SWP13

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

Economics Department Working Paper No. 13

PRODUCTIVITY GROWTH AND DEVELOPMENT IN LATIN AMERICA

May 31, 1968

This paper was prepared by Professor Henry J. Bruton of Williams College during July-August 1967 when he worked as a visiting scholar with the Industrialization Division. It builds upon previous research done by Professor Bruton, some of which is also reflected in his December 1967 article in the American Economic Review on "Productivity Growth in Latin America."

The paper focuses on the derivation of the "production function," i.e., output as a function of, on the one hand, increased inputs of capital and labor and, on the other hand, productivity growth. This leads to a comparison of productivity trends in industrialized countries and in four Latin American countries. Latin American productivity growth generally is found to be quite low, and the author tries to deduce (partly through statistical techniques) some of the major reasons for this state of affairs. In a final chapter, some policy implications are suggested.

As Professor Bruton himself emphasizes, many of his findings are heuristic, i.e., their value lies mainly in their inducement to further research. In part, the difficulties are statistical, e.g., the unreliability and ambiguity of existing output data. In part, they are analytical and reflect our limited understanding of the respective roles in dynamic growth on (a) resource allocation in agriculture and industry, (b) volume, timing and efficiency of infrastructure investments (including expenditures in education and research), and finally (c) the political and social framework.

Professor Bruton wishes to acknowledge the many useful comments on earlier versions of the paper by Bertil Walstedt, Herman G. van der Tak, Bela Balassa, Enrique Lerdau and other members of the Bank's staff.

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PRODUCTIVITY GROWTH AND DEVELOPMENT IN LATIN AMERICA

Introduction

Over the past decade a large number of studies have been presented that show that long-run increases in output per worker cannot be satisfactorily explained simply in terms of rising capital/labor ratios as these ratios are conventionally measured. The accumulated evidence covering numerous countries and a variety of time spans has convinced many economists that additions to the existing stock of machines and equipment identical to the existing ones can explain only a very small part of measured increases in output per worker. The evidence applies to individual sectors of an economy and to total output as well. As a consequence of these findings the role that capital formation played in growth and development theories in the late 1940's and early 1950's has been considerably modified, and attention is now being directed toward other possible sources of increased output.

Increased output in excess of that explained by increased inputs is known by numerous names - the Residual, a Measure of Our Ignorance, etc. - but perhaps the most common (and the most euphonious) is simply increased productivity of the conventionally identified, i.e., labor or capital inputs. The present paper is one of a series of studies which seeks to examine various aspects of productivity growth in several Latin American countries. Although primary concern in this report is with a single, and rather narrow, aspect of the general question of the role of productivity growth in Latin American development, it is useful to see how this particular issue fits in with the other issues treated in detail in other papers. In Chapter I, therefore, a brief review of a variety of issues is presented. It also seemed useful to include in this chapter a short discussion of some of the conceptual problems associated with efforts to measure productivity growth. Chapter II analyzes growth trends in productivity in industrialized countries and in Latin America. In Chapter III consideration is given to the role of productivity growth in bringing about what is called "structural change." Finally, in Chapter IV, an attempt is made to explore some of the policy implications of the findings and arguments reviewed in Chapters I through III. Chapter IV may be read first to get a general notion of the paper.

I. CONCEPTUAL AND MEASUREMENT PROBLEMS

1 This chapter has two objectives. Section A reviews the various ways that productivity growth can be defined and measured and the kind of evidence that leads to the conclusions that capital's role in the growth process is other than was thought to be the case in the early days of growth and development economics. Section B reviews a variety of aspects of productivity growth that have been treated elsewhere and that are related to the central question examined in Chapter II.

