trade and Industrialization Experiments: Analysis of Poverty

(Percent composition of households with real incomes of less than 120,000 *won*)

Household category	Basic run	C-1	C-2	C-3	C-4	C-5	C-6	C-7
Wage earners								
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	0.9	0.9	0.9	0.7	0.6	1.1	1.1	0.8
Skilled workers	12.3*	11.8*	11.4*	7.5	5.2	14.7*	12.7*	12.1*
Apprentices	0.3**	0.3**	0.3*	0.3*	0.2*	0.3**	0.3**	0.3**
Unskilled workers	12.9*	13.0*	13.5*	11.2*	9.1	12.6*	12.9*	13.3*
White-collar workers	4.5	4.5	3.4	2.2	1.7	4.6	4.5	4.5
Government workers	8.6*	9.1*	12.5*	11.9*	10.3	13.4*	7.6	9.0*
Self-employed								
1: Manufacturing	3.0*	3.1*	3.8*	3.3	2.7	3.7*	3.2*	3.2*
2: Services	7.6	7.5	9.1	8.0	6.9	8.4	8.2	7.6
Capitalists	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture								
Laborers	14.6**	14.5**	16.2**	15.6**	18.1**	14.9**	14.2**	14.3**
Farm size 1	18.1*	18.0*	15.9*	20.8*	22.6*	14.6*	17.9*	17.8*
Farm size 2	15.3*	15.2*	11.8	16.4*	19.4*	10.6	15.3*	14.9*
Farm size 3	2.0	2.1	1.0	1.9	3.1	0.8	2.1	2.1
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent <90,000 *won*	23.8%	24.3%	20.2%	17.9%	19.4%	22.4%	23.0%	24.7%
Percent <120,000 *won*	38.3%	38.9%	33.5%	30.3%	31.3%	36.4%	38.0%	39.4%
Mean incomes (000 *won*)								
Bottom decile	43.8	43.0	46.7	49.3	46.1	44.9	43.8	42.8
Next decile	71.5	70.6	77.6	82.2	78.5	73.8	71.8	70.1
Top decile	591.0	577.9	625.3	684.2	712.0	591.3	592.0	572.8
Overall	202.2	198.8	217.9	235.2	238.5	206.9	203.1	197.0

NOTE: No asterisk: share represents less than $\frac{1}{3}$ of group population; single asterisk, share represents $\frac{1}{3}$ to $\frac{2}{3}$ of group population; double asterisk, share represents more than $\frac{2}{3}$ of group population.

TABLE E.13

Trade and Industrialization Experiments: Composition by Groups of Top Decile of the Overall Distribution

(Percent)

Household category	Basic run	C-1	C-2	C-3	C-4	C-5	C-6	C-7
Wage earners								
Engineers	2.5%	2.4%	1.9%	2.2%	2.4%	1.3%	2.4%	2.5%
Technicians	2.9	2.9	2.8	3.5	3.8	2.3	2.8	3.1
Skilled workers	0.8	1.0	0.8	1.9	3.0	0.5	0.8	0.8
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	3.3	3.2	3.2	4.9	6.1	3.3	3.2	2.9
White-collar workers	22.3	21.8	25.6	31.1	33.6	20.9	22.3	21.6
Government workers	9.4	8.6	4.8	5.7	6.4	3.7	11.5	8.7
Self-employed								
1: Manufacturing	2.9	3.2	2.6	4.1	5.1	2.2	2.7	2.9
2: Services	17.6	18.3	13.1	14.7	15.6	15.1	16.2	18.4
Capitalists	15.1	14.9	12.7	13.2	13.5	12.1	14.7	14.9
Agriculture								
Laborers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.5	0.5	0.9	0.3	0.1	1.1	0.5	0.5
Farm size 2	1.6	1.7	2.8	1.2	0.5	3.6	1.6	1.8
Farm size 3	11.9	12.2	17.2	9.0	4.8	21.0	12.0	12.3
Farm size 4	9.2	9.3	11.6	8.2	5.1	12.9	9.3	9.6

TABLE E.14

Trade and Industrialization Experiments: Mean Group Incomes as a Percent of Basic-Run Values

Household category	Basic run[a]	C-1	C-2	C-3	C-4	C-5	C-6	C-7
Wage earners								
Engineers	504	94%	92%	108%	116%	73%	98%	96%
Technicians	266	98	105	125	135	92	99	100
Skilled workers	143	101	109	135	150	94	100	99
Apprentices	102	101	108	132	147	95	100	99
Unskilled workers	146	98	107	132	145	105	99	94
White-collar workers	295	97	117	140	150	100	101	96
Government workers	203	95	85	95	103	75	101	95
Self-employed								
1: Manufacturing	198	100	99	131	152	89	96	95
2: Services	241	100	97	109	114	97	98	99
Capitalists	777	97	87	97	103	78	97	96
Agriculture								
Laborers	68	98	109	106	95	109	99	98
Farm size 1	116	99	121	109	99	122	100	99
Farm size 2	143	99	122	110	98	123	101	100
Farm size 3	258	99	122	108	94	125	101	98
Farm size 4	415	99	124	111	95	128	101	100
AVERAGE	202	98%	108%	116%	118%	102%	100%	97%

[a] Average real incomes of groups in thousands of *won*

TABLE E.15

Trade and Industrialization Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

(Percent)

Category	Basic run	C-1	C-2	C-3	C-4	C-5	C-6	C-7
National income accounts[a]								
Wages, Nonagric.	533	517	608	693	736	520	548	506
Self-employed	219	219	225	241	250	223	212	214
Agric. income	350	344	456	380	325	450	354	342
Property income	186	180	181	185	187	166	181	177
National income	1,387	1,370	1,554	1,582	1,582	1,480	1,389	1,344
GDP accounts[a]								
Consumption	1,385	1,349	1,513	1,539	1,541	1,340	1,392	1,326
Investment	435	410	347	364	383	317	434	402
Exports[b]	211	273	210	224	231	326	221	215
Imports (−)[b]	417	386	327	346	378	380	418	317
GDP	1,615	1,646	1,743	1,781	1,776	1,664	1,629	1,326
Whlse. price index	99.7	106.2	125.9	120.3	115.4	136.7	100.0	108.2
Agric. Terms of trade	99.7	97.9	130.2	98.2	83.8	125.9	99.8	97.3
Exchange rate[c]	.277	.277	.277	.277	.277	.360	.276	.277
Production[d]								
Agriculture	581	581	580	634	640	580	582	581
Food, bev. & tob.	318	319	335	360	369	389	315	316
Shelter & transp.	685	676	674	682	690	642	691	655
Manufacturing	738	752	780	773	772	772	734	764
Services	550	549	592	589	582	572	552	542
TOTAL	2,871	2,878	2,961	3,038	3,053	2,955	2,874	2,859
Employment[e]								
Agriculture	4,639	4,640	4,641	4,640	4,639	4,640	4,643	4,640
Food, bev. & tob.	452	432	400	434	450	543	442	433
Shelter & transp.	687	665	632	621	621	625	697	654
Manufacturing	928	961	957	936	937	865	917	978
Services	1,894	1,903	1,972	1,970	1,953	1,928	1,900	1,897
TOTAL	8,600	8,602	8,602	8,602	8,600	8,602	8,599	8,602

[a] Real values in billions of *won*, 1968 prices
[b] In billions of *won*, valued at world prices
[c] At 1,000 *won* to the dollar
[d] Real gross production in billions of *won*, 1968 prices
[e] By thousands of workers

TABLE E.16

Technology and Manpower Experiments: Decile Distribution of Real Household Income

(Percent)

Decile	Basic run	D-1	D-2	D-3	D-4	D-5	D-6
1	2.22%	2.22%	2.22%	2.20%	2.20%	2.29%	2.29%
2	3.62	3.64	3.67	3.62	3.59	3.71	3.72
3	4.67	4.69	4.77	4.68	4.62	4.75	4.78
4	5.71	5.74	5.87	5.75	5.65	5.79	5.82
5	6.86	6.89	7.05	6.91	6.80	6.93	6.96
6	8.21	8.24	8.43	8.27	8.16	8.27	8.30
7	9.94	9.97	10.15	9.99	9.91	9.99	10.01
8	12.38	12.39	12.52	12.39	12.39	12.40	12.39
9	16.46	16.45	16.39	16.41	16.55	16.40	16.36
10	29.92	29.77	28.93	29.78	30.13	29.50	29.37
Gini coefficient	.398	.397	.389	.397	.402	.392	.391

TABLE E.17

Technology and Manpower Experiments: Analysis of Poverty

(Percent composition of households with real incomes of less than 120,000 *won*)

Household category	Basic run	D-1	D-2	D-3	D-4	D-5	D-6
Wage earners							
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	0.9	0.9	1.0	0.7	1.1	1.2	1.2
Skilled workers	12.3*	11.9*	7.5	10.2*	14.2*	15.3*	14.3*
Apprentices	0.3**	0.3**	0.3*	0.3**	0.3**	0.5*	0.4*
Unskilled workers	12.9*	12.9*	11.2*	12.2*	13.2*	6.3	6.5*
White-collar workers	4.5	4.6	4.8	4.3	4.3	7.4	7.6
Government workers	8.6*	8.8*	9.7*	8.2*	9.3*	9.0*	9.2*
Self-employed							
1: Manufacturing	3.0*	2.9*	3.4*	3.3*	2.7	2.8*	2.8*
2: Services	7.6	7.7	7.9	7.7	7.5	7.1	7.2
Capitalists	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture							
Laborers	14.6**	14.6**	15.7**	14.3**	15.0**	14.9**	14.9**
Farm size 1	18.1*	18.1*	19.6*	19.1**	17.2*	18.3*	18.4*
Farm size 2	15.3*	15.2*	16.6*	16.8*	13.8*	15.3*	15.4*
Farm size 3	2.0	2.0	2.3	2.9	1.5	2.0	2.0
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent <90,000 *won*	23.8%	23.8%	22.4%	25.5%	22.5%	22.8%	22.9%
Percent <120,000 *won*	38.3%	38.3%	36.2%	40.2%	36.7%	37.4%	37.5%
Mean incomes (000 *won*)							
Bottom decile	43.8	43.7	44.3	41.7	45.3	45.4	45.1
Next decile	71.5	71.5	73.4	68.5	73.8	73.5	73.3
Top decile	591.0	585.6	578.4	564.4	619.1	585.2	577.8
Overall	202.0	201.3	204.2	194.0	210.4	203.0	201.2

NOTE: No asterisk, share represents less than $\frac{1}{3}$ of group population; single asterisk, share represents $\frac{1}{3}$ to $\frac{2}{3}$ of group population; double asterisk, share represents more than $\frac{2}{3}$ of group population.

TABLE E.18

Technology and Manpower Experiments: Composition by Groups of Top Decile of the Overall Distribution

(Percent)

Household category	Basic run	D-1	D-2	D-3	D-4	D-5	D-6
Wage earners							
Engineers	2.5%	2.4%	2.4%	2.9%	2.0%	2.4%	2.4%
Technicians	2.9	2.8	2.9	3.6	2.1	2.4	2.8
Skilled workers	0.8	0.9	3.3	1.6	0.4	0.7	0.9
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	3.3	3.4	5.3	3.6	3.3	8.4	3.4
White-collar workers	22.3	22.1	21.4	22.8	22.8	15.5	22.1
Government workers	9.4	9.1	8.4	10.3	7.9	8.7	9.1
Self-employed							
1: Manufacturing	2.9	3.0	1.9	2.3	3.9	3.0	3.0
2: Services	17.6	17.7	18.2	18.6	16.6	19.5	17.7
Capitalists	15.1	14.9	14.3	15.0	15.0	15.3	14.9
Agriculture							
Laborers	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.5	0.5	0.4	0.4	0.6	0.5	0.5
Farm size 2	1.6	1.7	1.5	1.2	1.9	1.7	1.7
Farm size 3	11.9	12.2	11.2	9.6	13.6	12.5	12.2
Farm size 4	9.2	9.3	8.8	8.1	9.9	9.4	9.3

TABLE E.19

Technology and Manpower Experiments: Mean Group Incomes as a Percent of Basic-Run Values

Household category	Basic run[a]	D-1	D-2	D-3	D-4	D-5	D-6
Wage earners							
Engineers	504	96%	96%	105%	90%	85%	83%
Technicians	266	97	98	106	90	88	88
Skilled workers	143	101	127	107	94	96	99
Apprentices	102	103	121	106	99	107	111
Unskilled workers	146	100	116	99	103	147	142
White-collar workers	295	99	98	97	106	80	79
Government workers	203	98	95	99	98	97	95
Self-employed							
1: Manufacturing	198	100	88	87	117	103	106
2: Services	241	99	101	97	102	104	103
Capitalists	777	98	92	95	104	103	101
Agriculture							
Laborers	68	100	97	93	106	101	100
Farm size 1	116	100	98	91	108	101	100
Farm size 2	143	100	98	91	108	101	100
Farm size 3	258	100	98	90	109	101	100
Farm size 4	415	100	98	90	109	101	100
AVERAGE	202	99%	101%	96%	104%	100%	99%

[a] Average real incomes of groups in thousands of *won*

TABLE E.20

Technology and Manpower Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Basic run	D-1	D-2	D-3	D-4	D-5	D-6
National income accounts[a]							
Wages, nonagric.	533	530	572	526	547	536	528
Self-employed	219	219	211	202	239	225	225
Agric. income	350	350	342	307	393	358	353
Property income	186	183	174	172	198	191	188
National income	1,387	1,379	1,370	1,286	1,490	1,408	1,393
GDP accounts[a]							
Consumption	1,385	1,378	1,387	1,309	1,465	1,411	1,392
Investment	435	430	411	420	445	450	439
Exports[b]	211	216	214	190	258	220	233
Imports (−)[b]	417	402	392	367	464	447	430
GDP	1,615	1,623	1,621	1,552	1,705	1,634	1,634
Whsle. price index	99.7	100.9	106.3	104.1	97.2	96.4	99.0
Agric. terms of trade	99.7	99.7	97.5	88.0	111.8	101.9	100.4
Exchange rate[c]	.277	.277	.277	.277	.277	.277	.277
Production[d]							
Agriculture	581	581	582	581	581	581	581
Food, bev. & tob.	318	315	315	300	338	314	311
Shelter & transp.	685	684	653	616	762	705	711
Manufacturing	738	725	721	663	800	769	758
Services	550	548	542	514	588	555	549
TOTAL	2,871	2,853	2,813	2,673	3,069	2,925	2,910
Employment[e]							
Agriculture	4,639	4,639	4,640	4,641	4,641	4,640	4,643
Food, bev. & tob.	452	437	460	494	381	413	394
Shelter & transp.	687	757	685	645	832	711	794
Manufacturing	928	879	950	984	790	991	944
Services	1,894	1,889	1,867	1,839	1,958	1,876	1,860
TOTAL	8,600	8,601	8,602	8,602	8,603	8,632	8,634

[a] Real values in billions of *won*, 1968 prices
[b] In billions of *won*, valued at world prices
[c] At 1,000 *won* to the dollar
[d] Real gross production in billions of *won*, 1968 prices
[e] By thousands of workers

APPENDIX F

Dynamic Experiments

Below we describe the major features of the dynamic experiments discussed in Chapters 7–9. The related tables, organized into sets by chapter, follow. Columns in the tables may not total because of rounding.

