The Effects of Family Planning Programs on Fertility in the Developing World

Nancy Birdsall, editor
Bryan Boulier
W. Parker Mauldin
Robert J. Lapham
David Wheeler

WORLD BANK STAFF WORKING PAPERS
Number 677

POPULATION AND DEVELOPMENT SERIES
Number 2
The Effects of Family Planning Programs on Fertility in the Developing World

Nancy Birdsall, editor
Bryan Boulier
W. Parker Mauldin
Robert J. Lapham
David Wheeler

The World Bank
Washington, D.C., U.S.A.
The Effects of family planning programs on fertility in the developing world.

(World Bank staff working papers; no. 677. Population and development series; no. 2)


HB1108.E39 1985 304.6'32'091724 85-9411

ISBN 0-8213-0536-0
FOREWORD

This paper is one in a special series of World Bank Staff Working Papers on population change and development. Prepared as background papers for the World Development Report 1984, they provide more detailed treatment and documentation of the issues dealt with in Part II of the Report. The papers cover a range of topics, including the effects of population growth and change on economic development, the determinants of fertility and mortality, the links between population growth and internal and international migration, and the management, financing, and effectiveness of family planning programs. They include several country and regional studies of fertility change and population policy.

The background papers draw on a large number of published and unpublished studies of individual researchers, on Bank policy analysis and research, and on reports of other organizations working on population and development programs and issues. The papers are the work of individuals and the views and interpretations expressed in them do not necessarily coincide with the views and interpretations of the Report itself.

I hope these detailed studies will supplement the World Development Report 1984 in furthering understanding of population and development issues among students and practitioners of development.

Nancy Birdsall
Staff Director
World Development Report 1984
Some of the Papers in the Population and Development Series


Merrick, Thomas W. Recent Fertility Declines in Brazil, Colombia, and Mexico. World Bank Staff Working Paper no. 692.


# Table of Contents

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDITOR'S INTRODUCTION</td>
</tr>
<tr>
<td>MEASURING FAMILY PLANNING PROGRAM EFFORT IN LDCs: 1972 AND 1982</td>
</tr>
<tr>
<td>W. Parker Mauldin and Robert J. Lapham</td>
</tr>
<tr>
<td>FAMILY PLANNING PROGRAMS AND CONTRACEPTIVE AVAILABILITY: THEIR EFFECTS ON CONTRACEPTIVE USE AND FERTILITY</td>
</tr>
<tr>
<td>Bryan L. Boulier</td>
</tr>
<tr>
<td>FEMALE EDUCATION, FAMILY PLANNING, INCOME AND POPULATION: A LONG-RUN ECONOMETRIC SIMULATION MODEL</td>
</tr>
<tr>
<td>David Wheeler</td>
</tr>
</tbody>
</table>
Editor's Introduction

Measuring the impact of family planning programs on fertility is less straightforward than it seems. To distinguish the specific impact of a program, analysts must estimate how fertility would have changed in its absence. That requires systematically eliminating other possible causes of a country's fertility decline—such as increases in income, education, and life expectancy in the same period. In addition, information on the change in the availability and quality of family planning information and services is needed (not on change in the use of services, since use is related to people's fertility goals and does not indicate the difference services alone would make to people who now have no access to them). Throughout much of the 1960s and 1970s, such information has been of poor quality or not available at all.

Given the analytical difficulties and the lack of good information, it was not surprising that a decade ago policymakers and planners could not completely agree on the relative importance to a fertility decline of the supply of family planning services versus the "demand" factors—increasing education, lower infant mortality, and the like. Early family planning programs in Korea, Hong Kong, and other areas of East Asia had been established in countries where a marked fall in fertility was already in progress; some of the continued decline might have occurred even without official programs. In other countries (such as India and Pakistan), where programs were also established in the 1950s and 1960s, fertility was changing little during the 1960s.

But organized family planning programs spread rapidly in the late 1960s and early 1970s. And beginning in the 1970s, information on family planning programs has been systematically gathered that permits analysis of the importance of the supply of family planning services compared with demand factors in affecting use of family planning methods and in affecting fertility. The evidence from these analyses is that both matter. Demand factors have an effect independent of family planning programs. At the same time, family planning programs have an effect independent of demand factors. The two effects, though weak by themselves, are powerful in combination.

The three papers in this volume represent an important contribution to these analyses. The first, by W. Parker Mauldin and Robert J. Lapham, is a careful and detailed explanation of their "index" of family planning program effort, measured at the country level and designed to allow cross-country comparisons. They first developed their index in the early 1970s. It was based on countries' performance in 1972 on fifteen criteria, such as the availability of many contraceptive methods, either through government programs or commercially; inclusion of fertility reduction in official policy; adequacy of the family planning administrative structure; and use of mass media and fieldworkers. In 1983–84, they updated their index, based on countries' 1982 performance on the same and additional criteria. The index is available for 87 countries for both 1972 and 1982.

-vii-
Their index for each country is based on the replies of country experts to a questionnaire that seeks specific information about inputs to a family planning policy. In their paper they explain how they have combined and weighted the replies on separate criteria into a single index for each country. They point out some of the difficult measurement problems in developing such an index, and discuss its resultant shortcomings. They also analyze the links among and relative importance of various inputs to the final index, and compare change in the index over time across countries.

Mauldin and Lapham show that family planning program effort in many countries is weak; in some countries though policy commitment is strong, services have not been built up. The most important single conclusion from their work, however, is the general tendency, despite setbacks in a few countries, for family planning program effort to be increasing over time in the developing world.

More importantly the index Mauldin and Lapham have developed, because it is comparable across countries, has made possible the kinds of analyses represented by the other two papers.

In the second paper, Bryan Boulier describes an economic model of the demand for contraception and the demand for children and shows how reductions in the costs of contraception can be expected to increase contraceptive use and decrease fertility. He shows theoretically why women who live near sources of modern contraceptives are systematically less likely to want additional children, controlling for residence, education and other socio-economic factors, than women who live far from a source -- in short why the demand for children will be lower the lower the costs of obtaining and using contraception. Boulier then estimates the model for a sample of developing countries, using the Mauldin-Lapham 1972 index of family planning as one variable explaining fertility change over the period 1965 to 1975. Other variables include the change during the same period in life expectancy, in adult literacy, in income per capita, and in the proportion of the population in cities of 100,000 or more. The effect of the family planning index is consistently positive -- that is a higher index is associated with a greater decline in fertility -- and statistically significant (see his Table 5; in Boulier's paper the index is labelled "score").

Boulier uses a number of approaches to assure that this positive effect of the family planning index is not exaggerated. One is to include fertility change 1960-65 in the equation along with the index; countries experiencing some fertility decline in the early 1960s are likely to have experienced more in the 1965-75 period, all other things the same. Inclusion of this variable does decrease the measured effect of the 1972 index on fertility decline, but it by no means eliminates the index's
effect, which remains statistically significant (for example, Table 5, col. 4). Boulier also provides simultaneous equation estimates of the fertility change equations with the index treated as an endogenous variable. Fertility decline in the period 1960-65 turns out to be an important predictor of the 1972 index; it is plausible that fertility decline itself induces government officials to augment resources for encouraging more fertility decline, particularly if it represents real demand for more services. However, even taking into account that a stronger family planning program in 1972 is associated with prior fertility decline (in 1960-65), it is still true that the effect of the program on fertility change in the concurrent period (1965-75) remains positive (Table 5, col. 6).

Finally Boulier provides an extensive and careful review of within-country studies of the effects of organized family planning programs, and of field experiments designed to directly test the effects of greater availability of family planning services on contraceptive use and fertility. He concludes:

Numerous studies of the effect of increased actual availability, including the results of experiments, indicate that increased access to sources of contraceptive supply results in an increase in contraceptive use and a decrease in fertility. Because of wide differences in the characteristics of the populations studied, because of differences among studies in the measurement of access to methods of contraception, and because of differences in methodology, it is not possible to summarize easily the estimated impacts of increased access on contraceptive use or fertility in these studies. In some studies the effects of access seem to be large (p. 51).

The third paper, by David Wheeler, adds in two ways to the first two papers. First, Wheeler incorporates the 1982 as well as the 1972 index of family planning into his analysis. He estimates the effect of change in the index over that period (interacted with change in female schooling) on the change in fertility, 1970 to 1980. He estimates the effect of the index taking into account the fact that the index itself is partly the result of ongoing changes in education, fertility and income (i.e. like Boulier he uses a simultaneous model in which the family planning index is endogenous).

Two of his findings regarding the effects of organized family planning programs merit special mention:
(1) In explaining fertility change, it is the combination of family planning with female education which must be stressed. Experimentation with alternative functional forms has suggested strongly that the interactive specification is appropriate. There is obviously a major policy implication in this result if it is to be believed: Rapid expansion of family planning programs in societies where females are being educated at low rates will not be very effective. Conversely, rapid expansion in educational opportunities for women seems to have proportionally greater impact on fertility when strong family planning programs are in place (p. A-29).

(2) Government family planning effort itself has been "reactive" in the 1970-80 period, i.e. "slow declines in fertility have stimulated greater government effort, while rapid declines seem to have retarded it" (p. A-35). Thus in his equation predicting the change in the family planning index in the last decade, Wheeler gets a result opposite to Boulier's. Boulier was of course explaining the 1972 level, not the 1972-82 change; in the early 1970s, governments were more likely to implement family planning programs if fertility was falling anyway, perhaps in response to demand for services. However, in the more recent past, governments were more likely to increase effort in family planning (usually from a lower base) where fertility was still high, presumably due in part to concern with their demographic situation.

Second, Wheeler incorporates his model of fertility change into a larger model in which fertility change itself feeds back to affect economic growth. He then uses the empirical results of estimating this model as a basis for simulating the long-run benefits of alternative investment strategies. The simulations permit him to compare the benefits of equivalent investments in physical capital vs. social programs -- female education and family planning.

The simulation results (for example, his simulations for Togo and Malawi) communicate the "same unmistakable message...: Investments in female schooling and family planning yield large payoffs in the long run," (p 28), large, that is, compared with the equivalent investment in physical capital. For Togo, the "social investment strategy" of investing in family planning and education doubles anticipated income per capita by 2050 over what it would be with the same resources going to physical investment. Simulations for a range of countries indicate that the social investment strategy is always better, with the degree of superiority greater where prior social investments have already established high rates of female schooling and family planning activity.
And what about the relative merits of investing in family planning vs. female education? For reducing population growth itself (not necessarily an end in itself), family planning investment yields superior results, especially where education is already widespread (Malaysia, Brazil and Mexico). For raising per capita income, female education dominates.

As Wheeler points out, his econometric results make it clear that long-run economic growth models should incorporate demographic factors (and conversely). Changes in national income have an impact on fertility, not only directly but also indirectly -- through effects on family planning activity and (through family planning) on infant mortality. Changes in fertility and mortality in turn have an impact on the domestic savings rate because they change population, the denominator of income per capita. In addition, they are the essential determinants of growth in the labor force.

Wheeler's results also show that estimates of the rate of return to investments in education and in family planning must take into account both the demographic effects of these programs and their general economic benefits. The three papers together make a powerful case for the economic and demographic benefits of investment in family planning programs.

Nancy Birdsall
MEASURING FAMILY PLANNING PROGRAM EFFORT IN DEVELOPING COUNTRIES, 1972 AND 1982

W. Parker Mauldin

Robert J. Lapham
Abstract

This paper addresses the following questions:

- What are the key elements in population policies and programs?
- What changes have occurred in population policies and programs, including the strength of program effort, from 1972 to 1982?

Using a new scale with thirty items to measure family planning program effort, the presentation is based on an analysis of over 300 questionnaires received from ninety-three countries. Attention is given to measurement problems and change in program effort 1972-82 (including findings by country and regional differences).

After about a quarter of a century of intensifying work in the family planning field in developing countries, this study shows that a great deal of family planning program effort exists in a small number of countries; moderate effort occurs in a larger number of countries; and weak or very little effort is found in an even greater number of countries, including many in the Middle East, North Africa and sub-Saharan Africa. Concerning change over time, between 1972 and 1982 there was a modest increase in program effort in more than half of the nearly 100 countries studied and a substantial increase in program effort in more than a third. In sub-Saharan Africa, about half of the countries had no change in program effort during this decade, but the other half did. Thus, modest beginnings vis-a-vis family planning programs have occurred in this region; however, it takes a while to "crank up," so that by 1982 only four countries in sub-Saharan Africa had reached even the weak program effort category and none the moderate category, while only Mauritius was in the strong category where it had been in 1972.

In a related study, we examined the impact of family planning programs and of socioeconomic factors on fertility decline in the period 1965-80 and on contraceptive prevalence 1977-82. We find that the level of "modernization," as reflected in seven socioeconomic factors, has a substantial relationship to fertility decline in 1965-80. That was to be expected based on sociodemographic theory. However, we also find that on balance, family planning programs have a significant, independent effect over and above the effect of socioeconomic factors. Good program effort adds substantially to the amount of fertility decline or contraceptive prevalence accounted for. On the other hand, weak and very weak programs have little discernible impact on fertility decline.

To conclude, we believe that this and our related studies demonstrate the ingredients of a good family planning program and the utility of a family planning program as one element in the armamentarium of development programs.
Acknowledgements

This paper reports some of the findings from a study initiated by the authors in 1983.

The study has been carried out with primary support from The Rockefeller Foundation, including a grant to Robert J. Lapham for research on the measurement of family planning program effort. Additional support necessary for the study was received from three other sources—the Agency for International Development, The World Bank, and The William and Flora Hewlett Foundation. This support is gratefully acknowledged.

We also received assistance from personnel in the Agency for International Development, The World Bank, The United Nations Fund for Population Activities, The International Planned Parenthood Federation, and several other institutions. For example, these individuals helped with the identification of persons knowledgeable about family planning programs in each of about 100 developing nations. In addition to expressing thanks for this support and assistance, we want to note with particular appreciation some 400 population specialists around the world who took the time and effort to respond to the questionnaire designed for this study.

Appreciation is also extended to several other individuals. Carol Mensah at The Rockefeller Foundation and Lisa Mages at the National Academy of Sciences organized the mailing and receipt of questionnaires; in addition, Ms. Mensah assisted with computer tabulations prepared at the Foundation and Ms. Mages helped with other aspects of the study including coding. Susan Lapham, now at the Bureau of the Census, prepared computer programs for the scoring process and several tables. The typing of text and complicated tables has been efficiently handled by Lucy Santiago, at the Academy. Finally, appreciation is expressed to the Population Council for the use of their computer and to Robert Sendek for advice on how to make it produce desired calculations and graphs.
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>7</td>
</tr>
<tr>
<td>Background and purpose</td>
<td>7</td>
</tr>
<tr>
<td>Methodology</td>
<td>7</td>
</tr>
<tr>
<td>A Framework for Understanding Program Effort</td>
<td>12</td>
</tr>
<tr>
<td>Change in Program Effort 1972-82</td>
<td>14</td>
</tr>
<tr>
<td>Findings by Country</td>
<td>16</td>
</tr>
<tr>
<td>Regional Differences</td>
<td>25</td>
</tr>
<tr>
<td>A Parsimonious Set of Program Effort Items</td>
<td>27</td>
</tr>
<tr>
<td>Program Effort and Fertility Decline 1965-80</td>
<td>29</td>
</tr>
<tr>
<td>Conclusions</td>
<td>32</td>
</tr>
<tr>
<td>Footnotes</td>
<td>38</td>
</tr>
<tr>
<td>References</td>
<td>39</td>
</tr>
</tbody>
</table>
Introduction

Background and Purpose

In 1972, Lapham and Mauldin suggested that fifteen key items could be used to characterize population policies and programs, and presented data on these items for twenty developing countries (LDCs). In 1976, these same items were used by Freedman and Berelson in a study that included twenty-three additional countries, while in 1978, they were used by Mauldin and Berelson for an analysis of fertility decline in 1965-75 in ninety-four countries.

In the summer of 1983, Lapham and Mauldin decided to revise this list of key items, and to gather information on them as of 1982. The purpose of this paper is to report on the result of that investigation.

In the present paper, we address the following questions:

• What changes have occurred in population policies and programs, including the strength of program effort, from 1972 to 1982?
• What are the key elements in population policies and programs?

Methodology

For our study, we expanded the number of key items to thirty (Figure 1), based on consultation with a number of knowledgeable persons, and pretested a new questionnaire among about thirty respondents. We also consulted with a large number of personnel within such organizations as the United Nations Fund for Population Activities (UNFPA), the World Bank, the Agency for International Development (AID), The Population
### Figure 1  Summary Description of the 30 Items Included in the 1983 Family Planning Program Effort Scale

<table>
<thead>
<tr>
<th>Scale Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. POLICY AND STAGE-SETTING ACTIVITIES</strong></td>
<td></td>
</tr>
<tr>
<td>1. Government's official policy or position concerning fertility/family planning and rates of population growth</td>
<td>Existence and type of official policy: to reduce the population growth rate; or to support family planning activities for other than demographic reasons; or to allow private and/or commercial family planning activities in the absence of government-sponsored activity; or to discourage family planning services. Whether or not the head of the government speaks publicly and favorably about family planning at least once or twice a year, and whether or not other high officials do so also.</td>
</tr>
<tr>
<td>2. Favorable statements by leaders</td>
<td>Level of the post (person appointed) to direct the national government family planning program, and whether or not the program director reports to the highest level of government.</td>
</tr>
<tr>
<td>3. Level of family planning program leadership</td>
<td>Minimum legal age at marriage for females at least 18 (higher scores for minimum legal ages of 19 and 20+), and the extent of effort to enforce any changes in the law since 1960 regarding legal age at marriage for females. (The score for the latter component is allowed only if the new legal minimum is at least 18.)</td>
</tr>
<tr>
<td>4. Age at marriage policy</td>
<td>Extent to which import laws and legal regulations facilitate the importation of contraceptive supplies that are not manufactured locally, and/or the extent to which contraceptives are manufactured within the country.</td>
</tr>
<tr>
<td>5. Import laws and legal regulations regarding contraceptives</td>
<td>Whether or not the advertising of contraceptives in the mass media is allowed with no restrictions; whether there are weak restrictions; whether there are social restrictions; or whether there are strong restrictions.</td>
</tr>
<tr>
<td>6. Advertising of contraceptives in the mass media allowed</td>
<td>Whether or not the advertising of contraceptives in the mass media is allowed with no restrictions; whether there are weak restrictions; whether there are social restrictions; or whether there are strong restrictions.</td>
</tr>
<tr>
<td>7. Other ministries/government agencies involved</td>
<td>Aside from the ministry or government agency that has primary responsibility for delivering family planning supplies and services, the extent to which other ministries and government agencies assist with family planning and/or other population activities. This involvement or assistance may be provided through the public sector, or through private-sector family planning programs or population activities, and is classified as follows: assistance with the delivery of family planning supplies and services; assistance in the form of services particular to that ministry; assistance with family planning information and education in specific ways; membership on a council for family planning that meets at least twice annually; moral support and small miscellaneous assistance; none.</td>
</tr>
<tr>
<td>8. In-country budget for program</td>
<td>Percent of the total family planning/population budget available from in-country sources. A top score is given if in-country sources provide 85% or more of the budget; no score is given if these sources provide less than 50% of the budget.</td>
</tr>
<tr>
<td><strong>B. SERVICE AND SERVICE-RELATED ACTIVITIES</strong></td>
<td></td>
</tr>
<tr>
<td>9. Involvement of private-sector agencies and groups</td>
<td>Extent to which private-sector agencies and groups assist with family planning and/or other population activities. These groups include family planning associations, special service groups (e.g., for sterilization services), religious associations, and so on. The involvement or assistance with family planning and population activities may include the following: delivery of family planning supplies and services; training; family planning information and education; membership in a family planning interagency group that meets at least twice annually; moral support; or other types of assistance.</td>
</tr>
<tr>
<td>10. Civil bureaucracy used</td>
<td>Use of the civil bureaucracy of the government to ensure that program directives are carried out, and the extent to which the senior government administrator at the following levels feels responsible for the success of the program: central government level; provincial or state levels; district/governorate/county/etc. levels; county levels.</td>
</tr>
<tr>
<td>11. Community-based distribution—CBD</td>
<td>Proportion of the country covered by CBD programs for the distribution of contraceptives in areas not easily served by clinics or other service points. Public and/or private CBD systems are included. The essential feature of CBD is that the contraceptive supplies are available upon request within the village, local community, or local residence neighborhood. CBD programs are assumed to be primarily rural; however, a partial extra score is allowed for urban-area CBD programs.</td>
</tr>
<tr>
<td>12. Social marketing</td>
<td>Proportion of the country covered by a social marketing program, that is, subsidised contraceptive sales in the commercial sector. The essential feature of social marketing is that contraceptives are sold at low cost, i.e., a (heavily) subsidised price, through channels easily available to rural and/or urban residents, such as local shops, pharmacies, or specially created local sales outlets. Some forms of social marketing are called &quot;commercial retail sales&quot; programs (CRS). Social marketing programs are assumed to be primarily urban programs; however, an extra score is allowed for rural-area programs.</td>
</tr>
<tr>
<td>Scale Item</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>13.* Postpartum programs</td>
<td>Extent of coverage of new mothers by postpartum programs, which may be hospital- or field-based. Most programs are of the former type. For hospital-based programs, the score is constructed from the proportion of deliveries in hospitals and maternity centers for which the new mothers are provided a family planning information and education service (by trained female workers), and the proportion of all deliveries in the country that take place in hospitals and maternity centers (often a small proportion). For field-based postpartum programs, the score is constructed from the proportion of women that are delivered in hospitals and that are offered a family planning information and education service by trained field workers.</td>
</tr>
<tr>
<td>14.* Home-visiting workers</td>
<td>Proportion of the population covered by a group of workers whose primary task is to visit women in their homes (at least in the rural areas) to talk about family planning and child care. Account is taken of the population that must be covered by each field worker; the score for the proportion of the country covered by field workers is deflated if the average population covered by each home-visiting worker is more than 15,000.</td>
</tr>
<tr>
<td>15. Administrative structure</td>
<td>Whether or not there is an adequate administrative structure and staff at three levels (national, provincial, and county). &quot;Adequate&quot; means that the administrative structure is sufficient to ensure that plans developed for each level are carried out; that the administrative structure is capable of recognizing and solving problems that cause low performance; and that the administrative structure is able and willing to use existing resources and/or to call upon higher administrative levels in obtaining resources needed to carry out plans for the delivery of family planning supplies and services.</td>
</tr>
<tr>
<td>16.* Training programs</td>
<td>Whether or not there is an adequate training program for each category of staff in the family planning program: administrative staff; physicians; nurses; paraprofessionals; village-level distributors; field workers/motivators; staff in other ministries and organizations; other types. &quot;Adequate&quot; means that the training provides personnel with the knowledge, information, and skills necessary to carry out their jobs effectively, and that facilities exist to carry out the training. The score is determined by the extent to which the training program, for each category of staff, is very good, moderately good, mediocre or poor, or nonexistent.</td>
</tr>
<tr>
<td>17. Personnel carry out assigned tasks</td>
<td>Extent to which each category of family planning program staff carries out assigned tasks (task implementation): administrative staff; physicians; nurses; paraprofessionals; village-level distributors; field workers/motivators; staff in other ministries and organizations; other types. The score is determined on the basis of the extent to which each category of staff carries out assigned tasks very well, moderately well, or poorly.</td>
</tr>
<tr>
<td>18.* Logistics and transport</td>
<td>Extent to which the logistics and transportation systems are sufficient to keep stocks of contraceptive supplies and related equipment available at all service points at all times, at the following levels: central; provincial; county. The score is based on the availability of supplies and equipment: all or almost all of the time; about half to three-quarters of the time; sometimes; or seldom or never.</td>
</tr>
<tr>
<td>19. Supervision</td>
<td>Whether or not there is an adequate system of supervision at all levels. &quot;Adequate&quot; means that: (a) supervisors exist at all levels of program operations in sufficient numbers to make possible supervisory visits at least once a month at service-delivery levels (and quarterly at higher administrative levels); (b) that supervisors in fact make such supervisory visits—to the work sites of the persons supervised; (c) that, during these supervisory visits, encouragement, advice, and support are provided to supervised workers, in addition to any necessary checking of operations and records that assist in the evaluation of worker performance; and (d) that supervisors carry through on providing/obtaining supplies and services identified as needed during their visits (or at least make serious attempts to obtain these needed supplies and services).</td>
</tr>
<tr>
<td>20.* Mass media for information, education, and communications (IMEC)</td>
<td>Frequency of mass media messages that provide family planning information, including where family planning services are available, and how much of the country is covered by various types of mass media: newspapers; magazines; radio; TV; mobile IMEC units (films, etc.); billboards and other outdoor media (buses, etc.); traditional types (puppet shows, folk dances, local theatre, etc.); other types. The frequency classifications include: at least once a month; sometimes (about once every three to six months); infrequently (about once a year or less often); never.</td>
</tr>
<tr>
<td>21. Incentives/disincentives</td>
<td>Use of monetary or other incentives for the adoption of family planning. The incentives may be provided to: clients; recruiters; service personnel, including CBD personnel; communities. The disincentives may refer to individuals or to communities, and include regulations or constraints designed to encourage family planning and/or small family size.</td>
</tr>
</tbody>
</table>
### Scale Item

**C. RECORD KEEPING AND EVALUATION**

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.***</td>
<td>Record keeping</td>
</tr>
<tr>
<td>23.***</td>
<td>Evaluation</td>
</tr>
<tr>
<td>24.***</td>
<td>Management use of evaluation findings</td>
</tr>
</tbody>
</table>

**D. AVAILABILITY AND ACCESSIBILITY OF FERTILITY CONTROL METHODS**

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.**</td>
<td>Male sterilization</td>
</tr>
<tr>
<td>26.**</td>
<td>Female sterilization</td>
</tr>
<tr>
<td>27.**</td>
<td>Pils (Injectables)</td>
</tr>
<tr>
<td>28.**</td>
<td>Condoms (and other conventional)</td>
</tr>
<tr>
<td>29.**</td>
<td>IUDs</td>
</tr>
<tr>
<td>30.***</td>
<td>Abortion</td>
</tr>
</tbody>
</table>

---

**Note:**
- *Included in the 1972 program effort scale, although with less detail for some questions.
- **Included in the 1972 program effort scale, as a combined question on the availability of male and female sterilisation services.
- ***Included in the 1972 program effort scale, as two questions: (a) on ready and easy access to pils, IUDs, and condoms, throughout the country in both the public and private sectors; (b) whether or not the Ministry of Health carries out a vigorous effort to provide family planning services throughout the country.
Council, The Pathfinder Fund, Battelle Memorial Institute, The Futures Group, The Research Triangle Institute (RTI), the International Planned Parenthood Federation (IPPF) in London, the IPPF Western Hemisphere, and Westinghouse Public Applied Systems, to develop a mailing list of persons knowledgeable about population policies and programs in specific countries. The questionnaire was translated from English into French and Spanish, and mailings were begun in late July 1983 to a sample of approximately 630 respondents, including personnel from agencies such as UNFPA, the World Bank, World Health Organization (WHO), and AID; program personnel; and other knowledgeable people both within and outside specific countries. We have had two follow-up mailings, and have received replies from more than 425 of our sample, a response rate of 67 percent. This paper is based on an analysis of the first 307 questionnaires received from ninety-three countries as of early December 1983.

Measures of family planning program effort include several items based on the judgments of knowledgeable actors (in family planning programs) and observers, rather than on the reported results of counting and sorting operations. With this data set, two broad sources of error must be considered: first, the validity of the actor or observer judgments, for example, about the quality of training programs, or of logistic systems; and second, the validity of the authors' interpretations of inconsistent respondent judgments on a given country's program.

Almost anyone acquainted with family planning programs in more than a handful of countries "knows" that some programs are "better" than others. Nonetheless, assigning objective criteria to distinguish between
good and poor programs is no small task, and one not often attempted by researchers. In this paper, a new measure of program effort is presented, which we believe is improved over our 1972 measure. However, it is not without problems. For example, the new scale includes attention to private sector activities, but further modification of this measure might improve the measurement of such activities. In addition, at the conceptual level, a number of the scale items depend heavily on judgments, rather than on observable and thereby verifiable facts. However, these judgments have been made by persons knowledgeable about the program on which they reported.

A Framework for Understanding Program Effort

Family planning programs are carried out within a variety of social and economic contexts, and their effects coincide with those of other influences on contraceptive use and fertility; it is therefore important to conceptualize the ways in which family planning programs might affect prevalence and fertility. Figure 2 represents schematically a conceptual framework that draws on earlier work by Freedman (1961-62), Easterlin (1978), and the Panel on Fertility Determinants, National Academy of Sciences (1983), with greater attention to the detailed processes "inside the program," and recognition of the proximate determinants of fertility.

Within our framework, program effort is characterized according to four components. First, there are two broad groups of program activities: **policy and stage-setting activities** (those steps a government, and/or to some degree private organizations, might undertake to affect the organization and implementation of a program); and **service and service-related activities** (steps taken to make it easier for people
Figure 2 A Framework for Understanding Program Effort in the Conditions of Fertility Decline

Institutions; social and econ. structure; norms; external conditions, etc.

Demand

Motivation for fertility regulation

Supply

"Within the Program"
Public or Private FP
(A)

Policies and stage-setting activities

Statistical record-keeping; evaluation, and management use of evaluation findings

Service & service-related activities

Availability & accessibility:
Contraception; Sterilization (M & F)
Abortion

Proximate determinants

Age at marr.
Breastfeeding

Use of contraception;
Use of abortion

Use of other methods:
rhythm
abstinence

FERTILITY
to obtain and use a variety of family planning methods). Closely linked to service delivery is record keeping and evaluation. Taken together, these three groups of activities "inside the program" make possible the availability and accessibility of fertility-control supplies and services (contraceptives, male and female sterilization, and, where culturally acceptable, abortion services). The responses to questionnaires used for this study were organized according to these components, which are described in detail in our full report.

Changes in Program Effort 1972-82

The major differences between the 1972 and 1982 measures of program effort are as follows:

- There are thirty items in the 1982 measure, as compared with fifteen items in the 1972 scale; twelve of the fifteen 1972 items are very similar in both scales, while three were represented by five questions for the new scale. One of the last-mentioned items, on "vigorous effort" to provide supplies and services, was not included directly in the 1982 scale.

- The 1982 questions were much more detailed than those for 1972.

- The scores for 1972 were zero, one, or two, whereas the 1982 scores ranged from zero to four, and part scores (for example, 0.5 or 0.1) were used. Thus at the low end of the scale, small efforts received a positive score in 1982 but a zero score in 1972. Accordingly, a minor part of the reported increase in scores from 1972 and 1982 is attributable to the revised scoring system, although this probably accounts for no more than one or two points.

In the new scale, there are eight items on policy and stage-setting activities, thirteen on service and service-related activities, three on record keeping and evaluation, and six on the availability and accessibility of fertility-control supplies and services. (Copies of the questionnaire and of the scoring codes and rules are available upon request. They will be published in the forthcoming full report on this study.)
With thirty items, the possible total scoring range is 0-120. Within this range, possible scores have been divided into four levels of effort:

<table>
<thead>
<tr>
<th>Program Effort Level</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong</td>
<td>80 and above</td>
</tr>
<tr>
<td>Moderate</td>
<td>55-79</td>
</tr>
<tr>
<td>Weak</td>
<td>25-54</td>
</tr>
<tr>
<td>Very little or none</td>
<td>0-24</td>
</tr>
</tbody>
</table>

One aspect of this scoring process must be emphasized: the reported scores represent the authors' best judgment as to the score indicated by the data received. Specifically, instead of taking the average of all answers on the questionnaires received for each country, we tried to ascertain the most appropriate score for each item for each country, using all of the information provided and otherwise available. For example, marginal notes and comments at the end of the questionnaires often provided clues; for some items, such as policies, reference was made to other documents, such as The Population Council Fact Books (Nortman and Fisher, 1982; Tietze, 1983) and the United Nations Monitoring Reports (United Nations, 1982 and forthcoming). In some cases, especially when no other information was available, the respondent data were averaged, although even in these cases, a respondent way out of line with others tended to be discounted.

The score range for each scale item is 0-4, with four indicating a strong policy or much activity on an item. However, a four does not mean that the maximum possible is being accomplished in the country. For example, a score of 4 on the training item can be obtained by having "very good" answers on training for two categories of personnel, and "moderately good" on training for four other categories.
Such a country might have poor training for a seventh category of personnel; in any case, the four "moderately good" situations could be improved.

Finally, the combined 1972 and 1982 program effort score was obtained by multiplying the 1972 score by two and dividing the 1982 score by two. This gave equal weight to the 1972 and 1982 scores since the maximum for the 1972 score was 30, and for the 1982 score was 120. The same cutting points as those previously established for the 1982 score were used to characterize programs as follows:

- **Strong**: 80+
- **Moderate**: 55-79
- **Weak**: 25-55
- **Very Weak**: 0-24 or None

This combined scale is used later in this paper, in an analysis of program effort and fertility decline.

**Findings by Country**

Figure 3 is a scatter diagram of program effort scores in 1972 and 1982, with each set of scores being transformed to a 0-100 scale. In general, there are more countries above than below the diagonal; this reflects moderately higher scores in 1982 than in 1972. Countries with the highest scores are very close to the diagonal; that is, countries with very high scores in 1972 typically maintained a strong program during the intervening decade. Countries with significantly weaker programs in 1982 than in 1972 include Costa Rica, Fiji, Vietnam, and Jamaica. Countries with significantly stronger programs in 1982 than in 1972 include Indonesia, Sri Lanka, Colombia, Mexico, and Bangladesh. Figure 3 also indicates that the average score increased from twenty-one
Figure 3. Program Effort in Developing Countries, 1972 and 1982

Program Effort 1972 vs. Program Effort 1982

<table>
<thead>
<tr>
<th>VALUE</th>
<th>1972</th>
<th>1982</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVERAGE</td>
<td>21</td>
<td>30</td>
</tr>
<tr>
<td>MEDIAN</td>
<td>23</td>
<td>25</td>
</tr>
</tbody>
</table>

$R^2 = 0.73$
to thirty during the decade, whereas the median score increased only from twenty-three to twenty-five. (Recall that for this scatter diagram, the scale is 0-100; on the scale of 0-120 used throughout the rest of this paper and in companion pieces, the increase in the average score for the countries included in both years is from twenty-five to thirty-five).

The changes in program effort scores are summarized in a 4x4 table (Table 1), which classifies scores as strong, moderate, weak, very weak, or none. Although this table obscures some of the changes, it also reflects others that are significant. Most of the countries remain on the diagonal, although the first group of countries identified above shifted from strong in 1972 to moderate in 1982, and to weak in the case of Costa Rica. Mexico and Bangladesh moved from weak to moderate, and Indonesia, Sri Lanka, and Colombia moved from moderate to strong. The largest gainers in program effort are shown in Figure 4.