A. The Meaning of Productivity Growth 1/

2. The rate of growth of productivity may be defined as the difference between the rate of growth of real output and the rate of growth of real input. Write P for real output, N for input, and A for productivity, then

$$A = \frac{P}{N}$$

and

$$\frac{\Delta A}{A} = \frac{\Delta P}{P} - \frac{\Delta N}{N}$$

where $\Delta A/A$, $\Delta P/P$, etc. are finite approximations to the relative rates of growth of the indicated variables. Where interest is in an aggregage output, and more than one input is isolated, e.g., GNP or manufacturing output, then the definitions may be written as

$$\frac{\Delta A}{A} = \sum u_i \frac{\Delta P_i}{P_i} - \sum v_i \frac{\Delta N_i}{N_i}$$

where u and v are relative shares of each product and input in aggregate output and aggregate input respectively.2/

3. These definitions point up a variety of issues relevant to an investigation of productivity growth.

(a) The central notion is clear enough. Inputs of given characteristics and quantity exist in the base period and produce a specified output. Over an identified time span if the quantities of inputs all increase at the same rate, and all characteristics of the inputs remain exactly as they were in the base period, then output and inputs grow at the same rate and there is no change in the productivity of the inputs. If output increases more rapidly than inputs, then productivity has by definition increased. Evidently therefore, one must be able to measure the quantity of inputs independently of their value (i.e., independently of their productivity).

1/ The reader conversant with the recent literature on productivity growth may wish to omit this section and the following one or to skim them quickly.

2/ Further elaboration of this procedure is in D. W. Jorgenson and Z. Griliches, "The Explanation of Productivity Change," Review of Economic Studies, July 1967.

This latter problem has attracted a great deal of attention with respect to the measurement of capital as an input, but it is important to recognize that the problem exists for any other input that one may isolate. Unfortunately there is no completely satisfactory way of so measuring the inputs.

(b) There is generally an aggregation problem with respect to both output and inputs. The usual practice of deflating an aggregate output series by a common deflator introduces an error. So too does the common practice of summing input services in constant prices. These sources of error cannot be eliminated without rather more complete data on the components of the series than are usually available - especially for the Latin American countries.

(c) A corollary difficulty is that of separating actual inputs of services from available stocks of the inputs. Again the capital input is the most obvious problem, as capital stock is evidently frequently available and not used. The same problem however exists with respect to labor and any other input that one may identify. What appears as rising productivity may in fact be simply increased utilization, and one must therefore make assumptions as to the changing degree of utilization of the factor inputs.

(d) A further point of direct relevance to the following discussion has to do with factor prices. This problem is the other side of the quantity of input problem mentioned as items (a) and (c) above. The idea is to measure the prices of the input services rendered and to be able to assume that these prices represent the marginal productivities of the inputs. Both the measurement and the assumption of equality between price and productivity are frequently defective. About the best that can be accomplished with present data is to assume errors are about the same over the time span being considered. If this were not the case then the computed $\Delta A/A$ would reflect changes in the quality of the measures as well as in productivity itself. Again, given the availability of data, all that can be done in the present context is to alert ourselves to the question and, to the extent possible, qualify interpretations where available evidence indicates price figures do not measure exactly the same thing over the time span covered.

(e) A final general point has to do with the quality of the data. Data in this field are always inadequate and incomplete, but this fact is not a sufficient reason for ignoring them or for proceeding to use an unsatisfactory model simply because good data are available for it and are not for a more powerful model. One of the important attributes of good analysis is the effectiveness with which available data are used in the context of the most suitable model. An important task then is to use the data which are available in an effective model to see what they show. One must then be equipped to appraise the results in terms of whether they are significantly affected by the shortcomings of the data. But this is a much more useful approach than is the use of less powerful models (or no formal models) with better data, and trying to decide the extent to which the results are defective due to the model - or to what the data mean when they are presented with no model to guide the analyst in an interpretation.

4. The preceding are all important points, and an important argument can be built around them to show that much of the research that indicates a modest role to inputs in accounting for growth is dubious (see especially the Griliches-Jorgenson paper cited in footnote 2). At the present time, however, the evidence is still clearly in favor of the position outlined in the opening paragraph of this paper, and it is deemed useful therefore to measure productivity growth in the manner described below and to seek an explanation of its behavior as well as to examine its consequences.