Rural Policy Experiments

A-1: Land reform. Half of the largest farms (size 4) are redistributed to the small farmers (sizes 1 and 2). The within-group inequality for small farms is also reduced.

A-2: Cooperatives. Transfer agricultural trade margins to farmers, subsidize agricultural net prices by 5 percent, and reduce rural interest rates by half.

A-3: Agricultural productivity and marketing. Increase agricultural productivity growth rate by 2.5 percentage points and attempt to stabilize grain prices through a government marketing board.

A-4: Production package. Combine experiments A-2 and A-3.

A-5: Public works and industry. Increase public investment and small-scale manufacturing in rural areas. Government investment is increased 30 percent per year, and investment in small-scale manufacturing is increased for two years to increase the firms' capital stock 30 percent.

A-6: Consumption subsidy. Subsidize the consumption of food, housing, and medical services for agricultural laborers and the two smallest farm sizes by giving them a 20 percent price subsidy.

A-7: Education and demographic change. Lower rural population growth rate by .5 percentage point, increase migration, and upgrade the skill composition of the labor force.

A-8: Social development. Combine experiments A-6 and A-7.

A-9: Rural development with land reform. Combine experiments A-1, A-4, A-5, and A-8.

A-10. Rural development without land reform. Combine experiments A-4, A-5, and A-8.

Urban Policy Experiments

B-1: Consumption subsidy. Subsidize the consumption of food, housing, and medical services for apprentices and skilled and unskilled workers by giving them a 20 percent price subsidy.

B-2: Education and demographic change. Lower urban population growth rate by .5 percentage point and upgrade the skill composition of the labor force.

B-3: Social development. Combine experiments B-1 and B-2, and increase rural-urban migration.

B-4: Small-scale industry. Various policies aimed at increasing investment in small firms (sizes 1 and 2).

B-5: Export promotion. Subsidize labor-intensive and export industries, lower their interest rate on old and new borrowing, and increase export targets.

B-6: Public works. Increase public investment in real estate and in transportation and communications, and also increase rural-urban migration.

B-7: Labor-intensive technology. Reduce the coefficient of capital 35 percent in the manufacturing sections and correspondingly increase the labor coefficients, using Cobb-Douglas production functions.

B-8: Decreased elasticity of substitution. Use CES functions in all non-service sectors and decrease the elasticity of substitution about 15 percent. Also increase migration and tighten credit.

B-9: Employment and technology. Combine experiments B-5, B-6, and B-7.

B-10: Nationalization of large-scale industry. A number of policies are specified to simulate nationalization.

B-11: Urban development. Combine experiments B-3 and B-9.

Combined Rural-Urban Strategies

C-1: Consumption subsidy. Combine experiments A-6 and B-1.

C-2: Education and demographic change. Combine experiments A-7 and B-2.

C-3: Employment. Combine experiments A-5, B-5, and B-6.

C-4: Reform capitalism. Combine experiments A-10, B-3, B-5, and B-6. Also increase taxation and migration.

C-5: Market socialism. Combine experiments B-3, B-5, B-10, and A-9 (but without the increase in agricultural productivity and the marketing board in that experiment). Also increase import substitution and taxation.

TABLE F.I

Rural Policy Experiments: Decile Distribution of Real Household Income

(Percent)

Decile	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN			A-1		
1	2.22%	2.07%	1.68%	2.42%	2.33%	2.13%
2	3.62	3.47	2.99	3.94	3.81	3.53
3	4.67	4.52	4.06	5.07	4.91	4.52
4	5.71	5.56	5.16	6.10	5.96	5.47
5	6.86	6.72	6.36	7.17	7.06	6.50
6	8.21	8.10	7.78	8.40	8.33	7.75
7	9.94	9.88	9.61	9.93	9.93	9.42
8	12.38	12.42	12.29	12.11	12.22	11.91
9	16.46	16.73	17.06	15.86	16.15	16.49
10	29.92	30.52	33.01	29.00	29.31	32.29
Gini coefficient	.398	.409	.444	.377	.385	.420
	A-2			A-3		
1	2.21%	2.08%	1.78%	2.22%	1.99%	1.57%
2	3.67	3.55	3.25	3.62	3.38	2.81
3	4.74	4.64	4.38	4.67	4.46	3.88
4	5.81	5.72	5.49	5.71	5.53	5.00
5	6.98	6.90	6.67	6.86	6.70	6.25
6	8.36	8.30	8.05	8.21	8.10	7.72
7	10.12	10.07	9.82	9.94	9.88	9.61
8	12.57	12.56	12.36	12.38	12.41	12.36
9	16.62	16.69	16.80	16.46	16.72	17.27
10	28.91	29.49	31.40	29.92	30.83	33.52
Gini coefficient	.391	.399	.423	.398	.414	.454
	A-4			A-5		
1	2.21%	2.05%	1.73%	2.45%	2.28%	2.02%
2	3.67	3.57	3.13	3.84	3.71	3.23
3	4.74	4.69	4.25	4.86	4.74	4.20
4	5.81	5.78	5.37	5.87	5.77	5.20
5	6.98	6.96	6.59	6.97	6.89	6.33
6	8.36	8.34	8.00	8.27	8.23	7.69
7	10.12	10.08	9.81	9.93	9.95	9.48
8	12.57	12.51	12.41	12.27	12.38	12.11
9	16.62	16.57	16.94	16.21	16.48	16.84
10	28.91	29.44	31.76	29.34	29.57	32.90
Gini coefficient	.391	.397	.430	.386	.393	.435

TABLE F.1 (continued)

Rural Policy Experiments: Decile Distribution of Real Household Income

(Percent)

Decile	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		A-6			A-7	
1	2.33%	2.13%	1.69%	2.22%	2.04%	1.95%
2	3.77	3.55	2.99	3.62	3.41	3.33
3	4.83	4.61	4.05	4.67	4.44	4.35
4	5.87	5.67	5.14	5.71	5.48	5.36
5	7.01	6.84	6.33	6.86	6.64	6.48
6	8.35	8.24	7.74	8.21	8.03	7.83
7	10.03	10.02	9.56	9.94	9.85	9.62
8	12.39	12.52	12.22	12.38	12.45	12.28
9	16.30	16.68	17.01	16.46	16.85	16.96
10	29.11	29.75	33.28	29.92	30.82	31.84
Gini coefficient	.387	.401	.446	.398	.414	.425
		A-8			A-9	
1	2.33%	2.02%	2.01%	2.14%	2.51%	2.55%
2	3.77	3.41	3.43	3.59	4.20	4.13
3	4.83	4.46	4.46	4.70	5.36	5.13
4	5.87	5.52	5.48	5.92	6.45	6.05
5	7.01	6.72	6.58	7.35	7.57	7.03
6	8.35	8.15	7.91	8.99	8.80	8.15
7	10.03	10.00	9.64	10.86	10.29	9.59
8	12.39	12.60	12.19	13.18	12.29	11.73
9	16.30	16.89	16.74	16.60	15.56	15.72
10	29.11	30.23	31.57	26.66	26.97	29.92
Gini coefficient	.387	.410	.419	.376	.353	.379
		A-10				
1	2.11%	2.40%	2.35%			
2	3.52	3.93	3.86			
3	4.58	5.02	4.91			
4	5.67	6.08	5.91			
5	6.91	7.21	6.99			
6	8.40	8.52	8.25			
7	10.29	10.14	9.84			
8	12.88	12.39	12.12			
9	16.98	16.11	16.09			
10	28.66	28.19	29.68			
Gini coefficient	.396	.374	.387			

TABLE F.2

Rural Policy Experiments: Analysis of Poverty

(Percent composition of households with real incomes of less than 120,000 *won*)

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN			A-1			A-2		
Wage earners									
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	0.9	1.1	0.4	1.0	1.3	0.6	1.0	1.2	0.5
Skilled workers	12.3*	12.2*	1.3	13.9*	16.1	2.8	15.3*	13.6	1.5
Apprentices	0.3**	0.5*	0.2	0.3**	0.7*	0.4	0.4**	0.6*	0.2
Unskilled workers	12.9*	19.4	16.1	14.5*	25.0*	28.0	14.8*	20.9*	19.0
White-collar workers	4.5	4.2	0.8	4.9	5.1	1.4	5.0	4.6	1.0
Government workers	8.6*	11.9	8.9	9.6*	14.3	13.6	10.1*	13.7	11.6
Self-employed									
1: Manufacturing	3.0*	3.2	1.8	3.5*	4.2	2.8	4.0*	3.9	2.3
2: Services	7.6	2.6	0.2	8.5	3.1	0.3	11.9*	4.9	0.4
Capitalists	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Agriculture									
Laborers	14.6**	19.1**	29.1**	17.7**	20.5**	33.5**	15.2**	20.1**	34.1**
Farm size 1	18.1*	15.2*	23.9*	15.1*	6.8	11.4	12.5*	10.2	17.7
Farm size 2	15.3*	9.9	16.1	8.6	2.4	4.0	8.9	6.0	10.9
Farm size 3	2.0	0.6	1.3	2.2	0.6	1.4	0.8	0.3	0.8
Farm size 4	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
Percent <90,000 *won*	23.8%	12.8%	8.0%	19.8%	10.1%	4.7%	22.0%	12.2%	6.9%
Percent <120,000 *won*	38.3%	23.2%	14.5%	34.2%	19.4%	9.9%	35.9%	22.0%	12.4%
Mean incomes (000 *won*)									
Bottom decile	43.8	57.3	68.2	48.2	64.5	85.7	44.9	57.7	72.1
Next decile	71.5	96.0	121.5	78.6	105.7	142.3	74.3	98.3	131.9
Top decile	591.0	844.0	1,341.4	577.6	813.1	1,301.3	586.4	816.1	1,272.1
Overall	202.2	283.1	418.1	204.0	283.9	414.7	206.8	282.4	415.6

	A-3			A-4			A-5		
Wage earners									
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	0.9	0.8	0.2	1.0	0.9	0.3	0.9	1.3	0.3
Skilled workers	12.3*	7.1	0.5	15.3*	8.2	0.8	13.3*	15.0	0.8
Apprentices	0.3**	0.4	0.1	0.4**	0.5*	0.2	0.3**	0.6*	0.2
Unskilled workers	12.9*	16.3	11.7	14.8*	18.3	15.1	13.6*	23.0*	18.7
White-collar workers	4.5	2.8	0.4	5.0	3.1	0.6	4.7	5.2	0.8
Government workers	8.6*	10.9	9.0	10.1*	13.1	12.1	9.0*	14.4	9.3
Self-employed									
1: Manufacturing	3.0*	2.3	2.1	4.0*	2.9	2.7	3.3*	4.8	1.8
2: Services	7.6	2.1	0.1	11.9*	3.8	0.3	9.5	4.1	0.2
Capitalists	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Agriculture									
Laborers	14.6**	22.1**	29.4**	15.2**	24.9**	33.7**	12.4**	11.6*	12.6
Farm size 1	18.1*	20.3*	28.1*	12.5*	14.5	21.9	16.1*	11.0	23.2
Farm size 2	15.3*	14.0	17.1	8.9	9.1	11.6	14.7*	8.4	27.0
Farm size 3	2.0	1.1	1.3	0.8	0.6	0.7	2.1	0.5	5.1
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent <90,000 *won*	23.8%	11.5%	7.5%	22.0%	10.3%	6.4%	21.8%	11.0%	4.2%
Percent <120,000 *won*	38.3%	20.7%	13.6%	35.9%	18.7%	11.8%	36.9%	21.3%	9.8%
Mean incomes (000 *won*)									
Bottom decile	43.8	59.4	70.5	44.9	61.2	74.7	48.3	62.4	88.9
Next decile	71.5	101.3	126.0	74.3	106.8	135.0	76.0	101.7	142.7
Top decile	591.0	922.6	1,503.0	586.4	881.0	1,369.9	579.8	809.3	1,451.1
Overall	202.2	306.7	461.5	206.8	305.7	442.6	202.2	279.6	453.9

Table continues overleaf

TABLE F.2 (continued)

Rural Policy Experiments: Analysis of Poverty

(Percent composition of households with real incomes of less than 120,000 *won*)