Table 2 presents scores for both overall program effort and the four components described earlier—policy and stage-setting activities, service and service-related activities, record keeping and evaluation, and availability and accessibility (AA). The table lists the ninety-three countries in order of program effort score. Ranging widely in their total program effort scores, the ninety-three countries include several with little or no program effort, and nine with scores over eighty. One of the latter, the People's Republic of China, is the only country to surpass 100, although three other countries in East Asia score in the nineties; Mexico, at seventy-nine, just misses this top category. In general, the high-scoring countries tend to do well on all components; note in particular their AA scores, which are at or near the maximum of twenty-four in five of the nine cases.
Table 1. Comparison of 1972 and 1982 Program Effort Scores: 87 Countries

<table>
<thead>
<tr>
<th>1982 Scores</th>
<th>1972 Scores</th>
<th>Moderate</th>
<th>Weak</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong (80+)</td>
<td>China (PRC), Singapore, Taiwan, Rep. of Korea, Mauritius, Hong Kong</td>
<td>Indonesia, Sri Lanka, Colombia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate (55-79)</td>
<td>Jamaica, Vietnam*, Fiji</td>
<td>El Salvador, India, Thailand, Tunisia, Dominican Republic, Philippines, Cuba, Malaysia, Panama, Trinidad &amp; Tobago</td>
<td>Mexico, Bangladesh</td>
<td></td>
</tr>
<tr>
<td>Weak (25-54)</td>
<td>Costa Rica</td>
<td>Chile</td>
<td>Brazil, Ecuador, Pakistan, Nepal, Egypt, Morocco, Haiti, Venezuela, Turkey, Kenya, Guatemala, Algeria, Papua N.G., Liberia, Honduras, Tanzania, Zimbabwe</td>
<td>Lebanon, Rwanda, Peru</td>
</tr>
</tbody>
</table>

*1972 Score is for North Vietnam only.
Figure 4. Countries Having Largest Gains in Program Effort, 1972-82
Table 2. Program Effort Scores for 93 Countries, Classified by Effort Levels and Components*  

<table>
<thead>
<tr>
<th>Effort Level and Country</th>
<th>Total Score</th>
<th>Policy &amp; Stage-Setting Activities</th>
<th>Service and Service-Related Activities</th>
<th>Record Keeping and Evaluation</th>
<th>Availability &amp; Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong</td>
<td>120</td>
<td>32</td>
<td>52</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>Maximum Possible Score</td>
<td>120</td>
<td>32</td>
<td>52</td>
<td>12</td>
<td>24</td>
</tr>
</tbody>
</table>

**Strong**

- China 100.9 31.0 40.1 6.8 23.0
- Republic of Korea 96.9 22.8 40.8 9.3 24.0
- Singapore 95.3 21.4 39.4 10.5 24.0
- Taiwan 92.6 20.1 37.1 11.4 24.0
- Indonesia 87.1 23.0 39.6 10.9 13.6
- Colombia 85.3 19.5 36.0 11.0 20.8
- Mauritius 84.6 25.4 39.3 8.3 11.6
- Hong Kong 82.6 17.7 30.0 11.4 23.5
- Sri Lanka 81.6 20.9 36.5 7.3 16.9

**Moderate**

- Mexico 78.6 23.2 30.7 8.3 16.4
- El Salvador 75.4 17.9 32.5 7.0 18.0
- India 74.7 25.7 26.3 6.8 13.9
- Thailand 70.5 16.6 23.9 8.5 19.5
- Tunisia 69.8 19.8 25.0 7.5 17.5
- Bangladesh 68.7 16.8 28.3 5.3 16.3
- Dominican Republic 64.3 16.3 27.4 5.6 15.0
- Jamaica 64.1 20.8 23.3 5.0 15.0
- Philippines 63.6 15.3 27.0 6.1 15.0
- Cuba 61.5 8.6 27.5 5.4 20.0
- Malaysia 61.1 18.9 18.4 8.7 15.1
- Panama 59.2 14.3 17.2 9.4 18.3
- Vietnam 57.6 16.6 25.4 5.4 10.2
- Fiji 55.4 16.9 22.1 3.2 13.2
- Trinidad 55.0 17.7 17.8 6.7 12.8

**Weak**

- Chile 52.1 14.2 18.8 8.2 10.9
- Brazil 50.1 11.6 18.5 7.6 12.7
- Ecuador 49.4 12.4 17.7 5.0 14.3
- Pakistan 48.5 16.8 14.5 6.3 8.9
- Nepal 46.3 18.3 15.8 5.1 7.1
- Egypt 43.7 16.1 17.5 3.0 9.1
- Morocco 43.4 12.9 19.2 4.9 8.4
- Haiti 43.8 15.2 15.3 5.1 8.2
- Lebanon 42.4 6.0 19.0 7.6 9.8
- Costa Rica 39.8 10.3 11.8 4.4 13.3
- Cyprus 39.0 7.7 17.9 3.4 10.0
- Venezuela 37.5 14.8 12.6 4.8 5.5
- Turkey 35.0 16.4 10.6 4.5 3.5
- Botswana 34.5 12.6 16.2 1.5 6.8
- Guatemala 34.1 5.6 11.6 5.5 11.4
- W. Samoa 33.8 13.3 12.0 3.6 4.9
- Kenya 33.7 13.7 12.7 3.8 3.5
- Zimbabwe 32.9 11.0 15.1 1.7 5.1
- Zambia 31.2 16.6 8.7 1.9 4.0
- Papua New Guinea 30.6 12.7 6.7 2.7 8.5
- Algeria 30.0 13.5 10.1 5.2 1.2
- Guyana 29.9 4.3 13.0 2.6 10.0
- Liberia 27.9 13.7 9.6 2.3 2.3
- Rwanda 27.6 16.7 8.3 2.0 0.6
- Peru 26.4 10.7 6.6 3.4 3.7
- Tanzania 26.2 11.1 11.6 1.6 1.9
- Honduras 26.2 17.6 4.6 0.0 4.0

*The information in this table is presented alphabetically by country in Appendix C.
Table 2. Program Effort Scores for 93 Countries, Classified by Effort Levels and Components* (cont'd)

<table>
<thead>
<tr>
<th>Component</th>
<th>Service Record</th>
<th>Policy &amp; Service-Keeping</th>
<th>Record Keeping</th>
<th>Availability &amp; Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effort Level</td>
<td>Total Score</td>
<td>Stage-Setting Activities</td>
<td>Related Activities</td>
<td>Evaluation</td>
</tr>
<tr>
<td>Very Weak or None</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senegal</td>
<td>22.9</td>
<td>9.4</td>
<td>9.2</td>
<td>1.5</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>22.1</td>
<td>4.0</td>
<td>8.8</td>
<td>2.4</td>
</tr>
<tr>
<td>Uganda</td>
<td>21.9</td>
<td>11.6</td>
<td>6.7</td>
<td>2.3</td>
</tr>
<tr>
<td>Congo</td>
<td>21.5</td>
<td>10.2</td>
<td>6.8</td>
<td>2.4</td>
</tr>
<tr>
<td>Ghana</td>
<td>20.5</td>
<td>10.1</td>
<td>7.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Yemen, PDR</td>
<td>20.2</td>
<td>7.5</td>
<td>9.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Jordan</td>
<td>19.0</td>
<td>5.0</td>
<td>2.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>17.8</td>
<td>9.6</td>
<td>4.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Nigeria</td>
<td>17.4</td>
<td>7.0</td>
<td>6.1</td>
<td>1.3</td>
</tr>
<tr>
<td>Mozambique</td>
<td>17.4</td>
<td>8.0</td>
<td>4.2</td>
<td>3.4</td>
</tr>
<tr>
<td>Afghanistan</td>
<td>16.7</td>
<td>4.8</td>
<td>8.4</td>
<td>1.5</td>
</tr>
<tr>
<td>Zaire</td>
<td>16.3</td>
<td>5.9</td>
<td>0.0</td>
<td>1.7</td>
</tr>
<tr>
<td>Lesotho</td>
<td>15.5</td>
<td>7.6</td>
<td>6.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Zambia</td>
<td>14.7</td>
<td>8.1</td>
<td>2.7</td>
<td>1.9</td>
</tr>
<tr>
<td>Togo</td>
<td>13.1</td>
<td>5.5</td>
<td>5.2</td>
<td>1.6</td>
</tr>
<tr>
<td>Burundi</td>
<td>12.3</td>
<td>9.5</td>
<td>1.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Mali</td>
<td>11.6</td>
<td>3.5</td>
<td>4.8</td>
<td>1.6</td>
</tr>
<tr>
<td>Paraguay</td>
<td>10.7</td>
<td>2.0</td>
<td>3.7</td>
<td>0</td>
</tr>
<tr>
<td>Madagascar</td>
<td>8.9</td>
<td>2.8</td>
<td>3.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Bolivia</td>
<td>8.7</td>
<td>2.5</td>
<td>4.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Somalia</td>
<td>8.5</td>
<td>3.5</td>
<td>3.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Chad</td>
<td>8.3</td>
<td>5.0</td>
<td>2.9</td>
<td>0</td>
</tr>
<tr>
<td>Yemen, AR</td>
<td>8.2</td>
<td>5.1</td>
<td>1.6</td>
<td>0</td>
</tr>
<tr>
<td>Cameroon</td>
<td>8.1</td>
<td>4.5</td>
<td>1.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Sudan</td>
<td>7.3</td>
<td>3.9</td>
<td>2.8</td>
<td>0</td>
</tr>
<tr>
<td>Niger</td>
<td>7.4</td>
<td>5.6</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>7.4</td>
<td>2.5</td>
<td>3.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Syria</td>
<td>7.3</td>
<td>2.4</td>
<td>2.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Malawi</td>
<td>6.5</td>
<td>4.0</td>
<td>1.1</td>
<td>0.3</td>
</tr>
<tr>
<td>Kuwait</td>
<td>6.1</td>
<td>3.1</td>
<td>1.0</td>
<td>0</td>
</tr>
<tr>
<td>Mauritania</td>
<td>4.2</td>
<td>1.3</td>
<td>1.4</td>
<td>0</td>
</tr>
<tr>
<td>Iraq</td>
<td>3.7</td>
<td>2.0</td>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>Ivory Coast</td>
<td>3.7</td>
<td>2.2</td>
<td>0.2</td>
<td>0</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td>3.6</td>
<td>2.3</td>
<td>1.0</td>
<td>0</td>
</tr>
<tr>
<td>Burma</td>
<td>3.4</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Central African Rep.</td>
<td>2.8</td>
<td>2.0</td>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>Guinea</td>
<td>2.3</td>
<td>1.7</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>Equitorial Guinea</td>
<td>0.5</td>
<td>0.0</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>Dem. Kampuchea</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Laos</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Libya</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mongolia</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*The information in this table is presented alphabetically by country in Appendix C.
How good is a score of ninety or more on this scale with a possible maximum of 120? Excellent, we suggest, and scores in the eighties are very good. However, another way to examine the data in Table 2 is according to how well countries do on each component. Other than total scores, what differentiates the strong, moderate, and weak program effort countries? For each program effort level, Table 3 shows the mean score and mean proportion of the maximum score obtained on each component. The results are instructive. For two components in Table 3—service and service-related activities, and availability and accessibility—the strong program effort countries score nearly three times as high as the weak effort countries. The differences among effort levels on policy and stage-setting activities are much less—69 percent of the maximum among the strong effort countries and 40 percent among the weak effort countries. It appears that the countries with strong program effort give considerable attention to providing services and to making sure that fertility-control supplies and services are readily and easily available and accessible to the population.

An additional comment is necessary. There is a lag, typically of several years, between the adoption of a policy, the implementation of the program, and resultant effects on fertility. Thus, countries that have recently adopted policies to reduce fertility may score high on this item but score less well on other items. Also, policy and stage-setting activities may be the easiest to implement in the development of population programs. If so, one would expect countries in general to score higher on this component. The data in Table 3 suggest that this is in fact the case: for all ninety-three countries, the highest proportion of the maximum score is obtained for the policy and stage-setting
Table 3. Mean Score and Proportion of Maximum Score Obtained on Each Component for Groups of Countries Classified by Level of Program Effort

<table>
<thead>
<tr>
<th>Program Effort Level</th>
<th>Policy and Stage-Setting Activities</th>
<th>Service and Service-Related Activities</th>
<th>Recordkeeping and Evaluation</th>
<th>Availability and Accessibility</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of Mean Max</td>
<td>% of Mean Max</td>
<td>% of Mean Max</td>
<td>% of Mean Max</td>
<td>Mean Max</td>
</tr>
<tr>
<td>Strong (9 Countries)</td>
<td>22.2 69</td>
<td>37.3 72</td>
<td>9.7 81</td>
<td>20.0 83</td>
<td>89.2 74</td>
</tr>
<tr>
<td>Moderate (15 Countries)</td>
<td>17.8 56</td>
<td>25.2 49</td>
<td>6.6 56</td>
<td>15.7 65</td>
<td>65.4 55</td>
</tr>
<tr>
<td>Weak (27 Countries)</td>
<td>12.9 40</td>
<td>13.1 25</td>
<td>4.0 33</td>
<td>7.1 30</td>
<td>37.1 31</td>
</tr>
<tr>
<td>Very Weak or None (42 Countries)</td>
<td>4.4 14</td>
<td>3.2 6</td>
<td>0.9 8</td>
<td>1.7 7</td>
<td>10.2 9</td>
</tr>
<tr>
<td>All Effort Levels</td>
<td>10.8 34</td>
<td>13.0 25</td>
<td>3.5 29</td>
<td>7.3 30</td>
<td>34.6 29</td>
</tr>
<tr>
<td>Maximum</td>
<td>32 52</td>
<td>12</td>
<td>24</td>
<td>120</td>
<td></td>
</tr>
</tbody>
</table>

Note: Mean scores are based on unit weights for each country.
activities. This can be attributed to the countries in the weak and very weak/none program effort groups. That is, in these countries, the percentage of the maximum score is higher for policy and stage-setting activities than for other components: for the weak effort group, 40 percent versus 25, 30, and 33 percent; and for the very weak/none group, 14 percent versus 6, 7, and 8 percent.

**Regional Differences**

While not surprising to specialists in the population field, the regional differences revealed by our study are remarkable: the mean unweighted program effort scores for 1982 are fifty-five for countries in South and East Asia, and forty-six for countries in Latin America (Table 4); the mean unweighted scores for countries in the Middle East and North Africa, and in sub-Saharan Africa, are much lower—twenty-four and eighteen respectively.

Table 4 also shows the means weighted by population size, for all ninety-three countries, for each region, and for components within regions. Whereas the mean unweighted program effort score for the ninety-three countries is about thirty-five, the weighted score is double that; the large countries, with their strong and moderate program effort, pull up the weighted average. Prominent in this process, of course, is China, but India's score of seventy-five for 706 million people also increases the weighted mean. Thus, measured on a country-by-country basis, the score of thirty-five out of 120 suggests a long way to go, while measured on a population basis, an average score of seventy out of 120 means a much higher level of program effort.

The regional differences are highlighted by the weighted scores. For East and South Asia, the weighted mean scores, total and for
Table 4. Mean Program Effort Scores, Classified by Region, and by Score Components (Unweighted and Weighted)*

<table>
<thead>
<tr>
<th>Region</th>
<th>Policy and Stage-Setting Activities</th>
<th>Service and Service-Related Activities</th>
<th>Recordkeeping and Evaluation</th>
<th>Availability and Accessibility</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unweighted</td>
<td>Weighted</td>
<td>Unweighted</td>
<td>Weighted</td>
<td>Unweighted</td>
</tr>
<tr>
<td>A. Mean Scores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South and East Asia</td>
<td>15.4</td>
<td>25.7</td>
<td>21.7</td>
<td>33.1</td>
<td>5.7</td>
</tr>
<tr>
<td>Latin America</td>
<td>12.6</td>
<td>14.6</td>
<td>17.1</td>
<td>21.4</td>
<td>5.2</td>
</tr>
<tr>
<td>Middle East and North Africa</td>
<td>7.7</td>
<td>11.6</td>
<td>8.9</td>
<td>11.2</td>
<td>2.5</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>7.9</td>
<td>7.1</td>
<td>6.4</td>
<td>6.7</td>
<td>1.5</td>
</tr>
<tr>
<td>All Regions (93 Countries)</td>
<td>10.8</td>
<td>21.7</td>
<td>13.0</td>
<td>27.7</td>
<td>3.5</td>
</tr>
<tr>
<td>Maximum Possible</td>
<td>32</td>
<td>52</td>
<td>12</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

| B. Percent of Maximum Score     |            |            |            |            |            |            |            |            |            |            |         |
| South and East Asia             | 48         | 80         | 42         | 64         | 48         | 50         | 52         | 73         | 46         | 70         |         |
| Latin America                   | 39         | 46         | 33         | 41         | 43         | 59         | 48         | 55         | 39         | 47         |         |
| Middle East and North Africa    | 24         | 36         | 17         | 22         | 21         | 26         | 21         | 20         | 20         | 26         |         |
| Sub-Saharan Africa              | 23         | 22         | 12         | 13         | 13         | 13         | 9          | 9          | 15         | 14         |         |
| All Regions (93 Countries)      | 34         | 68         | 25         | 53         | 29         | 51         | 30         | 61         | 29         | 59         |         |
| Maximum Possible                | 100        | 100        | 100        | 100        | 100        | 100        | 100        | 100        | 100        | 100        |         |

*Scores are weighted according to population size in 1982.
each component, go up; to a lesser degree, the same occurs for Latin America. However, the result in Africa is the same: weighted and unweighted scores are low, especially for the components availability and accessibility of fertility-control supplies and services, and service and service-related activities. Therefore, the differences between sub-Saharan Africa and East and South Asia are greater in light of the weighted scores.

The lower panel in Table 4 presents the unweighted and weighted means in terms of the percent of maximum score. For all ninety-three countries, the weighted percent of maximum score is fifty-nine, but the differences among regions are striking: the score for South and East Asia at 70 percent of the maximum is five-fold greater than that for sub-Saharan Africa, and considerably higher than that for Latin America and the Middle East and North Africa.

A Parsimonious Set of Program Effort Items

Steps described in detail in our full report led to the selection of a parsimonious set of program effort variables, which together turn out to be excellent predictors of crude birth rate declines:

1. Supervision system
2. Personnel carry out assigned tasks
3. Use of mass media for information, education, and communication (IE&C)
4. Postpartum programs
5. Availability and accessibility of fertility-control supplies and services.
6. Management use of evaluation findings.
These variables give an $R^2$ value of .80 with CBR decline 1965-80. Note that this set includes five individual program effort items plus the availability and accessibility component, that is, the summary measure for that component. The five individual items include four service and service-related items, one record-keeping and evaluation item, and no policy and stage-setting items. An $R^2$ of .77 is obtained using three of the variables, supervision system, personnel carry out assigned tasks, and availability/accessibility. It should be noted that several items included in our program effort scale such as social marketing and use of incentives have been but little used. If they are used more in the future it is possible that they would be important indicators of a successful program.

It is of some interest to compare this set of predictors with the "least good" set, which includes the following:

1. Statements by leaders
2. Import laws and legal regulations
3. Advertising of contraceptives allowed
4. Training program
5. Use of incentives and disincentives
6. Social marketing program

Many family planning programs have been in existence for a decade or more, and we speculate that the relatively small contribution of the first three items listed above reflects the fact that while probably important, these items are inadequate without the addition of programmatic activities. We may not have a good measure of training programs, and it may be that how workers actually perform their jobs is much more important than the training program itself. Incentives and disincentives have been little used, with the notable exceptions of China and Singapore, and as a result there is not much variance in the scores
on this item for most of the countries. Similarly, social marketing
programs are relatively new and are not yet widely used.

Program Effort and Fertility Decline

We turn next to a brief cross-tabulational analysis relating
our program effort index to fertility decline. Table 5 presents data on
CBR decline 1965-80, with countries classified by socioeconomic
setting in 1970 and by strength of program effort 1972-82. The mean
CBR decline in each of the 16 cells of the table was calculated by
assigning unit weights to each country. It is also possible to weight
the data by population size. However, when this is done, China dominates
the summary values in the column and row in which it is located. (Using
weights by population size increases the average CBR decline for
countries with a strong program effort from the 36 shown to 43, and the
average value for countries in the upper middle socioeconomic group from
13 to 37. Similarly, India lowers the average for countries with
moderate program effort from 26 to 21, and increases the average for
countries in the lower middle social setting group from 5 to 15.)

The mean CBR declines in the 16 cells of the table, with unit
weights for countries, are as follows:

<table>
<thead>
<tr>
<th>Socioeconomic Setting</th>
<th>Program Effort 1972-82</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strong</td>
</tr>
<tr>
<td>High</td>
<td>34</td>
</tr>
<tr>
<td>Upper Middle</td>
<td>43</td>
</tr>
<tr>
<td>Lower Middle</td>
<td>..</td>
</tr>
<tr>
<td>Low</td>
<td>..</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
</tr>
</tbody>
</table>
Table 5 1965-80 Crude Birth Rate Declines (in percents), by 1970 Social Setting and 1972-82 Program Effort: 87 Developing Countries

<table>
<thead>
<tr>
<th>Social Setting</th>
<th>Strong</th>
<th>Moderate</th>
<th>Weak</th>
<th>Very Weak or None</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Singapore</td>
<td>43</td>
<td></td>
<td>59</td>
<td>1. Brazil</td>
<td>27</td>
</tr>
<tr>
<td>2. Hong Kong</td>
<td>40</td>
<td></td>
<td>35</td>
<td>2. Mexico</td>
<td>22</td>
</tr>
<tr>
<td>4. Taiwan</td>
<td>30</td>
<td></td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Mauritius</td>
<td>28</td>
<td></td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Costa Rica</td>
<td>24</td>
<td></td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Trin. &amp; Tob</td>
<td>23</td>
<td></td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Fiji</td>
<td>18</td>
<td></td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>34</td>
<td>Mean 31</td>
<td>Mean 21</td>
<td>Mean 11</td>
<td>25</td>
</tr>
<tr>
<td>Upper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. China</td>
<td>43</td>
<td></td>
<td>37</td>
<td>1. Turkey</td>
<td>34</td>
</tr>
<tr>
<td>2. Thailand</td>
<td>30</td>
<td></td>
<td>28</td>
<td>2. Egypt</td>
<td>12</td>
</tr>
<tr>
<td>5. Tunisia</td>
<td>19</td>
<td></td>
<td>19</td>
<td>5. Morocco</td>
<td>6</td>
</tr>
<tr>
<td>7. El Salvador</td>
<td>11</td>
<td></td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>43</td>
<td>Mean 31</td>
<td>Mean 23</td>
<td>Mean 12</td>
<td>3</td>
</tr>
<tr>
<td>Middle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Indonesia</td>
<td>28</td>
<td></td>
<td>27</td>
<td>1. Haiti</td>
<td>11</td>
</tr>
<tr>
<td>2. India</td>
<td>17</td>
<td></td>
<td>16</td>
<td>2. Pakistan</td>
<td>9</td>
</tr>
<tr>
<td>Mean</td>
<td>19</td>
<td>Mean 7</td>
<td>Mean 2</td>
<td>Mean 2</td>
<td>5</td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Bangladesh</td>
<td>0</td>
<td></td>
<td>0</td>
<td>1. Mauritania</td>
<td>6</td>
</tr>
<tr>
<td>2. Nepal</td>
<td>-1</td>
<td></td>
<td>-1</td>
<td>2. Laos, PDR</td>
<td>5</td>
</tr>
<tr>
<td>4. Guinea</td>
<td>2</td>
<td></td>
<td>2</td>
<td>4. Togo</td>
<td>2</td>
</tr>
<tr>
<td>5. Nigeria</td>
<td>1</td>
<td></td>
<td>1</td>
<td>5. Senegal</td>
<td>1</td>
</tr>
<tr>
<td>7. Chad</td>
<td>0</td>
<td></td>
<td>0</td>
<td>7. Eritrea</td>
<td>0</td>
</tr>
<tr>
<td>8. Ethiopia</td>
<td>0</td>
<td></td>
<td>0</td>
<td>8. Madagascar</td>
<td>0</td>
</tr>
<tr>
<td>9. Malawi</td>
<td>0</td>
<td></td>
<td>0</td>
<td>9. Mozambique</td>
<td>0</td>
</tr>
<tr>
<td>10. Rwanda</td>
<td>0</td>
<td></td>
<td>0</td>
<td>10. Uganda</td>
<td>0</td>
</tr>
<tr>
<td>11. Senegal</td>
<td>0</td>
<td></td>
<td>0</td>
<td>11. Cameroon</td>
<td>0</td>
</tr>
<tr>
<td>12. Sudan</td>
<td>0</td>
<td></td>
<td>0</td>
<td>12. Zaire</td>
<td>0</td>
</tr>
<tr>
<td>13. Zaire</td>
<td>0</td>
<td></td>
<td>0</td>
<td>13. Zambia</td>
<td>0</td>
</tr>
<tr>
<td>14. Liberia</td>
<td>0</td>
<td></td>
<td>0</td>
<td>14. Ireland</td>
<td>0</td>
</tr>
<tr>
<td>15. lesotho</td>
<td>0</td>
<td></td>
<td>0</td>
<td>15. South Africa</td>
<td>0</td>
</tr>
<tr>
<td>Mean</td>
<td>0</td>
<td>Mean 1</td>
<td>Mean 1</td>
<td>Mean 1</td>
<td>1</td>
</tr>
</tbody>
</table>

*1972 Program Effort Score is for North Vietnam only.
The CBR declines increase in an orderly fashion as one moves from very weak or none to strong on program effort, and from low to high on social setting. The single exception is the cell in which China is located—strong on program effort and upper middle on social setting. China's CBR decline has been greater than might be expected on the basis of its socioeconomic conditions. However, that country's extremely strong population policy and program are well known, and thus the reader is unlikely to be surprised by this large decrease in fertility rates despite more modest, though impressive, socioeconomic achievements. CBR declines are somewhat greater when countries are classified by strength of program effort rather than by social setting; this suggests that program effort can, and does, lead to more rapid fertility decline than would be likely based only on SES variables. (The marginal CBR declines range from 1 to 25 on social setting and from 3 to 36 on program effort.)

A few countries merit attention. Indonesia is well known for its vigorous family planning program, which we classified as moderate in 1972 and strong in 1982. On social setting, it ranks in the lower middle group. Indonesia's CBR decline was appreciably more than expected on the basis of SES—28 percent rather than the average of 5 for all countries in that grouping. Mexico did not start its population program until 1974, but by 1982 had developed a moderately strong program. Its average program effort score for the 1972-82 period placed it just below the cut-off point between weak and moderate effort. Finally, although Brazil, Turkey, and Lebanon are examples of countries with weak or very weak program effort, they rank relatively high on SES variables, and their CBR declines have been more than 25 percent. Private-sector family planning efforts are significant in several states in Brazil; moreover,
some observers believe that organized family planning programs plus availability and accessibility of fertility-control methods should place Brazil in the moderate program effort group. We believe, however, that these three countries illustrate fertility decline that is due primarily to socioeconomic factors, coupled with changing demand for children.

Conclusions

After about a quarter of a century of intensifying work in the family planning field in developing countries, this study shows that a great deal of family planning program effort exists in a small number of countries; moderate effort occurs in a larger number of countries; and weak or very little effort is found in an even greater number of countries, including many in the Middle East, North Africa, and sub-Saharan Africa. However, despite increases in program effort during the last decade in a number of countries, program effort remains low in many countries, especially as regards the ready and easy availability and accessibility of fertility-control supplies and services.

Concerning change over time, between 1972 and 1982 there was a modest increase in program effort in more than half of the ninety-three countries studied and a substantial increase in program effort in more than a third. Table 6 summarizes these changes, using four SES categories and, to measure change in program effort, the difference in the proportions of the maximum score obtained in 1972 and 1982. The first column in Table 6 indicates a scattering of countries with modest to substantial increases in program effort, in all four SES categories. The second column, where countries up in proportion .10 to .24 are listed, has a larger number, again in all four SES categories, including seven with low SES--six of them in sub-Saharan Africa. A still larger
Table 6 Change in Program Effort 1972-82: 87 Countries Classified by Socioeconomic Conditions and Amount of Change in Program Effort a/

<table>
<thead>
<tr>
<th>Socioeconomic Conditions in 1970</th>
<th>Up in Proportion .25 or more</th>
<th>Up in Proportion .10 - .24</th>
<th>Essentially No Change: + .09</th>
<th>Down in Proportion .10 or more</th>
<th>Total Number of Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>.53 x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>.42 x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lebanon</td>
<td>.35 x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>.43</td>
<td>Mean .19</td>
<td></td>
<td></td>
<td>Mean .23</td>
</tr>
<tr>
<td>No. of Countries</td>
<td>3</td>
<td>No. of Countries 3</td>
<td></td>
<td></td>
<td>No. of Countries 5</td>
</tr>
<tr>
<td><strong>Upper Middle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>.28 **</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morocco</td>
<td>.25 x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>.27</td>
<td>Mean .17</td>
<td></td>
<td></td>
<td>Mean .19</td>
</tr>
<tr>
<td>No. of Countries</td>
<td>2</td>
<td>No. of Countries 9</td>
<td></td>
<td></td>
<td>No. of Countries 1</td>
</tr>
<tr>
<td><strong>Lower Middle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haiti</td>
<td>.27 x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>.26 **</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Papua N.G.</td>
<td>.26 x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>.26</td>
<td>Mean .16</td>
<td></td>
<td></td>
<td>Mean .19</td>
</tr>
<tr>
<td>No. of Countries</td>
<td>3</td>
<td>No. of Countries 8</td>
<td></td>
<td></td>
<td>No. of Countries 1</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bangladesh</td>
<td>.47 x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>.47</td>
<td>Mean .14</td>
<td></td>
<td></td>
<td>Mean .19</td>
</tr>
<tr>
<td>No. of Countries</td>
<td>1</td>
<td>No. of Countries 7</td>
<td></td>
<td></td>
<td>No. of Countries 0</td>
</tr>
<tr>
<td>Total No. of Countries</td>
<td>9</td>
<td>27</td>
<td>45</td>
<td>6</td>
<td>87</td>
</tr>
</tbody>
</table>

a/ Measured as the difference in the proportion of the maximum possible score 1972 and 1982.

Key: ++ strong program effort in 1982; * moderate program effort in 1982; x weak program effort in 1982.
number of countries had essentially no change in program effort between 1972 and 1982, some because they scored high on the program effort scale in 1972 and stayed high (for example, Singapore and Taiwan), and some because they scored low on both dates. A handful of countries, nearly all with high SES, went down in program effort between 1972 and 1982.

To show the relationship between change in program effort 1972-82 and the actual level in 1982, the strength of program effort in the latter year is indicated in Table 6 by the symbols + and x: ++ = strong; + = moderate; x = weak. Among the nine countries in the first column (up in proportion .25 or more), in 1982, two had strong program effort, two had moderate program effort, and five were still in the weak category. The second column in Table 6 also includes a wide range of 1982 program effort, here with the addition of several countries that had very weak program effort in 1982. A clear message here is that there is much room for increased program effort. Note that among the thirteen countries that went up .10-.24 in proportion, nine were still in the weak category in 1982.

The question of program effort change 1972-82 can also be examined from a regional perspective, presented in Table 7. Here we see that the South and East Asia region is represented in all four columns, as is Latin America. The sub-Saharan African countries are bunched in the two middle columns; about half had no change in program effort during this decade, but the other half did. Thus, modest beginnings vis-a-vis family planning programs have occurred in this region; however, it takes a while to "crank up," so that by 1982 only four countries had reached even the weak category and none the moderate category, while only Mauritius was in the strong category, where it had been in 1972.
### Table 7. Change in Program Effort 1972-82: 87 Countries Classified by Region and Amount of Change in Program Effort

<table>
<thead>
<tr>
<th>Region</th>
<th>Up in Proportion</th>
<th>Up in Proportion</th>
<th>Essentially No Change:</th>
<th>Down in Proportion</th>
<th>Total Number of Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.25 or more</td>
<td>.10 - .24</td>
<td></td>
<td>.10 or more</td>
<td></td>
</tr>
<tr>
<td>South &amp; East Asia</td>
<td>Bangladesh .47 +</td>
<td>Thailand .22 +</td>
<td>Afghanistan</td>
<td>Fiji .27 +</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sri Lanka .28 ++</td>
<td>Nepal .19 x</td>
<td>Laos</td>
<td>Vietnamb .19 +</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indonesia .26 ++</td>
<td>Pakistan .16 x</td>
<td>Burma</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Papua N.G. .26 x</td>
<td></td>
<td>Malaysia</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hong Kong</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>** Mongolia</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>India</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>** Singapore</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>** Kampuchea</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Korea, Rep. ++</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean .32</td>
<td>No. of Countries 4</td>
<td></td>
<td>Mean .23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean .18</td>
<td>No. of Countries 3</td>
<td></td>
<td>No. of Countries 13</td>
<td></td>
</tr>
<tr>
<td>Latin America</td>
<td>Mexico .53 +</td>
<td>Peru .22 x</td>
<td>Bolivia</td>
<td>Costa Rica .37 x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brazil .42 x</td>
<td>Ecuador .21 x</td>
<td>Honduras x</td>
<td>Jamaica .26 +</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Haiti .27 x</td>
<td>El Salvador .20 +</td>
<td>Cuba</td>
<td>Panama .15 +</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nicaragua .18</td>
<td></td>
<td>Paraguay</td>
<td>Chile .10 x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Colombia .15 ++</td>
<td></td>
<td>Dom. Rep. +</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>** Trin. &amp; Tob.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean .41</td>
<td>No. of Countries 3</td>
<td></td>
<td>Mean .22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean .19</td>
<td>No. of Countries 5</td>
<td></td>
<td>No. of Countries 8</td>
<td></td>
</tr>
<tr>
<td>Middle East &amp; North Africa</td>
<td>Lebanon .35 x</td>
<td>Tunisia .18 +</td>
<td>Iraq</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morocco .25 x</td>
<td>Yemen, PDR .17</td>
<td>Sudan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jordan .18</td>
<td>Kuwait</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Algeria .15 x</td>
<td>Syria</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Egypt .11 x</td>
<td>Libya</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean .30</td>
<td>No. of Countries 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean .15</td>
<td>No. of Countries 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>Rwanda .23 x</td>
<td>Burundi .11</td>
<td>Burkina Faso</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Senegal .19</td>
<td>Togo .11</td>
<td>Somalia</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Uganda .18</td>
<td>Togo .11</td>
<td>Cameroon</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Congo .18</td>
<td>Burundi .10</td>
<td>Zaire</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zimbabwe .17</td>
<td>Mauritius ++</td>
<td>Chad</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mozambique .15</td>
<td></td>
<td>Ethiopia</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lesotho .13</td>
<td></td>
<td>Ghana</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Liberia .13 x</td>
<td></td>
<td>Guinea</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zambia .12</td>
<td></td>
<td>Ivory Coast</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tanzania .12 x</td>
<td></td>
<td>Kenya</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tanzania .12 x</td>
<td></td>
<td>Madagascar</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malawi .10</td>
<td></td>
<td>Malawi</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Togo .11</td>
<td></td>
<td>Mauritius ++</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Burundi .10</td>
<td></td>
<td>Niger</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mali .10</td>
<td></td>
<td>Nigeria</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean .15</td>
<td>No. of Countries 0</td>
<td></td>
<td>No. of Countries 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No. of Countries 16</td>
<td></td>
<td></td>
<td>No. of Countries 3</td>
<td></td>
</tr>
<tr>
<td>Total No. of Countries</td>
<td>9</td>
<td>27</td>
<td></td>
<td>6</td>
<td>87</td>
</tr>
</tbody>
</table>


*Measured as the difference in the proportion of the maximum possible score 1972 and 1982.  1972 Score is for North Vietnam only.
Figure 5. Crude Birth Rates, 1965 and 1980
As regards fertility decline during the period 1965-80 on which we concentrated, there was substantial fertility decline in Asia (about 26 percent) and in the Americas (about 23 percent); however, there was almost no decline in sub-Saharan Africa, and more than 15 percent decline in only three countries in the Middle East and North Africa (Turkey, Tunisia, and Cyprus). Several large countries—Bangladesh, Pakistan, and Nigeria—have had hardly any change and still have high fertility. However, large countries—those with populations of 40 million or more—showed greater declines than did smaller countries: an average of 27 percent as compared with less than 9 percent. China is so large that it affects the average appreciably. If this is left out of the calculations, countries with 40 million or more population had an average decline of 18 percent.
Footnotes

1/ A long form questionnaire has been designed by the authors in an attempt to address this issue, but it would not be feasible for the large number of countries necessary to carry out a micro-level analysis such as that presented here.

2/ Data on crude birth rates are from the U.N. Population Division publications and the World Bank, as well as for some countries, from the National Academy of Sciences reports on levels and trends of fertility and mortality. More detail on country-specific sources is available from the authors.

A similar table using total fertility rates leads to the same general conclusion.

3/ The socioeconomic level of a country is designated on the basis of systematic statistical analysis of such variables as adult literacy, school enrollment, life expectancy at birth, GNP per capita, and the urbanization rate. The method is discussed in detail in our full report.
References


FAMILY PLANNING PROGRAMS AND CONTRACEPTIVE AVAILABILITY:
THEIR EFFECTS ON CONTRACEPTIVE USE AND FERTILITY

Bryan L. Boulier
Abstract

This paper reviews the evidence on the effects of family planning programs and increased accessibility and availability of contraception supplies on contraceptive use and fertility. Following the presentation of an economic model which provides a framework for evaluating empirical analyses of the determinants of contraceptive use and fertility, the paper gives estimates of the effects of the expansion of national family planning programs on fertility decline in developing countries and then reviews past research on the effects of increased contraceptive availability within countries.

A regression analysis of cross-national data indicates that the expansion of family planning programs from 1965 to 1975 resulted in measurable fertility decline even after controlling for trends in fertility prior to 1965 and changes in literacy, urbanization, life expectancy, and income per capita over the decade. The estimated contribution of family planning program effort to fertility decline varies with the specification of the regression equation, although all models find statistically significant effects of program effort on fertility. A high estimate implies that, for a typical country experiencing the average amount of socioeconomic change from 1965 to 1975 and the average expansion of family planning program effort, fertility decline prior to 1965 accounted for 33 percent of fertility decline from 1965 to 1975, socioeconomic change 27 percent, and family planning effort 40 percent.