B. Choice of Productivity Measure

5. There are two widely used measures of productivity: the average product (gross or value added) of labor or the average product of a capital and labor input mix. Which measure is more suitable depends, in large part, on the problem under consideration, and one should not think in terms of one measure as generally superior to the other.

(a) Consider first the measurement of the growth of productivity of the capital-labor combined input. The usual approach is to write a production function something like

$$1) \quad P_t = F(K_t\ L_t\ S_t)$$

Here K_t and L_t represent the quantity of capital and labor services available during time period t, P_t is gross domestic (or national) product during the same period, and S_t is a shift factor.3/ The interpretation of 1) is quite simple. It asserts that in period t the maximum output the economy can produce is determined by the quantity of capital and labor services available and the nature of their relationship as given by F. The shift factor S indicates that over successive periods the entire function shifts in such a manner that direct inputs, K and L, become increasingly (conceivably decreasingly) productive, i.e., P grows more rapidly than the weighted average of capital and labor. It was empirical evidence showing the shift factor to be of equal or greater importance than increased capital and labor that lead to the emphasis on increases in productivity as an essential element in growth theory. So the search begins for an explanation of S.

6. One frequently used approach is the following. Suppose there is a shift factor acting in such a way that it has no effect on the marginal rates of substitution between capital and labor, but simply increases (or decreases) the output obtained from the given inputs of capital and labor. In this event the function above may be written as

$$P_t = A_t\ f(K_t\ L_t)$$

and A_t measures the cumulative shifts that occur over successive periods of time. To find a way to isolate A requires further specification of the form

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3/ One may also factor out labor and put the argument in terms of output per worker, capital per worker, and shift component defined in terms of output per worker.

of the function. The most frequently used function is, of course, the Cobb-Douglas production function written as

$$P_t = A_t K_t^a L_t^b \qquad a + b = 1$$

where a and b are elasticities of output with respect to capital and labor respectively. That $a + b = 1$ means, of course, that constant returns to capital and labor are assumed to exist. Now take logarithms, differentiate totally with respect to time, and assume that changes in A do not affect a and b, then

$$\Delta P/_P = \Delta A/_A + a\ \Delta K/_K + b\ \Delta K/_K$$

and evidently

$$\Delta A/_A = \Delta P/_P - (a\ \Delta K/_K + b\ \Delta L/_L)$$

This last equation states that proportionate increases in the productivity of capital and labor are equal to the difference between the actual change in output and that which would have occurred had there been no change in A. Explaining productivity change then means explaining $\Delta A/_A$ of a particular time period.4/

7. Although the preceding measure of productivity growth was derived from a particular function, the form of the function does not seem to matter a great deal insofar as estimating $\Delta A/_A$ is concerned. Another common function is

$$P_t = C_t\ (w_o\ L_t + r_o\ K_t)$$

$$C_t = \frac{P_t}{w_o\ L_t + r_o\ K_t}$$

where w_o and r_o are payments to labor and capital respectively in the base period, and C then is the measure of productivity growth.5/ The measures C_t and A_t will not yield very different answers for most data.6/ The form then of the function does not seem to be of great importance, but the other assumptions - especially constant returns to scale - are and relaxing them will give different estimates of productivity growth.

4/ The argument produced here was originated by Robert Solow, "Technical Change and the Aggregative Production Function," Review of Economics and Statistics, August 1957. It has been discussed at length by many others. A good review is Richard R. Nelson's "The Aggregate Production Function," The American Economic Review, September 1964.

5/ This formula has been used by John W. Kendrick in his study Productivity Trends in the United States, Princeton University Press, 1961. It has also been used by many others as well.

6/ The same seems to hold true for another newly popular production function, the constant elasticity of substitution function.