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		A-6			A-7			A-8	
Wage earners									
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	1.0	1.3	0.3	0.9	1.2	0.9	1.0	1.4	0.7
Skilled workers	13.8*	16.1	0.8	12.3*	15.3	6.8	13.8*	19.1*	5.3
Apprentices	0.3**	0.6*	0.1	0.3**	0.6*	1.3	0.3**	0.6*	1.2
Unskilled workers	14.1*	22.6*	15.0	12.9*	24.5*	29.6	14.1*	27.2*	30.3
White-collar workers	4.9	5.5	0.7	4.5	4.9	2.2	4.9	6.1	2.1
Government workers	9.7*	14.3	8.2	8.6*	11.6	13.7	9.7*	13.4	14.1
Self-employed									
1: Manufacturing	3.4	4.5	1.6	3.0*	3.4	2.9	3.4*	4.5	3.0
2: Services	8.3	3.3	0.1	7.6	2.7	0.3	8.3	3.2	0.3
Capitalists	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Agriculture									
Laborers	14.7**	16.5*	30.6**	14.6**	16.2**	22.2*	14.7**	13.4*	23.7*
Farm size 1	15.6*	9.5	24.5*	18.1*	11.9	12.6	15.6*	7.1	12.3
Farm size 2	12.0*	5.3	15.9	15.3*	7.4	7.0	12.0*	3.7	6.5
Farm size 3	2.0	0.4	2.3	2.0	0.4	0.3	2.0	0.2	0.6
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent <90,000 *won*	21.6%	12.3%	7.1%	23.8%	13.9%	6.9%	21.6%	13.9%	5.7%
Percent <120,000 *won*	35.9%	22.5%	13.1%	38.3%	24.7%	13.4%	35.9%	24.6%	11.4%
Mean incomes (000 *won*)									
Bottom decile	46.8	58.8	72.2	43.8	55.3	73.6	46.8	54.9	79.2
Next decile	75.7	97.8	128.1	71.5	92.7	125.6	75.7	92.6	135.0
Top decile	584.3	819.5	1,424.2	591.0	837.2	1,201.5	584.3	820.3	1,243.6
Overall	205.2	281.3	440.7	202.2	278.0	387.0	205.2	277.1	404.3

	A-9			A-10		
Wage earners						
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	1.4	1.4	0.9	1.3	1.1	0.8
Skilled workers	21.0*	12.1	2.7	19.7**	9.6	2.2
Apprentices	0.4**	0.8	1.3	0.4**	0.6	0.9
Unskilled workers	18.4*	33.9*	43.7	17.1*	27.5	32.9
White-collar workers	6.8	5.1	1.4	6.5	4.2	1.3
Government workers	13.1*	22.5	36.8	12.2*	18.7	29.1
Self-employed						
1: Manufacturing	5.9**	5.2	5.4	5.3**	3.9	3.9
2: Services	16.9*	6.9	0.8	15.8*	5.7	0.6
Capitalists	0.2	0.0	0.0	0.2	0.0	0.0
Agriculture						
Laborers	13.4**	9.5	3.6	10.9*	13.4*	17.2
Farm size 1	1.6	1.1	0.6	6.1	7.9	4.4
Farm size 2	0.5	0.6	0.6	4.0	6.4	5.4
Farm size 3	0.5	1.0	2.1	0.5	1.0	1.4
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.0
Percent <90,000 *won*	21.6%	5.8%	1.6%	23.2%	6.9%	2.0%
Percent <120,000 *won*	33.8%	12.2%	3.8%	36.6%	14.4%	4.9%
Mean incomes (000 *won*)						
Bottom decile	44.6	77.9	121.1	43.3	74.1	111.5
Next decile	74.6	130.3	196.3	72.0	121.6	182.6
Top decile	554.7	836.6	1,420.7	586.7	871.3	1,405.4
Overall	211.2	316.4	487.1	208.1	315.4	485.0

NOTE: No asterisk, share represents less than $\frac{1}{3}$ of group population; single asterisk, share represents $\frac{1}{3}$ to $\frac{2}{3}$ of group population; double asterisk, share represents more than $\frac{2}{3}$ of group population.

TABLE F.3

Rural Policy Experiments: Composition by Groups of Top Decile of the Overall Distribution

(Percent)

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN			A-1		
Wage earners						
Engineers	2.5%	1.5%	1.1%	2.6%	1.6%	1.2%
Technicians	2.9	2.7	4.2	3.2	2.9	4.2
Skilled workers	0.8	0.5	1.0	1.0	0.5	0.9
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	3.3	3.1	3.0	3.6	3.1	2.7
White-collar workers	22.3	21.8	31.6	24.0	23.6	32.9
Government workers	9.4	6.5	7.4	10.2	7.2	7.8
Self-employed						
1: Manufacturing	2.9	2.4	6.7	2.9	2.4	6.5
2: Services	17.6	21.5	28.3	19.2	23.1	29.0
Capitalists	15.1	13.1	10.8	15.4	13.5	11.0
Agriculture						
Laborers	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.5	0.5	0.0	0.1	0.1	0.0
Farm size 2	1.6	1.6	0.1	0.8	0.9	0.0
Farm size 3	11.9	12.7	1.5	13.8	15.2	2.5
Farm size 4	9.2	12.1	4.3	3.2	5.9	1.3
	A-2			A-3		
Wage earners						
Engineers	2.2%	1.5%	1.2%	2.5%	1.8%	1.2%
Technicians	2.6	2.7	4.2	2.9	3.2	4.9
Skilled workers	0.4	0.4	1.2	0.8	1.2	1.3
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	2.4	3.0	3.2	3.3	4.5	3.6
White-collar workers	19.7	19.6	31.4	22.3	26.2	35.4
Government workers	7.3	5.8	7.1	9.4	7.1	5.9
Self-employed						
1: Manufacturing	1.6	2.2	6.9	2.9	3.7	6.0
2: Services	9.2	14.0	24.5	17.6	23.0	27.2
Capitalists	13.1	12.1	10.4	15.1	13.3	10.3
Agriculture						
Laborers	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	1.9	1.3	0.1	0.5	0.2	0.0
Farm size 2	5.3	3.9	0.4	1.6	0.6	0.0
Farm size 3	22.1	19.6	3.2	11.9	6.5	0.9
Farm size 4	12.2	13.9	6.2	9.2	8.7	3.3

TABLE F.3 (continued)
Rural Policy Experiments: Composition by Groups of Top Decile of the Overall Distribution

(Percent)

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		A-4			A-5	
Wage earners						
Engineers	2.2%	1.8%	1.3%	2.6%	1.4%	1.2%
Technicians	2.6	3.3	4.8	3.0	2.6	4.8
Skilled workers	0.4	1.1	1.5	0.8	0.4	1.6
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	2.4	4.5	3.8	3.3	2.9	3.5
White-collar workers	19.7	24.6	33.8	22.8	20.7	33.7
Government workers	7.3	6.6	5.9	9.6	5.9	8.8
Self-employed						
1: Manufacturing	1.6	3.5	6.3	2.7	1.8	7.0
2: Services	9.2	16.9	23.8	14.5	17.7	26.6
Capitalists	13.1	12.5	10.1	15.1	12.6	11.0
Agriculture						
Laborers	0.0	0.0	0.0	0.1	0.1	0.0
Farm size 1	1.9	0.6	0.0	1.0	1.4	0.1
Farm size 2	5.3	2.0	0.2	2.1	2.8	0.0
Farm size 3	22.1	11.6	2.6	12.8	16.2	0.3
Farm size 4	12.2	11.0	5.9	9.6	13.5	1.4
		A-6			A-7	
Wage earners						
Engineers	2.4%	1.2%	1.1%	2.5%	1.5%	0.9%
Technicians	2.9	2.4	4.9	2.9	2.4	3.3
Skilled workers	0.7	0.2	1.2	0.8	0.3	0.2
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	3.0	2.4	3.2	3.3	1.8	1.6
White-collar workers	21.2	18.4	31.7	22.3	20.0	26.7
Government workers	8.5	5.2	7.9	9.4	6.3	6.2
Self-employed						
1: Manufacturing	2.6	1.7	7.1	2.9	2.0	5.2
2: Services	17.0	19.4	28.7	17.6	20.4	26.1
Capitalists	14.8	12.5	10.9	15.1	13.1	10.6
Agriculture						
Laborers	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	1.1	1.5	0.0	0.5	0.6	0.2
Farm size 2	3.4	4.6	0.1	1.6	2.1	0.7
Farm size 3	12.8	16.9	0.7	11.9	16.1	7.6
Farm size 4	9.6	13.6	2.5	9.2	13.4	10.7

Table continues overleaf

TABLE F.3 (continued)
Rural Policy Experiments: Composition by Groups of Top Decile of the Overall Distribution
(Percent)

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	A-8			A-9		
Wage earners						
Engineers	2.4%	1.2%	1.0%	1.6%	2.1%	1.3%
Technicians	2.9	2.1	4.1	2.1	3.9	5.4
Skilled workers	0.7	0.1	0.3	0.1	1.4	1.1
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	3.0	1.3	2.0	1.4	4.3	4.4
White-collar workers	21.2	16.6	28.6	15.0	26.6	38.6
Government workers	8.5	5.1	6.9	5.1	6.4	5.8
Self-employed						
1: Manufacturing	2.6	1.4	5.7	0.6	4.0	6.2
2: Services	17.0	18.1	26.1	5.1	15.9	22.6
Capitalists	14.8	12.4	10.7	12.0	12.9	10.7
Agriculture						
Laborers	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	1.1	1.8	0.2	5.1	1.6	0.2
Farm size 2	3.4	5.5	0.9	16.0	3.7	0.2
Farm size 3	12.8	20.0	4.9	28.7	12.7	2.4
Farm size 4	9.6	14.4	8.6	7.2	4.5	1.1
	A-10					
Wage earners						
Engineers	1.5%	2.0%	1.3%			
Technicians	1.8	3.7	5.0			
Skilled workers	0.1	1.3	1.1			
Apprentices	0.0	0.0	0.0			
Unskilled workers	1.2	4.0	4.4			
White-collar workers	13.5	25.2	35.0			
Government workers	4.5	5.9	5.4			
Self-employed						
1: Manufacturing	0.6	4.1	6.2			
2: Services	4.4	14.9	21.6			
Capitalists	11.5	12.7	10.5			
Agriculture						
Laborers	0.1	0.1	0.1			
Farm size 1	6.5	2.6	1.8			
Farm size 2	13.5	4.1	1.6			
Farm size 3	27.3	9.8	2.6			
Farm size 4	13.5	9.6	3.4			

TABLE F.4

Rural Policy Experiments: Mean Group Incomes as a Percent of Basic-Run Values

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN[a]			A-1		
Wage earners						
Engineers	504	514	713	100%	101%	95%
Technicians	266	346	649	100	99	92
Skilled workers	143	185	337	99	98	92
Apprentices	102	139	275	99	99	93
Unskilled workers	146	185	280	99	97	91
White-collar workers	295	396	715	101	101	96
Government workers	203	242	369	101	101	97
Self-employed						
1: Manufacturing	198	258	571	97	98	94
2: Services	241	420	912	100	100	98
Capitalists	777	1,072	1,507	100	101	99
Agriculture						
Laborers	68	89	87	89	108	115
Farm size 1	116	166	162	114	114	121
Farm size 2	143	209	202	116	114	121
Farm size 3	258	379	351	101	101	108
Farm size 4	415	707	685	67	67	72
AVERAGE	202	283	418	101%	101%	98%
	A-2			A-3		
Wage earners						
Engineers	93%	99%	96%	100%	118%	113%
Technicians	97	99	93	100	119	117
Skilled workers	91	99	98	100	125	115
Apprentices	89	96	96	100	124	113
Unskilled workers	94	99	98	100	123	117
White-collar workers	97	95	95	100	120	117
Government workers	94	96	95	100	112	102
Self-employed						
1: Manufacturing	82	96	97	100	126	105
2: Services	80	82	87	100	113	111
Capitalists	85	90	93	100	111	105
Agriculture						
Laborers	107	98	98	100	92	105
Farm size 1	134	121	124	100	91	96
Farm size 2	134	119	121	100	91	101
Farm size 3	126	113	114	100	89	103
Farm size 4	121	109	111	100	89	105
AVERAGE	102%	100%	99%	100%	109%	109%

[a] Average real incomes of groups in thousands of *won*

Table continues overleaf

TABLE F.4 (continued)
Rural Policy Experiments: Mean Group Incomes as a Percent of Basic-Run Values

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	A-4			A-5		
Wage earners						
Engineers	93%	116%	108%	99%	96%	108%
Technicians	97	118	108	99	96	111
Skilled workers	91	122	109	97	96	114
Apprentices	89	119	105	96	95	112
Unskilled workers	94	122	111	98	95	111
White-collar workers	97	114	106	99	95	109
Government workers	94	108	95	99	95	113
Self-employed						
1: Manufacturing	82	121	99	94	88	110
2: Services	80	96	94	90	89	103
Capitalists	85	99	96	99	92	110
Agriculture						
Laborers	107	91	106	142	163	229
Farm size 1	134	112	115	113	119	122
Farm size 2	134	110	121	104	108	96
Farm size 3	126	103	117	100	104	82
Farm size 4	121	98	117	100	104	82
AVERAGE	102%	108%	105%	100%	100%	108%
	A-6			A-7		
Wage earners						
Engineers	95%	90%	101%	100%	98%	83%
Technicians	98	93	109	100	93	75
Skilled workers	97	91	107	100	91	73
Apprentices	97	92	108	100	92	72
Unskilled workers	97	92	107	100	84	75
White-collar workers	97	92	104	100	95	80
Government workers	96	92	107	100	99	86
Self-employed						
1: Manufacturing	95	88	109	100	95	79
2: Services	98	94	107	100	98	87
Capitalists	97	92	106	100	99	88
Agriculture						
Laborers	115	122	106	100	106	130
Farm size 1	117	123	105	100	106	131
Farm size 2	117	123	105	100	106	130
Farm size 3	102	107	93	100	106	133
Farm size 4	102	107	92	100	107	136
AVERAGE	101%	100%	105%	100%	98%	92%