Studies of the effects of contraceptive availability on contraceptive use and fertility within countries are of three types: (1) comparisons of contraceptive use among women by knowledge of source of supply; (2) analysis of differentials in contraceptive use or fertility among population sub-groups having differential access to family planning services or differential exposure to family planning inputs; and (3) controlled experiments assessing the impacts of alternative contraceptive delivery systems. A review of these three types of studies provides overwhelming support for the hypothesis that increased availability of contraceptive supplies results in increased contraceptive use and fertility decline. While some studies show that increased accessibility has effects on contraceptive use and fertility even at very low levels of social and economic development, the review also concludes that there is little evidence on the distributional consequences of increased access to family planning services and the socioeconomic circumstances under which family planning inputs would have the greatest marginal impact on contraceptive use and fertility decline.

Acknowledgements

I would like to thank Martha Ainsworth, Nancy Birdsall, Rodolfo Bulatao, William McGreevey, and Nicholas Prescott for helpful comments.
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Introduction</td>
<td>47</td>
</tr>
<tr>
<td>II. Theory</td>
<td>48</td>
</tr>
<tr>
<td>III. National Family Planning Programs</td>
<td>55</td>
</tr>
<tr>
<td>A Review of Previous Research</td>
<td>55</td>
</tr>
<tr>
<td>New Estimates of the Effects of National Family Planning Programs on Fertility Decline</td>
<td>64</td>
</tr>
<tr>
<td>IV. Evidence on the Effects of Availability, Contraceptive Uses, and Fertility: Within Country Studies</td>
<td>75</td>
</tr>
<tr>
<td>V. Experiments</td>
<td>94</td>
</tr>
<tr>
<td>VI. Conclusion</td>
<td>100</td>
</tr>
<tr>
<td>Appendix</td>
<td>103</td>
</tr>
<tr>
<td>References</td>
<td>113</td>
</tr>
</tbody>
</table>
I. Introduction

Access to modern methods of contraception differs greatly among developing countries and within developing countries. In Nepal in 1976, only 6 percent of currently married women knew of an outlet for contraceptive supplies; and, of those who knew of an outlet, only about 40 percent reported that the outlet was within two hours of their residence (Rodriguez 1978). In the same year in Costa Rica, nearly 90 percent of women knew of a source of supplies; and, of those who knew of a source, about 80 percent indicated that the source was located within thirty minutes of their home. In urban areas of Costa Rica, nearly all women resided within thirty minutes of an outlet, but only 60 percent of women living in rural areas had comparable accessibility (Rodriguez 1978). A component of most conventional family planning programs is increasing accessibility to, and availability of, contraceptive supplies. Increasing availability lowers the information and travel costs of obtaining contraception. The purpose of this paper is to review evidence on the effects of increased accessibility or availability on contraceptive use and fertility.

Section II of this paper describes an economic model of the demand for contraception and the demand for children and shows how reductions in the costs of contraception can be expected to increase contraceptive use and decrease fertility. The model provides a framework for interpreting past empirical research on these issues. Section III provides estimates of the effects of the expansion of national family planning programs on fertility decline in developing countries over the 1965-1975 decade, derived from cross-national data. Section IV examines studies of the effects of increased accessibility within countries, and Section V summarizes the results of family
planning experiments which have attempted to measure the impact of increased availability on contraceptive use and fertility. Section VI is a conclusion.

II. Theory

In order to provide a framework for examining empirical work on the effects of improved access to contraceptive methods on contraceptive use and fertility, I develop in this section a simple one-period model of the demand for children and demand for contraception by couples who have achieved a given stage in the life cycle (for example, duration of marriage). The model, described in more detail in an Appendix, is similar to one examined by Rosenzweig and Seiver (1982).

The household is characterized by a fixed level of wife's schooling and a level of excess (or deficit) fertility, representing deviations from optimal planned fertility in previous periods. The household derives satisfaction from live births in the planning period and from other commodities consumed by household members. Community norms and other characteristics of the environment in which the couple resides may affect the couple's preferences for additional children compared to other goods. The gain in satisfaction from an additional birth is inversely related to the level of excess fertility. That is, a couple having more children than it had planned to have at a given point in the life cycle will derive less satisfaction from an additional birth than a couple having just the number it had planned or having fewer children than planned, other things being equal. Excess fertility is assumed to be inversely related to wife's schooling and positively related to fecundity and to the price (or availability) of contraception in previous periods. These assumptions are plausible if women with more schooling and
users of contraception have better control over the variance of fertility for a given level of fecundity (Rosenzweig and Seiver 1982, p. 174).

The household is assumed to maximize satisfaction subject to a budget constraint which equates expenditure on additional children, contraception, and other goods to full income. Prices (or costs) of children, contraceptives, and other goods include the time costs of purchasing and consuming goods. It is assumed that the price of contraception is inversely related to wife's schooling on the hypothesis that women with more schooling have lower information costs about sources of supply or, alternatively, have greater efficiency in contraceptive use, so that the number of births averted per unit of contraception is greater for more educated women. Finally, it is assumed that more educated women have higher values of time, so that the price of children is greater for such women.

The necessary condition for maximizing satisfaction subject to the full income constraint is that, at the margin, the amount of other goods the couple is willing to give up for another child in terms of satisfaction equals the amount of other goods it must give up to have another child, where this latter amount equals the ratio of the net price of a child to the price of other goods. The net price of a child equals the full price of a child, including time costs, minus savings in contraceptive costs from having another birth. That is, if a couple decides to have an additional birth, then it need not use contraception for a period of time, so that the expenditures resulting from the decision to have an additional child are less than direct expenditures on the child. Savings in contraceptive costs are positively related to the price of contraceptives and negatively related to the efficiency of contraception (that is, the number of births averted per unit of contraception). Put another way, if contraceptives were relatively expensive and not very
efficient, then a couple deciding to have an additional birth would have considerable savings in expenditures on contraception.

Solving for the first order conditions for a maximum yields demand equations for contraceptives (C) and number of births (n):

\[ C = C(P_c(S), P_n(S), P_z, \bar{n}, X(\bar{n}, S, \rho), E) \]  \hspace{1cm} (1)
\[ n = n(P_c(S), P_n(S), P_z, F, \bar{n}, X(\bar{n}, S, \rho), E) \]  \hspace{1cm} (2)

where \( P_c, \ P_n \) and \( P_z \) are the full prices of contraceptives, children, and other goods, respectively; \( F \) is full income; \( \bar{n} \) is the number of births the couple would have in the absence of contraception (fecundity); \( X \) is excess fertility; \( S \) is years of wife's schooling; \( \rho \) is the full price of contraceptives in previous periods; and \( E \) is a vector of variables influencing preferences for children compared to other goods. Equations (1) and (2) show that the demand for contraception and the demand for children depend on the same variables. Since couples only use contraception to reduce the number of births per period, the demand for contraception and the demand for children respond in opposite directions to changes in prices, income, or other variables. For example, if the number of births demanded decreases when the price of children increases, then the demand for contraception is positively related to the price of children. I now describe the predicted effects of changes in various variables on the demands for contraception and for children. A fuller description is contained in the appendix.

A reduction in the price of contraceptives (or improvement in access) has two effects on the quantity of children demanded. The first effect is a substitution effect which induces the couple to increase the quantity of
contraceptives used and to reduce the number of births. The second influence of a price reduction is an income effect. That is, the fall in the price of contraceptives raises full income and thus may induce the couple to buy more or fewer contraceptives. There are no direct estimates of the influence of increased income on contraceptive use, but the direction of the effect can be inferred from estimates of the effect of income on the demand for children. There are numerous estimates of the effect of increases in income on the demand for children in developing countries. Most estimates, although not all (Boulier 1982), suggest a small negative impact of increased income on fertility (at least above very low levels of income), implying that contraceptive use increases with income. Hence, the effect of increased income on the demand for contraception resulting from a decrease in the price of contraception augments the substitution effect. Since, however, the influence of income on the demand for children is small, and since expenditures on contraception constitute only a small fraction of income (Lewis 1983), this income effect is likely to be small.

The foregoing discussion suggests that the demand for children is positively related to the price of contraception (and thus inversely to its availability). Modest support for this conjecture is shown in data gathered by the World Fertility Survey (WFS) and the Contraceptive Prevalence Surveys (CPS). The proportion of married women aged thirty to thirty-nine wanting more children is generally lower for women residing in locations where contraceptive supplies are more readily available. For example, in Mexico in 1978, only one-fifth of women aged thirty to thirty-nine who state that a source of supply is within twenty-five minutes of their residence want additional children compared to one-quarter of women who know only of a distant source and two-fifths of women knowing no source. This evidence is
only suggestive, however, since other variables which jointly determine family size and availability, such as income and education, may lurk behind this correlation and since women who want more children have less incentive to search for a source of supply (see Section IV). Controlling for location of residence, education, and knowledge of source does not eliminate the differences for most countries. (Focusing only on reports of women who know of a source reduces the bias resulting from the fact that women wanting no more children are more likely to search for a source.) Among Mexican women with lower primary education residing in urban areas, 27 percent of those who state that supply sources are nearby want additional children compared to 36 percent of women who know only of distant sources and 37 percent of women who know of no source. The corresponding percentages for rural women with lower primary education are 33 percent, 42 percent, and 52 percent, respectively. Among women aged thirty to thirty-nine who know of a nearby source, the percentage wanting more children is lower than the corresponding percentage among women who know only of a distant source in ten of fifteen countries for which information is available.

An important implication of the hypothesis that the demand for children is inversely related to the price of contraceptives is that empirical estimates of the availability on contraceptive use which hold constant some measure of the demand for children (for example, desire for additional children) will underestimate the impact of increased availability on contraceptive use. Several of these studies are summarized in Section IV below.

I now turn to the predicted effects of other determinants of contraceptive use and fertility. An increase in the price of children is expected to decrease the demand for children and to increase contraceptive
use. Couples having excess fertility (higher levels of \( X \)) are expected to want fewer additional births and to use more contraception.

The influence of wife's schooling on the demand for contraceptives is complex. On the one hand, if increased schooling is associated with a lower price of contraception and a higher price of children, then a rise in schooling increases the demand for contraception. On the other hand, schooling may affect the timing of fertility. To the extent that women with more schooling have lower excess fertility at any point in their life cycle, they will have smaller demand for contraception than women with less schooling, other things being equal. For empirical evidence on this point, see Rosenzweig and Seiver (1982). The impact of schooling on contraceptive use is thus \textit{a priori} unpredictable and is therefore an empirical question.

Microeconomic studies of the demand for children generally reveal a negative association between wife's schooling and fertility, at least above low levels of education (Cochrane 1979; Boulier 1982), implying that the demand for contraception is ordinarily positively associated with schooling, other things being equal.

The effect of increased fecundity (\( \bar{n} \)) on contraceptive use cannot be predicted \textit{a priori}. Fertility will be positively related to fecundity unless contraceptive use rises with increased fecundity and unless births averted per contraceptive is sufficiently large.

Because women who faced high prices for contraception in the past (\( \rho \)) have higher levels of excess fertility in the present, extending services to couples who formerly did not have ready access to contraception is likely to result in greater increases in contraceptive use than improvements in
access for couples who already face relatively low prices for contraceptives. It is also possible that increased availability of contraception may shift the timing of fertility in the life cycle. Older couples having faced relatively high prices for effective contraception in the past are likely to have engaged in measures such as postponement of age at marriage, reduced coital frequency, and prolonged lactation in order to avoid excess fertility in the future. Young couples having ready access to effective contraception do not have the same incentive to delay childbearing. In fact, it is quite possible that fertility of young women will rise with increased availability. For example, Schultz (1971) reports that the marginal contribution of family planning workers in Taiwan diminished considerably as the duration of the national family planning program increased. While fertility of young women declined in response to family planning inputs in the early years of the program, within five years of the initiation of the program there was a positive association at the district level between cumulative family planning inputs and the age-specific fertility rates of women aged fifteen to nineteen. Rindfuss and Morgan (1983) find that the probability that a couple conceives in the first three months of marriage among women not pregnant at the time of marriage has increased significantly in Taiwan and Korea and among the Chinese population of Malaysia. They attribute the increase to greater coital frequency among young couples and hypothesize that the increase in coital frequency is explained by a rising share of romantic versus arranged marriages in these countries. An alternative explanation is simply that increased contraceptive availability lessens the need to delay childbearing.

Finally, changes in environmental variables such as community norms influencing preferences for children and other goods may influence
contraceptive use. If, for example, policies to persuade couples of the desirability of small families were successful, then contraceptive use would rise. If exposure to modernization raises the satisfaction for goods relative to children (Freedman, et. al. 1981), then contraceptive use would be expected to rise.

The remainder of this paper examines evidence on the association between availability of, or access to, family planning services and contraceptive use and fertility.

III. National Family Planning Programs

A Review of Previous Research

In recent years, there have been numerous attempts to assess the contribution of national family planning programs to fertility decline. Approaches to measuring program effects relevant to assessing the impact of contraceptive availability on fertility decline include comparisons of fertility declines within countries before and after program intervention (United Nations, 1978 and 1982) and cross-sectional studies of fertility levels and changes in fertility levels in countries with programs and those without (see studies reviewed below). None of these types of studies is ideal for assessing the effects of increased contraceptive availability on contraceptive use or fertility.

Time series data for a single country are usually not adequate to allow separation of the influence of the introduction of the national family planning program on fertility decline from other factors influencing fertility change, such as growth in per capita income or improvement in female employment opportunities. The second category of studies has the advantage that one
can control for the influences of socioeconomic change on fertility, but is not directly a test of the effect of increased accessibility on use or fertility, since national programs typically have many more components than distribution of contraceptives. In this section, I review briefly previous research in this latter category and present the results of an empirical analysis of family planning program effort on fertility decline in sixty-eight less-developed countries.

The most influential paper in the literature on the contribution of national family planning programs to fertility decline is one by Mauldin and Berelson (1978). Later work on this topic is very often a critique or extension of this early piece of research. Given the importance of this paper, I begin this section with a summary and critique of it. Findings of other studies are indicated as appropriate.

The Mauldin-Berelson paper, hereafter MB, examines the correlates of fertility decline in ninety-four developing countries over the period 1965-1975. The main purpose of the paper is to determine how much of the fertility decline over this period is associated with socioeconomic change and how much can be attributed to population policies and programs. While their overall discussion of the sources of fertility change is sophisticated, the procedure for estimating the relative influences of socioeconomic change and family planning programs on fertility change is quite simple. First, MB constructed a data file of variables expected to influence the demand for children, including indicators of education of parents and children, health, economic status, and status of women. They then selected for the final analysis a set of variables having high zero order correlations with percentage declines in the crude birth rate. Variables selected on the basis of relevance to
fertility decline (that is, high zero order correlations), subject to data availability, were the following:

1. Adult literacy (ages 15 and over),
2. Primary and secondary school enrollment as a percentage of the 5-19 group,
3. Life expectancy at birth,
4. Infant mortality rate,
5. Percentage of adult males in nonagricultural labor force,
6. GNP per capita, and
7. Percentage of population living in cities of more than 100,000.

They were unable to find satisfactory measures of the status of women for a sufficiently large sample of countries. For the sample of countries for which such data were available, variables such as percentage of women enrolled in primary or secondary school, adult female literacy rates, and nonagricultural employment of women were highly correlated with other indicators of development (MB 1978, pp. 139-141), leading them to speculate that their estimate of the impact of family planning programs would be unaffected by the inclusion of variables reflecting women's status. MB note that the socioeconomic variables included in their analysis may either represent true causes of fertility decline or may just be surrogates for underlying causal forces (MB 1978, pp. 99-100).

To capture the influence of family planning programs, they constructed an index of family planning effort derived from data collected by Lapham and Mauldin (1972). These data consist of values for fifteen characteristics of national population policy for each country. The characteristics are given in Table 1. To construct a summary index of effort,
<table>
<thead>
<tr>
<th></th>
<th>Program Criteria Used to Estimate Family Planning Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Fertility reduction included in official planning policy</td>
</tr>
<tr>
<td>2.</td>
<td>Favorable public statements by political leaders</td>
</tr>
<tr>
<td>3.</td>
<td>Contraception readily and easily available, publicly and commercially throughout the country</td>
</tr>
<tr>
<td>4.</td>
<td>Customs and legal regulations allow importation of contraceptives not manufactured locally</td>
</tr>
<tr>
<td>5.</td>
<td>Vigorous effort to provide family planning services to all married women of reproductive age</td>
</tr>
<tr>
<td>6.</td>
<td>Adequate family planning administration structure</td>
</tr>
<tr>
<td>7.</td>
<td>Training facilities available and utilized</td>
</tr>
<tr>
<td>8.</td>
<td>Full-time home-visiting field workers</td>
</tr>
<tr>
<td>9.</td>
<td>Postpartum information, education, and service programs</td>
</tr>
<tr>
<td>10.</td>
<td>Abortion services openly and legally available to all</td>
</tr>
<tr>
<td>11.</td>
<td>Voluntary sterilization services (male and female) openly and legally available to all</td>
</tr>
<tr>
<td>12.</td>
<td>Use of mass media on a substantial basis</td>
</tr>
<tr>
<td>13.</td>
<td>Government provides substantial part of family planning budget from its own resources</td>
</tr>
<tr>
<td>14.</td>
<td>Record keeping systems for clients at clinic level and for program service statistics</td>
</tr>
<tr>
<td>15.</td>
<td>Serious and continuous evaluation effort</td>
</tr>
</tbody>
</table>

two points were awarded if the criterion were scored yes, one point if scored a qualified yes, and zero points if partially yes or no. Points were added to form an index ranging from zero to thirty. While one can quarrel with the particular criteria and implicit weighting that assigns equal value to each, it is reasonable to suppose that the index is sufficiently correlated with effort so that minor adjustments would not be likely to alter significantly findings of the empirical analysis. Since values of the individual categories of the index for each country are not available, it is not possible to determine which components of programs are most important for inducing fertility decline in particular socioeconomic settings.

To allocate the relative influences of socioeconomic change and program effort on fertility change, the authors regress various fertility measures on socioeconomic variables, then on the effort index, and finally on both sets of variables. The values of the $R^2$ are used to partition the influence of the variables on birth rate decline. The procedure can be illustrated with the regressions using the percentage decline in the birth rate from 1965 to 1975 as the dependent variable and values of the socioeconomic variables for 1970. The $R^2$ for the seven socioeconomic indicators alone is .66, for the effort index alone is .78, and for both sets of variables together is .83. From an analysis of the effects of proximate determinants of the crude birth rate, MB conclude that about 55-70 percent of the 1965-1975 crude birth rate decline is the result of declining marital fertility (MB 1978, p. 122). Using the $R^2$ values from the reported regressions, they conclude that 40 to 45 percent (= .66 x [55 to 70 percent]) of the decline in crude birth rate over this decade was attributable to changes induced by improvements in social setting and only about 10 to 15 percent (= [.83 - .66] x [55 to 70 percent]) was the result of organized family planning programs. Hernandez (1981, p.
632) reports an even smaller effect, about 4 to 6 percent, these lower figures being obtained by adding variables for island status, pace of social change, and 1970 population density to the set of variables characterizing social setting.

This procedure for allocating the relative influences of socioeconomic variables and family planning effort on fertility decline is incorrect, as can be seen in the following example. The MB allocation procedure assumes that the influence of family planning is added onto the influence of social setting. An alternative approach would be to give primacy to family planning effort and to add the influence of social setting variables. If this approach were taken, one would estimate that family planning effort would account for 43-54 percent (= .78 x [55 to 70 percent]) of the decline in the crude birth rate and social setting only 3-4 percent (= [.83 - .78] x [55 to 70 percent]). This second decomposition gives a much different picture of the influence of family planning effort. However, neither is correct. Since socioeconomic variables and family planning effort are both relevant to explaining fertility decline, it is inappropriate to gauge their relative importance by contributions to the coefficient of determination (Hendry and Marshall, 1983). What is relevant to assessing the impact of programs is the magnitude and statistical significance of the coefficient of the family planning variable, not its influence on $R^2$. Unfortunately, MB do not present the unstandardized regression coefficients which would enable one to estimate directly the contribution of family planning programs in this way.

In addition to the regression analysis, MB present a 4x4 table in which countries are cross-classified by level of program effort and by an index of social setting (MB 1978, Table 12, p. 110). Countries having scores of 20+ on the family planning index are denoted as having strong programs, 10-19
moderate programs, and 0-9 as weak programs. The final category is countries which have no program. Countries are also ranked by an index of social setting, this index being constructed by summing the ranks of countries for each of the seven socioeconomic variables. Table 2 is a condensed version of their Table 12. Of twenty-three countries having both high or upper middle social setting and also having strong or moderate programs, the median decline in the crude birth rate over the period 1965-1975 is 24 percent. Only El Salvador and Iran have declines of less than 15 percent. On the other hand, of twenty-five countries ranked as having the same social setting but having a weak program or no program at all, the median decline in the crude birth rate over the same period is only 4 percent. Only four countries have declines of 10 percent or more. Three countries are categorized as having lower-middle or low social setting but also having a strong or moderate program. The percentage decline in these countries are North Vietnam, 23 percent; India, 16 percent; and Indonesia, 13 percent. The final cell consists of the forty-three countries which have lower-middle or low social setting and simultaneously have weak programs or no program at all. None of these countries has a decline in the crude birth rate of more than 5 percent. There are no differences in fertility declines between countries that have weak programs or that have no program. If it were the case that the level of social setting and the level of family planning effort were independent, that is, that a strong family planning program could be exogenously imposed in any country, regardless of the level of social setting, then one would conclude that family planning program effort has a very large impact on fertility decline.
Table 2: 1965-1975 Crude Birth Rate Decline by Social Setting and Program effort: 94 Countries 1/
(Percent)

<table>
<thead>
<tr>
<th>Social Setting 2/</th>
<th>Program Effort 3/</th>
<th>Strong or moderate</th>
<th>Weak or none</th>
</tr>
</thead>
<tbody>
<tr>
<td>High or Upper Middle</td>
<td>Number of countries: 23</td>
<td>Median CBR Decline: 24</td>
<td>Number of Countries: 25</td>
</tr>
<tr>
<td>Lower Middle or Low</td>
<td>Number of Countries: 3</td>
<td>Median CBR Decline: 16</td>
<td>Number of Countries: 43</td>
</tr>
</tbody>
</table>

1. Mauldin and Berelson, 1978, Table 12, p. 110.

2. Social setting is an index of development level based on adult literacy, primary and secondary school enrollment rates, life expectancy, infant mortality, urbanization, percent of males in the nonagricultural labor force, and GNP per capita.

3. Program effort is defined as strong (20 or more points) moderate (10-19 points), weak (1-9 points), and none (0 points).
There is, however, an objection to the hypothesis that the level of family planning effort and social setting are truly independent. First, it is quite possibly the case that only countries with a relatively high level of socioeconomic development can have strong or moderately strong family planning programs. The small number of countries with low levels of development that have strong or moderate programs suggests that such countries lack administrative and other resources to carry out effective programs; either it is difficult to organize programs in such environments or there is little demand for program services in such settings. Indeed, Demeny (1979) argues that the MB approach, also adopted in a similar analysis by Tsui and Bogue (1978) with the same conclusions, may well overstate the impact of family planning programs relative to the effects of changes in socioeconomic variables, since economic development may be necessary before countries can undertake effective programs. Path analyses by MB (1979, p, 106) and by Tolnay and Christenson (1983) in which the effort index is "explained" in part by socioeconomic variables find that the indirect effect of development through its influence on program effort is quite large. Kelly and Cutright (1983) also find statistically significant correlations between pre-1965 levels of development and the magnitude of program effort.

Demeny (1979) raises two further questions with respect to the MB and Tsui-Bogue estimates of the effects of family planning programs on fertility decline. First, variables such as female employment opportunities and cultural characteristics omitted from the analyses may account jointly for fertility decline and program effort. Omission of such variables biases upward the estimate of program impact. Second, countries which have experienced fertility declines in the past are more likely to devote resources to encourage additional reductions in fertility than countries without such
declines, and would be likely also to experience greater reductions in fertility even without family planning programs. Wheeler (1982) and Kelly and Cutright (1983) report that pre-program fertility declines are associated with higher levels of program effort in 1972. Omission of past trends in fertility from the regressions may also lead to an upwardly biased estimate of program impact.

New Estimates of the Effects of National Family Planning Programs on Fertility Decline

To establish the impact of national family planning programs on fertility, I have estimated several statistical models using the data provided by MB supplemented with World Bank data on income per capita, crude birth rates prior to 1965, total fertility, and expectation of life at birth. Table 3 gives the definitions and mean values of variables used in the analysis. Table 4 presents estimates of the impacts of socioeconomic variables and family planning program effort on 1975 levels of the crude birth rate and total fertility rate for sixty-eight countries, with independent variables measured for the most recent date for which they were available. Regressions including lagged values of fertility are also shown. Specifications including lagged variables are appropriate either if current levels of fertility depend not only upon current levels of independent variables but also on their past values or if fertility adjusts only slowly to changes in environmental variables (including family planning effort) (Johnston, 1972, pp. 300-303). Inclusion of past fertility in the equation also helps to control for the influence of variables affecting fertility but omitted from the regression. Variables such as infant mortality and the proportion not employed in agriculture are highly linearly correlated with other socioeconomic variables and are not available for all countries at earlier dates. The coefficient of the duration of the program (that is, 1975 minus the date at which the program
<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCORE</td>
<td>Family Planning index</td>
<td>7.22</td>
<td>8.10</td>
</tr>
<tr>
<td>CBR75</td>
<td>Crude birth rate, 1975</td>
<td>40.21</td>
<td>9.03</td>
</tr>
<tr>
<td>CBR65</td>
<td>Crude birth rate, 1965</td>
<td>43.96</td>
<td>5.81</td>
</tr>
<tr>
<td>TF75</td>
<td>Total fertility rate, 1975</td>
<td>5.65</td>
<td>1.54</td>
</tr>
<tr>
<td>TF65</td>
<td>Total fertility rate, 1965</td>
<td>6.14</td>
<td>1.41</td>
</tr>
<tr>
<td>LIT70</td>
<td>Adult library rate, 1970</td>
<td>.45</td>
<td>.28</td>
</tr>
<tr>
<td>LIT60</td>
<td>Adult library rate, 1960</td>
<td>.38</td>
<td>.27</td>
</tr>
<tr>
<td>EXP75</td>
<td>Total fertility rate, 1975</td>
<td>54.66</td>
<td>9.58</td>
</tr>
<tr>
<td>EXP65</td>
<td>Total fertility rate, 1965</td>
<td>52.59</td>
<td>9.28</td>
</tr>
<tr>
<td>URB70</td>
<td>Proportion, living in cities 100,000 +, 1970</td>
<td>.19</td>
<td>.19</td>
</tr>
<tr>
<td>URB60</td>
<td>Proportion living in cities 100,000 +, 1960</td>
<td>.14</td>
<td>.15</td>
</tr>
<tr>
<td>YPC75</td>
<td>1975 income per capita in 1,000 's of 1975 U.S. dollars</td>
<td>.41</td>
<td>.43</td>
</tr>
<tr>
<td>YPC65</td>
<td>1965 income per capita in 1,000 's of 1975 U.S. dollars</td>
<td>.31</td>
<td>.42</td>
</tr>
<tr>
<td>CATH</td>
<td>14 country is Catholic, 0 otherwise</td>
<td>.26</td>
<td>.44</td>
</tr>
<tr>
<td>MOSLEM</td>
<td>14 country is Moslem, 0 otherwise</td>
<td>.21</td>
<td>.41</td>
</tr>
<tr>
<td>ISLAND</td>
<td>14 country is an island, 0 otherwise</td>
<td>.16</td>
<td>.37</td>
</tr>
<tr>
<td>DENS65</td>
<td>Population density in 1965</td>
<td>.16</td>
<td>.57</td>
</tr>
<tr>
<td>ΔCBR</td>
<td>Change in crude birth rate, 1965-1975</td>
<td>-3.75</td>
<td>4.13</td>
</tr>
<tr>
<td>ΔTF</td>
<td>Change in total fertility rate, 1965-1975</td>
<td>-.49</td>
<td>.98</td>
</tr>
<tr>
<td>ΔALIT</td>
<td>Change in adult literacy rate, 1960-1970</td>
<td>.08</td>
<td>.08</td>
</tr>
<tr>
<td>ΔEXP</td>
<td>Change in life expectancy, 1965-1975</td>
<td>4.40</td>
<td>1.72</td>
</tr>
<tr>
<td>ΔURB</td>
<td>Change in proportion urban, 1960-1970</td>
<td>.05</td>
<td>.06</td>
</tr>
<tr>
<td>ΔYPC</td>
<td>Change in per capita income, 1965-1975</td>
<td>.10</td>
<td>.14</td>
</tr>
<tr>
<td>ΔCBR6065</td>
<td>Change in crude birth rate, 1960-1965</td>
<td>-1.57</td>
<td>2.12</td>
</tr>
<tr>
<td>ΔTF6065</td>
<td>Change in total fertility rate, 1960-1965</td>
<td>-.14</td>
<td>.31</td>
</tr>
</tbody>
</table>

Sources: Mauldin and Berelson (1978) and World Bank data files.
Table 4: Estimates of the Contemporaneous Determinants of Fertility 1/

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Dependent Variables</th>
<th>OLS</th>
<th>OLS</th>
<th>OLS</th>
<th>OLS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(a) CBR75</td>
<td>(b) CBR75</td>
<td>(c) TF75</td>
<td>(d) TF75</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>52.88 (5.76)</td>
<td>1.88 (5.04)</td>
<td>6.74** (1.50)</td>
<td>2.07** (1.02)</td>
<td></td>
</tr>
<tr>
<td>SCORE</td>
<td>-0.46** (0.10)</td>
<td>-0.36** (0.05)</td>
<td>-0.03 (0.03)</td>
<td>-0.05** (0.02)</td>
<td></td>
</tr>
<tr>
<td>LIT70</td>
<td>-12.62** (4.23)</td>
<td>-3.12 (2.33)</td>
<td>-1.46 (1.10)</td>
<td>-1.98** (0.67)</td>
<td></td>
</tr>
<tr>
<td>EXP75</td>
<td>-0.07 (0.14)</td>
<td>-0.04 (0.07)</td>
<td>0.00 (0.04)</td>
<td>0.02 (0.82)</td>
<td></td>
</tr>
<tr>
<td>URB70</td>
<td>-6.67* (3.93)</td>
<td>-0.13 (2.12)</td>
<td>-0.92 (1.02)</td>
<td>-0.72 (0.62)</td>
<td></td>
</tr>
<tr>
<td>YPC75</td>
<td>0.91 (1.92)</td>
<td>0.21 (1.00)</td>
<td>0.10 (0.50)</td>
<td>-0.09 (0.30)</td>
<td></td>
</tr>
<tr>
<td>ISLAND</td>
<td>-3.48** (1.62)</td>
<td>0.81 (0.91)</td>
<td>-1.72** (0.42)</td>
<td>-0.48* (0.28)</td>
<td></td>
</tr>
<tr>
<td>CATH</td>
<td>3.17** (1.34)</td>
<td>-0.02 (0.74)</td>
<td>0.19 (0.35)</td>
<td>0.19 (0.21)</td>
<td></td>
</tr>
<tr>
<td>MOSLEM</td>
<td>2.49* (1.34)</td>
<td>-0.29 (0.73)</td>
<td>0.69* (0.35)</td>
<td>0.11 (0.22)</td>
<td></td>
</tr>
<tr>
<td>1965 Fertility 2/</td>
<td>1.01** (0.08)</td>
<td></td>
<td>0.64** (0.06)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.84</td>
<td>0.96</td>
<td>0.63</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td></td>
</tr>
</tbody>
</table>

1. Standard errors in parentheses; * denotes statistical significance at the .10 level (two-tail test) and ** denotes statistical significance at the .05 level.

2. 1965 fertility is defined as the 1965 crude birth rate in the crude birth rate regressions and 1965 total fertility in the total fertility rate regressions.
began) is not statistically significant in part because there is a very high correlation between the duration of the program and its level of effort in 1972. Estimates of the coefficients of the effort variable in the 1975 cross-section regressions are not affected by the exclusion of these other variables.

The estimated crude birth rate equation without lagged fertility suggests that crude birth rates are negatively associated with literacy, urbanization, and island status, and that fertility is higher in predominantly Catholic or Moslem countries. The coefficient of SCORE, the index of family planning program effectiveness, is highly statistically significantly different from zero and implies that a one-point increase in its value reduces the crude birth rate by one-half point. Adding the 1965 crude birth rate to the equation reduces the absolute magnitudes of all coefficients, including that of SCORE. Only the coefficients of SCORE and lagged fertility are statistically significant. The coefficient of the lagged value of the crude birth rate indicates that countries having a one-point higher crude birth rate in 1965 have birth rates higher by one point in 1975, other things being equal. When the total fertility rate is the dependent variable and its lagged value is omitted from the equation, all coefficients have the same sign that they do in the crude birth rate equation, although only the coefficients of island status and the dummy variable for Islamic countries are statistically significant. When the 1965 total fertility rate is added to the equation, the coefficients of SCORE and adult literacy become significantly different from zero. Countries having higher fertility rates in 1965 have higher fertility rates in 1975, other things being equal, but the coefficient of lagged total fertility is less than one. The coefficient of SCORE in the regression implies that a one-point increase in the effectiveness of the family planning
program reduces total fertility by .05 points. The estimated impact of family planning effort is small but not negligible. For example, the estimated coefficient implies that if Ecuador (SCORE = 6) had a program effort comparable to that of Colombia (SCORE = 16), then total fertility would have been 5.9 in 1975 rather than 6.4.

Several additional regression specifications were estimated. Interaction terms involving the products of program effectiveness and socio-economic variables were included in all of the above equations to see whether the contribution of family planning programs to fertility decline varied with the level of development. None of the coefficients was statistically significant individually, nor was the set of coefficients taken as a whole. At face value, this result would imply that the contribution of family planning programs to fertility decline is independent of development level. However, it should be remembered that the sample of countries having low levels of development and effective family planning programs is very small, so that there may not be sufficient variation in the interaction terms to detect variations in the impact of family planning programs with development level. In other experiments, the squared value of the effectiveness variable was introduced into the equations. No evidence of diminishing marginal returns to program effort was discovered. However, given that SCORE is formed by assigning an arbitrary number of points to categories which may or may not have equal impact on fertility decline, it is not clear that the failure to find nonlinearities means that there are no diminishing returns to family planning inputs.

Table 5 presents regressions of first differences in fertility rates over the 1965-1975 period on first differences in socio-economic variables over the same period and the index of program effort. An implicit assumption
Table 5: Estimates of Fertility Change Equations, 1965-1975

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>△CBR (OLS)</td>
<td>.52</td>
<td>.71</td>
<td>.78</td>
<td>.13</td>
<td>.14</td>
<td>.17</td>
</tr>
<tr>
<td>△CBR (OLS)</td>
<td>(.72)</td>
<td>(.69)</td>
<td>(.70)</td>
<td>(.15)</td>
<td>(.13)</td>
<td>(.14)</td>
</tr>
<tr>
<td>△CBR (2SLS)</td>
<td>-.45**</td>
<td>-.35**</td>
<td>-.40**</td>
<td>-.06**</td>
<td>-.03**</td>
<td>-.05**</td>
</tr>
<tr>
<td></td>
<td>(.04)</td>
<td>(.05)</td>
<td>(.08)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
</tr>
<tr>
<td>△LIT (OLS)</td>
<td>3.10</td>
<td>1.63</td>
<td>2.41</td>
<td>.00</td>
<td>-.03</td>
<td>.10</td>
</tr>
<tr>
<td></td>
<td>(4.08)</td>
<td>(3.87)</td>
<td>(4.01)</td>
<td>(.86)</td>
<td>(.71)</td>
<td>(.74)</td>
</tr>
<tr>
<td>△LIT (OLS)</td>
<td>-.24</td>
<td>-.29</td>
<td>-.28*</td>
<td>-.02</td>
<td>-.05</td>
<td>-.05</td>
</tr>
<tr>
<td></td>
<td>(.16)</td>
<td>(.15)</td>
<td>(.15)</td>
<td>(.03)</td>
<td>(.03)</td>
<td>(.03)</td>
</tr>
<tr>
<td>△URB (OLS)</td>
<td>-5.26</td>
<td>-3.63</td>
<td>-4.39</td>
<td>-2.12*</td>
<td>-2.45**</td>
<td>-1.54</td>
</tr>
<tr>
<td></td>
<td>(5.13)</td>
<td>(4.87)</td>
<td>(5.00)</td>
<td>(1.09)</td>
<td>(1.16)</td>
<td>(1.97)</td>
</tr>
<tr>
<td>△YPC (OLS)</td>
<td>.22</td>
<td>3.25</td>
<td>3.17</td>
<td>-.69</td>
<td>-.12</td>
<td>.11</td>
</tr>
<tr>
<td></td>
<td>(2.01)</td>
<td>(2.15)</td>
<td>(2.17)</td>
<td>(.42)</td>
<td>(.48)</td>
<td>(.40)</td>
</tr>
<tr>
<td>Fertility Change 1960-1965</td>
<td>.60**</td>
<td>.45*</td>
<td>1.24**</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.20)</td>
<td>(.27)</td>
<td>(.23)</td>
<td>(.31)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R^2</td>
<td>.77</td>
<td>.80</td>
<td>.66</td>
<td>.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td>68</td>
</tr>
</tbody>
</table>

1/ Standard errors in parentheses; * denote statistical significance at .10 level (2-tail test); ** denotes statistical significance at .05 level (2-tail test).