(b) Prior to the last decade or so, productivity growth almost always meant labor productivity only, i.e., changes in the ratio output/labor. Interest in this ratio was to some extent a matter of its use as an indicator of economic welfare. Also it was frequently used as an indicator of the "total" factor productivity discussed above. Recently, however, its use has rested on considerations of relevance to the present discussion.

8. In the modern sectors of many activities what might be called a Leontief production function seems generally applicable.7/ In such a function the capital-output ratio appears to be more or less similar from country to country (aggregate or sectoral ratios), while labor output ratios vary widely. A more precise statement is this: the variance of capital output ratios among countries is so very much smaller than the variance of labor output ratios, that it seems not unrealistic to assume that the capital output ratio, relative to the labor output ratio, is the same for a given modern sector in all countries.8/ That the capital output ratios (especially full capacity, fixed capital) are similar is explained in terms of fixed coefficients of production on the capital side and the fact that so much of modern capital equipment outside the Communist countries originates in the United States and Western Europe. With these assumptions the rate of growth of labor productivity becomes especially relevent. In particular in making international comparisons of rates of growth of productivity (or rates of decline in costs) attention can be limited to labor productivity.9/ As noted below this argument is useful in the context of understanding the implications of an import substitution strategy of development.

9. A further consideration in the use of labor productivity has to do with some evidence that the productivity of non-labor inputs moves in the same direction and at about the same rate as that of labor.10/ Labor productivity growth may then serve as a proxy for the more inclusive measure. More importantly, this evidence also suggests something about the sources of productivity growth: namely that it seems to occur generally in an activity and is not concentrated on one input. This latter point incidentally is consistent with that noted earlier, that a rising capital-labor ratio explains a very small proportion of observed increases in labor productivity.

7/ See especially W. Leontief, "An International Comparison of Factor Costs and Factor Use (Review Article)," American Economic Review, June 1964

8/ Some friends in the World Bank have strongly challenged my working hypothesis that the capital-output ratio tends to be the same for a given modern sector in all countries.

9/ See Bela Balassa, "An Empirical Demonstration of Classical Comparative Cost Theory," Review of Economics and Statistics, August 1963: and Deborah Paige and Gottfried Bombach, A Comparison of National Output and Productivity, OEEC, Paris 1959.

10/ Data in W. E. G. Salter, Productivity and Technical Change, Cambridge 1960 and the Kendrick volume cited in footnote 5 suggest this to be often true. More on this point in Chapter II.

10. There are a variety of other issues associated with the productivity concept and its measurement. The preceding brief survey seems adequate as a means of making clear the basic definition and the main approaches to measurement.11/

II. GROWTH TRENDS IN PRODUCTIVITY

A. Industrialized Countries

11. The earlier theories of growth placed capital formation at the heart of the growth process. Note has already been taken of the evidence that measured productivity growth is so great that it implies that something more (or other) must be at the heart of this process. The purpose of this section is first to look briefly at some of this evidence, and secondly to derive a more satisfactory view of capital's role.

(a) Table 1 presents estimates of $\Delta A/_A$ for GNP for a number of countries for which data are readily available. The last column in this table shows that productivity growth as defined by $\Delta A/_A$ accounted for from 38 to 79 percent of the growth of output for these countries during the 1950's. In most cases the percentage exceeded 50 percent. Evidently then a theory of growth that leaves $\Delta A/_A$ unexplained, leaves about one-half of growth unexplained.

12. A similar picture emerges if one looks at individual industries or sectors of the economy. With the Kendrick data one may compute that proportion of growth of output due to increased productivity (defined by C above) for the two-digit ISIC industry groups in the United States. These proportions range from a low of 17 percent to a high of 74 percent for the period 1929 to 1953. The mean value is about 40 percent and sixteen of twenty ratios fall between 30 and 60 percent.

13. Evidence presented by Reddaway and Smith for thirteen manufacturing activities in Great Britain for the period 1948-54 indicate a picture similar to that described by the Kendrick data.12/ Their data indicate that from 12 to 82 percent of the increment in output between 1948 and 1964 was due to the increased productivity of capital and labor. The average for all activities was 47 percent. Again then it is evident that in not explaining productivity growth, a substantial part of actual growth is left unexplained.