TABLE F.4 (continued)
Rural Policy Experiments: Mean Group Incomes as a Percent of Basic-Run Values

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	A-8			A-9		
Wage earners						
Engineers	95%	88%	87%	79%	120%	111%
Technicians	98	87	86	86	120	114
Skilled workers	97	82	79	77	123	107
Apprentices	97	84	78	74	119	99
Unskilled workers	97	77	82	79	112	117
White-collar workers	97	87	86	85	112	114
Government workers	96	91	91	81	101	97
Self-employed						
1: Manufacturing	95	83	86	57	119	101
2: Services	98	92	91	65	89	95
Capitalists	97	91	92	77	99	104
Agriculture						
Laborers	115	130	139	150	189	292
Farm size 1	117	130	140	202	169	215
Farm size 2	117	131	139	198	149	177
Farm size 3	102	114	123	139	100	119
Farm size 4	102	114	125	92	65	78
AVERAGE	101%	98%	96%	104%	112%	115%
	A-10					
Wage earners						
Engineers	78%	121%	109%			
Technicians	85	122	111			
Skilled workers	76	126	106			
Apprentices	73	122	101			
Unskilled workers	79	115	119			
White-collar workers	83	114	109			
Government workers	81	102	96			
Self-employed						
1: Manufacturing	58	125	102			
2: Services	64	90	94			
Capitalists	76	100	103			
Agriculture						
Laborers	165	182	267			
Farm size 1	183	151	232			
Farm size 2	175	130	179			
Farm size 3	141	97	122			
Farm size 4	135	91	103			
AVERAGE	103%	112%	115%			

TABLE F.5

Rural Policy Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN			A-1		
National income accounts[a]						
Wages, nonagricultural	533	865	1,665	535	862	1,646
Self-employed	219	395	780	220	397	783
Agricultural income	350	598	576	356	610	622
Property income	186	253	315	187	254	319
National income	1,387	2,223	3,612	1,398	2,235	3,647
Gross domestic product accounts[a]						
Consumption	1,385	2,195	3,348	1,397	2,210	3,389
Investment	435	552	889	436	553	890
Exports[b]	211	583	1,503	211	586	1,517
Imports (−)[b]	417	651	1,460	419	654	1,478
GDP	1,615	2,679	4,280	1,625	2,694	4,317
Wholesale price index	99.7	148.2	203.9	99.5	148.1	204.1
Agricultural terms of trade	99.7	123.4	87.3	99.3	124.8	93.5
Exchange rate[c]	.277	.387	.438	.277	.387	.439
Production[d]						
Agriculture	581	788	1,081	594	795	1,084
Food, beverages, and tobacco	318	530	821	318	531	819
Shelter and transportation	685	1,185	1,867	687	1,188	1,878
Manufacturing	738	1,430	2,533	737	1,438	2,554
Services	550	926	1,576	551	930	1,591
TOTAL	2,871	4,859	7,877	2,887	4,882	7,925
Employment[e]						
Agriculture	4,639	4,823	5,286	4,644	4,780	5,198
Food, beverages, and tobacco	452	361	348	451	366	354
Shelter and transportation	687	799	700	688	803	708
Manufacturing	928	1,159	1,574	926	1,185	1,624
Services	1,894	2,332	2,785	1,896	2,340	2,812
TOTAL	8,600	9,475	10,694	8,605	9,474	10,695
Migration[e]	237	245		277	279	

TABLE F.5 (continued)
Rural Policy Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		A-2			A-3	
National income accounts[a]						
Wages, nonagricultural	518	840	1,610	533	974	1,862
Self-employed	177	328	691	219	416	798
Agricultural income	464	698	666	350	505	563
Property income	174	236	298	186	258	317
National income	1,415	2,204	3,544	1,387	2,271	3,801
Gross domestic product accounts[a]						
Consumption	1,414	2,179	3,284	1,385	2,229	3,426
Investment	411	547	878	435	579	880
Exports[b]	194	579	1,481	211	602	1,379
Imports (−)[b]	390	650	1,437	417	680	1,306
GDP	1,628	2,655	4,207	1,615	2,729	4,379
Wholesale price index	105.7	147.6	200.1	99.7	142.8	210.4
Agricultural terms of trade	104.1	121.2	84.2	99.7	95.0	73.0
Exchange rate[c]	.277	.387	.432	.277	.387	.402
Production[d]						
Agriculture	581	787	1,080	581	864	1,292
Food, beverages, and tobacco	310	517	801	318	566	883
Shelter and transportation	677	1,178	1,851	685	1,196	1,861
Manufacturing	741	1,422	2,493	738	1,431	2,560
Services	563	923	1,554	550	923	1,591
TOTAL	2,872	4,827	7,778	2,871	4,980	8,186
Employment[e]						
Agriculture	4,638	4,820	5.279	4,638	4,815	5,272
Food, beverages, and tobacco	417	349	349	452	383	357
Shelter and transportation	677	795	697	687	784	685
Manufacturing	927	1,174	1,599	928	1,159	1,556
Services	1,940	2,334	2,764	1,894	2,325	2,809
TOTAL	8,599	9,472	10,687	8,600	9,467	10,679
Migration[e]	237	245		237	245	

Table continues overleaf

TABLE F.5 (continued)
Rural Policy Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		A-4			A-5	
National income accounts[a]						
Wages, nonagricultural	518	947	1,768	534	841	1,751
Self-employed	177	357	706	222	393	813
Agricultural income	464	596	679	352	635	431
Property income	174	240	304	186	242	310
National income	1,415	2,253	3,721	1,390	2,223	3,590
Gross domestic product accounts[a]						
Consumption	1,414	2,212	3,374	1,387	2,185	3,357
Investment	411	577	879	437	572	962
Exports[b]	194	602	1,387	214	530	1,557
Imports (−)[b]	390	685	1,310	420	604	1,578
GDP	1,628	2,706	4,330	1,618	2,684	4,298
Wholesale price index	105.7	141.9	207.4	99.4	162.6	191.5
Agricultural terms of trade	104.1	92.9	74.6	100.3	131.3	67.9
Exchange rate[c]	.277	.387	.397	.277	.387	.447
Production[d]						
Agriculture	581	864	1,293	581	786	1,071
Food, beverages, and tobacco	310	554	852	317	514	824
Shelter and transportation	677	1,190	1,839	686	1,187	1,916
Manufacturing	741	1,422	2,526	741	1,431	2,566
Services	563	921	1,557	551	935	1,617
TOTAL	2,872	4,952	8,067	2,876	4,853	7,994
Employment[e]						
Agriculture	4,638	4,820	5,273	4,636	4,818	5,280
Food, beverages, and tobacco	417	372	353	445	323	343
Shelter and transportation	677	782	685	691	803	696
Manufacturing	927	1,169	1,590	928	1,175	1,587
Services	1,940	2,328	2,779	1,897	2,351	2,783
TOTAL	8,599	9,472	10,680	8,597	9,470	10,689
Migration[e]	237	245		237	245	

TABLE F.5 (continued)
Rural Policy Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		A-6			A-7	
National income accounts[a]						
Wages, nonagricultural	522	813	1,695	533	829	1,516
Self-employed	217	382	784	219	394	758
Agricultural income	359	663	499	350	635	790
Property income	183	243	308	186	256	321
National income	1,382	2,210	3,562	1,387	2,228	3,654
Gross domestic product accounts[a]						
Consumption	1,400	2,214	3,337	1,385	2,207	3,403
Investment	421	516	904	435	556	862
Exports[b]	201	537	1,512	211	597	1,486
Imports (−)[b]	401	600	1,505	417	664	1,431
GDP	1,621	2,667	4,247	1,615	2,695	4,319
Wholesale price index	103.2	160.1	194.4	99.7	146.7	215.0
Agricultural terms of trade	102.0	137.9	76.8	99.7	134.0	122.0
Exchange rate[c]	.277	.387	.440	.277	.387	.438
Production[d]						
Agriculture	581	786	1,073	581	774	1,038
Food, beverages, and tobacco	318	511	816	318	526	790
Shelter and transportation	680	1,160	1,884	685	1,197	1,875
Manufacturing	740	1,422	2,511	738	1,444	2,569
Services	552	930	1,598	550	941	1,604
TOTAL	2,871	4,809	7,883	2,871	4,881	7,876
Employment[e]						
Agriculture	4,642	4,824	5,277	4,639	4,643	4,848
Food, beverages, and tobacco	442	337	349	452	389	356
Shelter and transportation	682	780	694	687	820	726
Manufacturing	928	1,178	1,574	928	1,193	1,716
Services	1,910	2,357	2,791	1,894	2,373	2,872
TOTAL	8,603	9,476	10,685	8,600	9,417	10,519
Migration[e]	237	245		352	343	

Table continues overleaf

TABLE F.5 (continued)
Rural Policy Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		A-8			A-9	
National income accounts[a]						
Wages, nonagricultural	522	782	1,589	471	937	1,860
Self-employed	217	381	758	167	370	752
Agricultural income	359	698	704	535	564	611
Property income	183	247	315	172	237	314
National income	1,382	2,219	3,631	1,428	2,229	3,805
Gross domestic product accounts[a]						
Consumption	1,400	2,233	3,420	1,453	2,210	3,537
Investment	421	520	882	373	637	952
Exports[b]	201	548	1,466	177	559	1,508
Imports (−)[b]	401	614	1,455	352	704	1,555
GDP	1,621	2,687	4,312	1,650	2,702	4,442
Wholesale price index	103.2	158.0	209.8	116.6	143.2	183.0
Agricultural terms of trade	102.0	148.7	110.5	118.9	88.6	66.7
Exchange rate[c]	.277	.387	.434	.277	.387	.409
Production[d]						
Agriculture	581	772	1,032	593	856	1,260
Food, beverages, and tobacco	318	505	773	301	555	876
Shelter and transportation	680	1,177	1,880	662	1,217	1,928
Manufacturing	740	1,436	2,558	750	1,442	2,574
Services	552	946	1,612	572	933	1,634
TOTAL	2,871	4,837	7,856	2,878	5,002	8,272
Employment[e]						
Agriculture	4,642	4,645	4,841	4,639	4,643	4,849
Food, beverages, and tobacco	442	357	343	378	368	363
Shelter and transportation	682	801	716	657	808	722
Manufacturing	928	1,211	1,727	953	1,236	1,698
Services	1,910	2,406	2,885	1,974	2,362	2,886
TOTAL	8,603	9,420	10,511	8,601	9,416	10,518
Migration[e]	353	344		352	343	

TABLE F.5 (continued)
Rural Policy Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9
		A-10	
National income accounts[a]			
Wages, nonagricultural	466	945	1,816
Self-employed	165	372	742
Agricultural income	538	537	620
Property income	172	236	316
National income	1,423	2,213	3,765
Gross domestic product accounts[a]			
Consumption	1,444	2,187	3,511
Investment	372	644	959
Exports[b]	177	561	1,527
Imports (−)[b]	352	710	1,568
GDP	1,642	2,682	4,429
Wholesale price index	116.6	141.6	180.6
Agricultural terms of trade	122.6	85.8	66.8
Exchange rate[c]	.277	.387	.408
Production[d]			
Agriculture	581	842	1,255
Food, beverages, and tobacco	298	557	861
Shelter and transportation	661	1,217	1,926
Manufacturing	748	1,440	2,572
Services	573	929	1,629
TOTAL	2,861	4,986	8,243
Employment[e]			
Agriculture	4,641	4,637	4,936
Food, beverages, and tobacco	377	375	354
Shelter and transportation	659	811	729
Manufacturing	948	1,229	1,710
Services	1,977	2,359	2,877
TOTAL	8,602	9,411	10,607
Migration[e]	352	348	

[a] Real values in billions of *won*, 1968 prices
[b] In billions of *won*, valued at world prices
[c] At 1,000 *won* to the dollar
[d] Real gross production in billions of *won*, 1968 prices
[e] By thousands of workers

TABLE F.6

Urban Policy Experiments: Decile Distribution of Real Household Income

(Percent)

Decile	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN			B-1		
1	2.22%	2.07%	1.68%	2.23%	2.12%	1.67%
2	3.62	3.47	2.99	3.67	3.55	2.99
3	4.67	4.52	4.06	4.74	4.62	4.09
4	5.71	5.56	5.16	5.80	5.68	5.22
5	6.86	6.72	6.36	6.96	6.84	6.47
6	8.21	8.10	7.78	8.31	8.21	7.93
7	9.94	9.88	9.61	10.02	9.96	9.77
8	12.38	12.42	12.29	12.41	12.44	12.41
9	16.46	16.73	17.06	16.38	16.62	17.00
10	29.92	30.52	33.01	29.48	29.98	32.45
Gini coefficient	.398	.409	.444	.393	.402	.439
	B-2			B-3		
1	2.22%	2.11%	1.60%	2.23%	2.11%	1.94%
2	3.62	3.52	2.88	3.67	3.51	3.36
3	4.67	4.57	3.96	4.74	4.56	4.45
4	5.71	5.62	5.10	5.80	5.61	5.52
5	6.86	6.78	6.37	6.95	6.76	6.68
6	8.21	8.15	7.85	8.31	8.13	8.05
7	9.94	9.91	9.74	10.02	9.90	9.80
8	12.38	12.42	12.43	12.41	12.41	12.32
9	16.46	16.65	17.12	16.38	16.68	16.72
10	29.92	30.27	32.97	29.49	30.33	31.17
Gini coefficient	.398	.406	.447	.393	.406	.417
	B-4			B-5		
1	2.22%	2.08%	1.71%	2.19%	2.01%	1.93%
2	3.63	3.47	3.02	3.66	3.38	3.29
3	4.68	4.52	4.08	4.75	4.42	4.32
4	5.72	5.56	5.16	5.83	5.47	5.34
5	6.87	6.72	6.35	7.01	6.62	6.48
6	8.23	8.11	7.75	8.38	8.01	7.87
7	9.96	9.90	9.58	10.10	9.81	9.69
8	12.40	12.45	12.27	12.51	12.40	12.36
9	16.48	16.77	17.08	16.51	16.82	17.00
10	29.83	30.43	33.00	29.05	31.06	31.72
Gini coefficient	.398	.409	.443	.391	.417	.426