2/ Endogenous variable in equations (3) and (6)

3/ △CBR6065 in crude birth rate equations; △TF6065 in total fertility rate equations.
is that the program score was zero in 1965. This assumption is not exactly correct, since a small number of countries had programs in 1965, some of which were quite effective (for example, Taiwan and Hong Kong). Omission of these countries from the sample does not change the results. Aside from providing an additional estimate of the 1975 equations, there are two further advantages of first difference equations compared to those estimated from a single cross-section. First, variables influencing fertility omitted from the 1975 equations but which are unchanged over the decade within a country will not enter the first difference equation, thus permitting sharper estimates of the impacts of measured variables on fertility. Second, first difference equations are likely to reduce the consequences of measurement errors in independent variables. For example, if the definition of literacy differs across countries, then the level of literacy as measured in one country may not be comparable with the level as measured in another. Nonetheless, measured increases in the level of literacy over time might be quite comparable.

Two first difference equations for each fertility variable are shown in Table 5. These equations correspond to the equations shown in Table 4, with one set including lagged values of fertility change. Changes in fertility over the five year period 1960 to 1965 are included in the equations rather than changes over the decade preceding 1965 in order not to restrict the sample size. Accurate estimates of fertility in 1955 are not available for most countries. There are four interesting findings in these equations. First, with the exception of the coefficient of urbanization in the total fertility equations, only the coefficients of program effort and lagged fertility change are statistically significant at conventional levels. Increases in urbanization and life expectancy are associated with fertility
decline. Increases in incomes per capita are associated with increases in the crude birth rate but declines in the total fertility rate. With the exception of the total fertility rate equation including lagged fertility changes, the coefficients of literacy are positive. Second, as suggested by Demeny (1979), countries experiencing declines in fertility in the past have declines in fertility in the future, other things being equal. Third, the coefficients of the program effort variables in the crude birth rate equations are nearly identical to those shown in Table 4, while the coefficient of SCORE in the total fertility equation excluding lagged fertility change is nearly twice the magnitude of the corresponding coefficient in Table 4, although its coefficient in the equation including lagged fertility change is somewhat smaller than in the corresponding Table 4 equation. Including past changes in fertility reduces considerably the estimated impacts of program effort. For example, the total fertility rate equation excluding lagged fertility implies that if Ecuador had attained a SCORE of 16 (the level of Colombia) rather than 6, then its total fertility rate would have declined by 1.1 points from 1965 to 1975 instead of its actual decline of .5 points. The total fertility rate equation including lagged fertility predicts a decline of only .8 points from this expanded effort compared to the actual decline of .5 points. Fourth, variables included in the equations account for a substantial proportion of the variance of fertility change over the decade. Alternative specifications including interaction terms between program effort and socio-economic changes did not reveal any evidence that program effectiveness was enhanced or reduced with changes in development nor was there any evidence of diminishing marginal returns to program effort.

Also shown in Table 5 are simultaneous equation estimates of the fertility rate equations with SCORE treated as an endogenous variable.
Statistical identification of the SCORE coefficient in the fertility rate equation is obtained by (somewhat arbitrarily) permitting values of socioeconomic variables in 1965 and earlier to affect SCORE but not fertility. The OLS estimates of the SCORE equation corresponding to the two-stage least squares (2SLS) estimates of the total fertility rate equation is:

\[
\text{SCORE} = -0.51 + 19.44 \Delta \text{LIT} + 0.26 \Delta \text{EXP} - 18.62 \Delta \text{URB} - 2.25 \Delta \text{YPC} \\
\quad - 9.65 \Delta \text{TF6065} - 0.66 \text{DENS65} + 12.13 \text{LIT60} + 11.10 \text{URB60} \\
\quad - 3.11 \text{YPC65} - 3.03 \text{CATH} - 0.06 \text{MOSLEM} + 4.68 \text{ISLAND} \\
\quad (1.85) (12.05) (.46) (15.13) (6.42) \\
\quad (3.15) (2.64) (4.27) (10.16) \\
\quad (2.30) (1.84) (2.10) (2.70)
\]

\[R^2 = 0.71 \quad n = 68\]  

Coefficient estimates in an equation containing lagged values of the crude birth rate change are similar. Lagged fertility change, literacy, and island status stand out as statistically significant and important determinants of SCORE. A decline in the total fertility rate by one-half point over the period 1960-1965 raises SCORE by nearly 5 points. As suggested by Demeny, it seems plausible to suppose that fertility decline induces government officials to augment resources for encouraging further fertility reduction. Other things being equal, a country having a 10 percent higher level of literacy in 1960 (i.e., an increase in the proportion literate by .10) has a one-point higher score and each additional 10 percent increase in the literacy rate from 1960 to 1970 raises SCORE by 2 points. Other things being equal, islands have scores nearly 5 points higher than countries that are not islands. Each 10 year increment in the expectation of life over the 1965-1975 decade raises
SCORE by about 2.5 points. Both the initial level of income per capita and subsequent increases in income per capita are negatively associated with SCORE. Predominantly Catholic countries have lower scores than other countries as do Moslem countries, but the coefficient of Islamic status is extremely small.

The coefficients of socioeconomic variables in the 2SLS crude birth rate and total fertility rate equations differ little from the OLS coefficients; the 2SLS estimates of the coefficients of lagged fertility change are slightly smaller than the corresponding OLS coefficients. The 2SLS estimates of the coefficients of SCORE are somewhat larger (in absolute value) than the OLS estimates. Given the rather arbitrary procedures used to identify the fertility rate equation, it is not clear that the simultaneous equation estimates are to be preferred to the OLS estimates.

In sum, all estimated equations show statistically significant effects of family planning program effort on fertility decline. Ordinary least squares estimates of coefficients of effort in the crude birth rate and total fertility rate equations estimated with 1975 cross-section data with a specification including the lagged value of fertility rates do not differ appreciably from those obtained using first differences over the period 1965 to 1975. Taking into account past levels of fertility or fertility change markedly reduces the estimated impact of program effort. Socioeconomic characteristics of a country and past levels of fertility change influence the index of family planning effort. A crude attempt to take into account the influence of socioeconomic variables on the level of family planning effort raised slightly the estimated impact of effort on fertility decline. In all cases, the estimated influence of program effort on fertility decline is rather small. If it could be assumed that program effort could be exogenously
imposed on a country, the estimates imply that increasing SCORE from (say) 0 to 18 points, the median level of program effort among countries with a positive score, would on average reduce the crude birth rate by six to seven points and would reduce the total fertility rate by one-half to three-quarters of a point. This small contribution of fertility decline may not be insignificant, however. An estimate of the contribution of family planning effort to fertility decline in the sixty-eight countries included in the sample can be made by using equation (5) in Table 5 to decompose the sources of fertility change over the decade 1965 to 1975. During this period, the total fertility rate declined by an average of one-half point in sample countries. For a hypothetical country experiencing the average increases in literacy, urbanization, life expectancy, and income per capita over the decade and attaining a SCORE of only 7.2, the average level of effort in 1972, 33 percent of the fertility decline is attributable to fertility reduction prior to 1965, only 27 percent to the direct effects of socioeconomic change, and fully 40 percent to family planning effort. This estimate is of course an upper bound estimate, since it ignores the effects of previous fertility decline and socioeconomic change as they may have influenced levels of effort.

In short, cross country analysis of the influence of family planning program activity on fertility change suggests that program effort may have had an important influence in bringing about fertility decline. As this section demonstrates, however, it is extremely difficult to separate the influence of program effort from the effects of demographic and socioeconomic change on fertility at the national level. Moreover, the aggregate index of program effort used in the empirical analysis does not allow one to estimate those components of program activity which contribute most toward fertility decline.
IV. Evidence on the Effects of Availability, Contraceptive Uses, and Fertility: Within Country Studies

Several studies have used data on either individuals or on areas within countries to investigate the effects of accessibility or availability on contraceptive use. Relatively little work has been done on the relation of accessibility to fertility decline. Comparison of results across studies is rendered difficult because of differing measures of accessibility and differing techniques for assessing the effects of accessibility on use or fertility. In what follows, I summarize first the findings relating to contraceptive use and then those pertaining to fertility.

World Fertility Survey (WFS) and Contraceptive Prevalence Survey (CPS) data have been used to estimate the influence of accessibility on contraceptive use in several countries. In some of the WFS data sets, women were asked if they knew of a source where they could go to obtain family planning information, services, and supplies. Those who responded positively were asked about travel time to nearest source. This question was selected to measure accessibility on the basis of experiments conducted by Rodriguez (1977), who found that respondents were better able to estimate travel time than distance to a family planning outlet. CPS also relied upon respondents' estimates of travel time. Thus, these surveys provide two measures of availability: (1) whether or not women know of an outlet and (2) self-reported estimates of travel time for women who do know of an outlet. Neither of these variables measures actual proximity to sources of supply nor prices of contraceptive supplies at the source, so that one must be cautious in interpreting findings of studies based on these measures of availability. For example, actual availability presumably increases both the fraction of women who know of an outlet and contraceptive use. On the other hand, women who are
highly motivated to restrict fertility are more likely to search for, and thus to know of, a source for family planning services and to use those services compared to women who are less highly motivated (Cornelius and Novak 1983, p.4). Cornelius and Novak cite as evidence for this association the findings of Chidambaram and Mastropoalo (1981) that the proportion of women wanting no more children is higher among women who know of an outlet than among women without such knowledge. Of course, this association may merely reflect the fact that desired family sizes may be reduced when contraceptive services are more readily available, as is suggested in Section II of this paper. Since most studies reviewed below hold constant desired for additional children when the effects of availability on contraceptive use are examined, it is quite possible that effects of availability on use are understated if availability causally affects desired fertility. However, to the extent that women more highly motivated to reduce fertility are more likely to know of sources of contraceptive supply, then there is an upward bias in the estimated impact of increased accessibility on use when subjective estimates of availability are used to measure actual availability. Cornelius and Novak (1983, p.5) also report that "some of the geography literature has suggested that those motivated to use a particular product or service may understate the distance or travel time to obtain that product or service." If this hypothesis were true, then users would understate travel time relative to non-users, biasing upwards the estimate of accessibility on use. Cornelius and Novak (1982, p.5) note, however, that Rodriguez (1977) and Kamnuansilya and Chamatrithiring (1981) have found fairly close agreement between perceived travel time and actual travel time obtained from community level data. Finally, to the extent that decreases in travel time and the recent government provision of family planning services and prices of government supplies are below those of private suppliers (Lewis 1983), it is unclear whether the measured effect of proximity
to sources is attributable to reduced travel time, reduced money prices of contraceptives, or both.

Rodriguez (1977) was the first to conduct an extensive analysis of the relation between perceived availability and contraceptive use with WFS data. The countries included in his study and the dates of the surveys were Colombia (1976), Costa Rica (1976), Korea (1974), Malaysia (1974), and Nepal (1976). Table 6, based on data given in his article, summarizes information on knowledge of sources of contraceptive supplies for these five countries. The percentage of currently married women knowing of an outlet for contraceptive supplies is very high in Costa Rica and Korea, fairly high in Colombia and Malaysia, and very low in Nepal. Of those knowing of an outlet, median reported travel time is only fifteen minutes in Colombia and Costa Rica, twenty minutes in Korea and Malaysia, and two hours in Nepal. In all countries, perceived travel times are smaller in urban areas than in rural areas. Leaving aside Nepal, over 85 percent of urban women in the other four countries knowing of an outlet reported travel times within one-half hour of their residence, whereas only 40 percent to 80 percent reported such proximity in rural areas. In Nepal, two thirds of urban women knowing of an outlet report travel time less than two hours compared to slightly over one third of rural women. There are substantial differences in knowledge of source by education. Less than 40 percent of women with no education know of a source in Colombia; over 90 percent of women with secondary education or higher have such knowledge. Differences in knowledge by education of women are smallest in Korea, where three-quarters of women with no education know of an outlet compared to about nine-tenths of women with secondary education or more. Differences by education narrow only slightly, when one controls for marriage duration, parity, and urban-rural residence (Rodriguez 1978, Table 2A).
Table 6: Knowledge of Source, Perceived Travel Time, and Use of Efficient Contraception Among Currently Married Women

|--------------------------|---------------|-----------------|------------|----------------|------------|

1. Percentage who know an outlet
   a. All women          | 66            | 89              | 86         | 77             | 6          |
   b. Place of residence
       city) urban      | 79            | 92              | 87         | 80             | 38         |
       town)            |               |                 |            |                |            |
   c. Village/rural     | 43            | 85              | 85         | 75             | 5          |

2. Education
   a. None               | 36            | 68              | 76         | 62             | 4          |
   b. Primary            | 66            | 88              | 87         | 84             | 30         |
   c. Secondary          | 90            | 93              | 91         | 90             | 38         |
   d. Higher             | 93            | 95              | 88         | 90             |            |

3. Among women knowing outlet, percentage who perceive nearest outlet to be within one-half hour (two hours in Nepal)
   a. All women          | 78            | 79              | 78         | 83             | 42         |
   b. Place of residence
       city) urban      | 188           | 95              | 86         | 90             |            |
       town)            |               |                 |            |                |            |
   c. Village/rural     | 41            | 62              | 67         | 79             |            |

4. Percentage using an efficient method--unadjusted
   a. 5-15 min, 0-2 hrs. | 44            | 55              | 32         | 33             | 27         |
   b. 20-30 min, 3-8 hrs.| 41            | 56              | 31         | 26             | 14         |
   c. > 60 min, > 1 day | 36            | 56              | 27         | 24             | 15         |

5. Percentage using an efficient method--adjusted 2/
   a. 5-15 min, 0.2 hrs. | 38            | 54              | 30         | 30             | 23         |
   b. 20-30 min, 3-8 hrs.| 38            | 56              | 29         | 26             | 13         |
   c. > 60 min, > 1 day | 36            | 56              | 26         | 24             | 13         |

6. % not using an efficient method among exposed women who want no more children
   a. 5-15 min, 0-2 hrs. | 45            | 29              | 52         | 55             | 51         |
   b. 20-30 min, 3-8 hrs.| 49            | 26              | 53         | 59             | 57         |
   c. > 60 min, > 1 day | 58            | 27              | 59         | 60             | 74         |

1/ Source: Rodriguez, 1978, various tables.

2/ Adjusted for duration of marriage, number of living children, place of residence, education, and desire for additional children.
The percentage of currently married women using an efficient contraceptive is much lower for women who do not know of an outlet compared to women who do. In Colombia, for example, fewer than 10 percent of women who do not know of an outlet use an efficient contraceptive; over 40 percent of women knowing of a source use such methods. The relatively high proportion of women in Costa Rica who use an efficient method among women who do not know of an outlet in part attributable to the fact that many of these women are protected by sterilization and thus have little incentive to know of a current source for contraceptive services (see the discussion of Pebley and Brackett (1982) below.) Among women knowing of a source, the percentage using a method is higher the closer they are to the source, but differences by travel time are rather small. Adjustment for parity, marriage duration, location of residence, education, and desire for additional children almost eliminates these differences in prevalence by travel time except in Nepal. Differences in use among women who know of a source and women who do not are still substantial even after such adjustment. There is essentially no difference in use of inefficient methods by reported proximity to source, although women who know of an outlet are slightly more likely to use an inefficient method than are others (Rodriguez 1978, p. 108). The biggest difference is in Colombia, where 14 percent of women reporting knowledge of a source use an inefficient method and only 9 percent of other women do so.

Table 6 also shows the percentage not using an efficient method among exposed women who want no more children. In all countries, the fraction of nonusers is very high among women not knowing of an outlet except in Costa Rica; differences among women with such knowledge by travel time are small except in Nepal. Controlling for parity, marriage duration, education, and rural-urban residence narrows these differences only slightly. Since the
fraction not knowing of a source is very small in Costa Rica and Korea, and since there is little difference in use among exposed women by proximity to source of supply, it is unlikely that expanding availability simply by increasing the sources of supply will have much impact on contraceptive use in these countries.

Pebley and Brackett (1982) use WFS data to analyze the relation of availability to contraceptive use in seven countries. Their sample adds Kenya, Mexico, Panama, and the Philippines to the countries examined by Rodriguez but omits Malaysia and Nepal. Chidambaram and Mastropoalo (1981) use nearly the same sample as Pebley and Brackett, omitting Panama but including Nepal. Since results for Nepal by Rodriguez are reported above and since the results of the two latter studies are similar, only the Pebley-Brackett findings are summarized here.

Table 7, constructed from data given by Pebley and Brackett, shows that there are substantial differences in use of contraception by women who know of an outlet compared to women not knowing an outlet in all countries. Women knowing of an outlet are more than twice as likely to be using contraceptives as women who do not know of an outlet in all countries except Costa Rica and Panama. Adjusting for socio-economic and demographic characteristics, including desires for additional children, reduces the differences between prevalence rates of women with and without knowledge of an outlet in Colombia, Kenya, Korea, and Panama. Differences in the adjusted figures are still substantial, however. In Colombia and Korea, prevalence among women knowing of an outlet remains more than 30 percent higher than among women not knowing an outlet. Similar adjustments do not affect the difference in Costa Rica and widen the difference in the Philippines.
Table 7: Percentage of Currently Married, Fecund, Non-pregnant Women Using Contraceptives in Seven World Fertility Surveys

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Type</th>
<th>Total</th>
<th>&lt;16 min.</th>
<th>16-60 min.</th>
<th>&gt;60 min.</th>
<th>Do Not know of an Outlet</th>
<th>Know of an Outlet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colombia</td>
<td>1976</td>
<td>Unadjusted</td>
<td>65.9</td>
<td>68.5</td>
<td>65.1</td>
<td>52.1</td>
<td>23.3</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adjusted 2/</td>
<td>61.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costa Rica</td>
<td>1976</td>
<td>Unadjusted</td>
<td>80.3</td>
<td>82.1</td>
<td>78.7</td>
<td>76.3</td>
<td>56.3</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adjusted 2/</td>
<td>80.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kenya</td>
<td>1977/78</td>
<td>Unadjusted</td>
<td>17.7</td>
<td>20.6</td>
<td>17.3</td>
<td>16.8</td>
<td>2.9</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adjusted 2/</td>
<td>12.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Korea</td>
<td>1974</td>
<td>Unadjusted</td>
<td>49.7</td>
<td>53.4</td>
<td>47.8</td>
<td>40.7</td>
<td>15.7</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adjusted 2/</td>
<td>49.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>1976/77</td>
<td>Unadjusted</td>
<td>63.7</td>
<td>66.0</td>
<td>64.2</td>
<td>51.2</td>
<td>16.1</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adjusted 2/</td>
<td>55.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panama</td>
<td>1976</td>
<td>Unadjusted</td>
<td>72.2</td>
<td></td>
<td></td>
<td></td>
<td>46.2</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adjusted 2/</td>
<td>72.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td>1980</td>
<td>Unadjusted</td>
<td>59.9</td>
<td>61.7</td>
<td>61.6</td>
<td>56.4</td>
<td>29.3</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adjusted 2/</td>
<td>57.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1/ Pebley and Brackett, 1982, Tables 1, 2, and 3.

2/ Adjusted for age, child mortality, sex ratios of children, husband's occupation, woman's education, whether last pregnancy was wanted, and desire for additional children.
Among women who know of an outlet, the percentage using contraception is positively related to the proximity of the source, although differences by travel time are small relative to those between women with and without knowledge of a source. Pebley and Brackett do not report the differences in prevalence by travel time adjusted for other characteristics of the household. They state only that differences are statistically significant for all countries except Costa Rica and conclude that "travel time makes little difference on use, once an outlet is known" (Pebley and Brackett 1982, p. 88).

Table 8 shows that knowledge of an outlet affects markedly the type of contraception used. Except in Costa Rica, users who know of a source are more likely to use modern methods than are women not knowing an outlet. Kenya is an extreme example. Three-fourths of women knowing of an outlet use modern methods; only one-fourth of women not knowing of an outlet use modern methods. The high proportion of women using modern methods of contraception among women not knowing of an outlet in Costa Rica, Korea, and Panama suggests that "knowledge of a source" may not be a good measure of actual availability in those countries. The percentage of these women protected by sterilization is 48 percent in Costa Rica, 51 percent in Korea, and 57 percent in Panama. Clearly, women protected by sterilization have little motivation to learn current sources for obtaining contraceptives. Were these women removed from the category "does not know of an outlet" in Table 8 and added to the users among those who know of an outlet, differences in prevalence by knowledge of source of family planning services would be even greater than is already shown.
Table 8: Percentage Distribution of Contraceptive Users by Method in Seven World Fertility Surveys 1/

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Know of an Outlet</th>
<th>Do Not Know of an Outlet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Modern</td>
<td>Traditional</td>
</tr>
<tr>
<td>Colombia</td>
<td>1976</td>
<td>75.6</td>
<td>24.4</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>1976</td>
<td>83.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Kenya</td>
<td>1977/78</td>
<td>72.9</td>
<td>27.1</td>
</tr>
<tr>
<td>Korea</td>
<td>1974</td>
<td>78.6</td>
<td>21.4</td>
</tr>
<tr>
<td>Mexico</td>
<td>1976/77</td>
<td>81.6</td>
<td>18.4</td>
</tr>
<tr>
<td>Panama</td>
<td>1976</td>
<td>87.2</td>
<td>12.8</td>
</tr>
<tr>
<td>Philippines</td>
<td>1978</td>
<td>48.6</td>
<td>51.4</td>
</tr>
</tbody>
</table>

1/ Pebley and Brackett, 1982, Table 5. Modern Methods include pill, condom, injectable, IUD, male and female sterilization, and female scientific methods.
Table 9 shows the proportion using contraception by knowledge of source and travel time for countries in which a Contraceptive Prevalence Survey was conducted. As in the WFS data described above, prevalence is much higher among women who know of a source than women who do not. For women having knowledge of a source, prevalence decreases as travel time increases. Table 10, constructed from data given in Cornelius and Novak (1983), shows that contraceptive prevalence differs only slightly by travel time in urban areas, controlling for socio-economic and demographic characteristics of women. Proximity to source in rural areas has a larger impact in Colombia and Honduras than in Costa Rica and Thailand.

The influence of actual availability on use has been studied in Bangladesh, India, Korea, Mexico, and Thailand. World Fertility Surveys of Bangladesh (1976), Korea (1974), and Mexico (1976) gathered information on public and private sources of contraceptive supply at the community level. Tsui, et al. (1981) matched this community-level data with individual records. For Mexico and rural Korea, the number of sources of supply within five kilometers of the community was used as a measure of availability. Categories used in the analysis for Korea were high (4 or more sources), medium (2-3), and low (0-1), and for Mexico high (5-6), medium (3-4), low (1-2), and none. For rural Bangladesh, availability was defined as high if an outlet was within three miles of the community, medium (4-7 miles), and low (8 or more miles). Table 11 shows the estimated odds probability of use of any type of contraception by availability of supply source with and without adjustment for wife's education and an index of community level of development. All estimates control for parity and marriage duration. With the exception of the unadjusted estimates for rural Bangladesh for areas of
Table 9 Knowledge of source of supply, perceived travel distance, and use of efficient methods of contraception among married women in twelve CPS surveys

|------------|---------------|---------------|-----------------|-----------------|---------------|------------|------------|------------|----------|-------------|-------------|

1. Percentage of women knowing of a source
   a. All women
      46  87  90  93  98  76  96  76  33  66  96  98
   b. Urban
      63  92  94  96  99  93  96  86  67  78  98  98
   c. Rural
      44  77  82  90  98  67  96  64  31  38  96  98

2. Of women knowing of a source, percentage who perceived travel time to be less than 30 minutes
   a. Total
      21  63  70  76  66  48  77  80  20  66  74  70
   b. Urban
      62  80  85  91  81  80  93  90  64  77  85  88
   c. Rural
      14  27  29  59  50  24  56  64  14  20  71  66

3. Percentage of women using efficient contraception
   a. All women
      9  37  41  55  56  24  40  34  7  17  47  54
   b. Urban
      < 30 minutes 27  49  50  62  62  46  41  55  39  27  62  64
      ≥ 30 minutes 18  47  34  53  54  53  40  28  30  32  56  55
don’t know of source 7  8  3  0  24  0  13  4  1  2  10  11
   c. Rural
      < 30 minutes 19  37  42  57  56  24  42  34  31  15  49  55
      ≥ 30 minutes 13  28  34  54  50  18  38  24  16  14  40  51
don’t know of source 3  1  1  3  7  0  7  3  0  0  6  3

a. Travel times for the Colombia 1978 Survey are: (a) less than or equal to 25 minutes and (b) greater than 25 minutes.

Source: Contraceptive prevalence survey tabulations.
Table 10: Percentage of Women Using Contraception by Travel Time to Source, Adjusted for Socioeconomic Characteristics, Five CPS Surveys 1/

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Travel Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt; 15 min.</td>
</tr>
<tr>
<td>Urban</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colombia</td>
<td>1980</td>
<td>64</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>1980</td>
<td>72</td>
</tr>
<tr>
<td>Honduras</td>
<td>1981</td>
<td>46</td>
</tr>
<tr>
<td>Nepal</td>
<td>1981</td>
<td>37</td>
</tr>
<tr>
<td>Thailand</td>
<td>1981</td>
<td>64</td>
</tr>
<tr>
<td>Rural</td>
<td></td>
<td>&lt; 15 min.</td>
</tr>
<tr>
<td>Colombia</td>
<td>1980</td>
<td>57</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>1980</td>
<td>66</td>
</tr>
<tr>
<td>Honduras</td>
<td>1981</td>
<td>31</td>
</tr>
<tr>
<td>Thailand</td>
<td>1981</td>
<td>59</td>
</tr>
<tr>
<td>Nepal</td>
<td>1981</td>
<td>23</td>
</tr>
</tbody>
</table>

Source: Cornelius and Novak, 1983, Tables 6, 7. Estimates adjusted for age, respondent's education, number of living children, and desire for additional children.
Table 11: Odds of Current Contraceptive use by Level of Availability Without Adjustment for Wife's Education and Community Level of Development 1/

<table>
<thead>
<tr>
<th>Country</th>
<th>Availability</th>
<th>None</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh, Rural, 1976</td>
<td>Unadjusted</td>
<td>.78</td>
<td>1.16</td>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjusted</td>
<td>.75</td>
<td>1.10</td>
<td>1.21</td>
<td></td>
</tr>
<tr>
<td>Korea, Rural, 1974</td>
<td>Unadjusted</td>
<td>.76</td>
<td>.93</td>
<td>1.41</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjusted</td>
<td>.78</td>
<td>.93</td>
<td>1.37</td>
<td></td>
</tr>
<tr>
<td>Mexico, 1976</td>
<td>Unadjusted</td>
<td>.37</td>
<td>.79</td>
<td>1.45</td>
<td>2.36</td>
</tr>
<tr>
<td></td>
<td>Adjusted</td>
<td>.77</td>
<td>.90</td>
<td>1.08</td>
<td>1.34</td>
</tr>
</tbody>
</table>

1/ Tsui, et al, 1981, Table 3. Odds represent the probability of being a user versus that of being a non-user. Both adjusted and unadjusted odds control for parity and marriage duration.
medium and high availability, the estimated net odds of contraceptive use increase monotonically with availability. Controlling for wife's education and community characteristics reduces differentials in odds of use by level of availability considerably in Mexico, but has only minor impact in Bangladesh and Korea. The adjusted estimates for Mexico imply that the odds probability of use is .77 to 1 for women with no access to family planning services compared to 1.34 to 1 for women in high availability areas, an increase in odds of use by about 74 percent (that is, 1.34/.77 = 1.74).

Table 12, taken from the same study, compares continuation rates (that is, the percent of ever users who are currently using a method of contraception) and percent using effective methods by level of availability. In Bangladesh, there is little difference in these measures of contraceptive use by proximity of supply. In Korea, continuation rates and percent using effective methods are similar in areas of low and medium supply, although both measures are much higher in areas with abundant supply sources. In Mexico, both measures of contraceptive use are strongly positively related to availability. Women residing in areas of abundant supply are over five times as likely to be using an effective method of contraception as women located in areas without a supply source. Over one-half of ever users are current users in areas of high supply; less than 15 percent of ever users are current users in areas with no source of supply. Unfortunately, no data are given which would show how adjustment for education would affect the estimated association between availability and these aspects of contraceptive use.

Entwistle, et. al. (1982) have used data from the 1981 Thailand CPS to investigate actual availability and contraceptive use. The Thailand National Family Planning Program provides services in hospitals, amphor
Table 12: Age-standardized Measures of Family Limitation by Service Availability Among Women 20-44 Years Old Continuously Married for at Least Three Years: Bangladesh, Korea, and Mexico 1/

<table>
<thead>
<tr>
<th>Country and Level of Availability</th>
<th>Percentage of Ever Users</th>
<th>Percentage Currently Using Effective Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh, Rural, 1976</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>6.7</td>
<td>4.5</td>
</tr>
<tr>
<td>Medium</td>
<td>9.5</td>
<td>5.6</td>
</tr>
<tr>
<td>High</td>
<td>9.5</td>
<td>5.6</td>
</tr>
<tr>
<td>Korea, Rural, 1974</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>29.0</td>
<td>25.2</td>
</tr>
<tr>
<td>Medium</td>
<td>32.7</td>
<td>25.4</td>
</tr>
<tr>
<td>High</td>
<td>44.0</td>
<td>33.4</td>
</tr>
<tr>
<td>Mexico, 1976</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>14.2</td>
<td>7.8</td>
</tr>
<tr>
<td>Low</td>
<td>26.0</td>
<td>16.8</td>
</tr>
<tr>
<td>Medium</td>
<td>39.6</td>
<td>27.4</td>
</tr>
<tr>
<td>High</td>
<td>51.5</td>
<td>39.1</td>
</tr>
</tbody>
</table>

1/ Tsui, et. al., 1981.
(district) health centers, and tambol (subdistrict) health centers. Hospitals
and amphor centers provide a wider array of methods than do tambol centers,
and if a district center is located close to a village then a tambol center as
well as a hospital may also be close to the village. The authors use a
trichotomous measure of availability: (1) a district center, where a hospital
or amphor health center is located, is close to the village (within 4
kilometers), (2) a district center is far from the village but a tambol center
is near, and (3) neither a district center nor a tambol center is within 4
kilometers of the village. Of the 193 villages included in their sample, 18
percent are near a district center, 50 percent are near a tambol center but
far from a district center, and 32 percent far from both. Holding constant
education, desire for additional children, and age of woman, they find that
proximity to a source of supply increases contraceptive use. For example,
among women thirty-five to forty-four with the modal characteristics of women
in this age group, the predicted level of use of efficient methods is 59.9
percent if neither a tambol nor district center is nearby, 65.1 percent if a
tambol center is nearby, and 67.5 percent if a district center is near
(Entwistle, et. al. 1982, p. 15). Among women aged twenty-five to forty-four,
there is no interaction between availability and education on use. That is,
proximity neither reduces nor increases the influence of education on
contraceptive use. For women fifteen to twenty-four, availability enhances
the positive effects of education on use. The authors suggest that
availability may encourage spacing among young women with four or more years
of schooling (Entwistle, et. al., 1982, pp. 13-14).

George Simmons (1971) analyzed data on IUD and sterilization acceptances
per 1,000 persons in 246 districts of India in 1966. Holding constant adult
literacy, urbanization, or per capita income, Simmons estimated that a 10
percent increase in the number of clinics per capita was associated with a 3 percent to 4 percent increase in the combined acceptance rates of IUDs and sterilization (Simmons 1971, Table V-5, p. 118). In a similar analysis of fifty-six districts with more complete data, he also found that a 10 percent increase in the number of extension workers per capita increased acceptance rates by 4-6 percent. He concluded that his results were "consistent with the hypothesis that past variations in the number of family planning acceptors by district has been the result of variations in the inputs to the family planning program" (Simmons 1971, p. 119).

Only a few studies have investigated the influence of program inputs or availability of family planning services on fertility decline. Some of these studies are summarized in this section.

T. Paul Schultz (1971, 1974) and Albert Hermalin (1975) examined the impact of two types of family planning workers on fertility change in the 381 administrative regions of Taiwan over the period 1964-1969. Because their results are generally similar, only the work by Schultz is summarized here. Measured inputs were the number of man-months of Village Health Education Nurses (VHEN) and Pre-Pregnancy Health Workers (PPHW) employed by the family planning program per thousand women aged fifteen to forty-nine in a district. In estimating the relation of fertility to inputs, all inputs were lagged one year. The VHEN disseminated principles of home economics, sanitation and hygiene, and family planning to the entire village population, and the PPHW contacted and recruited mothers, usually over age thirty, with recently delivered births. Schultz's regressions relating the change in fertility over the period 1964 to 1969 to cumulative family planning inputs and differences in child mortality rates, proportion of adult males employed in agriculture, and proportions of men and women age twelve years and over
with primary education certificates imply that a 1 percent increase in the number of VHEN decreased the total fertility rate by slightly more than 1 percent and a 1 percent increase in the number of PPHW decreased total fertility by slightly less than 2 percent (Schultz 1974, Table 5, p. 280). These elasticities are calculated at the mean values of VHEN and PPHW over the period 1964-1968. The average number of man-months of VHEN per thousand women in the reproductive ages was .26 and the average number of PPHW was 1.4. The marginal impact of additional manpower on fertility was much greater for women aged thirty to thirty-nine than for women in other age groups.

Estimates given in Schultz (1971) imply diminishing returns to additional inputs of manpower in any given cross-section at a point in time and diminishing returns over time. For example, according to the estimates for 1966, if only one-third of a man-month of a PPHW's time had been allocated to a community of 1,000 women of childbearing age in 1964 and 1965, then an increase in PPHW by only one-tenth of a man-month would be required to avert one additional birth. If the community had had 1.6 man-months of PPHW time, then an additional one-tenth of a man-month would have averted only one-half of a birth. From 1965 to 1968, evaluated at the mean number of months of PPHW time, the marginal cost of averting a birth rose fifteen-fold, assuming no changes in personnel costs per man-month.

Three other findings are of interest. First, in the early years of the program, the marginal impact of VHEN on fertility decline exceeded the marginal impact of PPHW, especially for women less than age thirty. Second, fertility rates of women aged fifteen to twenty-four were negatively associated with cumulative inputs of field workers in the early years of the program, but were positively associated with cumulative inputs in the later year of the program. Schultz suggests that the ability of younger women to
control fertility with the increased availability of modern contraception led to reductions in child spacing and perhaps promoted earlier marriage (Schultz 1971, pp. 32-35). Third, marginal impacts of family planning inputs differed depending on the characteristics of areas. For example, program inputs were more effective in 1966 in agricultural regions with low child mortality and high proportions of children enrolled in schools, but were neither more or less effective in regions with higher or lower levels of adult education (Schultz 1971, p. 57). In addition, family planning program inputs were more effective in areas with substantial decline in child mortality from 1961 to 1965 and in localities with more rapid increases in child schooling rates (Schultz 1971, p. 58). Nonetheless, the direct effects of family planning inputs in reducing fertility were large relative to impacts of terms involving interactions with socioeconomic variables.

Rosenzweig and Wolpin (1982) examined the determinants of recent fertility among women in India in 1968-1971, measuring family planning inputs by the fraction of villages having a family planning clinic in the district in which a woman resides. Holding constant wife's and husband's education, wife's age, farm and non-farm residence, and district level health, schooling, and sanitation characteristics, they found that doubling the number of villages in a district with a family planning clinic (from 2 percent to 4 percent) would reduce fertility by 13 percent, reduce child mortality, and raise school attendance by 11 percent. Over the lifetime of a representative woman, this fertility reduction would lead to a decline in births by about one-half child. The combined effect of fertility and mortality decline would reduce family size by about four-tenths of a child.
V. Experiments

There have been numerous experiments to assess the impact of alternative contraceptive delivery systems on contraceptive use and fertility (Cuca and Pierce 1977; Faruqee 1982; Faruqee and Johnson 1982; and Agree 1983). In this section of the paper I review briefly a few of these experiments. Two criteria are imposed in selecting the projects to be reviewed. First, the experiment must have a control group. Without a control group one cannot measure the impact of the delivery system independent of other environmental changes taking place during the course of the experiment. For example, a test of the efficacy and feasibility of household delivery of contraceptives in Morocco conducted over the period 1977-1979 showed an increase in contraceptive prevalence from 50 percent to 65 percent among urban women and from 12 percent to 45 percent among rural women (Agree 1983). It is quite possible that the distribution systems had a significant effect on use, but without a control site in which women were not exposed to the intervention, one cannot conclude unambiguously that increased accessibility was the source of increased contraceptive prevalence. Second, pre-program and post-program measures of fertility or contraceptive use must be reported. This criterion eliminates experiments which measure output by the number of contraceptives delivered.