11/ There are many papers discussing the various difficulties and issues involved in defining and measuring productivity growth. The Kendrick volume (footnote 5) has some useful discussion. See also Evsey Domar, "On the Measurement of Technological Change," Economic Journal, December 1961.

12/ W. B. Reddaway and A. D. Smith, "Progress in British Manufacturing Industries in the Period 1948-54," Economic Journal, March 1960.

Table 1

Annual Average Growth Rate of Total Output and Productivity for Certain Countries

Country and Period	$\Delta P/P$	$\Delta A/A$	$\Delta A/A / \Delta P/P$
Belgium			
1949-54	3.6	2.5	.69
1954-59	2.3	1.6	.70
Netherlands			
1949-54	4.9	2.7	.55
1954-59	4.1	1.6	.39
Norway			
1949-59	3.7	2.3	.62
Sweden			
1949-59	3.4	2.5	.73
United Kingdom			
1949-59	2.5	1.2	.48
France			
1949-54	4.8	3.8	.79
1954-59	4.1	2.8	.68
Italy			
1949-54	6.4	4.[illegible]	.69
1954-59	5.7	4.1	.72
West Germany			
1950-54	8.3	5.6	.67
1954-59	6.6	3.5	.53
Israel			
1952-58	9.[illegible]	3.9	.40
Japan			
1950-58	7.9	3.0	.38
United States			
1947-54	4.4	2.9	.66
1954-60	3.5	2.1	.60

Sources: Economic Commission for Europe, Some Factors in the Economic Growth in Europe During the 1950's, United Nations, Geneva, 1964.
O. Aukrust, "Factors of Economic - A Review of Recent Research", Productivity Measurement Review, Feb. 1965.
Richard R. Nelson, paper cited in footnote 4.
Henry J. Bruton, "Productivity Growth in Latin America," American Economic Review, December 1967.

14. It is useful to note also the wide variation among the sectors in the rate of growth of productivity. This wide variation holds also for the United States data, and, as noted below, holds for some Latin American countries as well. This fact has important implications for any explanation of productivity growth, and for a variety of factors associated with some distribution and allocation questions of economic development. Some of these issues are explored below.

15. Data for the less developed countries are not so plentiful, but one may offer a bit of evidence even here. From data on rates of growth of GNP (or GDP) for the decade of the 1950's and for the average investment GNP ratios for the same period for 39 countries with per capita incomes below US$500, a least squares regression equation relating the two variables may be computed. For 39 such countries the equation is

$$\Delta P/_P = 2.02 + \underset{(0.5)}{.18}\ I/_P \qquad \bar{r}^2 + .23$$

The equation indicates that if the investment rate were increased from say .10 to .20 the growth of output would increase by about 50 percent. In the simplest version of the capital output ratio model, on the other hand, a doubling of the investment rate will double the rate of growth of output.

16. In the same rough and ready fashion one may interpret the intercept figure - 2.02 - as the rate of growth of output not related to capital formation. The average annual rate of growth of output for these countries was 4.95 percent, so about 40 percent of the actual average growth of output would have occurred had the investment rate been zero. In general this latter figure is doubtless too low as variations in the investment rate explain less than one-quarter of the variance in $\Delta P/_P$.13/ Despite the obvious shortcomings of the argument, it seems safe to say that this bit of evidence is consistent with that for the richer countries, namely that capital formation, as conventionally measured, is not alone in its growth producing powers.14/

17. Much more evidence could be offered, but the preceding paragraphs should give a flavor of the kind of evidence available to support the position that an explanation of productivity growth is an essential ingredient of a theory of economic development.

(b) Evidently these results have major policy implications for developing countries and for aid-giving countries and lending agencies. It is useful then to try to say something about these implications at a general level before proceeding to some more specific issues related to the productivity question in Latin America.