TABLE F.6 (continued)

Urban Policy Experiments: Decile Distribution of Real Household Income

(Percent)

Decile	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		B-6			B-7	
1	2.23%	2.05%	2.06%	2.21%	2.13%	1.57%
2	3.64	3.44	3.49	3.68	3.62	2.89
3	4.69	4.42	4.54	4.80	4.74	4.05
4	5.73	5.51	5.58	5.91	5.86	5.26
5	6.88	6.67	6.73	7.12	7.06	6.60
6	8.23	8.06	8.09	8.51	8.44	8.14
7	9.95	9.87	9.85	10.24	10.17	10.03
8	12.38	12.46	12.38	12.59	12.55	12.64
9	16.44	16.85	16.73	16.40	16.46	17.06
10	29.84	30.63	30.54	28.55	28.98	31.76
Gini coefficient	.397	.412	.409	.386	.391	.437
		B-8			B-9	
1	2.18%	1.98%	1.06%	2.17%	2.06%	2.01%
2	3.58	3.38	2.04	3.68	3.53	3.46
3	4.65	4.48	3.07	4.85	4.68	4.57
4	5.72	5.60	4.37	6.00	5.81	5.66
5	6.90	6.82	5.94	7.25	7.04	6.83
6	8.27	8.24	7.76	8.68	8.45	8.20
7	9.99	10.02	9.96	10.44	10.21	9.93
8	12.39	12.50	12.96	12.80	12.61	12.38
9	16.40	16.64	18.04	16.54	16.57	16.60
10	29.93	30.35	34.80	27.58	29.04	30.34
Gini coefficient	.399	.410	.492	.379	.395	.407
		B-10			B-11	
1	2.17%	1.99%	1.74%	2.16%	2.06%	1.96%
2	2.58	3.37	3.04	3.68	3.55	3.42
3	4.65	4.42	4.09	4.85	.471	4.58
4	5.71	5.47	5.15	6.02	5.88	5.74
5	6.87	6.63	6.31	7.29	7.13	6.98
6	8.24	8.02	7.70	8.74	8.57	8.40
7	9.98	9.82	9.51	10.51	10.34	10.16
8	12.46	12.43	12.22	12.87	12.73	12.57
9	16.62	16.91	17.18	16.58	16.58	16.56
10	29.72	30.94	33.06	27.29	28.45	29.63
Gini coefficient	.399	.417	.443	.377	.390	.402

TABLE F.7

Urban Policy Experiments: Analysis of Poverty

(Percent composition of households with real incomes of less than 120,000 *won*)

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN			B-1			B-2		
Wage earners									
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	0.9	1.1	0.4	0.9	1.3	0.5	0.9	1.1	0.3
Skilled workers	12.3*	12.2	1.3	10.2*	10.1	0.7	12.3*	11.4	0.7
Apprentices	0.3**	0.5*	0.2	0.3*	0.5*	0.1	0.3**	0.4*	0.1
Unskilled workers	12.9*	19.4*	16.1	11.7*	18.3*	13.8	12.9*	18.3*	11.7
White-collar workers	4.5	4.2	0.8	4.8	5.0	0.9	4.5	5.3	7.6
Government workers	8.6*	11.9	8.9	9.1*	13.3	8.9	8.6*	12.1	1.0
Self-employed									
1: Manufacturing	3.0*	3.2	1.8	3.2*	3.9	1.9	3.0*	3.2	1.5
2: Services	7.6	2.6	0.2	8.2	3.1	0.2	7.6	2.6	0.2
Capitalists	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Agriculture									
Laborers	14.6**	19.1**	29.1**	15.2**	19.7**	30.2**	14.6**	18.3**	27.6**
Farm size 1	18.1*	15.2*	23.9*	18.7*	14.9	24.7*	18.1*	16.0*	27.6*
Farm size 2	15.3*	9.9	16.1	15.7*	9.4	16.6	15.3*	10.5	19.8
Farm size 3	2.0	0.6	1.3	2.1	0.5	1.4	2.0	0.6	2.2
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent <90,000 *won*	23.8%	12.8%	8.0%	22.9%	12.2%	7.9%	23.8%	12.3%	8.6%
Percent <120,000 *won*	38.3%	23.2%	14.5%	37.1%	22.2%	14.1%	38.3%	22.5%	15.2%
Mean incomes (000 *won*)									
Bottom decile	43.8	57.3	68.2	44.5	58.8	68.8	43.8	58.5	65.8
Next decile	71.5	96.0	121.5	73.0	98.3	123.1	71.5	97.8	118.6
Top decile	591.0	844.0	1,341.4	586.5	830.0	1,335.5	591.0	840.6	1,359.5
Overall	202.2	283.1	418.1	203.5	283.0	423.1	202.2	284.2	424.4

	B-3			B-4			B-5		
Wage earners									
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	0.9	1.3	0.8	0.9	1.1	0.4	0.8	0.9	0.9
Skilled workers	10.3*	12.3	2.4	12.3*	12.9	1.5	9.3	10.8	7.8
Apprentices	0.3*	0.4*	0.6	0.3**	0.5*	0.2	0.3*	0.5*	0.5
Unskilled workers	11.7*	22.3*	21.2	12.8*	19.5*	16.3	12.7*	17.0*	29.2*
White-collar workers	4.8	6.4	2.4	4.5	4.2	0.8	3.5	2.8	1.9
Government workers	9.0*	12.8*	13.1	8.6*	12.2	9.6	11.8*	13.7	19.3
Self-employed									
1: Manufacturing	3.2*	4.1	2.9	2.9*	3.0	1.7	3.4*	2.2	2.6
2: Services	8.2	3.2	0.3	7.6	2.7	0.2	8.9	1.9	0.2
Capitalists	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Agriculture									
Laborers	15.0**	16.9**	27.3**	14.6**	18.9**	29.1**	16.2**	20.3**	21.7*
Farm size 1	18.7*	12.6	17.9	18.2*	14.9*	23.5*	17.6*	17.5*	10.2
Farm size 2	15.7*	7.4	10.5	15.3*	9.6	15.5	13.9*	11.6	5.4
Farm size 3	2.1	0.3	0.6	2.0	0.5	1.2	1.5	0.8	0.2
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent <90,000 *won*	22.9%	13.6%	6.4%	23.8%	12.8%	7.6%	20.9%	12.6%	7.3%
Percent <120,000 *won*	37.1%	23.6%	12.4%	38.3%	23.1%	13.9%	34.3%	22.5%	14.2%
Mean incomes (000 *won*)									
Bottom decile	44.5	57.1	75.7	43.8	57.5	70.1	45.5	57.6	71.7
Next decile	72.9	95.2	131.0	71.5	96.2	124.2	76.1	97.1	122.6
Top decile	586.5	821.4	1,216.2	588.5	843.5	1,356.3	604.4	891.7	1,179.9
Overall	203.4	276.9	400.1	201.9	283.6	422.9	212.4	294.2	381.1

Table continues overleaf

TABLE F.7 (continued)

Urban Policy Experiments: Analysis of Poverty

(Percent composition of households with real incomes of less than 120,000 *won*)

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		B-6			B-7			B-8	
Wage earners									
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	0.9	1.1	0.7	1.0	1.1	0.3	0.7	0.6	0.2
Skilled workers	11.9	15.0	5.4	6.1	5.0	0.3	9.2*	4.8	0.1
Apprentices	0.3**	0.6*	1.2	0.2*	0.7	0.2	0.2**	0.3	0.0
Unskilled workers	12.7*	24.9*	27.7	10.5*	15.1	8.2	11.8*	15.1*	5.9
White-collar workers	4.5*	4.4	1.9	5.0	5.0	0.5	4.1	3.2	0.3
Government workers	8.5*	11.4	12.4	10.2*	14.7	9.0	7.9*	10.2	4.5
Self-employed									
1: Manufacturing	3.1*	3.8	2.3	3.6*	2.9	1.4	3.0*	3.1	1.6
2: Services	7.8*	2.7	0.3	8.0	2.8	0.1	7.5	3.3	0.2
Capitalists	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Agriculture									
Laborers	14.6**	16.2**	24.6**	15.9**	21.4**	29.3**	13.7**	18.5**	21.7**
Farm size 1	18.3*	12.1	14.7	20.0*	18.0*	28.0*	19.8**	21.7*	28.9**
Farm size 2	15.4*	7.2	8.4	17.0*	12.4	20.2	18.1*	17.0*	27.6**
Farm size 3	2.1	0.3*	0.4	2.4	0.9	2.5	3.8	2.3	9.3
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
Percent <90,000 *won*	23.7%	13.9%	6.7%	22.1%	11.3%	7.7%	27.2%	15.2%	17.2%
Percent <120,000 *won*	38.2%	24.7%	13.0%	35.6%	20.4%	13.5%	41.9%	25.7%	24.4%
Mean incomes (000 *won*)									
Bottom decile	43.9	55.2	74.3	44.4	60.1	68.9	40.1	52.1	42.4
Next decile	71.7	92.7	127.4	73.7	102.1	126.7	65.8	88.8	81.3
Top decile	588.1	841.5	1,222.7	572.1	818.3	1,391.8	550.7	797.7	1,388.5
Overall	201.8	278.7	393.8	204.5	288.3	449.7	188.5	269.2	411.4

	B-9			B-10			B-11		
Wage earners									
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	1.0	0.9	0.9	0.9	1.1	0.7	1.1	1.0	0.9
Skilled workers	3.8	3.9	2.3	10.7*	9.6	1.6	2.8	2.3	0.7
Apprentices	0.2*	0.6	1.0	0.3**	0.5*	0.2	0.2	0.4	0.4
Unskilled workers	10.7*	13.9	20.3	12.3*	17.1*	18.1	9.5	11.2	13.1
White-collar workers	4.2	4.0	1.0	1.9	1.6	0.3	4.6	5.7	1.6
Government workers	13.9*	17.9*	22.8	10.4*	14.3	15.3	14.9*	19.6*	21.9
Self-employed									
1: Manufacturing	4.2	2.2	2.1	3.0*	2.2	2.2	4.7*	2.6	1.9
2: Services	9.4	2.2	0.2	8.1	2.1	0.2	10.2	2.5	0.2
Capitalists	0.2	0.0	0.0	0.2	0.1	0.1	0.2	0.1	0.0
Agriculture									
Laborers	17.3**	21.4**	27.3**	14.9**	19.4**	26.0*	17.8**	22.0**	30.5**
Farm size 1	18.8*	19.2*	13.9	18.9*	18.1*	20.9*	18.6*	19.3*	18.1
Farm size 2	14.7*	12.8	7.9	16.1*	13.0	13.6	14.2*	12.6	10.2
Farm size 3	1.5	1.0	0.3	2.3	1.1	1.0	1.4	1.0	0.5
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent <90,000 *won*	19.8%	11.7%	5.5%	23.8%	13.8%	8.6%	19.4%	11.3%	5.4%
Percent <120,000 *won*	32.2%	20.8%	11.0%	38.0%	24.2%	15.7%	31.6%	20.1%	10.5%
Mean incomes (000 *won*)									
Bottom decile	45.8	58.6	80.2	43.1	55.0	66.8	46.0	59.4	81.1
Next decile	77.7	100.7	138.2	71.2	93.0	116.6	78.4	102.3	141.7
Top decile	581.8	828.0	1,210.5	590.6	853.4	1,267.6	581.7	820.5	1,226.9
Overall	214.4	290.9	408.2	203.0	282.4	393.9	216.5	293.9	423.3

NOTE: No asterisk, share represents less than $\frac{1}{3}$ of group population; single asterisk, share represents $\frac{1}{3}$ to $\frac{2}{3}$ of group population; double asterisk, share represents more than $\frac{2}{3}$ of group population.