Table 13 summarizes the characteristics and results of eleven experiments involving increased accessibility of contraception. With the exception of the contraceptive delivery experiment in Rio de Janeiro (Experiment 3), a project in an urban area where contraceptives were already available, all experiments report that greater availability yields bigger declines in fertility or increases in prevalence. Project effects are,
Table 13 Results of Eleven Family Planning Program Experiments

1. Matlab, Bangladesh
   a. Contraceptive Distribution Program of the Cholera Research Laboratory
   b. Rural
   c. 1976-1977
   d. To test hypothesis that ubiquitous availability of contraceptives will increase prevalence and reduce fertility
   e. TFR in treatment area fell 13% relative to control in first year. TFR in both areas fall in the second year with a greater decline in the control area.

2. Matlab, Bangladesh
   a. Family Planning Health and Services Project
   b. Rural
   c. 1977-1981
   d. Contraceptive distribution, tetanus immunization, and oral rehydration therapy.
   e. Before the project began, TFR in the treatment area was about 6% below the control area TFR. After the program, the treatment area TFR was about 28% below the control area TFR.

3. Rio de Janeiro, Brazil
   a. Household Delivery of Family Planning Information and Condoms
   b. Urban
   c. 1981-1983
   d. To test alternative methods of contraceptive delivery systems.
   e. No difference among increases in contraceptive prevalence and control area or any of three methods for delivering contraceptives: 1) mini-health posts plus home visits for contraceptive delivery, 2) mini-health posts without home visits, and 3) home visits without health posts.
4. **Boyaca, Colombia**
   a. Boyaca Household Distribution
   b. Rural
   c. 1977-1981
   d. Household distribution of contraceptives with basic health services, including antihelmintics to improve children's nutritional status.
   e. Before the program, contraceptive prevalence was 16% in all areas. Prevalence rose to 43% in the control area, 59% in the area in which orals were distributed, and 53% in the area in which only antihelmintics were distributed. Differences in the latter two areas are not statistically significant.

5. **Ghana**
   a. The Danfa Project
   b. Rural
   c. 1970-1978
   d. To test alternative methods for delivery of health and family planning services.
   e. No change in fertility or contraceptive prevalence or contraceptive acceptance rates in the control area. Fertility decline greatest and acceptance rates highest in area with comprehensive health services and next greatest in area with distribution of contraceptives and health and nutrition education. Lower rates of fertility decline and contraceptive acceptance were observed in areas with contraceptive distribution only. Because of relatively poor measurement of fertility rates, it is not clear whether the fertility declines in the last areas were substantially lower than declines in other areas.

6. **Meru District, Kenya**
   a. Kinga Social Marketing Experiment
   b. Rural
   c. 1972-1975
   d. Incentive program to shopkeepers to distribute condoms and extensive IEC activities.
   e. Contraceptive prevalence rates increased from 21% to 25% in treatment area. No change in control area (20% vs. 19%).
7. Cheju Province, Korea
   a. Korean Population Policy and Program Evaluation Project
   b. Rural
   c. 1976-1979
   d. Home visits by canvassers for distribution of oral pills and condoms and referrals for IUD's and sterilization. Tubal ligation was subsidized.
   e. The control area was rural Korea, which was served by the national family planning program. Prevalence rose from 18% to 35% in Cheju Province and from 26% to 45% in the rural Korea. Fertility fell by 35% in the test area but only 29% in rural Korea. The additional decline in Cheju was attributed to an increase in tubal ligation relative to the rest of rural Korea.

8. San Pablo Autopan, Mexico
   a. Community Based Family Planning Demonstration Project
   b. Rural
   c. 1976-1977
   d. Household delivery of MCH services and contraceptives.
   e. Prevalence increased from 7% to 25% in San Pablo Autopan, but only from 5% to 9% in the surrounding vicinity.

9. Bohol, Philippines
   a. Bohol Integrated Maternal Child Health and Family Planning Project
   b. 80% rural
   c. 1974-1979
   d. Delivery of MCH and family planning services by local primary health care centers, midwives, traditional birth attendants, and barrio workers providing outreach services.
   e. 15% decline in the general fertility rate in areas served by the program compared with a 9% decline in non-project areas.

10. Jamkhed, Maharashtra State, India
    a. Comprehensive Rural Health Project
    b. Rural
    c. 1971-1978
Table 13 (page 4)

d. Delivery of maternal and child health care and family planning services

e. In areas served by the program, the crude birth rate fell from 40 in 1971 to 23 in 1976 and the proportion of eligible couples using contraceptives rose from 3% to 51%. In a non-program area the crude birth rate was 37 in 1976, and fewer than 10% of eligible couples were using contraception.

11. Taiwan

a. Contraceptive Inundation

b. 24 Townships

c. April, 1974 – December, 1975

d. In twelve townships, six cycles of oral pills and six dozen condoms were provided free to post-partum women. Households were visited four times after initial contact. Beginning in January, 1975, all women aged 20 to 44 were visited and contraceptive supply depots were set up to increase accessibility.

e. From April, 1974 to December, 1975, contraceptive prevalence increased by 75 percent in the experimental areas, but by only 30 percent in control areas.

Sources: Agree (1983), Cuca and Pierce (1977), Faruquee (1982), and Faruquee and Johnson (1982).
however, very small in the contraceptive distribution program of the Cholera Research Laboratory in Bangladesh (Experiment 1) and the condom marketing scheme in Kenya (Experiment 6). Aside from the fertility reducing and use enhancing effects of availability, it is difficult to draw any other lessons from the experiments because of the diverse nature of the projects and of the target populations. There is modest evidence that combining contraceptive delivery with maternal or child health services yields a bigger impact on fertility than contraceptive delivery alone (Experiment 1 versus Experiment 2; Experiment 5). Of course, it is difficult to evaluate whether or not access to contraceptive supplies is the same in programs offering services other than contraceptive distribution. For example, clinics offering multiple services may be open more hours per day than those providing only contraceptive supplies. In addition, evidence from other experiments on integration of services is less positive. For example, an experiment in Narangwal, Punjab in India provided different mixes of family planning and health services: (a) family planning services and family planning education; (b) family planning services, women's health care, and child health care; (c) family planning and women's health care; (d) family planning and child care (including nutrient supplements); and (e) no services. In areas with projects, there was little difference among interventions in the number of new acceptors or in levels of contraceptive use adjusted for efficiency of method at comparable dates following program intervention (Faruqee 1982, Figure 3 and Figure 4, p. 13).
VI. Conclusion

Economic theory suggests that increasing access to, or availability of, contraceptive methods will increase contraceptive use and reduce the demand for children. This paper has reviewed many studies of the empirical association among contraceptive availability, contraceptive use, and fertility. Cross-national evidence on the impact of family planning effort indicates that the expansion of family planning programs over the decade 1965 to 1975 resulted in measurable fertility decline. This evidence, however, does not in itself indicate that increased availability of contraceptive supplies reduced fertility, since family planning programs include many components other than contraceptive distribution. Studies of perceived availability suggest that women who do not know of an outlet for contraceptives are less likely to use contraception than women who do know of an outlet and that women who know of a closer source of supply are more likely to use contraception, especially more efficient methods of contraception, than women who know only of more distant sources. Controlling for rural-urban residence, education, and other socioeconomic variables has little effect on the association between increased contraceptive use and increased perceived proximity in most countries. An important weakness of these studies is that women who wish to restrict fertility and who therefore wish to use contraception are more likely to search for, and to find, a source of supply. Knowledge of a source and use of contraception are thus jointly determined. Consequently, it may well be the case that the results of studies of the relation of perceived availability to use may overstate the impact of increased access. For this reason, studies relating use of contraception or fertility to measures of actual availability such as distance from residence
to nearest supply source, density of clinics, and extension worker inputs per
couple provide much more useful evidence.

Numerous studies of the effect of increased actual availability,
including the results of experiments, indicate that increased access to
sources of contraceptive supply results in an increase in contraceptive use
and a decrease in fertility. Because of wide differences in the
characteristics of the populations studied, because of differences among
studies in the measurement of access to methods of contraception, and because
of differences in methodology, it is not possible to summarize easily the
estimated impacts of increased access on contraceptive use or fertility in
these studies. In some studies the effects of access seem to be large. For
example, Rosenzweig and Wolpin (1982) estimated that doubling the fraction of
villages with a family planning clininc (from 2 percent to 4 percent) in India
in 1970 would have lowered the total fertility rate by 13 percent. In his
study of Taiwan, Schultz (1971) estimated that in the mid 1960s a 1 percent
increase in the number of field workers per thousand women of reproductive age
was associated with a fertility decline of between 1 and 2 percent.

Few studies have explored whether there are interactions between
socioeconomic characteristics of couples and the effects of increased access.
This issue is worthy of further attention since such studies might show the
distributional consequences of increased access and might also provide some
evidence as to the conditions under which family planning inputs would have
the greatest marginal impact on contraceptive use and fertility decline.

Entwistle, et al (1982) found virtually no differences of increased proximity
on contraceptive use by education of mother in Thailand. Schultz (1981) found
that the marginal effects of family planning inputs on fertility decline were
neither higher nor lower in areas in which parents had more or less education,
but did find that the marginal impacts were greatest in areas that had experienced the largest declines in child mortality and the greatest increases in child enrollment ratios in the period before the advent of the family planning program.

In short, there is overwhelming evidence that greater access to contraceptive supplies results in increased use of contraception and fertility decline. We have as yet, however, rather weak evidence on the precise magnitudes of these effects and the ways in which differentials in socioeconomic characteristics of couples make these effects large or small.
Appendix

In order to provide a framework for examining empirical research on the effects of improved access to contraceptive methods on contraceptive use and fertility, I develop in this section a simple one-period model of the demand for children and the demand for contraception by couples who have reached a given point (for example, marriage duration) in the life cycle. The model is adapted from one used by Rosenzweig and Seiver (1982) in their investigation of the effects of education on contraceptive choice.

The household is characterized by a fixed level of wife's education, $S$, and a level of excess (or deficit) fertility, $X$, representing deviations from optimal planned fertility in previous periods. The household's utility function is:

$$U = U(N, Z; X, E) \quad U > 0, \quad U_{N} > 0, \quad U_{X} < 0,$$

where $N$ is live births in the planning period, $Z$ is a composite commodity consumed by household members, and $E$ is a set of variables characterizing the environment in which the household resides. Community norms affecting preference for children versus other goods could be a component of $E$.

The number of births in a period,

$$N = \bar{n} - A(C),$$
is the difference between the number of children the couple would have in the absence of contraception, \( n \), and the number of births averted by contraception, \( A \), where the number of births averted depends on the quantity of contraceptives used, \( C \).

Excess fertility is assumed to be negatively related to wife's schooling and positively to the price (availability) of contraception in previous periods, \( \rho \), and fecundity, \( \bar{n} \),

\[
(3) \quad X = X(S, \rho, \bar{n}) \quad X_S < 0, X_\rho > 0, X_{\bar{n}} > 0.
\]

These assumptions are plausible if wives with more schooling and users of contraception have better control over the variance of fertility, for a given level of fecundity, so that deviations from planned fertility are smaller for wives with more \( S \) or for couples with a lower \( \rho \) (Rosenzweig and Seiver, 1982, P. 174; Keyfitz, 1971). Similarly, for a given level of contraceptive use, wives with higher fecundity (\( \bar{n} \)) are likely to have higher excess fertility.

The budget constraint is

\[
(4) \quad F = P_n n + P_c C + P_z Z,
\]

where \( F \) is full income, \( P_n \) is the price of a child, and \( P_c \) and \( P_z \) are the per unit costs of contraceptives and the composite commodity, respectively. All prices incorporate time costs of purchasing and consuming goods. It is further assumed that the price of contraception is inversely related to wife's

---

\( ^{1/} \) It would be relatively easy to incorporate selection of contraceptive method into the model, but the complications of introducing more than one method do not yield insights important to the questions addressed in this paper. If more than one method is used, then optimal usage would involve a choice of methods such that the marginal costs of averting a birth are identical for each method.
schooling on the hypothesis that women with more schooling have lower information costs about contraception or, alternatively, have greater efficiency in contraception use, so that births averted per unit of contraception are lower for more educated women. Finally, it is assumed that more educated women have higher values of time, so that the price of children is greater for such women. For simplicity, it is assumed that:

\[
\begin{align*}
(5) \quad P_c &= \gamma + \phi(S) \quad \phi_s < 0, \text{ and} \\
(6) \quad P_n &= \alpha + \theta(S) \quad \theta_s > 0,
\end{align*}
\]

where \(\gamma\) and \(\alpha\) are direct prices of contraception and children, respectively, and \(\phi(S)\) and \(\theta(S)\) are functions reflecting the modifying impacts of schooling on these prices.

The first order conditions for the maximization of (1) subject to (2) - (6) are

\[
\begin{align*}
(7a) \quad &- U_n A_c + \lambda (P_n A_c - P_c) = 0 \\
(7b) \quad &U_z - \lambda P_z = 0,
\end{align*}
\]

where \(\lambda(>0)\) is a Lagrangean multiplier. These conditions can be rearranged to yield:

\[
\begin{align*}
\frac{U_n}{U_z} &= \frac{P_n - P_c / A_c}{P_z}.
\end{align*}
\]

An alternative specification is to introduce schooling into the births averted function.
Since $\frac{P_c}{A_c}$ is the marginal cost of averting a birth, the net price of a child is $P_n$ minus the savings in contraceptive costs from having an additional birth. Thus, equation (8) indicates that at the optimum, the marginal rate of substitution of children for other goods equals the ratio of the net price of a child to the price of other goods.

Differentiating totally the first order conditions and solving for the response of contraceptive use to changes in the model's parameters, we obtain

\begin{align*}
(9a) \quad \frac{\delta C}{\delta \gamma} &= \frac{\delta C^*}{\delta \gamma} - C \frac{\delta C}{\delta F} \\
(9b) \quad \frac{\delta C}{\delta \beta} &= -A_c \frac{\delta C^*}{\delta \gamma} - (\bar{n} - A) \frac{\delta C}{\delta F} \\
(9c) \quad \frac{\delta C}{\delta S} &= \left( -A_c \frac{\theta_s}{s} + \phi_s + A_c \frac{U_{nx}}{\lambda} X \right) \frac{\delta C^*}{\delta \gamma} + \lambda U \frac{\delta C^*}{\delta x} + \frac{\delta C^*}{\delta P} \\
&\quad - \left( (\bar{n} - A) \frac{\theta_s}{s} + C \frac{\phi_s}{s} \right) \frac{\delta C}{\delta F} \\
(9d) \quad \frac{\delta C}{\delta \bar{n}} &= \left( A_c \frac{U_{nx}}{n} X \right) \frac{\delta C^*}{\delta \gamma} + \left( U_{zn} + \frac{U_{xz}}{n} \frac{\delta C^*}{\delta P} \right) - C \frac{\delta C}{\delta F}
\end{align*}
contraceptives used and reduces the number of children demanded. The second
influence of a change in price is an income effect. That is, the fall in
price raises real income and thus may induce the couple to buy more or fewer
contraceptives. There are no direct empirical estimates of the effect of
income on the demand for contraception. However, it can be shown from
equation (10) that

\[
\frac{\delta C}{\delta F} = - \frac{1}{A_c} \frac{\delta n}{\delta F}
\]

Thus, if children are normal goods, then contraception is an inferior good.
Conversely, if fertility falls as full income rises, then contraception is a
normal good. There are numerous estimates of the effect of increases in full
income on the demand for children in LDC's.\(^3\) Most estimates, although not
all, suggest a small negative impact of income on fertility, which implies
that contraception is a normal good. Hence, the effect of increased income on
the demand for contraception resulting from a decrease in the price of
contraception augments the substitution effect. Since, however, the effect of
income on the demand for children is small and since expenditures on
contraception are likely to be only a small fraction of income, the income
effect is likely to be small.

Aside from the important theoretical argument that the quantity of
contraception demanded is inversely related to its price (and thus positively
to its availability), the foregoing discussion also suggests that the demand
for children is positively related to the price of contraception (and thus

\(^3\) The estimates assume that the coefficient of husband's income in a
demand for children equation represents the impact of changes in full
income.
where \( \frac{\delta C}{\delta \gamma} < 0 \) is the compensated substitution effect of a change in the price of contraception and \( \frac{\delta C}{\delta P_z} \) is the Hicksian (income) compensated cross-substitution effect of the influence of \( P_z \) on \( C \). It can be shown that \( \frac{\delta C}{\delta P_z} > 0 \), so that contraception and \( Z \) are Hicksian substitutes.

To interpret the influences of changes in various parameters on the demand for contraception it is useful to recall that \( n = \bar{n} - A \), so that

\[(10) \quad \frac{\delta n}{\delta \kappa} = -A \frac{\delta C}{\delta \kappa} \quad \kappa = \gamma, \beta, S, F, P, E.\]

Equation (10) shows that the demand for children and the demand for contraception respond in opposite ways to changes in parameters. That is, a change in any parameter which leads to an increase (decrease) in the demand for contraception simultaneously reduces (raises) the demand for children.

Returning to equation (9a), we see that a reduction in the price of contraception (or improvement in access) has two effects on the quantity of contraceptives demanded. The first effect is a compensated substitution effect \( \left( \frac{\delta C}{\delta \gamma} < 0 \right) \) which induces the couple to increase the quantity of
inversely to its availability). An important implication of this result is that empirical estimates of the effect of availability on use which hold constant some measure of the demand for children (for example, desired family size or desire for additional children) will **understate** the impact of increased availability on use of contraception.

Equation (9b) shows that an increase in the price of children unambiguously yields an increase in contraceptive use, provided that contraception is a normal good.

The influence of wife's schooling on the demand for contraception (equation (9c)) is complex. The first term in this equation consists of three components. The first two components reflect the influence of increased schooling on the price of a child and on the price of contraception, respectively. The signs of these components imply that a rise in schooling increases the demand for contraception. However, the third component includes the influence of increased schooling on the timing of fertility. To the extent that women with more schooling have lower excess fertility at any given period in their life cycle (\(X_s < 0\)), then women with more schooling have a smaller demand for contraception than women with less schooling, other things being equal. For empirical evidence on this latter point see Rosenzweig and Seiver (1982). We now turn to the second term in the equation. Since \(X_s < 0\) and \(\frac{\delta C}{\delta P_z} > 0\), the sign of this term depends on the sign of \(U_{zX}\). Thus, if an increase in \(X\) raises (lowers) the marginal utility of \(Z\), the second term is negative (positive). The third term is a composite of the income effects resulting from the changes in schooling on the prices of children and contraception and has an ambiguous sign. This analysis is useful in that it reveals some of the channels through which schooling affects contraceptive use. However, the analysis implies that the impact of an increase in
schooling on contraceptive use is a priori unpredictable and is thus an empirical question. Microeconomic studies of the demand for children generally, but not always, reveal a negative association between education and fertility, suggesting that the demand for contraception is ordinarily positively associated with schooling.

Equation (9d) shows the effect of increased fecundity on contraceptive use. The first term is unambiguously positive; the sign of the second term is a priori ambiguous. The effect of increased fecundity on the demand for children is

\[ (12) \quad \frac{\delta n}{\delta n} = 1 - A_c \frac{\delta C}{\delta n}. \]

Even if the net effect of increased fecundity on contraceptive use is positive \( (\frac{\delta C}{\delta n} > 0) \), fertility will be positively related to fecundity unless \( \frac{\delta C}{\delta n} \) and births averted per unit of contraception are sufficiently large.

Equation (9e) reveals the influence of contraception availability in the past to current contraceptive use. Given the assumptions stated earlier, the first term in this equation is positive; that is, the higher the previous price, the higher will be current demand for contraception, other things being equal. The sign of the second term depends on preferences. If the sum of the two effects is positive, then extending service to couples who formerly did not have ready access to contraception is likely to result in greater increases in contraceptive use than improvements in access for couples which already face relatively low prices for contraceptives. More speculatively, if this equation has a positive sign, then increasing availability of contraception may shift the timing of fertility in the life cycle. Older couples having faced relatively high prices of effective contraception in the
past are likely to have engaged in measures such as postponing age at
marriage, reducing coital frequency, and prolonging lactation in order to
avoid future excess fertility. Young couples, facing relatively low prices
of contraception, do not face the same incentive to delay childbearing. Thus,
it is quite possible that fertility of young women will rise with increased
availability.

Finally, equation (9f) shows that changes in environmental variables
such as community norms with respect to childrearing may also influence
contraceptive use. For example, if policies to persuade couples of the
desirability of small families were successful, then $U_{ne} < 0$ and contraceptive
use would increase. Alternatively, if exposure to modernization raises the
marginal utility of consumption of goods other than children, then
$U_{ze} > 0$ and contraceptive use will increase.
References


114


FEMALE EDUCATION, FAMILY PLANNING, INCOME, AND POPULATION: A LONG-RUN ECONOMETRIC SIMULATION MODEL

David Wheeler
This paper is a cross-country analysis of the dynamic relationships linking education, population policy, demographic change, and economic growth. It develops an econometric simulation model for comparing the long-run benefits of equivalent investments in physical capital, female education, and family planning programs.

The core of the model is a set of econometric equations which are estimated using simultaneous equations techniques. These equations are designed to track changes in five critical variables: National output, investment, total fertility, infant mortality, and family planning activity. The equations are fitted to data on decennial changes in relevant variables for 70 developing countries.

Among the results of the estimation exercise, the following appeal particularly noteworthy:

1. Primary and secondary education substantially increase labor productivity.
2. The marginal contribution of uneducated labor declines with development.
3. Dependency rates have no apparent impact on savings and investment rates.
4. Female schooling and family planning activity have a strongly interactive impact on fertility.
5. Infant mortality responds strongly to female education.
6. Family planning and total fertility are simultaneously determined. Government behavior seems primarily "reactive" (rapid expansion in family planning is associated with relatively slow fertility decline, and conversely).

In the full simulation model, the econometric equations are linked to standard age cohort tables for survival and fertility. The paper reports results from comparative simulation exercises for eleven developing countries. In all cases, physical investment is dominated by enhanced female education and family planning. Both yield higher income and lower populations in the long run. Female education dominates as a contributor to both income and reduced population in the poorest countries, while family planning has a greater impact on population size in middle-income countries.
Acknowledgements

For many valuable contributions, I am grateful to Nancy Birdsall, Bryan Boulier, and Warren Sanderson.
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>122</td>
</tr>
<tr>
<td>I. The Econometric Model - An Overview</td>
<td>125</td>
</tr>
<tr>
<td>A. Economic Submodel</td>
<td>125</td>
</tr>
<tr>
<td>B. Demographic Submodel</td>
<td>128</td>
</tr>
<tr>
<td>II. The Simulation Model</td>
<td>134</td>
</tr>
<tr>
<td>A. Introduction</td>
<td>134</td>
</tr>
<tr>
<td>B. Age-specific Fertility and Mortality Schedules</td>
<td>136</td>
</tr>
<tr>
<td>C. Incorporating Unit Cost Estimates for Education and Family Planning</td>
<td>140</td>
</tr>
<tr>
<td>D. Malawi and Togo: An Illustration</td>
<td>143</td>
</tr>
<tr>
<td>III. Alternative Social Policies: Comparisons for Eleven Countries</td>
<td>157</td>
</tr>
<tr>
<td>Bibliography</td>
<td>166</td>
</tr>
<tr>
<td>Appendix: Econometric Results</td>
<td>170</td>
</tr>
<tr>
<td>I. Output Change and Investment</td>
<td>171</td>
</tr>
<tr>
<td>A. Output Change</td>
<td>171</td>
</tr>
<tr>
<td>B. Savings-investment Behavior</td>
<td>185</td>
</tr>
<tr>
<td>II. Fertility, Mortality, and Family Planning</td>
<td>193</td>
</tr>
<tr>
<td>A. Specification and Estimation Issues</td>
<td>193</td>
</tr>
<tr>
<td>B. Fertility</td>
<td>194</td>
</tr>
<tr>
<td>C. Mortality</td>
<td>200</td>
</tr>
<tr>
<td>D. Family Planning</td>
<td>204</td>
</tr>
</tbody>
</table>
Introduction

As its title implies, this paper covers an extremely broad subject. It builds, however, on a long-standing tradition in economics which began with Malthus (1798/1959); was extended in the early twentieth century by Fetter (1912), Keynes (1923), and Hansen (1939); and formalized mathematically by Nelson (1956) and Enke (1963). These scholars and many others have been interested in analyzing the long-run dynamics linking output and population in national economies. Their primary concern has been to identify the conditions under which output growth can outpace population growth.

In recent years, this concern has spread rapidly within the community of development scholars, planners, and policy-makers. Although some scholars (e.g., Simon (1977)) have defended moderate population growth as a stimulant to economic development, most hold the contrary view. Policy discussion has therefore been focused on appropriate means for reducing the growth rate of population in developing countries.

Several approaches are currently advocated by major participants in the debate. Some emphasize general policies which promote rapid economic growth, on the grounds that this stimulates many changes whose net result is declining fertility. A more direct approach is advocated by those who support enhanced human resource investments, and
particularly female education. Among proponents of this view, the anticipated impact is twofold: A stimulus to economic productivity, and a direct effect on fertility as education changes female perceptions, earning opportunities, and status within family groups. Finally, the most direct approach is advocated by those who support rapid expansion of contraceptive programs.

This is not a debate which one faction can "win," in any meaningful sense. Fast-growing societies can afford to finance good educational programs, and the latter (as noted above) are themselves important in assuring rapid growth. Contraceptive programs will be more welcome in communities where education and economic growth have already altered traditional perceptions and aspirations. The policy problem is therefore to assign relative degrees of emphasis to the different approaches.

Such assignment is problematic when good numbers are unavailable, of course, and this problem has dogged development planning for a long time. Relevant policy simulation models were constructed in the early 1970's (e.g., Blandy/Wery (1973); Barlow/Davies (1974)), but many parameter values had to be guessed. By the late 1970's, the data base had improved sufficiently to support the statistical estimation of long-run policy models (e.g., Hazledine/Moreland (1977); Wheeler (1980; 1984a); Marris (1982); Mera/Shishido (1984)). This paper extends that tradition. It uses the latest available data to estimate a policy simulation model which compares the growth outcomes associated with equivalent investments in physical capital, education, and family
planning.

The first part of the paper describes the structure of the model. All of its equations are fitted to a cross-section of measured changes in relevant variables during the 1960's and '70's. The economic submodel includes simultaneously-estimated equations for physical investment and output growth. It incorporates schooling and "managerial efficiency" (as measured by the World Bank) as policy variables. The demographic submodel includes simultaneously estimated equations for fertility, infant mortality, and family planning. Policy variables include female schooling, measures of national family planning effort, and many public health indices.

The simulation model is discussed in the second part of the paper. For policy simulation, the econometric equations are combined with a set of demographic "housekeeping" equations which track age cohorts through time. Once country-specific initial conditions and hypothetical time paths for the policy variables are specified, the model can project national income and population for an arbitrary number of periods into the future.

In the third part of the paper, simulation results are presented for eleven developing countries: Togo, Malawi, Kenya, India, Bangladesh, Malaysia, Indonesia, Brazil, Bolivia, Honduras, and Mexico. The simulations project the long-run consequences of equivalent expenditure

---

1. The Appendix contains an extensive technical discussion of estimation procedures and results.
increases on physical investment and the two social investment options: Female education and family planning programs. In all cases, both social investment options yield higher incomes per capita in a relatively short period of time. Female education yields the best economic result (i.e. the highest level of income per capita), while enhanced family planning seems generally better as an instrument for pure population control.

I. The Econometric Model - An Overview

The core of the simulation model is a set of five econometric equations which are used to explain changes in output, investment, fertility, infant mortality, and family planning effort. As previously noted, these equations are grouped into two submodels which are estimated as simultaneous systems.

A. Economic Submodel

1). Output Change

In the economic submodel, output change and physical investment are jointly determined. In the output change equation, the basic variables are changes in capital and labor. Neither variable is included in "raw" form, however. The output elasticity of labor is assumed to be affected by education. To control for its impact, growth in the labor force is interacted with measures of primary and secondary educational attainment. The equation also allows for a change in the output elasticity of uneducated labor as economic development proceeds. To control for this effect, labor force growth is interacted with the
prevailing level of per capita income.

The measure of capital stock change is also modified in the output change equation. Aggregative time series measures of the capital stock are rare in developing countries, but measures of annual gross domestic investment (GDI) are generally available. Division of GDI by output yields the investment rate, which is the dependent variable in the second equation of the economic submodel. Simple algebra suffices in turn to show that the growth rate of the aggregate capital stock is identically equal to the product of the investment rate and the output/capital ratio.

Although the output/capital ratio cannot be directly observed, it can be proxied by an index of effectiveness in economic management. Such an index has been developed by the World Bank's country economists. It would be unwise to assume that this index is truly exogenous to the output change equation, since its construction has undoubtedly been influenced by observed differences in growth rates. It is therefore treated as an endogenous variable in the model.

The final specification of the term which represents change in the capital stock is thus rather complex. It is a product of two variables: The investment rate and the World Bank management performance index. As previously noted, both variables are treated as endogenous in the estimation exercise.

A full discussion of the output equation results is provided in the Appendix. The pattern suggested by the results can be summarized as
follows: Very poor societies generally have low schooling rates and disproportionately low management performance indices. Much of their labor force is engaged in subsistence agriculture. With continuing investment in physical and human capital, however, major changes in prevailing productivity patterns occur. The marginal contribution of raw labor declines as structural change occurs. At the same time, better schooling makes a major contribution to labor productivity and to the productivity of capital. After several decades of rapid growth, the economy is characterized by a relatively high output elasticity of capital, a high output elasticity for educated labor, and a very low output elasticity for uneducated labor.

2). Investment

National savings rates are very important in determining investment rates, and existing empirical work suggests that the most important determinants of the savings rate in developing countries are the output growth rate, income per capita, and capital inflow. There has been considerable controversy over the importance of dependency rates in this context (Ram (1982,1984); Leff (1969,1984)). Since rapid population growth increases the child dependency rate, it is important to test the

2. The correlation between low schooling and poor economic management is, of course, what would be expected. The reduced-form regression used to produce fitted values for the World Bank management performance index suggests substantial importance for general education as a determinant of relative performance. Education does not account for a large proportion of variation, however. Since expatriate skills can always be employed, at least some of the education handicap can be compensated for. Such a compensatory policy has been obvious in several African states (e.g. Ivory Coast).
proposition that child dependency reduces the national savings rate. The econometric results reported in the Appendix find no significant effect.

For the investment rate itself, the determinants of the savings rate should remain important. In addition, it is plausible to suppose that political stability could have an effect. A series of regression experiments suggested, however, that only income per capita and capital inflow were significant determinants of the investment rate. Considerable stability in investment behavior is suggested by the fact that the previous decade's investment rate is also highly significant.

B. Demographic Submodel

Much disagreement remains concerning appropriate models for explaining international differences in fertility and infant mortality. It is probably not controversial, however, to allow for simultaneous causation in the specification of behavioral equations. An appropriate treatment of the demographic equations should allow for joint determination of at least four variables: Fertility, infant mortality, governmental family planning effort, and income per capita.

It is easy to argue that fertility and infant mortality affect one another. If fertility is influenced by desired family size, then the infant survival rate is an important determinant of expectations. In addition, lactation has some contraceptive effect, so that an enhanced infant survival rate should have a purely physiological impact on fertility. It can also be argued that fertility has an impact on infant mortality. Some evidence suggests that child spacing affects infant
survival probability, and child spacing is clearly related to fertility.

Measures of family planning effectiveness should also be considered jointly determined in the demographic submodel. Family planning programs attempt to reduce fertility through low-cost provision of contraceptives and instruction in their use. Such programs should work if optimal fertility is conditional on the cost of contraception, and if "achieved" fertility is conditional on correct use of contraceptives. Family planning activity may also be affected by fertility, however. In countries where fertility decline is already evident, the government may be willing to increase its family planning effort because it perceives receptivity to be high and political risk low.

Finally, income per capita should be treated as a jointly-determined variable in the demographic submodel. The economic theory of fertility determination suggests (on the assumption that children increase parents' happiness) that per capita income and fertility should be positively related, other things equal. Societies with rapidly expanding income per capita will find it easier to finance programs which enhance infant survival rates, since revenues will expand at constant tax rates. By the same argument, family planning programs

3. In fact, other things are not likely to be equal in this kind of international cross-section work. Increasing per capita income is correlated with many changes which increase the opportunity cost of child-rearing. An estimated coefficient for per capita income in this context will represent mixed effects, and it seems more likely to be negative than positive.
might be encouraged. Treatment of per capita income as a jointly-determined variable is made necessary by its implicit denominator - population. It therefore joins fertility, infant mortality, and family planning effort in the simultaneous system.

1). **Fertility**

The fertility equation incorporates the effects of female schooling, family planning activity, infant mortality, and income per capita. Female schooling and planning effort are explicitly interacted on two prior hypotheses: (1). Enhanced planning effort affects fertility in proportion to the level of education of the fertile-age female population; (2). Enhanced female education affects fertility in proportion to the cost of contraception and the availability of technical instruction concerning proper use.

In the regression results, the schooling-planning interaction, income per capita, and infant mortality all appear significant as determinants of fertility change. For income per capita, the major effect seems contemporaneous. For schooling-planning and infant mortality, the results suggest somewhat more importance for a lagged effect. One ambiguity is introduced by some doubt about whether fertility change and change in infant mortality are simultaneously determined.

2). **Infant mortality**

Regression analysis of the determinants of infant mortality has
allowed for the effects of changes in female schooling, family planning effectiveness, per capita income, and the fertility rate. In addition, the impacts of a large number of social policy variables were tested. Among these were doctors per capita, nursing persons per capita, incidence of breast feeding at various ages, vaccination rates, access to clean water, and availability of ORT (oral rehydration therapy) packets. None of the available measures for the social policy variables seems to contribute significantly to the explanation of variance in infant mortality rates, with the possible exception of ORT packet availability. The limited number of observations limits the credibility of that result.

Female education seems to dominate all other variables as a determinant of changes in the infant mortality rate (IMR). In fact, three quarters of the variance in IMR changes can be accounted for by an equation which incorporates lagged changes in the IMR and the lagged change in the planning-schooling interaction. Obviously, most of the movement remains "unexplained," in the usual sense. The apparent absence of any impact for the other policy variables is surprising and must have something to do with data problems. It is not clear whether the main problem lies in the available measure of the infant mortality rate or in the measures for the policy variables.

3). Family Planning

Family planning effort has been treated as an endogenous variable in the fertility and mortality equations because of the possibility that
it has been jointly determined with fertility change. The most reasonable argument in favor of the hypothesis of joint determination focuses on "encouragement effects." In a society where the fertility rate is already declining, government planners may be able to institute family planning programs at lower cost and political risk.

It should be noted, however, that the "encouragement" hypothesis has no unique claim to validity here. If governments are inclined to undertake family planning efforts, and if they perceive no autonomous tendency for fertility to decline, then they may decide to intervene more actively. This idea seems perfectly plausible a priori, and ambiguity surrounds the expected sign of the fertility change coefficients in the family planning equation.

Among the other variables which have been considered thus far, female education and per capita income again seem like candidates for inclusion in the family planning equation. Female education may enter on both the demand side and the supply side (through the availability of appropriate cadres), and it seems reasonable to suppose a priori that increases in income would make it easier to undertake and finance family planning programs.

Existing work on the determinants of family planning activity suggests that certain structural variables may also be important. The work of Kelly and Cutright (1983), suggests that pressure on the land and heightened sensitivity to "limited space" on islands or in peninsular countries have had something to do with family planning effort.
Kelly and Cutright argue (implicitly) that the pressure of population on the existing arable land may become visible to government planners as a pattern of rapidly declining marginal labor productivity on existing plots and an upsurge of rural-urban migration. The associated rise in rural poverty may create a perception of political threat which is sufficient to stimulate an interest in population control. This interest should be enhanced when nations occupy islands or peninsulas, since the perception of "limited space" would be enhanced by obvious restrictions on movement.

These arguments are plausible, although the use of pressure on arable land as a determinant of interest in fertility control seems unnecessarily restrictive. In Africa, it has become quite common for national leaders to deride the notion of fertility control on the grounds that African states are "underpopulated" (i.e. have low population densities). It is clear that these leaders most frequently have total land in mind when such statements are made. For the present purposes, therefore, I have employed the standard definition of population density rather than density on arable land as the relevant variable.