13/ The $\bar{r}^2$ would surely be higher if actual data for the rate of growth of capital were available. This is suggested by some data on actual rates of growth of capital and output.

14/ A similar equation for 51 low income countries was computed for the period 1960-64. The resulting equation is $\Delta P/_P = \underset{(.08)}{3.32} + .10\ I/_P$ and $\bar{r}^2$ is virtually zero. For this short period however there are many reasons why the explanatory power of the independent variable is low. Data for both equations were taken from the World Tables of the IBRD.

18. Obviously we need to know something about the sources of productivity growth. As long as a production function with two inputs, capital and labor, and constant returns is used then these sources of productivity growth are limited to improvements in the quality of these inputs and in the efficiency of the system in the allocation and utilization of existing resources. Consequently improvements in the quality of physical capital (new technical knowledge "embodied" in plant and equipment) and improvements in the quality of the labor force (education, health, etc.) have received great emphasis as sources of growth in numerous studies to date. Similarly, considerable attention has been given to improving the allocation of resources and to eliminating underutilization of existing capital.

19. It is immediately clear, however, that new technology, increased education, or, indeed the design and execution of policies to effect a better allocation of existing resources are not free goods. They can be acquired or created only at a cost. This cost is in the form of the use of currently available resources for purposes other than those which yield immediately available resources for purposes other than those which yield immediately available consumer goods. In this sense their acquisition or creation requires saving in the same sense that the building of a machine to make a machine requires saving. Thus it seems reasonable to speak of "investment" in education, in research, in health, and in improved allocation. Once it is accepted that these sources of productivity growth are not free and that they do yield a flow of services - i.e., their existence does result in output being higher than it would be in their absence - then the sources of these flows are a form of capital, for the essence of capital is the fact that it yields a stream of income over time, and that indeed income is the product of capital. Furthermore, as the creation of any form of capital involves a cost, it is socially worthwhile only if the capital value of the income stream it yields is greater than the cost of the capital. From the recognition of the investment characteristics of this type of expenditures it was a quick step to seeking to measure the rate of return on such investment, and to seek to identify that part of the growth of output (total or per worker) that could be attributed to these various factors.

20. In a general sense then, growth and development theory moved from a narrowly defined capital approach (in the late 40's and early 50's) to a somewhat anti - or non-capital approach (in the late 50's and early 60's) to a wide all-inclusive capital approach (as of now). One may then think of the central task of development as consisting of finding investible resources - i.e., resources not required for the production of consumer goods - and to use them to create that form of capital, very broadly defined, which will make the maximum contribution to increasing the capacity of the economy. We may speak of this as the generalized capital formation approach to development.15/

15/ See the short "Comment" of Harry G. Johnson in The Residual Factor and Economic Growth, OECD, Paris 1964. This generalized capital formation approach underlies the approach followed in Henry J. Bruton, Principles of Development Economics, Prentice-Hall, Englewood Cliffs, New Jersey, 1965.

21. Little real progress has been made in empirical work in their context of this approach.16/ Of the many difficulties involved in an empirical investigation there are three that are especially pertinent to the present discussion.

(i) Some major source of productivity growth may have been overlooked. A long list of suggestions is possible, but one source that seems very important for developing countries has to do with learning. If a new activity is created in a country, then one might expect that productivity of the resources engaged in this activity would be relatively low at the outset but rise as management and labor became better acquainted with what they were doing. In this case the increased productivity requires no outlays on education, research, health, etc., but does imply subnormal profits or extra high prices over a period of time.