TABLE F.8

Urban Policy Experiments: Composition by Groups of Top Decile of the Overall Distribution

(Percent)

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN			B-1		
Wage earners						
Engineers	2.5%	1.5%	1.1%	2.5%	1.4%	1.1%
Technicians	2.9	2.7	4.2	2.9	2.3	3.4
Skilled workers	0.8	0.5	1.0	1.5	0.9	2.1
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	3.3	3.1	3.0	4.6	4.0	4.0
White-collar workers	22.3	21.8	31.6	21.5	20.1	31.1
Government workers	9.4	6.5	7.4	9.0	5.9	7.2
Self-employed						
1: Manufacturing	2.9	2.4	6.7	2.8	2.1	6.8
2: Services	17.6	21.5	28.3	16.8	20.2	27.7
Capitalists	15.1	13.1	10.8	15.0	12.9	10.9
Agriculture						
Laborers	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.5	0.5	0.0	0.5	0.6	0.0
Farm size 2	1.6	1.6	0.1	1.6	1.9	0.1
Farm size 3	11.9	12.7	1.5	12.1	14.8	1.4
Farm size 4	9.2	12.1	4.3	9.2	12.9	4.2
	B-2			B-3		
Wage earners						
Engineers	2.5%	1.6%	1.2%	2.5%	1.4%	1.1%
Technicians	2.9	2.8	4.5	2.9	2.2	3.2
Skilled workers	0.8	0.6	2.0	1.5	0.5	1.1
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	3.3	3.8	4.3	4.6	2.7	3.4
White-collar workers	22.3	19.8	27.9	21.5	17.4	26.2
Government workers	9.4	6.8	8.3	9.0	5.9	6.8
Self-employed						
1: Manufacturing	2.9	2.6	7.6	2.8	1.8	5.9
2: Services	17.6	22.0	29.2	16.8	19.3	26.6
Capitalists	15.1	13.3	11.2	15.0	12.9	10.7
Agriculture						
Laborers	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.5	0.4	0.0	0.5	0.7	0.1
Farm size 2	1.6	1.6	0.0	1.6	2.5	0.4
Farm size 3	11.9	12.6	0.8	12.1	18.2	5.3
Farm size 4	9.2	12.1	3.0	9.2	14.5	9.2

TABLE F.8 (continued)
Urban Policy Experiments: Composition by Groups of Top Decile of the Overall Distribution
(Percent)

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		B-4			B-5	
Wage earners						
Engineers	2.5%	1.5%	1.0%	2.2%	1.7%	0.8%
Technicians	3.0	2.6	4.0	3.2	3.1	3.2
Skilled workers	0.8	0.4	0.8	1.6	0.5	0.2
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	3.3	3.1	3.1	3.7	3.9	1.6
White-collar workers	22.3	21.9	32.0	25.3	26.6	20.7
Government workers	9.4	6.3	6.9	5.7	4.9	3.8
Self-employed						
1: Manufacturing	3.2	2.8	7.9	3.5	2.8	4.3
2: Services	17.5	21.2	27.7	14.5	23.7	28.3
Capitalists	14.8	12.7	10.4	12.9	12.9	10.2
Agriculture						
Laborers	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.5	0.5	0.0	0.7	0.2	0.4
Farm size 2	1.6	1.6	0.1	2.1	0.9	1.4
Farm size 3	11.9	13.1	1.6	14.2	8.6	11.9
Farm size 4	9.2	12.3	4.5	10.4	10.2	13.2
		B-6			B-7	
Wage earners						
Engineers	2.6%	1.5%	1.0%	2.3%	1.5%	1.0%
Technicians	3.1	2.6	3.7	2.8	2.7	4.3
Skilled workers	0.9	0.2	0.3	4.9	4.1	4.7
Apprentices	0.0	0.0	0.0	0.0	0.0	0.1
Unskilled workers	3.4	1.7	2.0	6.2	5.9	5.4
White-collar workers	22.6	20.8	27.2	20.5	19.4	28.9
Government workers	9.6	6.0	6.7	7.8	5.7	6.7
Self-employed						
1: Manufacturing	2.5	1.1	4.1	1.6	2.4	6.8
2: Services	17.3	20.1	27.6	18.3	23.0	28.7
Capitalists	15.0	12.7	10.5	13.9	12.4	9.7
Agriculture						
Laborers	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.5	0.6	0.1	0.4	0.3	0.0
Farm size 2	1.6	2.2	0.6	1.4	1.2	0.0
Farm size 3	11.8	16.5	6.3	11.1	10.4	0.8
Farm size 4	9.1	14.0	9.9	8.8	11.0	2.9

Table continues overleaf

TABLE F.8 (continued)
Urban Policy Experiments: Composition by Groups of Top Decile of the Overall Distribution
(Percent)

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	B-8			B-9		
Wage earners						
Engineer	3.0%	2.5%	1.4%	1.9%	1.7%	0.7%
Technician	4.1	4.3	4.8	2.9	3.3	3.6
Skilled workers	2.2	3.5	3.9	7.9	5.4	1.8
Apprentice	0.0	0.0	0.1	0.0	0.0	0.0
Unskilled workers	3.7	4.3	3.8	6.0	6.6	3.6
White-collar workers	23.6	25.6	36.0	21.4	19.8	23.8
Government workers	10.9	8.0	7.9	4.4	3.7	3.8
Self-employed						
1: Manufacturing	2.7	4.0	7.6	1.8	1.8	3.4
2: Services	19.4	21.3	24.0	14.7	25.6	30.7
Capitalist	15.1	13.5	10.4	11.0	11.7	9.1
Agriculture						
Laborers	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.3	0.1	0.0	0.7	0.2	0.2
Farm size 2	0.9	0.4	0.0	2.2	1.0	0.8
Farm size 3	7.4	4.8	0.0	14.5	8.8	7.9
Farm size 4	6.7	7.7	0.1	10.6	10.4	10.6
	B-10			B-11		
Wage earners						
Engineers	2.0%	1.4%	0.8%	1.7%	1.7%	0.9%
Technicians	2.9	2.8	3.3	2.6	2.9	3.3
Skilled workers	0.9	0.5	0.6	10.3	8.9	5.5
Apprentices	0.0	0.0	0.0	0.0	0.1	0.1
Unskilled workers	3.5	3.4	2.2	7.4	8.9	6.4
White-collar workers	32.4	32.0	39.1	19.5	15.5	19.6
Government workers	8.4	5.5	4.6	3.8	3.1	3.9
Self-employed						
1: Manufacturing	3.4	3.5	6.5	1.5	1.9	4.0
2: Services	15.7	22.6	27.4	13.2	24.3	31.1
Capitalists	11.0	10.5	7.2	10.5	11.4	9.3
Agriculture						
Laborers	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.4	0.2	0.0	0.7	0.3	0.1
Farm size 2	1.3	0.8	0.2	2.4	1.1	0.5
Farm size 3	9.9	7.5	2.3	15.4	9.3	5.9
Farm size 4	8.2	9.3	5.8	11.0	10.7	9.4

TABLE F.9

Urban Policy Experiments: Mean Group Incomes as a Percent of Basic-Run Values

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN[a]			B-1		
Wage earners						
Engineers	504	514	713	98%	96%	97%
Technicians	266	346	649	98	92	86
Skilled workers	143	185	337	110	110	110
Apprentices	102	139	275	110	110	110
Unskilled workers	146	185	280	111	109	108
White-collar workers	295	396	715	98	96	97
Government workers	203	242	369	98	97	99
Self-employed						
1: Manufacturing	198	258	571	97	95	99
2: Services	241	420	912	98	96	97
Capitalists	777	1,072	1,507	99	97	101
Agriculture						
Laborers	68	89	87	100	102	100
Farm size 1	116	166	162	100	103	100
Farm size 2	143	209	202	100	103	100
Farm size 3	258	379	351	100	103	100
Farm size 4	415	707	685	100	103	100
AVERAGE	202	283	418	101%	100%	100%
	B-2			B-3		
Wage earners						
Engineers	100%	105%	106%	98%	96%	91%
Technicians	100	101	101	98	89	77
Skilled workers	100	105	111	110	100	91
Apprentices	100	104	109	110	101	89
Unskilled workers	100	107	112	110	94	94
White-collar workers	100	95	91	98	87	80
Government workers	100	102	104	98	95	90
Self-employed						
1: Manufacturing	100	104	108	97	89	86
2: Services	100	102	103	98	93	88
Capitalists	100	101	104	99	96	91
Agriculture						
Laborers	100	99	93	100	108	120
Farm size 1	100	99	92	100	106	119
Farm size 2	100	99	92	100	108	120
Farm size 3	100	98	91	100	108	122
Farm size 4	100	98	92	100	112	125
AVERAGE	100%	101%	101%	100%	98%	95%

[a] Average real incomes of groups in thousands of *won*

Table continues overleaf

TABLE F.9 (continued)
Urban Policy Experiments: Mean Group Incomes as a Percent of Basic-Run Values

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		B-4			B-5	
Wage earners						
Engineers	100%	99%	94%	95%	109%	75%
Technicians	100	98	94	108	111	74
Skilled workers	100	99	96	118	107	69
Apprentices	100	100	98	116	108	72
Unskilled workers	100	101	101	110	114	73
White-collar workers	100	102	100	112	118	72
Government workers	100	100	98	87	95	72
Self-employed						
1: Manufacturing	103	107	111	109	114	73
2: Services	100	100	100	97	113	94
Capitalists	97	97	96	86	103	84
Agriculture						
Laborers	100	101	103	102	95	140
Farm size 1	100	101	104	111	94	144
Farm size 2	100	101	104	112	95	143
Farm size 3	100	101	104	111	93	148
Farm size 4	100	100	104	112	93	152
AVERAGE	100%	100%	100%	105%	104%	90%
		B-6			B-7	
Wage earners						
Engineers	100%	99%	84%	92%	98%	97%
Technicians	101	98	82	96	100	102
Skilled workers	101	91	78	138	142	132
Apprentices	101	92	76	129	136	121
Unskilled workers	101	83	80	122	126	131
White-collar workers	100	98	84	96	95	100
Government workers	101	98	90	93	95	102
Self-employed						
1: Manufacturing	95	84	74	84	104	108
2: Services	98	97	92	101	103	110
Capitalists	99	96	90	89	92	94
Agriculture						
Laborers	100	107	125	96	95	93
Farm size 1	100	105	126	98	95	92
Farm size 2	100	107	126	98	94	91
Farm size 3	99	107	128	98	93	90
Farm size 4	99	111	131	98	92	88
AVERAGE	100%	99%	93%	101%	102%	107%

TABLE F.9 (continued)
Urban Policy Experiments: Mean Group Incomes as a Percent of Basic-Run Values

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		B-8			B-9	
Wage earners						
Engineers	106%	124%	112%	88%	104%	75%
Technicians	109	119	107	104	110	80
Skilled workers	110	133	128	163	152	97
Apprentices	108	129	126	151	144	92
Unskilled workers	98	109	115	128	132	99
White-collar workers	95	103	108	103	98	81
Government workers	99	103	105	80	84	74
Self-employed						
1: Manufacturing	90	110	111	86	104	72
2: Services	96	92	90	97	111	104
Capitalists	93	97	96	72	87	77
Agriculture						
Laborers	90	81	61	101	92	133
Farm size 1	84	74	54	111	91	137
Farm size 2	84	74	54	112	92	135
Farm size 3	81	72	53	112	90	136
Farm size 4	81	72	50	114	90	136
AVERAGE	93%	95%	98%	106%	103%	97%
		B-10			B-11	
Wage earners						
Engineers	92%	101%	83%	84%	105%	85%
Technicians	100	102	80	100	105	80
Skilled workers	106	107	80	176	173	121
Apprentices	107	109	91	163	163	113
Unskilled workers	105	107	88	139	150	123
White-collar workers	133	134	113	100	88	75
Government workers	94	93	79	77	81	77
Self-employed						
1: Manufacturing	107	118	93	80	103	77
2: Services	97	106	95	94	108	105
Capitalists	70	78	63	70	85	79
Agriculture						
Laborers	96	90	105	102	94	126
Farm size 1	97	89	104	114	93	127
Farm size 2	97	88	104	115	94	127
Farm size 3	97	87	105	115	92	129
Farm size 4	97	86	107	117	92	130
AVERAGE	100%	100%	93%	107%	104%	100%

TABLE F.10

Urban Policy Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN			B-1		
National income accounts[a]						
Wages, nonagricultural	533	865	1,665	530	839	1,658
Self-employed	219	395	780	219	390	784
Agricultural income	350	598	576	351	630	578
Property income	186	253	315	187	252	321
National income	1,387	2,223	3,612	1,390	2,223	3,638
Gross domestic product accounts[a]						
Consumption	1,385	2,195	3,348	1,391	2,211	3,391
Investment	435	552	889	433	538	909
Exports[b]	211	583	1,503	209	568	1,544
Imports (−)[b]	417	651	1,460	415	631	1,515
GDP	1,615	2,679	4,280	1,618	2,685	4,329
Wholesale price index	99.7	148.2	203.9	100.3	153.1	200.7
Agricultural terms of trade	99.7	123.4	87.3	100.0	130.0	87.6
Exchange rate[c]	.277	.387	.438	.277	.387	.439
Production[d]						
Agriculture	581	788	1,081	581	788	1,079
Food, beverages, and tobacco	318	530	821	320	531	831
Shelter and transportation	685	1,185	1,867	687	1,182	1,893
Manufacturing	738	1,430	2,533	740	1,437	2,574
Services	550	926	1,576	549	925	1,571
TOTAL	2,871	4,859	7,877	2,877	4,863	7,948
Employment[e]						
Agriculture	4,639	4,823	5,286	4,643	4,826	5,292
Food, beverages, and tobacco	452	361	348	454	363	357
Shelter and transportation	687	799	700	686	792	706
Manufacturing	928	1,159	1,574	928	1,171	1,594
Services	1,894	2,332	2,785	1,893	2,326	2,753
TOTAL	8,600	9,475	10,694	8,604	9,478	10,702
Migration[e]	237	245		238	246	

TABLE F.10 (continued)
Urban Policy Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		B-2			B-3	
National income accounts[a]						
Wages, nonagricultural	533	859	1,648	529	797	1,528
Self-employed	219	394	777	220	386	757
Agricultural income	350	589	508	351	669	728
Property income	186	253	313	187	254	319
National income	1,387	2,207	3,528	1,390	2,221	3,617
Gross domestic product accounts[a]						
Consumption	1,385	2,181	3,279	1,390	2,214	3,373
Investment	435	553	900	433	541	872
Exports[b]	211	587	1,540	210	582	1,497
Imports (−)[b]	417	651	1,482	415	642	1,440
GDP	1,615	2,669	4,237	1,618	2,695	4,302
Wholesale price index	99.7	147.6	202.0	100.3	151.3	214.0
Agricultural terms of trade	99.7	122.0	77.4	100.0	141.0	110.9
Exchange rate[c]	.277	.387	.444	.277	.387	.443
Production[d]						
Agriculture	581	785	1,077	581	777	1,054
Food, beverages, and tobacco	318	530	816	321	522	801
Shelter and transportation	685	1,184	1,853	686	1,190	1,880
Manufacturing	738	1,429	2,535	740	1,445	2,575
Services	550	921	1,534	549	936	1,574
TOTAL	2,871	4,849	7,816	2,877	4,870	7,884
Employment[e]						
Agriculture	4,639	4,782	5,248	4,638	4,698	5,023
Food, beverages, and tobacco	452	355	337	454	378	354
Shelter and transportation	687	798	693	684	809	710
Manufacturing	928	1,144	1,527	927	1,191	1,675
Services	1,894	2,312	2,707	1,896	2,354	2,786
TOTAL	8,600	9,392	10,511	8,599	9,430	10,548
Migration[e]	237	243		352	350	