The definition of an appropriate dummy variable for "Island-Peninsular" status seems more problematic. Using an atlas and the area statistics in my data file, I have constructed separate dummy variables for "large" islands and peninsulas (e.g. Indonesia, the Philippines, Malaysia) and their "small" counterparts (e.g. Haiti, Korea, Jamaica). I have used 100,000 square kilometers as the dividing line.
The results suggest important roles for several variables in the determination of family planning effort during the 1970's. The large, positive coefficient for contemporaneous fertility change combines with the (much) smaller, negative coefficient for lagged change to favor the "reactive" hypothesis. Thus, governments seem to have reacted to slow declines in fertility by promoting family planning (ceteris paribus), and conversely for rapid declines. The results also suggest that income, female education, and perceived population pressure all had something to do with the change in planning effort during the 1970's. No significant impact of "Island-Peninsular Status" was discernible.

II. The Simulation Model

A. Introduction

The econometric results presented above provide the essential equations for a long-run model of economic-demographic dynamics. In the economic submodel, changes in national income and physical capital accumulation are jointly determined. Predetermined variables include the rate of human capital accumulation (measured by primary and secondary schooling); the effectiveness of economic management; political stability; foreign investment (proxied by the [current account deficit/GDP] ratio); and the growth rates of population and the labor force. The latter is determined by past rates of fertility and infant mortality, as well as by prevailing age-specific mortality rates in the interim.
In the demographic submodel, changes in fertility, infant mortality, and family planning activity are jointly determined. Predetermined variables include the growth rate of national income; female schooling; lagged change in the infant mortality rate; lagged change in income per capita; lagged change in fertility; and the level of population density.

The econometric results make it clear that long-run economic growth models should incorporate demographic factors (and conversely). Changes in national income have an impact on fertility, both directly and indirectly (through effects on family planning activity and (through family planning) on infant mortality). Changes in fertility and mortality have an impact on the domestic savings rate because they change population, the denominator of income per capita. In addition, they are the essential determinants of growth in the labor force.

The results make it particularly clear that estimates of the rate of return to investments in education and family planning must take into account both economic and demographic factors. For example, the results suggest substantial direct returns to education through its impact on labor productivity. They also raise the possibility of powerful indirect effects for female education through induced fertility decline.

An evaluation of the indirect impact of female education on national income is complicated by several factors. First, its impact on fertility may be partly (or totally) offset by its simultaneous impact on infant mortality, so that the growth rate of population may be little
effected. Even if a higher female schooling rate does induce a lower population growth rate, the positive impact on income per capita may be counteracted by a subsequent decline in the growth rate of the labor force. Age-specific mortality rates will obviously join the infant mortality rate in determining changes in the labor force.

When so many complex, long-run dynamics are in question, it is not possible to produce an evaluation of returns to education from calculations based solely on the econometric equations. They must be embedded in a long-run simulation model which also incorporates realistic initial conditions and appropriate models of age-specific fertility and mortality. This chapter will be concerned with the specification and application of such a model.

B. Age-Specific Fertility and Mortality Schedules

While the estimated econometric equations certainly form the core of the simulation model, it is clear that additional elements must be added. The most important of these are equations which allow for the impact of age-specific rates of fertility and mortality on population dynamics. The fertility equations must translate a general rate (produced by the econometric model) into rates by age cohort for women whose ages are between approximately 15 and 49. These cohort rates are extremely important, since they determine the time-phasing of additional births during the first decades of the simulation. The mortality equations make an important contribution by determining female survival to age 49, and survival generally (particularly to the age of retirement
Country-specific fertility and mortality schedules are not common in the developing world. For mortality, much effort has gone into the construction of tables which can be applied with approximate validity to poor countries generally. The most widely-utilized approaches have been those of Coale and Demeny (1966) and Brass (1971). As Hill and Trussell (1977) have noted, the Brass approach is most convenient for computer simulation because it establishes a continuous logistic relationship between life expectancy at birth and age-specific survival rates.

The Brass model has been used for the simulations reported here. It is basically a two-parameter logit model which relates the probability of death to age. As a brief expositional aid here, these two parameters will be termed "A" and "B." "A" will be taken as the parameter which determines the general position of the relationship (that is, the parameter which determines whether half the population has died at approximately age 35 as opposed to age 55). "B" will represent the "slope" parameter (that is, the parameter which determines the responsiveness of death probability to age as the latter increases).

The mortality schedule incorporated in the simulation model is based on calculations reported in Hill and Trussell (1977, p. 317). These calculations take the form of a table of computed life expectancies at birth associated with many different values of Brass' "A" and "B" parameters. I have chosen the middle "B" value (1.00) as the basis for establishing a continuous bivariate relation between life expectancy and
the "A" value. The results reported in Hill and Trussell are for increments of .1 in "A" values, but the relation between "A" and life expectancy is almost exactly linear within the relevant range of life expectancy values. I have therefore fitted a bivariate regression to the "A" and life-expectancy values to establish a continuous relationship.

One further complication in the treatment of age-specific mortality must be dealt with. The appropriate specification of the statistical model of demographic change is in fertility rates and infant mortality rates. Thus, the estimated stochastic equations will produce infant mortality rate predictions which are conditional on the values of predetermined variables in the model. These mortality predictions must in turn be made consistent with the full set of age-specific mortality rates used in the simulation.

In order to ensure rough consistency between rates, I have adopted a rather awkward expedient. The prevailing methods for calculating infant mortality rates and life expectancies at birth are so closely related that the variables as reported in the standard sources do not really have "independent" status. This dependency registers as near-exact linearity in the relation between life expectancy and infant mortality in the sample of 70 countries used for this study. I have fitted a bivariate regression to the data for 1980, and have used the results as the basis for predicting life expectancy at birth from the infant mortality estimate which emerges from the demographic equations.
Thus, the simulation model employs a three-step procedure for determining age-specific mortality rates. Once the values of the predetermined variables are set, the infant mortality rate for a simulation period is predicted. This rate is plugged into the bivariate regression result, which generates a prediction of life expectancy at birth. This prediction is in turn used to generate a Brass "A" value, which joins with a "B" value of 1.00 and the Brass standard life table logit values (reported in Hill and Trussell, p. 316) to produce age-specific mortality rates.

The econometric model is fitted to data on decennial changes in the variables of interest, and it is therefore natural to adopt the decade as the appropriate simulation period for the model. For population cohort survival prediction, this amounts to the use of the Brass table logit values for every tenth year in the generation of survival probabilities.

For the prediction of cohort fertility rates, the use of decennial simulation periods permits a rather simple approach. Since the model operates on ten-year intervals, fertility rates for ten-year female age cohorts must be predicted. The relevant cohorts are 10-20, 20-30, 30-40, and 40-50. The econometric equations generate a prediction of change in the total fertility rate, which can be combined with the initial rate to produce the prevailing fertility rate during each simulation period. The only remaining information is a schedule which dictates the proportion of total fertility which is accounted for in each of the four decades of
fertility.

The best current source of appropriate fertility schedule estimates seems to be the work of Coale and Trussell (1974). Their estimates for Peru (p. 199) are closest to those required for the present purposes, and the following interval proportions have been adopted: [10-19] .08; [20-29] .47; [30-39] .36; [40-49] .09. Since age at marriage and age of first delivery both tend to increase with female education and life expectancy, it is unrealistic to suppose that the proportions will stay fixed in the long run. No systematic basis seems to exist for predicting shifts in the proportions, however, and Peru does have the advantage of lying near the midpoint for incomes per capita in the sample of 70 countries.

C. Incorporating Unit Cost Estimates for Education and Family Planning

Once the age-specific mortality and fertility schedules are in place, most of the "housekeeping" functions in the simulation model are provided for. From given initial conditions, the model can produce estimates of population size by ten-year cohort. These in turn can be used to generate estimates of the age groups relevant for primary and secondary schooling; the ten-year cohorts relevant for fertility calculations; and the total population aged 15-65, which can be used as a proxy for the labor force.

When pre-specified time paths for the primary and secondary schooling rates for males and females are added to the econometric equations and "housekeeping" functions, the resulting model is
sufficiently articulated to generate long-run simulation paths for the major variables of interest. Several additional adjustments must be made, however, before the model is appropriate for a comparison of the comparative returns to education, family planning, and physical investment.

The first adjustment has to do with the treatment of family planning activity. The econometric results suggested strongly that the treatment of family planning as an endogenous variable was appropriate. Changes in family planning activity have been significantly associated with contemporaneous changes in fertility and income per capita. For an explicit comparison of benefits, however, family planning must be regarded as a policy variable. Its future time path is therefore pre-specified in the simulation model.

It would be inappropriate for an analysis of comparative benefits to treat social investments as costless, of course. In order to assure a conservative estimate of the comparative impact of incremental expenditures on education and family planning, the simulation model subtracts all such expenditures directly from investment. The rate of physical capital accumulation therefore decreases as social investment increases.

Unit cost estimates for education and family planning have been derived from recent data published by the World Bank (Zymelman, 1982), and the Population Council (Nortman, 1982), respectively. The data in Zymelman (1982) are sufficient to provide estimates for the (US) dollar
cost of primary and secondary education per pupil for almost all countries in the 70-nation sample. The numbers are obviously rough, but they have been adopted for the simulation model because they seem to be the best available. The median cost of primary education per student is approximately $100, while the cost for secondary education is closer to $200.

The family planning data in Nortman (1982) are much rougher, but again they seem to be the best available. The Nortman data are sufficient to calculate family planning costs per fertile-age woman for less than a third of the nations in the 70-country sample. They vary widely, but they are generally far lower than education unit costs. The median cost per fertile-age woman in the sample is approximately $1.00.

Thus, the calculation of cost for investments in education and family planning is based on the subtraction of full additional costs from physical investment. In the case of education, total primary and secondary students are calculated using predicted age-cohort sizes and pre-specified time paths for primary and secondary schooling ratios. These totals are then multiplied by the Zymelman estimates of unit cost for the country in question to produce the associated full cost.

In the case of family planning, a slightly more involved procedure is employed. Where cost data are not available, they are estimated from the available data for "similar" countries (Thus, the unit cost for Malawi is estimated from the central tendency in unit costs for African states). Unit costs are then assumed to be proportional to the index of
quality in family planning effort. Thus, if the current index value is 30 and the simulation experiment shifts it to 60, the estimated cost per fertile-age woman is doubled. The total cost is then calculated from the predicted number of women in the fertile-age cohort.

D. Malawi and Togo: An Illustration

All the elements are now in place, and it is possible to do comparative simulation experiments for specific countries. It should be clear by now that no general answer is possible to the question "What are the relative returns to female education and family planning when reduced physical investment is used to calculate opportunity cost?" The econometric results show clearly that the past matters for particular countries. A large number of country-specific initial conditions must be set before the simulation model can be run. Differing cost estimates for schooling and family planning programs complicate things still further.

Under these circumstances, we must be content with predicting some alternative futures for a set of countries, and examining the results to see if there are similarities in the general pattern. As will be seen shortly, the general pattern seems strikingly similar across countries whose initial circumstances are quite different. For the present, the approach will be illustrated and its implications analyzed in detail for the cases of two African states: Togo and Malawi. Togo and Malawi provide excellent material for a comparative case study in this context because their economic growth records are similar but their social investment efforts have apparently been quite different.
1). The Historical Record

Malawi and Togo are small, relatively stable African countries whose leaders have parleyed rapidly expanding export earnings into high rates of physical capital accumulation and economic growth. Togo has augmented its traditional dependence on tropical plantation crops with a lucrative phosphate mining operation since the mid-1960's. It seems to have been affected by the "mining state" syndrome, since its growth rate has been quite uneven (averaging 8.4% in the 1960's and 3.3% in the 1970's). Despite high domestic investment rates (19.1 for the 1960's; 28 for the 1970's), Togo seems to have been plagued by relatively high incremental capital/output ratios. For the 1970's, the World Bank country economists awarded it a mediocre economic management score of 4.

Malawi, on the other hand, has apparently grown as quickly with lower investment rates (12.3 for the 1960's; 21.8 for the 1970's). Malawi's GDP growth rates for the 1960's and 1970's were 5.2% and 5.8%, respectively. A major reason for Malawi's relatively low incremental capital/output ratio may be found in management performance, which was awarded a superior 7 by the World Bank. Generally, Malawi seems to have depended on expatriate managers to a greater degree than Togo.

Part of the reason for Malawi's greater dependency on educated expatriates becomes evident when the social statistics for the two countries are examined. Togo has had a clear edge in human resource investment. In 1960, Togo had male primary and secondary enrollment ratios of 63 and 4, respectively, while the ratios for Malawi were 30 and
1. By 1980, Togo's ratios were 144 and 51, while Malawi's were 70 and 6. For females, the educational differences are just as striking. Togo's female primary/secondary ratios were 24/1 and 89/16, respectively, in 1960 and 1980. For Malawi, the ratios were 15/.3 and 49/2.

The infant mortality statistics support the view that the health care in Togo has also been superior. In 1960, the infant mortality rates (IMR's) for both Togo and Malawi were among the highest in the world -- 193 and 209, respectively. Both countries registered declines during the first two decades of independence, but the Togolese decline was much faster. By 1980, Togo's IMR stood at 107, while Malawi's IMR, at 169, had not even reached Togo's 1970 level (141).

In 1960, the total fertility rates for Malawi and Togo were nearly identical -- 7.0 and 6.7, respectively. Both rates were unchanged in 1970, but by 1980 a divergence in experience had begun emerging. The Malawian rate actually rose during the 1970's, to 7.8. At the same time, the Togolese rate fell slightly, to 6.5. Malawi's rate of population growth increased from 2.8% per year in the 1960's to 2.9% in the 1970's, while Togo's rate fell from 2.9% to 2.4%.

This small set of comparative numbers is sufficient to show that the growth experiences of Malawi and Togo have been generally consistent with the pattern suggested by the econometric results. Both have had high investment rates, high labor force growth rates, and a rapid expansion of national income. Togo's higher income per capita (twice that of Malawi in 1970) reflects what is known about the relative
development levels of the two economies. Since Togo's schooling rates were twice those of Malawi at independence, the two impacts roughly balance in the terms posed by the econometric output equation: Togo's "raw" labor productivity is smaller, while the contribution of education is greater. Since the income and education ratios are about the same and their effects opposed, they should roughly balance.

The patterns of comparative change in fertility and its basic determinants also seem consistent with the econometric results. Here it is important to recall the overwhelming dominance of the interaction between female schooling and family planning effort in the fertility equation. The "gestation period" for education averages about a decade, and the econometric results suggest a relatively long lag in the response of fertility to change in both planning/education and infant mortality. The latter response is comparatively weak, and the response to change in income per capita is weaker still.

Consider, then, the relevant historical evidence for Togo and Malawi. Both countries exhibited no public interest in family planning until the early 1970's. Once some efforts began, however, they were substantially greater in Togo (which had a change of 11 for the 1970's) than in Malawi (whose change was 6). Togo began its period of family planning expansion with a female populace whose schooling rates were twice those of Malawi. Furthermore, Togo had experienced much greater declines in infant mortality during the two previous decades (31%; 28%) than had Malawi (6%; 15%).
Under these conditions, it is not surprising that the fertility experience of the two countries began diverging by 1980. In Malawi, which was wretchedly poor in 1960, the rapid increase in income seems to have promoted an actual expansion of fertility toward a level which had been desired but unsustainable at lower income and nutrition levels. Small gains in female education in the late 1960's and a modest decline in infant mortality were apparently insufficient to counter this trend.

In Togo, by contrast, greater social investment levels during the previous decades apparently began paying off by the late 1970's. If there was a tendency to increase fertility toward the biological maximum with increasing income, it was apparently more than offset by the impact of enhanced female education, family planning, and infant survival. The data suggest that Togolese demographic history passed a critical milestone sometime during the late 1970's.

2). A Prelude to Simulation

When the simulation model is run for Togo and Malawi, it will predict their future growth paths using evidence systematically drawn from the histories of states which are further advanced in education, health care, and family planning. If these historical patterns are relevant, and if management performance can be brought back up to a respectable level, then Togo should have great potential for reductions in fertility and rapid economic growth during the coming decades.

As previously stated, the lagged effects of expenditures during the 1970's should begin registering in the 1980's. Togo's female primary
education rate is currently quite high, so that enhanced family planning efforts should have a pronounced impact. Some family planning efforts are already being made, so the impact of further advances in female education should be significant, as well.

For Malawian fertility, the 1980's look less hopeful. Current rates of female education are still relatively low, and current family planning effort is negligible. If the patterns suggested by the estimated fertility equation continue to hold true, then even a "big push" in female education or family planning is unlikely to have a major impact during this decade. Since a major vaccination campaign has recently been completed, it seems likely that Malawi's IMR will decline sharply during the 1980's. Continued high fertility, coupled with rapidly falling infant mortality, should assure a surge in population growth during the coming decade. By the 1990's, the impact of greater social investments in the 1980's should become visible.

3). Some Illustrative Results

In order to explore the growth dynamics implicit in the econometric equations, alternative futures for Togo and Malawi have been simulated under four sets of assumptions about the path of social investments. The baseline case assumes that family planning effort and the female schooling ratios remain at their 1980 levels. The three alternative cases build in progressively greater rates of increase in family planning and education.

The first alternative tracks the impact of increases of 10 per
decade in the family planning score and the combined female primary/secondary schooling ratio. The other two alternatives impose increases of 20 and 30 per decade, respectively. Increases are terminated at ceilings of 80 (slightly below the current Chinese score) and 200 for planning and education, respectively. In order to assure rough comparability, both countries are assumed to maintain economic management scores of 7 throughout the simulation.

The same unmistakable message is communicated by all the results: Investments in female schooling and family planning yield large payoffs in the long run. The Togolese case will serve as the basis for analyzing the general quality of the results, and a comparison with the projections for Malawi will be used for a discussion of the apparent importance of initial conditions.
As the simulation begins in 1980, Togo has an income per capita of \$(US) 363 and a population of approximately 2.6 million. It has made relatively rapid strides in female (and male) education during the 1970's, and has recently embarked on a modest family planning program. Infant mortality has fallen considerably from the pre-independence level, and the economy is maintaining a high rate of investment. With substantial numbers of secondary and university graduates now available and the chastening experience of the 1970's in mind, the government manages to improve its management performance level from 4 to 7 in 10 on the World Bank scale.

A glance at Togo's demographic profile in 1980 immediately reveals a looming problem for the coming decade. Although Togo's total fertility rate has already fallen slightly in response to large social investments, it is still among the highest in the world at 6.5. Since infant mortality has continued to decline and a large number of women are just entering the prime years for fertility, the population growth rate is on the verge of jumping sharply upward. From a 2.4% annual increase during the 1970's, a move upward to a peak of 3.9% is anticipated for the 1980's.

Obviously, this surge is going to put a strain on the social infrastructure, and anticipated education costs are a matter of particular concern. On the assumption that the female and male schooling rates continue only at their levels of the 1970's, an additional 4% of national output will have to be allocated to primary and secondary
education. On the assumption that all additional costs are subtracted from physical investment, the investment rate will drop from 28% to about 24%.

The obvious implication is that Togo is in for a period of relatively slow growth of income per capita. Improved management performance and the consequent decrease of the incremental capital/output ratio assure that the disappointing experience of the 1970's is not repeated. Output is anticipated to grow at a respectable 6.3%, but the high anticipated rate of population growth (3.9%) implies a growth in income per capita of only 2.9% during the decade.

In the early 1980's, the Togolese leadership is faced with an important decision. They can move forward rapidly with female education and family planning, allocating additional scarce resources to these activities, or they can simply maintain the status quo, keep the investment rate high, and count on continuing increases in income per capita and declines in infant mortality to move fertility downward in the long run.

The comparative consequences of the two strategies can be most easily discerned by comparing columns "0" (no change in family planning effort or education rates) and "+30" (decennial increases of 30 in both the family planning index and the sum of female primary and secondary education). A glance at the simulated time series for income per capita and population leaves little doubt about the outcome: By 2050, the social investment strategy has doubled the anticipated income per capita and
more than halved the anticipated population. The population stands at about 11 million and population growth is near ZPG at .4% annually.

The basis for superior performance under the social investment option can be discerned in the evolution of three basic numbers: The fertility rate; the investment rate; and the growth rate of national output. The most striking difference between the "0" and "+30" columns can be seen in the comparative time plots for the total fertility rate. Under the "laissez faire" strategy, continued declines in the infant mortality rate and increases in income per capita promote a steady, unspectacular fall in the fertility rate. This averages about .5 per decade until 2020, when declines of about .4 set in. By 2050, the fertility rate has declined from its current level of 6.5 to about 3.3.4

The contrast provided by the numbers in the maximum social investment column is striking. During the first decade of the program, gains seem rather modest because the affected population is still in school. By the 1990's, however, the response begins coming dramatically into view. In the last decade of the twentieth century and the first decade of the twenty-first, the fertility rate drops from 5.8 to 3.1.

The evolution of the IMR is also critical for population growth projections, of course, but the econometric results have yielded only a relative mild contribution for education and family planning as compared with the "autonomous" forces propelling decline. Social investments clearly make some difference, as evidenced by the comparative time paths taken by the IMR from 1980 to 2030. The "big push" promotes a more rapid rate of decline for the IMR, so that it is half that which characterizes the baseline case by 2020. The absolute rate of decline is quite rapid in both cases, however. It is therefore the fertility story which dominates the comparison.
By this time, full family planning efforts are in progress, and female primary and secondary schooling have become well-nigh universal. Some lagged responsiveness continues the momentum through 2020, at which point asymptotic behavior begins setting in.\(^5\) By 2050, the Togolese fertility rate has descended to a level which is near the current rates for the two Germanies.

A look at the three other critical time paths reveals that the social investment strategy has encouraged a self-reinforcing process. During the 1990's, the financial burden imposed by additional investments in female schooling and family planning leads to an investment rate which is modestly lower (23.7 as opposed to 24.1 in the baseline case). It is important to recall, however, that the output growth rate and the investment rate are \textit{simultaneously} determined in the model. Some payoff to female education is almost immediate, since new secondary school graduates enter the labor force during the first decade of the "big push." Their predicted incremental productivity is apparently enough to offset the impact of the reduced rate of physical capital formation, because the predicted output growth rates for the baseline and "big push" cases are both 6.3%.

The Togolese case, then, seems particularly fortuitous. The ability to maintain a high investment rate assures continued growth of income per capita, which in turn prevents downward pressure on the

\textbf{---------}

5. Recall that the fertility change equation has been specified in percent changes, so that constant proportional rates of decline translate to smaller decrements with the passage of time.
national savings rate. The "big push" turns out to be effectively costless even in the short run, and the long-run results speak for themselves. For Togo, in any case, the future looks pretty attractive even under the baseline assumptions. The economy continues growing nicely, and ultimate population size doesn't suggest a level of crowding more onerous than that which currently characterizes the Benelux countries.

Malawi

Togo's projected experience suggests an ultimate reward for the educational foundations laid in the 1960's and 1970's. As we will see now, the projections for Malawi suggest that it is also possible to be "haunted by history" for a long time. As the 1980's begin, Malawi is justifiably praised for its rapid rate of agricultural development. In the face of tremendous fluctuations in world markets during the years since independence, Malawi has maintained a relatively steady GDP growth rate of over 5%. By 1980, it is beginning to leave the extreme poverty of the early 1960's behind. Its educational efforts have been modest by current African standards, but it has not hesitated to use expatriate personnel where local educational skills have been lacking.

As in Togo's case, the Malawian leadership faces a demographic crunch in the 1980's. Unfortunately for Malawi, its emerging problem is of unnerving size. By 1980, the demographic results are in from two decades of steady agricultural growth, modest investment in female primary education, and negligible investment in family planning and
female secondary education. With opportunity costs stable at low levels for uneducated rural women and some expansion of income, improved nutrition and unchanged aspirations have combined to move the fertility rate upward towards the biological maximum. By 1980, Malawi is threatening to become the world leader in fertility with a rate of 7.8.

The policy problem for Malawi's leaders therefore emerges on an apparent note of urgency. The recent jump in the fertility rate, coupled with a continued decline in the infant mortality rate, implies a jump in the population growth rate from 2.9% in the 1970's to around 3.7% in the 1980's. Again, the cost of schooling the next generation promises a major diversion of national resources.

If anything, the appeal of the "big" push would seem to be stronger for Malawi than for Togo. A glance at the projected time series for income per capita and population reinforces this view rather dramatically. Under the maximum social investment option, Malawi seems to stand a chance of stabilizing its population growth by the late twenty-first century. Its future looks crowded and relatively poor, but the prospects for average income under the "big push" are certainly better (by a factor of three) than under the baseline case.

It is clear that the basic message for Malawi is the same as that for Togo: The social investment strategy pays off, and rather quickly. During the "big" push, the relative decline in the investment rate continues for some time. Although the rate of physical capital formation stays below the baseline rate through 2020, however, the output equation
predicts a recovery of GDP growth to parity by the 1990's. The reason for this is again the short-run productivity impact of enhanced female secondary education. The rapid decline of population growth under the social investment option is sufficient to assure that relative economic performance will be progressively better as Malawi moves into the twenty-first century.

What is sad about the Malawian case is the anticipated future consequences of past policies. If the international behavioral pattern registered by the estimated fertility equation continues to hold true, and if the rest of the econometric equations remain approximately valid, then Malawi's economic future does not look as bright as its past.

The key to the problem can be seen in the projected time series for the total fertility rate and the investment rate. Its dimensions can be most clearly seen by considering the projected experience under the optimistic assumptions incorporated in the "big push" case. Since basic education levels are relatively low and planning activity almost nonexistent in 1980, the first decade of social investment is effectively devoted to establishing the preconditions for progress on the demographic front. Only during the mid-1990's is Malawian fertility predicted to fall back to its 1970 level. From then on, the fall is quite rapid (decrements of 1.1 or more for three decades), but the damage is effectively done. Very large cohorts in the fertile-age population of women are assured until well into the twenty-first century. As late as 2020, then, Malawi's population growth rate is projected at 3%, even under the full set of optimistic assumptions.
The consequences of this phenomenon for investment are serious. If the basic national propensity to save and invest remains constant, then the pressure of the demographic bulge on the investment rate is projected to dominate through the year 2050. The output-enhancing effects of education are sufficient to assure a very modest growth rate of income per capita, but after 70 years of effort, national income has only grown to $US 1510 — scarcely an encouraging prospect when compared to the recent histories of success stories like Singapore.

The basic message seems relatively clear here. If the econometric results mean anything, then Malawi will be faced with a painful choice in the 1980's. In the face of an unprecedented demand for educational expenditures, it will either have to look to the industrial countries for greatly increased transfers (an unlikely prospect at this point), or it will have to force the national savings rate to historically unprecedented levels (and use the investible funds productively, even though it has very few secondary school graduates of either sex). If it is unable to increase the investment rate, then the results suggest that Malawi is in for a long period of relative retardation in economic growth.

III. Alternative Social Policies: Comparisons for Eleven Countries

Thus far, the simulation results have suggested that the social investment option is generally better than the baseline option, at least for two small African states. Two important questions remain, however. First, it would be useful to have some notion of the relative payoff to
investments targeted on family planning or female schooling. Secondly, a sampling from simulations for a much broader set of countries should precede any categorical statements about the superiority of the social investment option.

In this section, an attempt will be made to resolve both questions. Eight sets of simulation results are considered for eleven countries: Togo, Malawi, Kenya, India, Bangladesh, Malaysia, Indonesia, Brazil, Bolivia, Honduras, and Mexico. The relevant initial conditions vary tremendously across these countries, so the apparent superiority of the social investment option under current African conditions can be tested in very different circumstances. Four of the simulation results to be reported will employ the four options (0,+10,+20,+30) already presented for Togo and Malawi. As in the previous two cases, they should provide a good sense of alternative futures under various assumptions about the social policy alternative generally.

The other four simulations represent an attempt to measure the returns to alternative social investment strategies. The three variables of greatest interest in the current context seem to be income per capita, total population, and the total fertility rate. Their long-run elasticities of response to alternative strategies are measured using the baseline case as the "numeraire." The baseline case is as previously specified: Family planning and the female primary and secondary schooling ratios are held at their 1980 levels; all incremental costs for education and family planning activities are subtracted from physical investment.
The other three cases simulate the effects of 10% increases in female schooling, family planning, and both activities. Once the results for income per capita, population, and total fertility are obtained for 2050, they are transformed into percent differences from the baseline case. These percent differences are divided by .10 to obtain response elasticity estimates. Since the simulations for Togo and Malawi have already demonstrated the importance of initial conditions, substantial variation in response elasticities across countries will undoubtedly be observed. The major questions are: (1). Despite the variation, will all the elasticities have the right sign? (that is, is the social investment option always preferable to the baseline option?) (2). Are the elasticities for female education unambiguously higher or lower than those for family planning? (3). Are there "increasing returns to scale"? (That is, are full system dynamics such that the response elasticity for a joint 10% increase is greater than the sum of elasticities for individual 10% increases?)

The answers to all the major questions can be determined from the comparative elasticity estimates, so a discussion of results will begin with a tabular presentation of the elasticities for income per capita and population. An economic performance index of 7 has been imposed in all cases for comparability.
Table 1
POLICY RESPONSE ELASTICITIES: 11 COUNTRIES

<table>
<thead>
<tr>
<th>Country</th>
<th>Female Education</th>
<th>Family Planning</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Togo</td>
<td>.705</td>
<td>.067</td>
<td>.776</td>
</tr>
<tr>
<td>Malawi</td>
<td>.249</td>
<td>.109</td>
<td>.270</td>
</tr>
<tr>
<td>Kenya</td>
<td>1.045</td>
<td>.288</td>
<td>1.367</td>
</tr>
<tr>
<td>India</td>
<td>.471</td>
<td>.357</td>
<td>.841</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>.413</td>
<td>.168</td>
<td>.592</td>
</tr>
<tr>
<td>Malaysia</td>
<td>.443</td>
<td>.392</td>
<td>.822</td>
</tr>
<tr>
<td>Indonesia</td>
<td>.577</td>
<td>.345</td>
<td>.914</td>
</tr>
<tr>
<td>Bolivia</td>
<td>.573</td>
<td>.102</td>
<td>.682</td>
</tr>
<tr>
<td>Brazil</td>
<td>.383</td>
<td>.216</td>
<td>.590</td>
</tr>
<tr>
<td>Honduras</td>
<td>.900</td>
<td>.283</td>
<td>1.205</td>
</tr>
<tr>
<td>Mexico</td>
<td>.601</td>
<td>.305</td>
<td>.866</td>
</tr>
</tbody>
</table>

The results seem unequivocal on the first question: The social policy option seems to be superior in every case, although the degree of superiority varies widely with initial conditions. Generally, it is clear that responses are higher when prior social investments have already established relatively high rates of female schooling and family
planning activity.

On the second question, the answer seems to be mixed. Education unquestionably dominates in the case of income per capita. The joint impact of education on fertility and productivity is so great that it dominates a direct attack on fertility through family planning in every case. It is important to recall in this context that education appears to dominate despite the large unit cost difference between education and family planning ($3.00 per fertile-age female for family planning at maximal effectiveness vs. around $50.00/pupil for primary schooling and $100.00/pupil for secondary schooling).

For population growth, the evidence is mixed but suggestive. In four cases (Togo, Malawi, Kenya, Bolivia), female education produces marginally superior results. In the remaining seven, family planning seems the better bet. For Malaysia, Brazil, and Mexico, the responsiveness of population size to family planning is around twice the responsiveness to education. Family planning seems to gain relative advantage as the societies move higher in education and planning simultaneously. Generally, the direct approach to population control seems superior, although the indirect approach through education is undeniably effective, as well.

The answer to the third question seems relatively unambiguous. The joint response elasticity is generally quite close to the sum of individual response elasticities, so that "dynamically increasing returns to scale" do not seem very important in this model.
Thus, the basic message of these four comparative simulations is quite consistent for the eleven countries: The social investment option always pays for itself very quickly. The long-run responsiveness of income and population seem to depend heavily on the degree to which the society has already made significant investments in education and family planning. For long-run gains in income per capita, investment in female education is the superior alternative at the margin. Except for societies which are initially at low levels of female schooling and family planning, the latter option seems superior as an instrument of population control. Even for the least-endowed societies, the superiority of education as a means of population control does not seem very significant.

Since the elasticity comparisons for the eleven countries yield such consistent conclusions, the results for the remaining four simulations are not very surprising. For each country, the experiment originally performed for Togo and Malawi is repeated. A baseline case is contrasted with projected outcomes when progressively larger investments are made in female education and family planning. In every case, the "big push" appears to be resoundingly better than the baseline case with the passage of time, all the numbers (including the physical investment rate itself) become better under the social investment options.
### Table 2

<table>
<thead>
<tr>
<th>Country</th>
<th>Income Per Capita ($US '000)</th>
<th>Population Projection, (Millions)</th>
<th>World Bank Projection, Ultimate Pop. (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inv.</td>
<td>Soc.</td>
<td>Inv.</td>
</tr>
<tr>
<td>Togo</td>
<td>4.5</td>
<td>10.5</td>
<td>25.3</td>
</tr>
<tr>
<td>Malawi</td>
<td>1.6</td>
<td>4.4</td>
<td>111.5</td>
</tr>
<tr>
<td>Kenya</td>
<td>1.6</td>
<td>4.4</td>
<td>303.2</td>
</tr>
<tr>
<td>India</td>
<td>2.3</td>
<td>4.7</td>
<td>3179.4</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>2.6</td>
<td>784.6</td>
<td>363.4</td>
</tr>
<tr>
<td>Malaysia</td>
<td>32.1</td>
<td>39.8</td>
<td>24.6</td>
</tr>
<tr>
<td>Indonesia</td>
<td>6.3</td>
<td>8.4</td>
<td>429.9</td>
</tr>
<tr>
<td>Bolivia</td>
<td>3.7</td>
<td>12.5</td>
<td>52.5</td>
</tr>
<tr>
<td>Brazil</td>
<td>32.3</td>
<td>41.7</td>
<td>298.5</td>
</tr>
<tr>
<td>Honduras</td>
<td>3.4</td>
<td>10.2</td>
<td>43.4</td>
</tr>
<tr>
<td>Mexico</td>
<td>39.7</td>
<td>52.4</td>
<td>240.4</td>
</tr>
</tbody>
</table>

In large part, the entries in the table above speak for themselves. For societies which currently have low incomes, schooling rates, and family planning effort, the economic gains associated with the social investment option are very large. Per capita income doubles for Togo and India. It approximately triples for Malawi, Kenya, Bangladesh, Bolivia, and Honduras. Even for relatively well-endowed societies such as Brazil, Malaysia, and Mexico, the economic gains are clear.

The population story is equally noteworthy. By 2050, projected population under the maximum social investment option is less than half

---

6. As reported in the 1983 World Development Report, Table 19
its baseline level for Togo, Malawi, Kenya, Bangladesh, Bolivia, and Honduras. Major reductions are also evident for the other countries. The population growth rate projections are of interest because they show that almost all the countries are near (or past) ZPG by 2050 in the aftermath of the "big push", while many are still growing at a good clip in the baseline case.

Finally, it is of some interest to compare the projections of the econometric simulation model with recent stable population projections by the World Bank. The methodological basis for these projections is entirely different. It is interesting to note, however, that the "baseline" and "big push" projections for 2050 (when extended using the rate of population growth in 2050 and the pace of decline in that rate) do seem roughly coincident with outer bounds for the Bank's projections of ultimate population size. Within those bounds, the Bank's projections seem to move somewhat randomly. They are close to the "big push" projections (which might be termed "optimistic") for Togo, Malawi, Kenya, India, Bolivia, and Honduras.

Somewhat more pessimism seems evident in the Bank's projections for Bangladesh, while substantial pessimism seems characteristic of the projections for Malaysia, Indonesia, Brazil, and Mexico. In all latter cases, the model has predicted very rapid fertility declines under the "big push" because female schooling rates and family planning efforts were already relatively advanced in 1980. It is at least possible that the Bank's projections have failed to take sufficient account of the potential for fertility decline in these four countries.
Bibliography


Marris, R. (1982), "Economic Growth in Cross Section," (mimeo.) World Bank


Zymelman, M. (1982), Educational Expenditures in the 1970's, (mimeo.), Education Department, World Bank
APPENDIX

ECONOMETRIC_RESULTS
I. Output Change and Investment

A. Output Change

The estimated output equation reflects a Cobb-Douglas \((\text{log-log})\) specification, since it is estimated in percent change form. While the treatment of change in the capital stock has been described at length in the text, some further notes about the treatment of labor force change should be added here. Change in the adult population has been used as a proxy for labor force change, since the available labor force data are notoriously unreliable. This substitution forces the assumption of constant labor force participation through time.