Table continues overleaf

TABLE F.10 (continued)

Urban Policy Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		B-4			B-5	
National income accounts[a]						
Wages, nonagricultural	534	869	1,692	598	934	1,391
Self-employed	221	403	819	223	433	835
Agricultural income	350	610	602	400	554	1,001
Property income	182	247	309	172	253	340
National income	1,386	2,240	3,692	1,497	2,282	3,830
Gross domestic product accounts[a]						
Consumption	1,384	2,211	3,425	1,445	2,246	3,608
Investment	436	558	892	353	618	946
Exports[b]	211	581	1,510	181	639	1,544
Imports (−)[b]	417	657	1,486	326	774	1,589
GDP	1,614	2,693	4,341	1,652	2,729	4,508
Wholesale price index	99.6	148.7	203.4	124.3	134.6	190.6
Agricultural terms of trade	99.7	126.1	91.1	113.6	115.6	146.4
Exchange rate[c]	.277	.387	.439	.277	.387	.398
Production[d]						
Agriculture	581	788	1,079	580	781	1,090
Food, beverages, and tobacco	318	530	821	331	561	815
Shelter and transportation	684	1,191	1,890	650	1,251	1,998
Manufacturing	737	1,439	2,566	757	1,494	2,602
Services	550	932	1,602	567	957	1,682
TOTAL	2,870	4,880	7,957	2,885	5,044	8,187
Employment[e]						
Agriculture	4,639	4,820	5,273	4,640	4,823	5,282
Food, beverages, and tobacco	452	356	373	432	395	328
Shelter and transportation	688	802	694	621	806	765
Manufacturing	928	1,152	1,538	982	1,104	1,478
Services	1,894	2,342	2,803	1,927	2,346	2,832
TOTAL	8,601	9,472	10,681	8,602	9,475	10,686
Migration[e]	237	245		237	246	

TABLE F.10 (continued)
Urban Policy Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		B-6			B-7	
National income accounts[a]						
Wages, nonagricultural	546	862	1,678	584	954	1,939
Self-employed	220	399	791	208	386	823
Agricultural income	350	669	666	341	535	485
Property income	185	252	306	169	228	286
National income	1,392	2,290	3,700	1,364	2,174	3,717
Gross domestic product accounts[a]						
Consumption	1,383	2,240	3,521	1,387	2,154	3,519
Investment	444	575	941	401	513	926
Exports[b]	215	583	1,564	187	518	1,467
Imports (−)[b]	426	658	1,563	380	598	1,569
GDP	1,616	2,740	4,463	1,595	2,587	4,343
Wholesale price index	97.8	152.1	218.0	109.3	160.6	199.4
Agricultural terms of trade	99.8	140.2	119.7	97.0	112.5	76.7
Exchange rate[c]	.277	.387	.456	.277	.387	.435
Production[d]						
Agriculture	581	777	1,053	581	774	1,040
Food, beverages, and tobacco	315	522	797	320	528	815
Shelter and transportation	695	1,257	2,078	638	1,093	1,912
Manufacturing	737	1,447	2,589	715	1,411	2,629
Services	546	945	1,620	539	886	1,587
TOTAL	2,873	4,948	8,137	2,794	4,692	7,983
Employment[e]						
Agriculture	4,640	4,698	5,023	4,640	4,698	5,017
Food, beverages, and tobacco	448	371	354	458	399	384
Shelter and transportation	695	828	742	670	776	713
Manufacturing	933	1,203	1,735	971	1,363	1,892
Services	1,885	2,373	2,842	1,862	2,236	2,685
TOTAL	8,601	9,473	10,697	8,601	9,473	10,690
Migration[e]	352	350		352	349	

Table continues overleaf

TABLE F.10 (continued)
Urban Policy Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		B-8			B-9	
National income accounts[a]						
Wages, nonagricultural	518	875	1,758	657	988	1,759
Self-employed	197	331	646	212	422	868
Agricultural income	274	386	257	405	525	725
Property income	165	217	257	152	217	281
National income	1,230	1,902	3,143	1,483	2,225	3,811
Gross domestic product accounts[a]						
Consumption	1,258	1,871	2,924	1,451	2,164	3,566
Investment	410	552	684	320	611	978
Exports[b]	162	432	1,226	166	546	1,639
Imports (−)[b]	339	537	1,095	297	674	1,789
GDP	1,491	2,318	3,739	1,640	2,647	4,394
Wholesale price index	107.5	162.5	219.1	139.5	157.6	200.1
Agricultural terms of trade	80.2	85.2	47.6	114.4	111.1	131.1
Exchange rate[c]	.277	.387	.456	.277	.387	.440
Production[d]						
Agriculture	574	756	1,012	580	762	1,039
Food, beverages, and tobacco	293	475	709	320	538	817
Shelter and transportation	591	979	1,631	610	1,227	2,248
Manufacturing	637	1,200	2,168	756	1,451	2,707
Services	494	779	1,347	554	897	1,674
TOTAL	2,589	4,189	6,866	2,820	4,875	8,485
Employment[e]						
Agriculture	4,638	4,697	5,091	4,640	4,698	5,023
Food, beverages, and tobacco	508	492	492	409	406	364
Shelter and transportation	639	691	533	601	791	769
Manufacturing	1,013	1,325	1,755	1,066	1,365	1,805
Services	1,801	2,146	2,633	1,883	2,213	2,732
TOTAL	8,599	9,351	10,504	8,601	9,473	10,696
Migration[e]	353	350		352	350	

TABLE F.10 (continued)
Urban Policy Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		B-10			B-11	
National income accounts[a]						
Wages, nonagricultural	596	923	1,600	642	953	1,723
Self-employed	215	406	755	209	417	903
Agricultural income	339	500	608	420	540	821
Property income	143	200	228	152	215	299
National income	1,396	2,151	3,481	1,487	2,206	3,942
Gross domestic product accounts[a]						
Consumption	1,380	2,112	3,180	1,464	2,164	3,732
Investment	394	580	831	310	599	1,018
Exports[b]	179	572	1,294	160	532	1,763
Imports (−)[b]	356	681	1,266	289	653	1,864
GDP	1,597	2,583	4,039	1,645	2,642	4,649
Wholesale price index	110.8	139.4	204.9	144.1	163.2	198.2
Agricultural terms of trade	95.3	104.3	91.7	118.8	113.9	121.5
Exchange rate[c]	.277	.387	.410	.277	.387	.451
Production[d]						
Agriculture	581	785	1,082	581	762	1,036
Food, beverages, and tobacco	319	530	784	319	536	829
Shelter and transportation	651	1,159	1,740	607	1,225	2,280
Manufacturing	686	1,352	2,335	757	1,458	2,702
Services	540	892	1,503	555	887	1,631
TOTAL	2,777	4,718	7,444	2,819	4,868	8,478
Employment[e]						
Agriculture	4,640	4,822	5,283	4,640	4,699	5,023
Food, beverages, and tobacco	454	427	386	405	399	364
Shelter and transportation	657	790	684	599	779	775
Manufacturing	903	1,107	1,571	1,067	1,372	1,760
Services	1,890	2,260	2,686	1,890	2,182	2,625
TOTAL	8,543	9,406	10,611	8,601	9,430	10,548
Migration[e]	238	246		353	350	

[a] Real values in billions of *won*, 1968 prices
[b] In billions of *won*, valued at world prices
[c] At 1,000 *won* to the dollar
[d] Real gross production in billions of *won*, 1968 prices
[e] By thousands of workers

TABLE F.11

Combined Rural-Urban Experiments: Decile Distribution of Real Household Income

(Percent)

Decile	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN			C-1		
1	2.22%	2.07%	1.68%	2.36%	2.18%	1.67%
2	3.62	3.47	2.99	3.83	3.62	2.98
3	4.67	4.52	4.06	4.91	4.69	4.06
4	5.71	5.56	5.16	5.96	5.75	5.17
5	6.86	6.72	6.36	7.10	6.92	6.41
6	8.21	8.10	7.78	8.43	8.29	7.86
7	9.94	9.88	9.61	10.10	10.03	9.71
8	12.38	12.42	12.29	12.41	12.48	12.35
9	16.46	16.73	17.06	16.23	16.57	17.02
10	29.92	30.52	33.01	28.66	29.46	32.76
Gini coefficient	.398	.409	.444	.381	.396	.442
	C-2			C-3		
1	2.22%	2.06%	1.98%	2.28%	2.24%	2.24%
2	3.62	3.45	3.38	3.79	3.69	3.74
3	4.67	4.48	4.43	4.90	4.75	4.79
4	5.71	5.52	5.46	6.00	5.81	5.81
5	6.86	6.68	6.59	7.18	6.97	6.92
6	8.21	8.07	7.95	8.56	8.36	8.23
7	9.94	9.86	9.71	10.28	10.11	9.90
8	12.38	12.44	12.28	12.65	12.57	12.30
9	16.46	16.78	16.80	16.49	16.60	16.41
10	29.94	30.65	31.42	27.87	28.91	29.65
Gini coefficient	.399	.412	.419	.378	.390	.393
	C-4			C-5		
1	2.03%	2.32%	2.30%	2.29%	2.22%	2.42%
2	3.54	3.87	3.90	3.88	3.85	4.27
3	4.67	4.98	5.01	5.09	5.06	5.49
4	5.81	6.07	6.08	6.34	6.27	6.59
5	7.08	7.25	7.22	7.69	7.59	7.70
6	8.57	8.62	8.54	9.19	9.07	8.93
7	10.45	10.31	10.19	10.89	10.82	10.39
8	13.00	12.63	12.46	13.03	13.04	12.36
9	17.00	16.37	16.23	16.20	16.36	15.61
10	27.86	27.59	28.07	25.40	25.72	26.23
Gini coefficient	.390	.373	.375	.354	.360	.346

TABLE F.12

Combined Rural-Urban Experiments: Analysis of Poverty

(Percent composition of households with real incomes of less than 120,000 *won*)

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN			C-1			C-2		
Wage earners									
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	0.9	1.1	0.4	1.1	1.6	0.4	0.9	1.2	0.9
Skilled workers	12.3*	12.2	1.3	12.1*	13.4	0.5	12.2*	14.4	5.0
Apprentices	0.3**	0.5*	0.2	0.3**	0.6*	0.1	0.3**	0.5*	1.0
Unskilled workers	12.9*	19.4*	16.1*	13.1*	21.1*	12.8	12.8*	23.4*	26.1
White-collar workers	4.5	4.2	0.8	5.3	6.4	0.8	4.5	5.9	3.1*
Government workers	8.6*	11.9	8.9	10.4*	15.8	8.4	8.5*	11.6	13.5
Self-employed									
1: Manufacturing	3.0*	3.2	1.8	3.8*	5.3	1.8	3.1*	3.3	2.9
2: Services	7.6	2.6	0.2	9.1	3.9	0.2	8.2	2.7	0.3
Capitalists	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Agriculture									
Laborers	14.6**	19.1**	29.1**	15.1**	16.7*	31.0**	14.6**	16.7**	24.3**
Farm size 1	18.1*	15.2*	23.9*	15.8*	9.9	25.5*	18.0*	12.4	14.3
Farm size 2	15.3*	9.9	16.1	11.9	5.1	16.3	15.0*	7.7	8.2
Farm size 3	2.0	0.6	1.3	1.9	0.3	2.3	2.0	0.4	0.4
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent <90,000 *won*	23.8%	12.8%	8.0%	20.5%	11.7%	7.1%	23.9%	13.5%	6.5%
Percent <120,000 *won*	38.3%	23.2%	14.5%	34.7%	21.7%	13.1%	38.4%	24.2%	12.8%
Mean incomes (000 *won*)									
Bottom decile	43.8	57.3	68.2	47.8	60.0	72.1	43.0	56.1	75.1
Next decile	71.5	96.0	121.5	77.5	99.7	128.1	71.4	93.8	128.5
Top decile	591.0	844.0	1,341.4	579.3	810.3	1,408.9	580.6	833.9	1,194.0
Overall	202.2	283.1	418.1	206.4	280.7	442.4	200.2	278.4	389.7