As noted in the text, the effect of education on the output elasticity of labor has been captured with interactions between the growth rate of the labor force and lagged primary and secondary schooling ratios. As shown in Wheeler (1980), these interactions reflect the time derivative of a mathematical specification of educational impact which has three parts: The probability of schooling during the relevant period in the past; the probability that schooling leads to relevant learning; and the impact of learning itself on productivity.

In the output equation, the impact of labor force growth is also modified to take account of structural change during the process of development. In the sample of countries which has been employed for this exercise, there are obvious structural differences between the richest
(e.g., Korea, Argentina) and the poorest (e.g., Upper Volta, Burundi). Many discussions of unemployment in recent years have focused on the question of whether economic growth and structural change lead to a decline in capacity to absorb uneducated or unskilled labor. Part of the theory of structural unemployment obviously turns on the relationship between the marginal productivity of uneducated labor and the level of economic development. Under strong assumptions about the shift in prevailing production technology, it is possible to argue that the marginal productivity of uneducated labor will actually decline as development proceeds.

It is important to allow for such a possibility in a model which relates education to economic growth and demographic change. In the output change equation, an interaction between growth in the labor force and the level of per capita income (a proxy for level of economic development) has therefore been introduced.

Although the discussion in the text is focused on the contributions of labor, capital, and education to output growth, the econometric estimation has also taken account of the possible impact of the many violent events which characterized the 1960's and 1970's. The role of certain structural variables has been considered, as well. In the following subsections, these variables are described in more detail.

1). Violence

It would obviously be a mistake to suppose that all forms of civil disorder can be treated as exogenous in an output change equation.
Strikes, attempted assassinations of public figures, and riots may all be caused by poor economic performance. However, there are other forms of violence whose historical roots go considerably beyond reactions to short-run economic fluctuations. Anti-colonial wars provide an example, as do many civil wars, revolutions, and incursions by mercenaries or others across national frontiers. Coups d'etat seem ambiguous in their relationship to output change in the short run.

In recent research on Sub-Saharan Africa (Wheeler, 1984b) I have taken a careful look at the relations between output growth and indices of the occurrence of violence in four categories (anti-colonial wars; civil wars (including revolutions); incursions by mercenaries and others; coups d'etat). I have used these results as the basis for constructing an index of relative stability for the 70 countries in the current sample. A "stable year" is considered to be one in which no coup, mercenary incursion, or act of civil war occurred.

For the 1970's, I have also set up a simple dummy variable for cases in which mass violence has had obviously devastating effects for the society in question. The countries which seem the best candidates in this category are Uganda, Nicaragua, Ethiopia, El Salvador, Bangladesh, China, and Argentina.

2). Mineral Exporters

One interesting set of results from my study of stagnation in Sub-Saharan Africa has to do with the lamentable record of mining states. Among African states which had large mining sectors at
independence, relative performance has been quite poor. Several arguments have been advanced to explain this phenomenon. It may have to do with particular volatility in the terms of trade, or (as seems more plausible) it may have to do with a perverse interaction between government expenditure policies and the trade cycle.

In all African mining states, the government either owns the mines outright or depends upon them as a major revenue source. Since the mines are essentially enclaves which are unaffected by the presence or absence of appropriate pricing policies elsewhere in the economy, their presence seems to encourage a pronounced form of fiscal indiscipline. In boom times, the government is pressured into dramatic increases in current expenditure commitments. When mineral price declines occur, retrenchment policies make matters even worse. Over time, the problem seems to cumulate.

During the 1970's, it might have been possible to argue that this sort of analysis was invalid because it did not apply to major oil exporters. The acid test could not come, of course, until a major decline in oil prices occurred. The experience of African oil exporters in the early 1980's suggests that the "mining states" problem can be generalized to include the oil states.

For the purposes of the present study, I thought that it would be of interest to see whether the "mining state" problem has been general. I therefore used the IMF trade yearbook to identify two kinds of states: Those which were overwhelmingly dependent on minerals exports of any kind
(including oil) during the early 1960's, and those for which some
dependency was evident. In the first group, I have identified Algeria,
Bolivia, Central African Republic, Chile, Congo, Guinea, Indonesia,
Jamaica, Liberia, Mauritania, Morocco, Peru, Sierra Leone, Togo, Trinidad
and Tobago, Venezuela, Zaire, and Zambia. In the secondary dependency
category are Ghana, Haiti, Malaysia, Philippines, Rwanda, and Tunisia.

I have also identified states which have had a major dependence on
oil exports during the period since 1966, and included a dummy variable
to control for the impact of the oil price boom on their growth rates.

3). Econometric Results: Summary of Findings

In this subsection, the results of a series of regression
experiments are summarized. There are references throughout to the
numbered results, which are presented in the next subsection. The output
equation results indicate, among other things:

1. Major contributions for education in all regressions

It should be noted that primary and secondary education ratios are
quite collinear, so that it has not been possible to investigate separate
impacts with great precision. It seems clear, however, that both
variables are related to output growth, and that the hypothesis of
approximately equal impacts cannot be rejected at any elevated level of
confidence. In order to make the total impact of education clear, I have
therefore added PrimaryEd and SecondEd together to produce Education (See
variable definitions below). This procedure forces equality of
coefficients in the regression result.

Equation 8 has been used in the simulation model. The magnitude of the measured education effect in Equation 8 can be gauged by considering the marginal impact of lagged schooling in a society whose adult population grew at 3% annually in the 1970's. The implied coefficient on schooling is approximately .15 per 10 points in the combined Primary-Secondary Enrollment Ratio. Since the upper bound on this ratio is somewhat above 200, the implied impact of schooling is substantial.

2. The obvious impact of specification error when the model does not take relative efficiency in capital use into account

Here it is important to recall that use of the investment rate alone as the capital change variable requires the assumption that the capital output ratio has been constant for societies as disparate as Ghana and Singapore.

When this specification is imposed (See Equations 1-6), the estimated coefficient for the investment rate (which can be interpreted as the product of the output elasticity of capital and the output-capital ratio (presumed constant)) is smaller than its standard error and wanders in the neighborhood of zero from equation to equation. When the efficiency effect is introduced by interacting the investment rate with the World Bank management performance index (produced from fitted values in a first-stage regression on predetermined variables), the whole character of the result changes.
With the inclusion of a correction for management performance, change in capital becomes approximately equal to education and change in the labor force as a determinant of output change. In Equation 8, the estimated coefficient for the investment rate varies from .014 (for C.A.R. and Guinea, which received performance scores of 1 in 1975) to .14 (for Singapore, with the top performance score of 10). If we assume a maximum marginal output-capital ratio of .3, then these results suggest a "potential" output elasticity of capital in the neighborhood of .4 -- not markedly different from estimates which have been obtained for the industrial economies.

3. Support for the hypothesis that the output elasticity of uneducated labor declines with development

Experimentation has shown that the interactive specification provides a substantially better fit to the data than labor force change alone. The interactive variable is expressed as a ratio in order to impose the constraint that the elasticity of "raw" labor not drop below zero in relatively wealthy societies. For a very poor society (1980 $150 (US)), the implied raw labor elasticity is about .8, while for a wealthy society (around 1980 $1500 (US) in this sample) the implied elasticity is about .08.

-------

1. The estimated Beta Coefficients provide one measure of relative impact. Note that they are in the neighborhood of .3 for capital, labor, and education in Equation 8.

2. This sort of constraint is especially necessary for econometric equations which are to provide the foundation for a long-run simulation model.
At this point, it is probably useful to summarize the implications of the evidence derived from the econometric results for the three main variables in the output change equation - capital, labor, and education. The impact of investment seems to depend centrally on management performance, while the elasticity of "raw" (uneducated) labor declines rapidly with development. Experimentation with alternative specifications has revealed no apparent trend in the impact of education as development proceeds.

While these results seem plausible, it would not be appropriate to make any grandiose claims for them. Formally, the output change model corresponds roughly to a variable-elasticity modification of the Cobb-Douglas model. It is in the neighborhood of a restricted translog model, but is not rigorously derived from such a model. It should therefore properly be seen as descriptive rather than "rigorously analytical."

In such a broad sample of societies, I suspect that we will have to be content with "descriptive" equations of this sort. The process of growth from a level of $US 150 to $2000 entails (in the absence of windfalls) a tremendously complex set of structural changes. The impacts of some of these changes can be captured qualitatively by econometric equations of the type employed here. The results can only be suggestive from the theoretical standpoint, but they do serve as a systematic basis for simulation modeling.

Among the regression results reported below, Equation 8 has been
featured because it controls for major exogenous shocks during the 1970's. As can be seen from the results for Equation 7, however, the estimated coefficients for capital, labor, and education are not significantly affected by the use of the three control variables. The results in Equation 8 do indicate:

i). The destructive impact of major internal wars.

ii). A worldwide recurrence of the "mining states" phenomenon. I have checked to see whether this result depends only on the African states. It definitely does not. This variable may also be indexing an aspect of management performance, albeit in a very deterministic way. Mining states had 1.5% lower growth rates annually, other things equal.\(^3\)

iii). The positive impact of the oil boom on oil exporters, as expected.

4). Estimated Output Equation Results

The following equations provide a sampling of the output results. Since the World Bank management performance index was only available for the 1970's, a growth equation for the 1970's alone has been estimated for use in the simulation model. For theoretical purposes, however, it is of interest to compare results when identical models have been fitted to

\(^3\) In passing, it is worth noting that the general quality of policy formation seems to be affected by such "exogenous" variables. The reduced-form regression for the management performance index suggested negative and significant impacts for mining status and internal warfare. It clearly doesn't help to have a war going on if you're trying to make sensible economic policy.
data for the 1960's and 1970's.

The variables employed in the output equations are as follows:

- **Growth** - Growth rate of GDP
- **Capital** - Investment rate
- **CapEff** - Product of Capital and the World Bank management performance index
- **Labor** - Percent change in the labor force
- **Lab/PCI** - Percent change in the labor force divided by per capita income
- **PrimaryEd** - Product of the lagged primary school enrollment ratio and contemporaneous percent change in the labor force
- **SecondEd** - Same product using the lagged secondary school enrollment ratio
- **Education** - Sum of PrimaryEd and SecondEd
- **MajorWar** - Dummy variable for extreme violence, as discussed above
- **OilState** - Oil exporter dummy
- **MiningState** - Dummy variable indicating dependence on minerals exports in the early 1960's

---

4. The number of "stable years" is not included in this set because it had no apparent impact on output change. Only major wars seem to have had a significant impact. In the case of the dummy variables for "major" and "modest" dependency on minerals exports, the estimated coefficients could not be distinguished at any reasonable level of confidence. They were therefore combined to produce a composite dependency dummy.
Output Change Equations: 1960's

1). "Raw" Capital and Labor Effects; Separate Education Effects

DEPENDENT VARIABLE: Growth60

NUMBER OF OBSERVATIONS: 65
PARAMETERS ESTIMATED: 5
R-SQUARE: .433
CORRECTED R-SQUARE: .395
SUM OF SQUARED RESID.: 1.32911311E0002
F(4/60): 11.4468
STANDARD ERROR: 1.4884E0000
LOG-LIKELIHOOD: -1.15478086E000

MEAN OF DEP. VARIABLE: 4.6450E0000

<table>
<thead>
<tr>
<th>VARIABLE COEFFICIENT</th>
<th>ERROR</th>
<th>T-STATISTIC</th>
<th>COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept -0.1804207937</td>
<td>1.601598987</td>
<td>-0.112650417</td>
<td>.0000</td>
</tr>
<tr>
<td>Capital60 0.07562143661</td>
<td>0.08054480716</td>
<td>0.9388741407</td>
<td>.1186</td>
</tr>
<tr>
<td>Labor60 1.164304823</td>
<td>0.3934126805</td>
<td>2.959499988</td>
<td>.3961</td>
</tr>
<tr>
<td>PrimaryEd60 4.401943674E-3</td>
<td>4.588117551E-3</td>
<td>0.9594226009</td>
<td>.2061</td>
</tr>
<tr>
<td>SecondEd60 7.295223921E-3</td>
<td>0.01551343757</td>
<td>0.4702519276</td>
<td>.0931</td>
</tr>
</tbody>
</table>

2). "Raw" Capital and Labor Effects; Combined Education Effect

DEPENDENT VARIABLE: Growth60

NUMBER OF OBSERVATIONS: 65
PARAMETERS ESTIMATED: 4
R-SQUARE: .433
CORRECTED R-SQUARE: .405
SUM OF SQUARED RESID.: 1.32962503E0002
F(3/61): 15.5029
STANDARD ERROR: 1.4764E0000
LOG-LIKELIHOOD: -1.15490601E000

MEAN OF DEP. VARIABLE: 4.6450E0000

<table>
<thead>
<tr>
<th>VARIABLE COEFFICIENT</th>
<th>ERROR</th>
<th>T-STATISTIC</th>
<th>COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept -0.2329612656</td>
<td>1.551290015</td>
<td>-0.1501726069</td>
<td>.0000</td>
</tr>
<tr>
<td>Capital60 0.07866027452</td>
<td>0.07739751243</td>
<td>1.01631528</td>
<td>.1234</td>
</tr>
<tr>
<td>Labor60 1.153662655</td>
<td>0.3840216011</td>
<td>3.004160837</td>
<td>.3924</td>
</tr>
<tr>
<td>Education60 4.971508286E-3</td>
<td>2.626961268E-3</td>
<td>1.892493942</td>
<td>.2885</td>
</tr>
</tbody>
</table>
3). "Raw" Capital Effect; Modified Labor Effect; Combined Education Effect

DEPENDENT VARIABLE: Growth60

<table>
<thead>
<tr>
<th>NUMBER OF OBSERVATIONS: 65</th>
<th>PARAMETERS ESTIMATED: 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-SQUARE: .359</td>
<td>CORRECTED R-SQUARE: .328</td>
</tr>
<tr>
<td>SUM OF SQUARED RESID.:</td>
<td>P(3/61): 11.4037</td>
</tr>
<tr>
<td>1.50136162E002</td>
<td>LOG-LIKELIHOOD: -1.19438554E000</td>
</tr>
<tr>
<td>STANDARD ERROR: 1.5688E0000</td>
<td></td>
</tr>
<tr>
<td>MEAN OF DEP. VARIABLE:</td>
<td>4.6450E0000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>ERROR</th>
<th>T-STATISTIC</th>
<th>BETA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.757693749</td>
<td>1.723022054</td>
<td>1.020122607</td>
<td>.0000</td>
</tr>
<tr>
<td>Capital60</td>
<td>0.04475348956</td>
<td>0.09240977878</td>
<td>0.4842938718</td>
<td>.0702</td>
</tr>
<tr>
<td>Lab/PCI60</td>
<td>55.46963553</td>
<td>55.05771728</td>
<td>1.007481571</td>
<td>.1349</td>
</tr>
<tr>
<td>Education60</td>
<td>0.01042463068</td>
<td>2.069671738E-3</td>
<td>5.036852216</td>
<td>.6049</td>
</tr>
</tbody>
</table>

Output Change Equations: 1970's

4). "Raw" Capital and Labor Effects; Separate Education Effects

DEPENDENT VARIABLE: Growth70

<table>
<thead>
<tr>
<th>NUMBER OF OBSERVATIONS: 59</th>
<th>PARAMETERS ESTIMATED: 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-SQUARE: .261</td>
<td>CORRECTED R-SQUARE: .206</td>
</tr>
<tr>
<td>2.86826347E002</td>
<td>LOG-LIKELIHOOD: -1.30366889E000</td>
</tr>
<tr>
<td>STANDARD ERROR: 2.3047E0000</td>
<td></td>
</tr>
<tr>
<td>MEAN OF DEP. VARIABLE:</td>
<td>4.2717E0000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>ERROR</th>
<th>T-STATISTIC</th>
<th>BETA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.14681011</td>
<td>1.755587891</td>
<td>0.6532342332</td>
<td>.0000</td>
</tr>
<tr>
<td>Capital70</td>
<td>-0.02610397838</td>
<td>0.06155516462</td>
<td>-0.4240745443</td>
<td>-.0521</td>
</tr>
<tr>
<td>Labor70</td>
<td>0.702211633</td>
<td>0.5502068474</td>
<td>1.276268437</td>
<td>.2000</td>
</tr>
<tr>
<td>PrimaryEd70</td>
<td>4.463611958E-3</td>
<td>6.297760681E-3</td>
<td>0.7087617621</td>
<td>.1803</td>
</tr>
<tr>
<td>SecondEd70</td>
<td>0.01449242021</td>
<td>0.01395632205</td>
<td>1.038412568</td>
<td>.2279</td>
</tr>
</tbody>
</table>
### 5). "Raw" Capital and Labor Effects; Combined Education Effect

**DEPENDENT VARIABLE:** Growth70

<table>
<thead>
<tr>
<th>NUMBER OF OBSERVATIONS: 59</th>
<th>PARAMETERS ESTIMATED: 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-SQUARE: .257</td>
<td>CORRECTED R-SQUARE: .217</td>
</tr>
<tr>
<td>SUM OF SQUARED RESID.: 2.88251915E0002</td>
<td>F(3/55): 6.3500</td>
</tr>
<tr>
<td>STANDARD ERROR: 2.2893E0000</td>
<td>LOG-LIKELIHOOD: -1.30513146E000</td>
</tr>
<tr>
<td>MEAN OF DEP. VARIABLE: 4.2717E0000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STANDARD ERROR</th>
<th>T-STATISTIC</th>
<th>BETA COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.182316285</td>
<td>1.742542966</td>
<td>0.6785005067</td>
<td>.0000</td>
</tr>
<tr>
<td>Capital70</td>
<td>-0.0211350597</td>
<td>0.06039756383</td>
<td>-0.3499323211</td>
<td>-.0422</td>
</tr>
<tr>
<td>Labor70</td>
<td>0.5876858914</td>
<td>0.5004803833</td>
<td>1.174243609</td>
<td>.1674</td>
</tr>
<tr>
<td>Education70</td>
<td>7.402418741E-3</td>
<td>2.717121825E-3</td>
<td>2.724360267</td>
<td>.4003</td>
</tr>
</tbody>
</table>

### 6). "Raw" Capital Effect; Modified Labor Effect; Combined Education Effect

**DEPENDENT VARIABLE:** Growth70

<table>
<thead>
<tr>
<th>NUMBER OF OBSERVATIONS: 59</th>
<th>PARAMETERS ESTIMATED: 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-SQUARE: .251</td>
<td>CORRECTED R-SQUARE: .210</td>
</tr>
<tr>
<td>SUM OF SQUARED RESID.: 2.90668759E0002</td>
<td>F(3/55): 6.1448</td>
</tr>
<tr>
<td>STANDARD ERROR: 2.2989E0000</td>
<td>LOG-LIKELIHOOD: -1.30759457E000</td>
</tr>
<tr>
<td>MEAN OF DEP. VARIABLE: 4.2717E0000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STANDARD ERROR</th>
<th>T-STATISTIC</th>
<th>BETA COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.350255101</td>
<td>1.808381387</td>
<td>0.746665007</td>
<td>.0000</td>
</tr>
<tr>
<td>Capital70</td>
<td>-9.504019402E-5</td>
<td>0.06664406337</td>
<td>-1.426086424E-3</td>
<td>-.0002</td>
</tr>
<tr>
<td>Lab/PCI70</td>
<td>65.54080521</td>
<td>68.70275709</td>
<td>0.9539763466</td>
<td>.1337</td>
</tr>
<tr>
<td>Education70</td>
<td>9.965332723E-3</td>
<td>2.359277347E-3</td>
<td>4.223892005</td>
<td>.5388</td>
</tr>
</tbody>
</table>
7). Modified Capital and Labor Effects; Combined Education Effect

**DEPENDENT VARIABLE:** Growth70

**NUMBER OF OBSERVATIONS:** 58 **PARAMETERS ESTIMATED:** 4  
**R-SQUARE:** .387 **CORRECTED R-SQUARE:** .353  
**SUM OF SQUARED RESID.:** $2.24519378E0002$ **F(3/54):** 11.3838  
**STANDARD ERROR:** 2.0391E0000 **LOG-LIKELIHOOD:** -1.21550486E001  
**MEAN OF DEP. VARIABLE:** 4.1923E0000

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STANDARD ERROR</th>
<th>T-STATISTIC</th>
<th>BETA COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.2963417689</td>
<td>0.9149422655</td>
<td>-0.3238912225</td>
<td>.0000</td>
</tr>
<tr>
<td>CapEff70</td>
<td>0.02412171872</td>
<td>6.405070519E-3</td>
<td>3.766034839</td>
<td>.4928</td>
</tr>
<tr>
<td>Lab/PCI70</td>
<td>130.3040624</td>
<td>57.702225</td>
<td>2.258215561</td>
<td>.2714</td>
</tr>
<tr>
<td>Education70</td>
<td>5.536577654E-3</td>
<td>2.362853217E-3</td>
<td>2.343174605</td>
<td>.3003</td>
</tr>
</tbody>
</table>

8). Modified Capital and Labor Effects; Combined Education Effect; Controls for Major Wars, Mining Status, Oil Producer Status

**DEPENDENT VARIABLE:** Growth70

**NUMBER OF OBSERVATIONS:** 58 **PARAMETERS ESTIMATED:** 7  
**R-SQUARE:** .598 **CORRECTED R-SQUARE:** .551  
**SUM OF SQUARED RESID.:** $1.47302670E0002$ **F(6/51):** 12.6494  
**STANDARD ERROR:** 1.6995E0000 **LOG-LIKELIHOOD:** -1.09327782E00  
**MEAN OF DEP. VARIABLE:** 4.1923E0000

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STANDARD ERROR</th>
<th>T-STATISTIC</th>
<th>BETA COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.131616094</td>
<td>0.8382525035</td>
<td>1.349970432</td>
<td>.0000</td>
</tr>
<tr>
<td>CapEff70</td>
<td>0.01442454761</td>
<td>5.794687463E-3</td>
<td>2.489271027</td>
<td>.2947</td>
</tr>
<tr>
<td>Lab/PCI70</td>
<td>122.3600558</td>
<td>48.8431221</td>
<td>2.505164504</td>
<td>.2548</td>
</tr>
<tr>
<td>Education70</td>
<td>5.298107629E-3</td>
<td>2.024734591E-3</td>
<td>2.616692406</td>
<td>.2874</td>
</tr>
<tr>
<td>MajorWar</td>
<td>-2.043565007</td>
<td>0.8176965512</td>
<td>-2.499172834</td>
<td>-.2476</td>
</tr>
<tr>
<td>MiningState</td>
<td>-1.764791793</td>
<td>0.5025402718</td>
<td>-3.511742028</td>
<td>-.3374</td>
</tr>
<tr>
<td>OilState</td>
<td>2.549441859</td>
<td>0.6500335208</td>
<td>3.922015985</td>
<td>.3831</td>
</tr>
</tbody>
</table>
B. Savings-Investment Behavior

In considering the problem of investment rate determination, I have had to devote some attention to savings rate determination. In this section, I will therefore present results for both savings and investment equations.

1). Savings Rates

Since this is an exercise in economic-demographic modeling, it is important to consider all possible linkages between population growth and economic growth. An explicit consideration of the impact of dependency rates on savings rates is therefore in order. There has been continuing controversy in the literature over the importance of dependency rates for savings rate determination in LDC's. The most recent major contribution has been made by Rati Ram (1982). Ram has used an improved data set to test Leff's finding (1969) that dependency rates are an important determinant of savings rates in LDC's. Ram's findings seem to reverse those of Leff.5

I have used the most recent data for the 70 LDC's in my data set to consider the evidence anew. In the savings equations which follow, I have looked at the cross-sectional evidence in levels (which Ram and Leff have done) and changes (which they have not done). In all cases, my

5. Leff apparently remains unsatisfied by these more recent findings. For an interesting but inconclusive debate concerning the effect of sample choice on results, see Leff (1984) and Ram's reply (1984).
results agree with Ram's. If anything, they suggest that the impact of increased child dependency rates on national savings behavior has been positive. Generally, however, the dependency results seem so weak as to warrant exclusion from final investment and/or savings equations.

In my treatment of the savings rate equations, I have consciously avoided much innovation. I have included life expectancy, on the theory that longer horizons may influence private savings behavior. I have also considered the impact of improved foreign exchange earnings, because it seems quite plausible to suppose that their impact on savings may be different than that of enhanced domestic income.

In other respects, I have deliberately followed the lead of Ram and others. The savings rate regression variables are as follows:

- **SavRate** - Domestic savings rate
- **ChildDep** - Proportion of children under 15 in the population
- **OldDep** - Proportion of people 65 and over in the population
- **Growth** - Percent change in GDP
- **IncomePC** - Income per capita
- **CapInFlow** - Ram's measure of "capital inflow", taken as the average value of the ratio: (Net Exports + Net Fac Payments + Net Unrequited Transfers)/GDP for the relevant decade
- **BarterTT** - Annual growth rate of the barter terms of trade
- **LifeExp** - Average life expectancy at birth for the decade in question

The suffix "Ch" is used with the variables defined above to denote decennial changes.

The four equations reported below provide representative results. The general magnitudes and patterns of significance in the level equations for the 1960's and 1970's are in accord with Ram's results.
(obtained from average data for the period 1970-77). Since my primary interest here was in testing prior results, I have not used an instrumental estimate for the GDP growth rate in the savings equations. I have used such an estimate in the final investment rate equations, however.

In the results reported below, the child dependency results suggest a positive relation in all cases. I have divided the full sample into regional subsamples, and this positive relation seems to hold generally. In the regional subsamples it is never "significant" by the standard test, however. The sign for the impact of elder dependency seems to wander randomly, and in no case could it be called truly "significant" either. It seems fair to conclude that there is no strong, systematic relation between dependency rates and savings rates in the data which are currently available.

All four of the regressions reported below (two on levels, two on changes) indicate important contributions for contemporaneous growth, income per capita, and capital inflow. The results suggest that income per capita is the most important explanatory variable in the set. In the level equations, I have concentrated on obtaining results from specifications identical to those of Ram and Leff. In the work on changes, I have also included changes in the barter terms of trade and life expectancy for reasons which were discussed above. The evidence suggests some role for changing foreign exchange income, but the life expectancy results are quite weak.
## Savings Equations

1). Determinants of Savings Rates in the 1960's

**DEPENDENT VARIABLE:** SavRate60

<table>
<thead>
<tr>
<th>NUMBER OF OBSERVATIONS: 65</th>
<th>PARAMETERS ESTIMATED: 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-SQUARE: .426</td>
<td>CORRECTED R-SQUARE: .377</td>
</tr>
<tr>
<td>SUM OF SQUARED RESID.:</td>
<td></td>
</tr>
<tr>
<td>3.86318051E0001</td>
<td></td>
</tr>
<tr>
<td>MEAN OF DEP. VARIABLE:</td>
<td></td>
</tr>
<tr>
<td>1.4255E0001</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>ERROR</th>
<th>T-STATISTIC</th>
<th>BETA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-31.13891262</td>
<td>18.5042551</td>
<td>-1.682797414</td>
<td>.0000</td>
</tr>
<tr>
<td>ChildDep60</td>
<td>0.8207086066</td>
<td>0.3483957497</td>
<td>2.355679159</td>
<td>.3582</td>
</tr>
<tr>
<td>OldDep60</td>
<td>1.348343087</td>
<td>1.377705516</td>
<td>0.9786874417</td>
<td>.1591</td>
</tr>
<tr>
<td>Growth60</td>
<td>0.6057343179</td>
<td>0.4318576894</td>
<td>1.402624829</td>
<td>.1496</td>
</tr>
<tr>
<td>IncomePC65</td>
<td>6.06901418E-3</td>
<td>1.576809289E-3</td>
<td>3.848920869</td>
<td>.4770</td>
</tr>
<tr>
<td>CapInflow60</td>
<td>-0.3887166785</td>
<td>0.1559523277</td>
<td>-2.492535278</td>
<td>-.2557</td>
</tr>
</tbody>
</table>

2). Determinants of Savings Rates in the 1970's

**DEPENDENT VARIABLE:** SavRate70

<table>
<thead>
<tr>
<th>NUMBER OF OBSERVATIONS: 67</th>
<th>PARAMETERS ESTIMATED: 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-SQUARE: .510</td>
<td>CORRECTED R-SQUARE: .470</td>
</tr>
<tr>
<td>SUM OF SQUARED RESID.:</td>
<td></td>
</tr>
<tr>
<td>3.93797328E0001</td>
<td></td>
</tr>
<tr>
<td>MEAN OF DEP. VARIABLE:</td>
<td></td>
</tr>
<tr>
<td>1.6260E0001</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>ERROR</th>
<th>T-STATISTIC</th>
<th>BETA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-7.666160526</td>
<td>16.88627918</td>
<td>-0.4539875508</td>
<td>.0000</td>
</tr>
<tr>
<td>ChildDep70</td>
<td>0.4812072794</td>
<td>0.3140461653</td>
<td>1.532281978</td>
<td>.2326</td>
</tr>
<tr>
<td>OldDep70</td>
<td>-1.192801667</td>
<td>1.169655247</td>
<td>-1.019789096</td>
<td>-.1594</td>
</tr>
<tr>
<td>Growth70</td>
<td>0.6189971183</td>
<td>0.3264881351</td>
<td>1.895925309</td>
<td>.1785</td>
</tr>
<tr>
<td>IncomePC75</td>
<td>7.383500272E-3</td>
<td>1.2745978E-3</td>
<td>5.792807952</td>
<td>.7042</td>
</tr>
<tr>
<td>CapInflow70</td>
<td>-0.2887176612</td>
<td>0.1418319732</td>
<td>-2.035631703</td>
<td>-.2029</td>
</tr>
</tbody>
</table>
3). Determinants of Savings Rate Changes, 1960's - 1970's

DEPENDENT VARIABLE: SavRateCh

NUMBER OF OBSERVATIONS: 68  
PARAMETERS ESTIMATED: 6

R-SQUARE: .394  
CORRECTED R-SQUARE: .345

SUM OF SQUARED RESID.: 2.75825897E0001  
F(5/62): 8.0544

STANDARD ERROR: 5.2519E0000  
LOG-LIKELIHOOD: -2.06131409E000

MEAN OF DEP. VARIABLE: 1.9752E0000

| VARIABLE | COEFFICIENT | STANDARD ERROR | T-STATISTIC | BETA
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.52206477</td>
<td>0.8855623947</td>
<td>1.718754973</td>
<td>.0000</td>
</tr>
<tr>
<td>ChDepCh</td>
<td>0.2384362492</td>
<td>0.4619660755</td>
<td>0.5161336772</td>
<td>.0731</td>
</tr>
<tr>
<td>OldDepCh</td>
<td>-1.226979748</td>
<td>1.872907065</td>
<td>-0.6551204653</td>
<td>-.0810</td>
</tr>
<tr>
<td>GrowthCh</td>
<td>0.472298965</td>
<td>0.2529634885</td>
<td>1.867063772</td>
<td>.1892</td>
</tr>
<tr>
<td>IncPCCh</td>
<td>9.466808494E-3</td>
<td>3.25638999E-3</td>
<td>2.907193792</td>
<td>.4252</td>
</tr>
<tr>
<td>CapInfCh</td>
<td>-0.5190649457</td>
<td>0.1309976342</td>
<td>-3.96239939</td>
<td>-.4092</td>
</tr>
</tbody>
</table>

4). Determinants of Savings Rate Changes, 1960's - 1970's

DEPENDENT VARIABLE: SavRateCh

NUMBER OF OBSERVATIONS: 60  
PARAMETERS ESTIMATED: 7

R-SQUARE: .476  
CORRECTED R-SQUARE: .417

SUM OF SQUARED RESID.: 2.01455629E0001  
F(6/53): 8.0262

STANDARD ERROR: 4.4884E0000  
LOG-LIKELIHOOD: -1.71504254E000

MEAN OF DEP. VARIABLE: 2.1196E0000

| VARIABLE | COEFFICIENT | STANDARD ERROR | T-STATISTIC | BETA
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.606531531</td>
<td>2.597487926</td>
<td>0.6184943211</td>
<td>.0000</td>
</tr>
<tr>
<td>SavRate60</td>
<td>-0.2282671815</td>
<td>0.08303021845</td>
<td>-2.749206081</td>
<td>-.3287</td>
</tr>
<tr>
<td>GrowthCh</td>
<td>0.3175192554</td>
<td>0.2500469677</td>
<td>1.269838456</td>
<td>.1463</td>
</tr>
<tr>
<td>IncPCCh</td>
<td>8.765203641E-3</td>
<td>3.213397705E-3</td>
<td>2.727705826</td>
<td>.3254</td>
</tr>
<tr>
<td>CapInfCh</td>
<td>-0.2631698895</td>
<td>0.1292976674</td>
<td>-2.035380025</td>
<td>-.2243</td>
</tr>
<tr>
<td>BarterTTCh</td>
<td>17.6149038</td>
<td>9.635684701</td>
<td>1.828091137</td>
<td>.2024</td>
</tr>
<tr>
<td>LifeExpCh</td>
<td>0.5927008718</td>
<td>0.5061581481</td>
<td>1.170979612</td>
<td>.1204</td>
</tr>
</tbody>
</table>
2). The Investment Rate

Since the domestic savings pool is likely to be an important determinant of investment, the results above apply directly to the specification of the investment rate equations. I have retained the GDP growth rate (treated as an endogenous variable), income per capita, and capital inflow as right-hand variables. I have also included change in the barter terms of trade and life expectancy, for the reasons discussed above. Finally, I have incorporated my stability measure, on the theory that stability is generally thought to be good for investment.

The cross-section results on levels reported below suggest important roles for the major determinants of the domestic savings rate and negligible roles for the other variables. The lagged investment rate has been included in the level equation for the 1970's, in order to capture any systematic long-run components of national investment behavior which are not directly observable. The results suggest the presence of such phenomena, but they also suggest relatively rapid regression toward the mean.

The latter phenomenon has also been controlled for in the investment change equation. This equation should probably be regarded as the most stringent test of the importance of the right-hand variables, and the change to dynamic form does have some consequences. The estimate of the GDP growth rate impact becomes negligible in size and significance, and it has been dropped from the final result. The other savings rate determinants (income per capita, barter terms of trade, capital inflow)
continue to perform very creditably.  

Investment Rate Equations

InvRate - Domestic investment rate
InstGr - GDP growth rate
IncPC - Income per capita (the prefix "log") denotes the natural logarithm

Other variables as previously defined. The suffix "Ch" continues to denote decennial changes.

1). Determinants of Investment Rates in the 1960's

DEPENDENT VARIABLE: InvRate60

NUMBER OF OBSERVATIONS: 64
PARAMETERS ESTIMATED: 6
R-SQUARE: .313
CORRECTED R-SQUARE: .254
SUM OF SQUARED RESID.: 1.16005958E0003
F(5/58): 5.2832
STANDARD ERROR: 4.4723E0000
LOG-LIKELIHOOD: -1.83527060E000
MEAN OF DEP. VARIABLE: 1.7272E0001

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STANDARD ERROR</th>
<th>T-STATISTIC</th>
<th>BETA COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-5.40773052</td>
<td>4.67906269</td>
<td>-1.15572944</td>
<td>.0000</td>
</tr>
<tr>
<td>logIncPC</td>
<td>2.307386653</td>
<td>0.979215726</td>
<td>2.356361925</td>
<td>.3658</td>
</tr>
<tr>
<td>InstGr60</td>
<td>0.402839052</td>
<td>0.5325728621</td>
<td>0.7564017639</td>
<td>.1049</td>
</tr>
<tr>
<td>CapInflow60</td>
<td>0.188226360</td>
<td>0.1015564007</td>
<td>1.853417006</td>
<td>.2085</td>
</tr>
<tr>
<td>LifeExp65</td>
<td>0.087962980</td>
<td>0.09111004831</td>
<td>0.9654586074</td>
<td>.1574</td>
</tr>
<tr>
<td>StableYrs60</td>
<td>0.107559514</td>
<td>0.1831894621</td>
<td>0.5871490269</td>
<td>.0677</td>
</tr>
</tbody>
</table>

6. Note that the logarithm of income per capita is used in the investment equations (including the change equation, where percent change is employed). This specification fits the data about as well as the linear specification, and is much more believable a priori. The linear specification builds in the assumption that large increases in per capita income will move the investment rate to unity -- implausible, to put it mildly. This kind of difference in specification is especially important for a long-run simulation model.
2). Determinants of Investment Rates in the 1970's

DEPENDENT VARIABLE: InvRate70

NUMBER OF OBSERVATIONS: 59  PARAMETERS ESTIMATED: 7
R-SQUARE: .550  CORRECTED R-SQUARE: .498
STANDARD ERROR: 5.1052E0000  LOG-LIKELIHOOD: -1.76177244E000
MEAN OF DEP. VARIABLE: 2.1289E0001

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STANDARD ERROR</th>
<th>T-STATISTIC</th>
<th>BETA COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-9.103831314</td>
<td>5.963953552</td>
<td>-1.526475891</td>
<td>.0000</td>
</tr>
<tr>
<td>InvRate60</td>
<td>0.3460886766</td>
<td>0.1030423651</td>
<td>3.358702767</td>
<td>.3890</td>
</tr>
<tr>
<td>logIncPC</td>
<td>2.631692282</td>
<td>1.251802092</td>
<td>2.102322962</td>
<td>.3327</td>
</tr>
<tr>
<td>InstGr70</td>
<td>1.851356549</td>
<td>0.6312951007</td>
<td>2.93263253</td>
<td>.3674</td>
</tr>
<tr>
<td>CapInflow70</td>
<td>0.4151308396</td>
<td>0.1684229211</td>
<td>2.464812015</td>
<td>.3562</td>
</tr>
<tr>
<td>LifeExp75</td>
<td>-0.06733567231</td>
<td>0.1145892293</td>
<td>-0.5876265397</td>
<td>-.0900</td>
</tr>
<tr>
<td>StableYrs70</td>
<td>5.208805746E-3</td>
<td>0.296426332</td>
<td>0.01757200756</td>
<td>.0019</td>
</tr>
</tbody>
</table>

3). Determinants of Investment Rate Changes, 1960's - 1970's

Note that the equation below is specified with the investment rate for the 1970's as the dependent variable. Since the investment rate for the 1960's is a righthand variable in the change equation, the form used here simply represents an algebraic transformation (adding the investment rate for the 1960's to both sides of the equation). Since the investment rate equation will be used with the output change equation in the simulation model, this form is preferable. Note that simultaneity again intrudes, since the percent change in per capita income includes the growth rate of output. Two-stage least squares have been employed and (as expected), the result is a substantial reduction in the estimated marginal impact of income growth on investment.
DEPENDENT VARIABLE: InvRate70

NUMBER OF OBSERVATIONS: 59
R-SQUARE: .550
SUM OF SQUARED RESID.: 1.35349268E0003
MEAN OF DEP. VARIABLE: 2.1289E0001
PARAMETERS ESTIMATED: 4
CORRECTED R-SQUARE: .526
F(3/55): 22.4242
LOG-LIKELIHOOD: -1.76138108E000'

STANDARD ERROR: 4.9607E0000
SUM OF SQUARED RESID.: 1.35349268E0003
MEAN OF DEP. VARIABLE: 2.1289E0001

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STANDARD ERROR</th>
<th>T-STATISTIC</th>
<th>BETA COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>6.615958839</td>
<td>1.912348325</td>
<td>3.459599254</td>
<td>.0000</td>
</tr>
<tr>
<td>InvRate60</td>
<td>0.5223198791</td>
<td>0.08125423902</td>
<td>6.428216982</td>
<td>.5871</td>
</tr>
<tr>
<td>PCIPCCh</td>
<td>2.404203053</td>
<td>0.494487667</td>
<td>4.862008121</td>
<td>.4771</td>
</tr>
<tr>
<td>CapInfCH</td>
<td>0.508789117</td>
<td>0.1439002101</td>
<td>3.535707952</td>
<td>.3493</td>
</tr>
</tbody>
</table>

II. Fertility, Mortality, and Family Planning

A. Specification and Estimation Issues

Explicit admission of the simultaneity problem in the demographic equations gives an obvious appeal to a dynamic specification. A behavioral model fitted to international data is only likely to provide useful information when time changes are employed. Equations fitted to variable levels across countries at one point in time will inevitably be plagued by masking correlations, and differing historical circumstances will intrude on the interpretation of results even if simultaneous equations techniques are employed.

The assumption implicit in such cross-sectional work is that behavioral relations have been similar across nations at all points in history. By contrast, the use of data on changes introduces the more reasonable assumption that behavioral relations have been similar in very
recent history.  

The demographic equation system to be estimated here is therefore based on a dynamic specification. Data for 1960, 1970, and 1980 are used to calculate decennial changes. The model allows for joint determination of fertility, infant mortality, and family planning, and treats per capita income as an endogenous right-hand variable. Two-stage least squares is applied to each equation to assure consistent parameter estimates.

B. Fertility

The fertility equation is basically log-log in form, with the exception of the interaction between female schooling and planning. The time derivative is therefore linear in percent changes, again with the exception of the schooling-planning interaction term. Because behavioral adaptation is important here, it seems appropriate to allow for relatively long adjustment lags.

--------

7. For simulation modeling, of course, the use of the change specification is extremely desirable. Predicted changes can be added to current levels for particular countries if dynamic equations are employed. Cross-sectional results would obviously be quite awkward to employ in this context.

8. This specification, while not explicitly asymptotic, has the advantage of generating percent changes in fertility rates. It should therefore produce realistic patterns of decline for intermediate-run simulations, given the observable range of fertility rates in developing countries.
Thus:

**Static Specification**

\[ \ln F_t = B_0 + B_1 \ln X_t + B_2 P_t S_t \]

where

- \( F_t \) = Total fertility rate
- \( X_t \) = Some appropriate righthand variable (e.g. per capita income)
- \( P_t \) = An index of family planning activity
- \( S_t \) = A measure of female schooling

**Dynamic Specification**

\[ f_t = B_1 x_t + B_2 DPSt \]

where \( f, x = \) Percent changes in \( F \) and \( X \)

\[ DPSt = [(dP/dt)S_t + (dS/dt)P_t] \]

The dependent variable in the estimating equation is percent change in the total fertility rate from 1970 to 1980. To allow for long lags in responsiveness, the equation is specified in contemporaneous decennial changes and lagged changes (that is, for the period 1960-1970).

1). **Data**

**Fertility, Mortality, and Per Capita Income**: These three variables in the fertility equation are drawn from standard sources. The infant mortality rate for 1960, 1970, and 1980 has been taken from U.N. data. The total fertility rates for 1960, 1970, and 1980 have been taken from the World Bank Data File, as has income per capita. It is worth noting that the specification of income per capita employed here allows for a more robust test of the effect of income than is usually the case. A standard criticism of the use of per capita income in cross section work
is that the same mean income can accompany greatly differing variances (i.e. distributions of income). In this work, percent change in per capita income is employed as the righthand variable. Thus, the income measure can be said to apply equally to all members of a society as long as the distribution of income remains roughly constant. Over a period as short as a decade, this assumption is probably not too bad. The data available for Western economies suggest that in most cases the distribution of income has exhibited stability over periods as long as fifty years.

**Female Schooling:** Female schooling rates have been derived from information on female primary and secondary education ratios for 1960, 1970, and 1980. The female schooling rates relevant for the most important age group (females from 15-29) during the 1970's have been proxied by the female primary ratio in 1965 (calculated as the mean of the rates for 1960 and 1970) and the female secondary ratio for 1970. Rates for the 1960's are proxied by the primary and secondary ratios in 1960. Lags are employed here to reflect the period during which the women should have been in primary or secondary school. Since prior experimentation revealed no significant difference in impact coefficients, schooling has been measured as the sum of the relevant primary and secondary rates.

**Family Planning:** Family planning "effort" by national governments must be measured somehow. The original contribution to index number construction in this context was made by Mauldin and Berelson (1978), who derived a relative measure of program effectiveness for a large number of
developing countries as of 1975. Data collection has continued, and I have benefitted from the World Bank's possession of program effectiveness indices for 1972 and 1982, along with estimated start dates for official sponsorship of family planning programs. Only India began such sponsorship before 1960, so the presence of performance ratings for 1972 and 1982 allows for the estimation of changes in program effectiveness during the 1960's and 1970's.

2). Results

The regression model fits the data quite well in this case (It should be recalled that the lefthand variable is a percent change -- this is a much more stringent test than that which is usually posed by straight cross-section work). The schooling-planning interaction, income per capita, and infant mortality all appear significant as determinants of fertility change. For income per capita, the major effect seems contemporaneous. For schooling-planning and infant mortality, the results suggest somewhat more importance for the lagged effect. One ambiguity is introduced by some doubt about whether fertility change and change in infant mortality are simultaneously determined. This problem will be considered again once the mortality results are in hand.

Since per capita income and infant mortality enter the equation in

---------

9. It is important to note that percent changes for all variables in the fertility equation are measured in true units. Thus, one percent is measured as .01.
percent change form, their coefficients can be combined to give total elasticity measures. For income per capita, the suggested total elasticity is approximately .16 (that is, an increase of one percent in income per capita is associated with a decline of approximately .16 percent in the total fertility rate). The total elasticity for infant mortality is approximately .32, or twice that of per capita income.

The results for the schooling-planning interaction term are more difficult to interpret because the relationship between this term and the lefthand variable is implicitly log-linear rather than log-log. If schooling is held constant at a value of 100 (e.g. Female primary enrollment ratio of 80; female secondary ratio of 20), family planning impact can be gauged using

\[ (-.0018 \times 100) \text{ Plan} + (-.0021 \times 100) \text{ LagPlan} \]

or

\[ (-.18 \text{ Plan} + (-.21) \text{ LagPlan} \]

The implied total responsiveness is a drop of .4% per 1 point increase in the index of program effectiveness. The implication can be seen by considering the impact of an increase of 80 (from zero up to the current Chinese score, as China seems to have done in about a decade) for a society with a total (and constant) female schooling ratio of 100 (not atypical of African societies in the mid-1970's). The result is a 32% drop in the total fertility rate. At a combined schooling ratio of 200 (the long-run maximum), the associated drop would be 64%. These are impressive numbers.
An alternative interpretation of this result can be derived from a consideration of the impact of educational improvements with the planning score held constant. If the program effectiveness index were held constant at 50, the implied coefficients on total schooling would be:

\[ (-.09) \text{School} + (-.10) \text{LagSchool} \]

Thus, each 1 point increase in the total female primary and secondary schooling ratio would decrease the fertility rate by about 0.2%, and a 100 point increase would decrease fertility by about 20% in the long run.

It is the interactive impact of education and family planning which must be stressed here. Experimentation with alternative functional forms has suggested strongly that the interactive specification is appropriate. There is obviously a major policy implication in this result if it is to be believed: Rapid expansion of family planning programs in societies where females are being educated at low rates will not be very effective. Conversely, rapid expansion in educational opportunities for women seems to have proportionally greater impact on fertility when strong family planning programs are in place.

3). **Estimated Fertility Equation**

Variable definitions are as follows:

- **Fert** - Percent change in the total fertility rate
- **DPS** - Time derivative of PS (see above)
- **IncPC** - Percent change in income per capita
- **InfMort** - Percent change in the infant mortality rate
Lag denotes changes for the period 1960-1970

Endogenous Variables (in 2SLS): IncPC, InfMort, Family Planning Index (Part of DPS)

Results:

**DEPENDENT VARIABLE: Fert**

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STANDARD ERROR</th>
<th>T-STATISTIC</th>
<th>BETA COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.05852846126</td>
<td>0.02667590014</td>
<td>2.194057593</td>
<td>0.0000</td>
</tr>
<tr>
<td>DPS</td>
<td>-1.806555149E-5</td>
<td>8.444163151E-6</td>
<td>-2.13941289</td>
<td>-0.1437</td>
</tr>
<tr>
<td>LagDPS</td>
<td>-2.075936979E-5</td>
<td>6.967642365E-6</td>
<td>-2.979396574</td>
<td>-0.4411</td>
</tr>
<tr>
<td>PCI</td>
<td>-0.1192015364</td>
<td>0.05813795033</td>
<td>-2.050322307</td>
<td>-0.1631</td>
</tr>
<tr>
<td>LagPCI</td>
<td>-0.04997192535</td>
<td>0.06348658308</td>
<td>-0.787125766</td>
<td>-0.0601</td>
</tr>
<tr>
<td>InfMort</td>
<td>0.122963698</td>
<td>0.1169353766</td>
<td>1.051552589</td>
<td>0.1708</td>
</tr>
<tr>
<td>LagInfMort</td>
<td>0.1981151561</td>
<td>0.1195299026</td>
<td>1.65745267</td>
<td>0.1761</td>
</tr>
</tbody>
</table>

C. Mortality

The mortality equation is specified in percent changes, again with the exception of the time derivative of the schooling-planning interaction. Prior theory suggests a treatment of lags which is different than that for the fertility equation. If the standard arguments are correct, than decennial changes in fertility and income should have purely contemporaneous effects on mortality. The fertility effect should come through increased child spacing, while the income effect should register rather quickly through increased purchases of health-related goods and services.
Since schooling and family planning activities may have lagged effects on behavior, it seems appropriate to allow for this possibility in the specified equation. In addition, the lagged infant mortality change is introduced to allow for the persistence of local (and at this point, "unexplainable") patterns of infant mortality decline.

1. Results

All variables are as previously defined, with one exception. Prior experimentation with the schooling variables showed that only female secondary education had any apparent impact. Thus, DPS is redefined as SecDPS here. The measures of percent change in per capita income (PCI) and percent change in the fertility rate (Fert) are treated as endogenous variables in the equation, as is the measure of contemporaneous change in family planning effort.

DEPENDENT VARIABLE: InfMort

NUMBER OF OBSERVATIONS: 60
PARAMETERS ESTIMATED: 6
R-SQUARE: .781
CORRECTED R-SQUARE: .760
SUM OF SQUARED RESID.: 6.30773634E0003
F(5/54): 38.4434
STANDARD ERROR: 1.0808E0001
LOG-LIKELIHOOD: -2.24791940E000
MEAN OF DEP. VARIABLE: -3.2994E0001

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STANDARD ERROR</th>
<th>T-STATISTIC</th>
<th>BETA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-15.9894256</td>
<td>3.249042453</td>
<td>-4.921273216</td>
<td>.0000</td>
</tr>
<tr>
<td>LagInfMort</td>
<td>0.391678583</td>
<td>0.2304590743</td>
<td>1.699558085</td>
<td>.2312</td>
</tr>
<tr>
<td>SecDPS</td>
<td>3.855411522E-3</td>
<td>4.307532761E-3</td>
<td>0.8950393964</td>
<td>.0873</td>
</tr>
<tr>
<td>LagSecDPS</td>
<td>-0.01965788647</td>
<td>5.096955227E-3</td>
<td>-3.856790103</td>
<td>-.5882</td>
</tr>
<tr>
<td>PCI</td>
<td>-0.07335550615</td>
<td>0.1064951428</td>
<td>-0.6888155104</td>
<td>-.0666</td>
</tr>
<tr>
<td>Fert</td>
<td>0.1890474918</td>
<td>0.4225988808</td>
<td>0.4473449892</td>
<td>.1146</td>
</tr>
</tbody>
</table>

This result suggests quite strongly that the fertility-mortality
The hypothesis of no contemporaneous impact for fertility change cannot be rejected at any reasonable level of confidence, given the results above. The same can obviously be said for DPS (contemporaneous change in the schooling-planning interaction) and PCI (contemporaneous change in per capita income).

In fact, the result above suggests that an extremely simple model can account for a large proportion of explained variance in infant mortality (IMR) changes during the 1970's. When the weak variables are dropped from the equation, it can be estimated by ordinary least squares:

**ORDINARY LEAST SQUARES**

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STANDARD ERROR</th>
<th>T-STATISTIC</th>
<th>BETA COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-15.23123689</td>
<td>2.67390716</td>
<td>-5.696247469</td>
<td>0.0000</td>
</tr>
<tr>
<td>LagInfMort</td>
<td>0.5046394521</td>
<td>0.1332964441</td>
<td>3.785843318</td>
<td>0.3035</td>
</tr>
<tr>
<td>LagSecDPS</td>
<td>-0.02145107357</td>
<td>2.660798299E-3</td>
<td>-8.0618939</td>
<td>-.6464</td>
</tr>
</tbody>
</table>

Thus, three quarters of the variance in IMR changes can be accounted for by an equation which incorporates lagged changes in the IMR and the lagged change in the planning-schooling interaction. Obviously, most of the movement remains "unexplained," in the usual sense. For the present, this rather unsatisfactory result will be adopted to serve two
purposes.

First, it will be incorporated into the simulation model as the predictive equation for infant mortality change. Secondly, the result seems to justify the treatment of infant mortality change as a predetermined variable in the fertility change equation. The revised fertility equation result is as follows:

Revised Fertility Equation

**TWO-STAGE LEAST SQUARES (InfMort predetermined)**

**DEPENDENT VARIABLE:** ADTFR7080

<table>
<thead>
<tr>
<th>NUMBER OF OBSERVATIONS:</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PARAMETERS ESTIMATED:</strong></td>
<td>7</td>
</tr>
<tr>
<td><strong>R-SQUARE:</strong></td>
<td>.813</td>
</tr>
<tr>
<td><strong>CORRECTED R-SQUARE:</strong></td>
<td>.791</td>
</tr>
<tr>
<td><strong>SUM OF SQUARED RESID.:</strong></td>
<td>2.37441291E-001</td>
</tr>
<tr>
<td><strong>F(6/53):</strong></td>
<td>38.3049</td>
</tr>
<tr>
<td><strong>STANDARD ERROR:</strong></td>
<td>6.9353E-002</td>
</tr>
<tr>
<td><strong>LOG-LIKELIHOOD:</strong></td>
<td>8.08290713E000</td>
</tr>
<tr>
<td><strong>MEAN OF DEP. VARIABLE:</strong></td>
<td>-1.523E-001</td>
</tr>
<tr>
<td><strong>DURBIN-WATSON STAT.:</strong></td>
<td>2.133</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STANDARD ERROR</th>
<th>T-STATISTIC</th>
<th>BETA COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.0360897995</td>
<td>0.02313986184</td>
<td>1.55963764</td>
<td>.0000</td>
</tr>
<tr>
<td>DPS</td>
<td>-1.486161481E-5</td>
<td>8.606471812E-6</td>
<td>-1.726795269</td>
<td>-.1182</td>
</tr>
<tr>
<td>LagDPS</td>
<td>-2.706516886E-5</td>
<td>5.600068836E-6</td>
<td>-4.83300646</td>
<td>-.5751</td>
</tr>
<tr>
<td>PCI</td>
<td>-0.1068006322</td>
<td>0.05751105652</td>
<td>-1.857045212</td>
<td>-.1461</td>
</tr>
<tr>
<td>LagPCI</td>
<td>-0.06132368824</td>
<td>0.0638015032</td>
<td>-0.96116369</td>
<td>-.0737</td>
</tr>
<tr>
<td>InfMort</td>
<td>-0.01647469306</td>
<td>0.07877650484</td>
<td>-0.2091320641</td>
<td>-.0248</td>
</tr>
<tr>
<td>LagInfMort</td>
<td>0.2632814438</td>
<td>0.1132951307</td>
<td>2.323854894</td>
<td>.2341</td>
</tr>
</tbody>
</table>

The only change associated with the result is a complete shift in explanatory weight from contemporaneous change in infant mortality to lagged change. For incorporation into the simulation model, the equation has been re-estimated without contemporaneous infant mortality change.

To summarize, then, the dominance of female education and family planning in the determination of changes in both fertility and mortality
is quite striking. Long lags in behavioral adaptation are suggested by the results. The two-equation system seems fundamentally recursive, with the only interaction occurring through a rather weak lagged impact of infant mortality on fertility.

D. Family Planning

The results for changes in family planning effort are of some independent interest here, since they exploit new measures of change in family planning activity during the past two decades. The equation relates changes in family planning to contemporaneous and lagged changes in the fertility rate and per capita income. Change in the incidence of female secondary education is also incorporated, along with the logarithm of population density and the dummy variables for "small" and "large" island-peninsular status.

The results are displayed below. Since the "island-peninsular" variables had no apparent partial relationship to family planning change during the 1970's, they have been dropped from the included results. The definitions of new variables are as follows:

- **Plan** - Change in family planning program score, 1970-80
- **FemSeced** - Change in the female secondary schooling rate, 1960-70
- **lnDens** - The logarithm of population density in 1970
Result:

DEPENDENT VARIABLE: Plan  (Endogenous variables: Fert, PCI)

NUMBER OF OBSERVATIONS: 61  PARAMETERS ESTIMATED: 8
R-SQUARE: .500  CORRECTED R-SQUARE: .434
STANDARD ERROR: 1.1116E0001  LOG-LIKELIHOOD: -2.29176774E000
MEAN OF DEP. VARIABLE: 8.9508E0000  DURBIN-WATSON STAT.: 2.161

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STANDARD ERROR</th>
<th>T-STATISTIC</th>
<th>BETA COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-20.21787232</td>
<td>12.07017072</td>
<td>-1.675027868</td>
<td>0.0000</td>
</tr>
<tr>
<td>LagPlan</td>
<td>-0.03133096929</td>
<td>0.1697309046</td>
<td>-0.1845920126</td>
<td>-0.0539</td>
</tr>
<tr>
<td>Fert</td>
<td>150.2327997</td>
<td>51.16820929</td>
<td>2.936057403</td>
<td>1.3606</td>
</tr>
<tr>
<td>LagFert</td>
<td>-45.06251902</td>
<td>34.79172371</td>
<td>-1.295208004</td>
<td>-0.3936</td>
</tr>
<tr>
<td>PCI</td>
<td>-4.104148641</td>
<td>11.0004616</td>
<td>-0.3730887658</td>
<td>-0.0554</td>
</tr>
<tr>
<td>LagPCI</td>
<td>20.71111358</td>
<td>11.21922867</td>
<td>1.846037208</td>
<td>0.2449</td>
</tr>
<tr>
<td>FemSeced</td>
<td>0.9619824651</td>
<td>0.2823539102</td>
<td>3.407009539</td>
<td>0.4454</td>
</tr>
<tr>
<td>lnDens</td>
<td>3.221968401</td>
<td>1.240890261</td>
<td>2.596497453</td>
<td>0.3348</td>
</tr>
</tbody>
</table>

As reported in the paper, these results suggest that government planning efforts have been primarily reactive: Slow declines in fertility have stimulated activity, while rapid declines in fertility seem to have retarded it. The results also suggest that income, female education, and perceived population pressure all had something to do with the change in planning effort during the 1970's. When the weak variables are dropped from the equation, the result is as follows:
### Summary Statistics

**Dependent Variable:** Plan  
**Number of Observations:** 61  
**ParametersEstimated:** 6  
**R-Square:** 0.498  
**Corrected R-Square:** 0.453  
**Sum of Squared Resids.:** 6.57154537E0003  
**F(5/55):** 10.9226  
**Standard Error:** 1.0931E0001  
**Log-Likelihood:** -2.29283979E000;  
**Mean of Dep. Variable:** 8.9508E0000  
**Durbin-Watson Stat.:** 2.167

### Variable Coefficients

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>T-Statistic</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-19.64515828</td>
<td>10.82053198</td>
<td>-1.81554458</td>
<td>0.0000</td>
</tr>
<tr>
<td>&quot;Deviation&quot;</td>
<td>42.89571047</td>
<td>27.25168947</td>
<td>1.574056923</td>
<td>0.1634</td>
</tr>
<tr>
<td>&quot;Trend&quot;</td>
<td>114.8238272</td>
<td>18.65143501</td>
<td>6.156299884</td>
<td>1.0399</td>
</tr>
<tr>
<td>LagPCI</td>
<td>21.44948502</td>
<td>10.58564987</td>
<td>2.026279472</td>
<td>0.2536</td>
</tr>
<tr>
<td>FemSedEd</td>
<td>0.9595379972</td>
<td>0.2758955806</td>
<td>3.477902745</td>
<td>0.4443</td>
</tr>
<tr>
<td>lnDens</td>
<td>3.12149231</td>
<td>1.111399612</td>
<td>2.808613819</td>
<td>0.3243</td>
</tr>
</tbody>
</table>
The African Trypanosomiases: Methods and Concepts of Control and Eradication in Relation to Development
C. W. Lee and J. M. Maurice

Here is a practical cost-benefit approach to an age-old problem affecting humans and livestock alike, the African Trypanosomiases. Describes new techniques that offer tsetse control without destroying game animals. Also summarizes current research in genetic control, the use of traps and screens, attractants, and pheromones.


Analyzing the Impact of Health Services: Project Experiences from India, Ghana, and Thailand
Rashid Faruqee


Volume II. Integrated Family Planning and Health Care
Carl E. Taylor and others

To village people, politicians, and international health planners, health and family planning have always seemed to fit naturally together. But in the early 1960s, when international awareness of the social and economic consequences of surging population growth moved family planning into a position of high priority, some international agencies began to advocate separation of family planning from health services. In international policy discussions the question continues to be important. This volume analyzes this question and provides arguments and evidence to support integration of health care and family planning; it outlines the purposes underlying the research in this area; and it proposes policy questions regarding the effectiveness, efficiency, and equity of such an integration.


Demographic Aspects of Migration in West Africa—K. C. Zachariah and others

Volume 1


Stock No. WP 0414. $15.

Volume 2


Stock No. WP 0415. $15.

(These Working Papers are background studies for Migration in West Africa: Demographic Aspects, described in this section.)

Economic Motivation versus City Lights: Testing Hypotheses about Inter-Changwat Migration in Thailand
Fred Arnold and Susan H. Cochrane


Stock No. WP 0416. $3.

Experiments in Family Planning: Lessons from the Developing World
Roberto Cuca and Catherine S. Pierce

A comprehensive review of experimental efforts in the developing world to determine more effective ways of providing family planning services.

The Johns Hopkins University Press. 1978. 276 pages (including bibliography, index of experiments).


Family Planning Programs: An Evaluation of Experience
Roberto Cuca


Stock No. WP 0345. $5.

Fertility and Education: What Do We Really Know?
Susan H. Cochrane

A model identifying the many channels through which education might...
Act to determine fertility and a review of the evidence of the relation between education and the intervening variables in the model that affect fertility.


Fertility and Its Regulation in Bangladesh
R. Amin and Rashid Faruqe
Stock No. WP 0383. $3.

Health
Fredrick Golladay, coordinating author
Draws on experience gained from health components of seventy World Bank projects in forty-four countries between 1975 and 1978. Emphasizes the disproportionately high expenditures incurred on curative medicine, maintenance of expensive hospitals, and sophisticated training of medical personnel at the cost of preventive care for the majority of the people. Points out that low-cost health care systems are feasible and recommends that the Bank begin regular and direct lending for health, in addition to having health components as part of projects in other sectors.
Sector Policy Paper. 1980. 90 pages (including 8 annexes, 4 figures, map).
Stock Nos. BK 9066 (Arabic), BK 9067 (English), BK 9068 (French), BK 9069 (Spanish). $5.

Health Issues and Policies in the Developing Countries
Fredrick Golladay
Stock No. WP 0412. $3.

Health, Nutrition, and Family Planning in India: A Survey of Experiments and Special Projects
Rashid Faruque and Ethna Johnson
Stock No. WP 0507. $5.

Infant and Child Mortality as a Determinant of Fertility: The Policy Implications
Susan Hill Cochrane and K. C. Zachariah
An illustrative analysis that suggests infant mortality may be an important component of a fertility reduction program in countries where mortality is high and few couples are able to have the number of surviving children they desire.

Integrating Family Planning with Health Services: Does It Help?
Rashid Faruque

Visit the World Bank Bookstore when you are in Washington, D.C.

Kenya: Population and Development
(See description under Country Studies listing.)

Migration in West Africa: Demographic Aspects
K. C. Zachariah and Julien Conde
The first study of the large-scale movement of people in nine West African countries. Discusses the volume and direction of internal and external flows and the economic and social characteristics of migrants.

Population and Family Planning in Bangladesh: A Study of the Research
Mohammad Alauddin and Rashid Faruque
Reviews major studies on family planning and on fertility trends, profiles, and determinants. Evaluates results of such studies and critiques their methodology and application. Underscores need for continued study and suggests directions for future research to improve the Bangladesh population problem.

Population and Poverty in the Developing World
Nancy Birdsall
Stock No. WP 0404. $3.

Population Policy and Family Planning Programs: Trends in Policy and Administration
Kandiah Kanagaratnam and Catherine S. Pierce
Stock No. WP 0447. $3.
Short-term Population Projection, 1980-2020 and Long-term Projection, 2000 to Stationary Stage by Age and Sex for All Countries of the World

My T. Vu, under the supervision of K. C. Zachariah

This report gives detailed population projections by age and sex for each country at five-year intervals from 1980 to 2020 and at twenty-five year intervals from 2000 to the year in which population becomes stationary in each country. The implied fertility and mortality measures are also given. Revised annually. The 1984 edition will be published as World Population Projections: Short- and Long-term Projections by Age and Sex for All Countries, with Related Demographic Statistics 1983. 391 pages.


NEW

Rapid Population Growth in Sub-Saharan Africa: Issues and Policies
Rashid Faruqee and Ravi Gulhati

No other country has higher fertility than Kenya and its neighboring countries in Sub-Saharan Africa. This Working Paper examines the reasons for fertility rates staying high, even rising in the face of greater education, falling mortality, and urbanization—factors that tend to lower fertility elsewhere. Calls for a viable population policy and programs appropriate to the culture.


Regional Aspects of Family Planning and Fertility Behavior in Indonesia
Dov Chernichovsky and Oey Astra Meesook


Stock No. WP 0462. $3.
### The World Bank Publications Order Form

**SEND TO:** YOUR LOCAL DISTRIBUTOR OR TO WORLD BANK PUBLICATIONS  
(Please see the other side of this form.)

**P.O. BOX 37525**  
**WASHINGTON, D.C. 20013 U.S.A.**

**Date**

**Name**  
Ship to: (Enter if different from purchaser)

**Title**

**Firm**

**Address**

**City**  
**State**  
**Postal Code**

**Country**  
**Telephone**

**Purchaser Reference No.**

Check your method of payment.  
Enclosed is my □ Check □ International Money Order □ Unesco Coupons □ International Postal Coupon. Make payable to World Bank Publications for U.S. dollars unless you are ordering from your local distributor.

Charge my □ VISA □ MasterCard □ American Express □ Choice. (Credit cards accepted only for orders addressed to World Bank Publications.)

<table>
<thead>
<tr>
<th>Stock Number</th>
<th>Author/Title</th>
<th>Customer Internal Routing Code</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Amount $</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All prices subject to change. Prices may vary by country. Allow 6-8 weeks for delivery.

Subtotal Cost $_____

Total copies ______ Air mail surcharge if desired ($2.00 each) $_____

Postage and handling for more than two complimentary items ($2.00 each) $_____

Total $_____

Thank you for your order.

IBRD-0053
Distributors of World Bank Publications

ARGENTINA, BAHRAIN, BANGLADESH, BELGIUM, BRAZIL, COSTA RICA, CANADA, CHILE, DENMARK, EGYPT, ALABAMA, FINLAND, FRANCE, GERMANY, FEDERAL REPUBLIC OF, ARGENTINA, GERMANY, FEDERAL REPUBLIC OF, AUSTRALIA, GUINEA, FIJI, SOLOMON ISLANDS, AND VANUATU

ARGENTINA

Tellier 'Linde
Overseas Document Delivery
Box 306, GPO
Sydney, NSW 2001
Australia

BAHRAIN
MEMBR
P.O. Box 2210
Manama Town 317

BANGLADESH
Mico Industries Development Assistance Society
G.P.O. Box 800
Dhaka

BELGIUM
Publications des Nations Unies
Av. du Rat 202
1060 Brussels

BRAZIL
Publicacoes Tecnicas Internacionais Ltda.
Rua Petodo Corredor 209
01409 Sao Paulo, SP

CANADA
Le Diffuseur
C.P. 85, 1001 Amapce Street
Boucherville, Quebec J6B 6E6

CHILE
Editorial Renacimiento
Miriadores 394
Santiago

COSTA RICA
Libreria Tijerina
Calle 11-11
Av. Fernandez Gutii
San Jose

CYPRUS
MEMBR
P.O. Box 298
Nicoua

DENMARK
Sanktendamchappen
Rosenuert Aa 11
DK-970 Copenhagen V

EGYPT, ARAB REPUBLIC OF
At Alhurm
Galal Street
Cairo

FINLAND
Akateminen Kirjakauppaa
P.O. Box 128
SF-00101
Helsinki 10

FRANCE
World Bank Publications
66 Avenue d'Iena
75116 Paris

GERMANY, FEDERAL REPUBLIC OF
UNO-Verlag
D-3800 Bonn 1
Sinserokstrasse 23

GREECE
MEMBR
24, Zippoundom Street
Athens-11525

HONG KONG, MACAU
Asia 2000 Ltd.
6 Fl. 146 Prince Edward Road, W.
Kowloon
Hong Kong

INDIA
LBs Publishers' Distributors Ltd.
Post Box 7015
New Delhi 110002
10 First Main Road
Camden Nagar
Bangalore 560009

Ireland
TDC Publishers
12 North Frederick Street
Dublin 1

ITALY
Unione Comicatneria Sannioni SPA
Via Lambamone 45
10012 Florence

JAPAN
Eastern Book Service (EBS)
37-3, Hongo 3-Chome, Bunkyo-ku
113
Tokyo

JORDAN
MEMBR
P.O. Box 3143
Amman

KENYA
Arco Book Service (E.A.) Ltd.
P.O. Box 43243
Nairobi

KOREA, REPUBLIC OF
Pan Korea Book Corporation
P.O. Box 101, Kwangyangnamun
Seoul

KUWAIT
MEMBR
P.O. Box 5465
Kuwait

MALAYSIA
University of Malaya Cooperative Bookshop, Limited
P.O. Box 1127, Jalan Pantai Baru
Kuala Lumpur

MEXICO
INFOTEC
San Lorenzo 153-11, Col. del Valle
Dinig. Benito Juarez
03100 Mexico City

MOROCCO
MEMBR
2 Rue Mouiere Racine
Casablanca

NETHERLANDS
Medical Books Europe, BV (MBE)
Noorderoewl 38,
7241 BL Lochem

NIGERIA
University Press Limited
Three Crowns Building Jemcho
Private Mail Bag 5095
Ibadan

NORWAY
Tarkan Karl Johan, A.S.
P.O. Box 1177
Sentrum
Oslo 1

PAKISTAN
Mika Book Agency
65. Shahrah-e-Qad-i-azam
P.O. Box No. 729
Lahore 5

PAKISTAN
Ediciones Librea Culturales
Panamere, S.A.
Av. 7, Esquina 16
Panama Zone 1

PERU
Editorial Desarrollo SA
Apartado 3824
Lima

PHILIPPINES
National Book Store
701 Rizal Avenue
Metro Manila

PORTUGAL
Livraria Portugal
Rue Do Carmo 75-77
1200 Lisbon

SAUDI ARABIA
Jaz Book Store
P.O. Box 3196
Riyadh 11471

SINGAPORE, TAIWAN, BURMA
Information Publications Private, Ltd.
25-26 1st Fl., Pte-Fu Industrial Bldg.,
24 New Industrial Road
Singapore

SPAIN
Mundi-Prensa libros, S.A.
Carnelo 37
28001 Madrid

SRI LANKA AND THE MALDIVES
Lake House Bookshop
P.O. Box 246
100, 5th Chittampalam A. Gardiner
Mawatha
Colombo 2
Sri Lanka

SWEDEN
For single titles:
ABCE Fritzers Kungl. Hovboohandel
Regensgrasatan 12, Box 16336
S-103 27 Stockholm

For subscription orders:
Wernergren-Williams AB
Box 3000
S-104 25 Stockholm

SWITZERLAND
Librairie Payot
6 Rue Geneve
Case postal 381
CH 1211 Geneva 11

TANZANIA
Central Department Store
506 Sibar Road
Bangkok

TRINIDAD & TOBAGO
Systematics Studies Unit
55 Eastern Main Road
Curepe
Trinidad, West Indies

TUNISIA
Societe Tunisienne de Diffusion
5 Avenue de Carthage

TURKEY
Hase1-Kapipevi A.S.
469. Isikli Katlasi
Beyoglu-Istanbul

UGANDA
Uganda Bookshop
Attn: Mr. Martin Luther Galiwango
P.O. Box 7145
Kampala

UNITED ARAB EMIRATES
MEMBR
P.O. Box 8097
Shanghai

UNITED KINGDOM AND NORTHERN IRELAND
Manoans Ltd.
P.O. Box 3
Alton, Hampshire GU3 2PG

UNITED KINGDOM

VENUEZUELA
Libreria del Este
Apdo. 60 327
Caracas 1060-A

WESTERN SAMOA
Wesley Bookshop
Apia

Please note that the information provided here is subject to change and is intended for reference purposes only. For the most current and accurate information, please refer to the World Bank Publications website or contact the appropriate distributor directly.
<table>
<thead>
<tr>
<th>ROOM NUMBER</th>
<th>NAME AND EXTENSION</th>
</tr>
</thead>
</table>

The Effects of family planning programs on