	C-3			C-4			C-5		
Wage earners									
Engineers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Technicians	1.0	1.2	1.0	1.4	1.5	1.6	1.5	1.9	1.9
Skilled workers	12.4*	19.7	5.8	14.3	13.9	4.8	15.2*	17.4	3.1
Apprentices	0.4**	1.6*	1.7	0.4**	1.3*	1.4	0.4**	0.9*	1.6
Unskilled workers	15.1*	25.0*	44.9	15.8*	22.5	40.6	17.1*	26.6*	38.7
White-collar workers	4.3	4.0	1.3	6.0	6.4	3.1	4.0	5.7*	2.8
Government workers	13.3*	19.2	27.1	16.1*	26.2*	36.9*	16.1*	25.3*	39.8
Self-employed									
1: Manufacturing	4.8*	4.3	1.2	6.3**	5.4	1.9	6.1*	7.5*	7.4
2: Services	16.8*	5.6	0.5	19.8*	6.9	0.7	19.5*	9.4	1.9
Capitalists	0.2	0.1	0.0	0.3	0.1	0.0	0.6	0.3	0.3
Agriculture									
Laborers	14.0**	9.5*	6.1	11.3	8.4	4.0	15.2**	4.2	1.5
Farm size 1	10.0*	5.7	5.4	5.0	4.3	2.7	2.3	0.4	0.3
Farm size 2	7.1	3.9	4.6	2.9	2.8	2.0	0.8	0.1	0.1
Farm size 3	0.8	0.3	0.4	0.4	0.4	0.3	1.2	0.3	0.6
Farm size 4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Percent <90,000 *won*	19.5%	9.6%	3.0%	21.2%	7.8%	2.7%	19.7%	11.0%	3.9%
Percent <120,000 *won*	32.8%	18.7%	6.6%	33.9%	15.6%	5.9%	31.9%	19.9%	7.8%
Mean incomes (000 *won*)									
Bottom decile	47.6	70.1	99.4	42.9	70.1	103.1	46.2	59.5	90.8
Next decile	79.1	117.1	165.9	74.7	117.1	175.1	78.2	103.4	160.3
Top decile	581.1	835.3	1,314.5	588.1	835.3	1,261.5	512.2	690.6	986.8
Overall	212.1	307.9	453.3	214.2	307.9	458.0	204.3	272.0	382.3

NOTE: No asterisk, share represents less than $\frac{1}{3}$ of group population; single asterisk, share represents $\frac{1}{3}$ to $\frac{2}{3}$ of group population; double asterisk, share represents more than $\frac{2}{3}$ of group population

TABLE F.13

Combined Rural-Urban Experiments: Composition by Groups of Top Decile of the Overall Distribution

(Percent)

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN			C-1		
Wage earners						
Engineers	2.5%	1.5%	1.1%	2.3%	1.1%	1.2%
Technicians	2.9	2.7	4.2	2.7	2.0	4.2
Skilled workers	0.8	0.5	1.0	1.1	0.4	2.1
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	3.3	3.1	3.0	4.1	3.2	4.2
White-collar workers	22.3	21.8	31.6	20.3	16.8	32.1
Government workers	9.4	6.5	7.4	8.0	4.7	7.5
Self-employed						
1: Manufacturing	2.9	2.4	6.7	2.2	1.5	6.9
2: Services	17.6	21.5	28.3	15.9	18.2	27.3
Capitalists	15.1	13.1	10.8	14.5	12.2	10.8
Agriculture						
Laborers	0.0	0.0	0.0	0.0	0.0	0.0
Farm size 1	0.5	0.5	0.0	1.2	1.5	0.0
Farm size 2	1.6	1.6	0.1	3.8	5.2	0.1
Farm size 3	11.9	12.7	1.5	13.8	18.6	0.7
Farm size 4	9.2	12.1	4.3	10.1	14.6	2.9
	C-2			C-3		
Wage earners						
Engineers	2.5%	1.5%	1.0%	2.0%	1.8%	1.2%
Technicians	3.0	2.6	3.6	2.8	3.1	4.4
Skilled workers	0.8	0.3	0.4	0.9	0.2	0.5
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	3.3	2.1	2.4	2.8	2.9	2.3
White-collar workers	22.4	18.2	23.3	22.6	22.2	30.7
Government workers	9.4	6.6	7.0	4.9	3.6	4.7
Self-employed						
1: Manufacturing	2.9	2.2	5.8	1.8	0.8	4.0
2: Services	17.7	20.8	27.1	5.2	12.1	22.4
Capitalists	15.1	13.3	10.9	11.2	11.1	10.2
Agriculture						
Laborers	0.0	0.0	0.0	0.1	0.2	0.2
Farm size 1	0.5	0.6	0.2	3.7	3.2	1.4
Farm size 2	1.6	2.1	0.6	8.2	5.9	1.9
Farm size 3	11.7	16.2	7.2	22.1	19.1	6.9
Farm size 4	9.1	13.5	10.5	11.7	13.8	9.2

TABLE F.13 (continued)
Combined Rural-Urban Experiments: Composition by Groups of Top Decile of the Overall Distribution
(Percent)

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		C-4			C-5	
Wage earners						
Engineers	1.2%	1.7%	1.1%	1.5%	1.3%	1.1%
Technicians	1.7	2.8	3.3	2.3	2.2	3.3
Skilled workers	0.4	0.7	0.9	0.7	0.4	1.5
Apprentices	0.0	0.0	0.0	0.0	0.0	0.0
Unskilled workers	1.9	5.0	3.6	2.7	3.0	3.6
White-collar workers	14.1	18.2	23.8	23.9	19.3	31.6
Government workers	2.4	2.7	3.7	5.7	3.4	5.0
Self-employed						
1: Manufacturing	0.5	1.0	3.5	1.1	1.1	4.8
2: Services	2.6	11.6	21.0	5.0	9.7	20.6
Capitalists	9.0	11.0	10.1	7.9	7.6	6.3
Agriculture						
Laborers	0.2	0.3	0.5	0.0	0.0	0.1
Farm size 1	8.4	5.2	3.3	5.3	5.3	1.8
Farm size 2	17.8	9.2	4.8	16.9	14.0	3.9
Farm size 3	26.9	17.6	9.7	22.1	24.3	11.5
Farm size 4	12.9	13.0	10.7	4.9	8.4	4.9

TABLE F.14

Combined Rural-Urban Experiments: Mean Group Incomes as a Percent of Basic-Run Values

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN[a]			C-1		
Wage earners						
Engineers	504	514	713	93%	85%	105%
Technicians	266	346	649	96	85	101
Skilled workers	143	185	337	105	99	117
Apprentices	102	139	275	105	100	116
Unskilled workers	146	185	280	107	100	115
White-collar workers	295	396	715	95	87	104
Government workers	203	242	369	94	88	105
Self-employed						
1: Manufacturing	198	258	571	89	83	106
2: Services	241	420	912	96	90	101
Capitalists	777	1,072	1,507	94	89	104
Agriculture						
Laborers	68	89	87	117	125	105
Farm size 1	116	166	162	119	123	102
Farm size 2	143	209	202	120	126	104
Farm size 3	258	379	351	104	109	92
Farm size 4	415	707	685	105	113	95
AVERAGE	202	283	418	102%	99%	105%
	C-2			C-3		
Wage earners						
Engineers	100%	102%	89%	90%	108%	98%
Technicians	100	96	79	101	109	98
Skilled workers	100	94	78	107	94	89
Apprentices	100	94	77	101	92	84
Unskilled workers	100	88	83	99	101	91
White-collar workers	100	89	74	105	106	98
Government workers	100	100	88	82	86	87
Self-employed						
1: Manufacturing	100	97	83	80	85	86
2: Services	100	98	89	67	82	94
Capitalists	100	100	89	73	85	95
Agriculture						
Laborers	100	106	127	143	183	306
Farm size 1	100	105	127	157	154	208
Farm size 2	100	105	127	150	139	175
Farm size 3	100	106	130	128	117	144
Farm size 4	100	106	133	119	114	138
AVERAGE	100%	99%	92%	105%	105%	107%

TABLE F.14 (continued)
Combined Rural-Urban Experiments: Mean Group Incomes as a Percent of Basic-Run Values

Household category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
		C-4			C-5	
Wage earners						
Engineers	72%	111%	95%	74%	88%	79%
Technicians	85	105	83	84	87	66
Skilled workers	97	112	94	97	100	88
Apprentices	92	109	89	94	94	79
Unskilled workers	93	122	102	91	95	85
White-collar workers	88	96	83	105	87	80
Government workers	68	79	80	71	82	68
Self-employed						
1: Manufacturing	52	88	80	61	84	65
2: Services	56	81	86	61	65	64
Capitalists	63	83	91	50	54	48
Agriculture						
Laborers	172	210	355	141	175	293
Farm size 1	201	175	248	191	163	221
Farm size 2	196	158	213	188	153	195
Farm size 3	143	115	156	117	89	130
Farm size 4	133	109	149	75	56	85
AVERAGE	106%	109%	109%	101%	93%	91%

[a] Average real incomes of groups in thousands of *won*

TABLE F.15

Combined Rural-Urban Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	BASIC RUN			C-1		
National income accounts[a]						
Wages, nonagricultural	533	865	1,665	516	785	1,718
Self-employed	219	395	780	216	377	783
Agricultural income	350	598	576	368	692	510
Property income	186	253	315	183	243	311
National income	1,387	2,223	3,612	1,387	2,208	3,609
Gross domestic product accounts[a]						
Consumption	1,385	2,195	3,348	1,409	2,228	3,383
Investment	435	552	889	414	506	910
Exports[b]	211	583	1,503	196	525	1,514
Imports (−)[b]	417	651	1,460	384	587	1,512
GDP	1,615	2,679	4,280	1,635	2,672	4,295
Wholesale price index	99.7	148.2	203.9	104.7	164.0	197.5
Agricultural terms of trade	99.7	123.4	87.3	104.7	144.8	78.3
Exchange rate[c]	.277	.387	.438	.277	.387	.439
Production[d]						
Agriculture	581	788	1,081	581	784	1,074
Food, beverages, and tobacco	318	530	821	318	511	818
Shelter and transportation	685	1,185	1,867	680	1,160	1,889
Manufacturing	738	1,430	2,533	740	1,427	2,546
Services	550	926	1,576	554	929	1,587
TOTAL	2,871	4,859	7,877	2,874	4,812	7,914
Employment[e]						
Agriculture	4,639	4,823	5,286	4,640	4,823	5,283
Food, beverages, and tobacco	452	361	348	436	336	350
Shelter and transportation	687	799	700	681	772	701
Manufacturing	928	1,159	1,574	925	1,189	1,594
Services	1,894	2,332	2,785	1,919	2,355	2,764
TOTAL	8,600	9,475	10,694	8,601	9,475	10,692
Migration[e]	237	245		237	246	

TABLE F.15 (continued)

Combined Rural-Urban Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	C-2			C-3		
National income accounts[a]						
Wages, nonagricultural	534	822	1,483	594	927	1,777
Self-employed	220	393	752	183	375	853
Agricultural income	349	631	760	535	764	893
Property income	186	257	318	169	236	339
National income	1,388	2,217	3,584	1,551	2,402	4,144
Gross domestic product accounts[a]						
Consumption	1,386	2,198	3,343	1,461	2,279	3,787
Investment	436	557	863	352	710	1,124
Exports[b]	211	601	1,486	180	653	2,011
Imports (−)[b]	418	666	1,420	151	798	2,130
GDP	1,615	2,690	4,272	1,842	2,844	4,792
Wholesale price index	99.5	145.9	215.2	124.4	139.4	161.9
Agricultural terms of trade	99.6	132.9	117.2	121.9	121.7	91.9
Exchange rate[c]	.277	.387	.441	.277	.387	.438
Production[d]						
Agriculture	581	774	1,040	581	847	1,271
Food, beverages, and tobacco	317	525	781	325	553	921
Shelter and transportation	687	1,197	1,863	662	1,342	2,237
Manufacturing	737	1,440	2,559	760	1,516	2,704
Services	550	936	1,572	572	977	1,714
TOTAL	2,872	4,872	7,815	2,900	5,235	8,847
Employment[e]						
Agriculture	4,639	4,644	4,851	4,640	4,657	4,942
Food, beverages, and tobacco	451	382	342	412	406	432
Shelter and transportation	689	819	715	630	858	828
Manufacturing	928	1,177	1,661	984	1,189	1,642
Services	1,893	2,353	2,804	1,936	2,362	2,852
TOTAL	8,600	9,376	10,373	8,602	9,472	10,695
Migration[e]	352	344		391	379	

Table continues overleaf

TABLE F.15 (continued)
Combined Rural-Urban Experiments: Real National Accounts, Production, Employment, and Miscellaneous Indicators

Category	Year 1	Year 5	Year 9	Year 1	Year 5	Year 9
	C-4			C-5		
National income accounts[a]						
Wages, nonagricultural	523	901	1,641	530	781	1,462
Self-employed	162	373	828	168	318	644
Agricultural income	634	742	966	497	740	785
Property income	167	232	338	133	170	199
National income	1,560	2,357	4,067	1,421	2,131	3,401
Gross domestic product accounts[a]						
Consumption	1,506	2,302	3,801	1,385	2,068	3,052
Investment	302	691	1,127	349	603	893
Exports[b]	156	605	2,036	159	481	1,275
Imports (−)[b]	280	768	2,213	287	541	1,155
GDP	1,684	2,830	4,751	1,606	2,611	4,065
Wholesale price index	144.8	144.5	163.4	125.5	167.1	230.4
Agricultural terms of trade	148.8	118.9	101.9	109.8	132.1	103.1
Exchange rate[c]	.277	.387	.449	.277	.397	.443
Production[d]						
Agriculture	581	838	1,240	592	769	1,021
Food, beverages, and tobacco	310	557	892	305	485	727
Shelter and transportation	643	1,347	2,285	629	1,205	1,905
Manufacturing	765	1,527	2,693	716	1,422	2,509
Services	584	969	1,700	539	888	1,451
TOTAL	2,883	5,239	8,810	2,781	4,770	7,614
Employment[e]						
Agriculture	4,640	4,603	4,773	4,640	4,603	4,773
Food, beverages, and tobacco	368	382	390	401	370	361
Shelter and transportation	607	834	830	621	798	688
Manufacturing	1,002	1,203	1,577	978	1,272	1,887
Services	1,984	2,353	2,805	1,904	2,266	2,593
TOTAL	8,601	9,375	10,375	8,544	9,309	10,303
Migration[e]	391	373		391	373	

[a] Real values in billions of *won*, 1968 prices
[b] In billions of *won*, valued at world prices
[c] At 1,000 *won* to the dollar
[d] Real gross production in billions of *won*, 1968 prices
[e] By thousands of workers

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