Empirical studies of this source of productivity growth are scarce 17/, but some generalizations seem possible. It cannot be a continuing source of increased productivity. In most developing countries, for example, productivity in traditional agriculture is not going to rise because of a learning effect. Even in new manufacturing activity the few available data suggest that laborers and managers can learn specific tasks quite readily. This does not mean that learning is not important, but rather that its impact is more or less dependent on the continued emergence of new activities. Thus the extent to which learning is important depends heavily on the capacity of the economy to generate new opportunities and new situations.18/

(ii) The role of technological change, embodied or otherwise, appears the most intractable issue connected with productivity growth. For those countries currently using a primitive technology, borrowing from abroad appears a reasonable approach. There are, however, well-known difficulties associated with the suitability of a technology created for one economic environment for use in a different one. Similarly little success has been gained

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16/ The most ambitious empirical effort has been that of Edward Denison, The Sources of Economic Growth in the United States, Committee for Economic Development, New York, 1962. This attempt is interestingly and imaginatively done, but the results are more illustrative than real.

17/ The best evidence has to do with experiences in certain new activities in the United States during the World War II. See, for example, Leonard Rapping, "Learning and World War II Production Functions," Review of Economics and Statistics, February 1965.

18/ See the following page for this footnote.

in identifying or measuring returns to resources engaged in technical research. In the context of development perhaps the single most important issue is that of 'borrowing technology from abroad' or 'creating one's own technology'. The resolution of this issue is essentially empirical and, as just noted, little headway has been made on empirical investigations of the question as of now. The usual approach at the present time is to say suppose that output grows at x percent per year because of purely technological factors, then see how such an assumption fits in with some of the data that we do have.19/ Most observers seem to think that technology is of great relevance in productivity growth, but nobody can give very firm evidence on how and how much.

(iii) A third issue of special relevance in the present context and for policy matters as well has to do with the interdependence of the various (assumed) sources of increased productivity. Argument and empirical work often imply that the effect on productivity of (say) education and technological change are additive. Evidently this is not the case. A technological innovation may require new labor skills before it is effective. Or increased education may result in new technical knowledge. And so on. Thus to identify education as a source of productivity growth separate from that produced by technological change is to misunderstand the nature of those sources of growth.

The second consequence of complementarity is of more immediate relevance, and is somewhat contrary to that just noted. Suppose it were granted that a division of the sources of past productivity growth into increased education, technological change, etc. in the manner of Denison and others was conceptually impossible because of the complementarity problem. It is not possible to say, for example, that one-third of the growth of GNP in country X over the past 50 years has its source in education. Does this mean that the generalized capital formation approach to development theory outlined at the end of the preceding section is invalid? Surely it does not mean this. It is one thing to dissect the past, and another thing to ask about the future. Even

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Footnote 18 on page 11:

Kenneth Arrow, "The Economic Implications of Learning by Doing," Review of Economic Studies, No. 29 1961 is the classic treatment of the learning process as a source of productivity growth. Arrow for the most part makes learning a function of accumulated gross investment on the grounds that the latter is an effective indicator of the appearance of new demands and new opportunities for learning.

19/ See, for example, the Falsen paper cited in footnote 4.

with complementarity it is still possible - indeed necessary - to ask, given the existing situation, will expenditure of investible resources on education - or technical research, or health clinics, or increased consumption - yield a return greater than expenditure elsewhere. This is a meaningful question to ask and one that is and must be answered by the policy maker.

Thus our ultimate interest is in the allocation of investible resources among the various capacity increasing uses which are open to the society. We learn about the consequences of investments by studying what has happened in the past - even though such studies are necessarily defective. This then is the logic of the emphasis on sources of productivity growth and on the generalized capital formation development model. It is important to emphasize that this model puts heavy weights on saving (capital formation) and on productivity growth and then broadens the allocation question in a corresponding manner. This approach has evident policy implication for both the developing countries and for those lending and aid agencies which have a concern in development.

B. Latin American Countries 20/

22. Efforts were made to estimate $\Delta A/_A$ for Argentina, Brazil, Chile, Colombia, and Mexico for various time spans since 1940. The results are summarized in Table 2. The mean value for $\Delta A/_A$ for the twenty observations is 1.4 and the mean of $\Delta A/_A$ as a proportion of $\Delta P/_P$ is .26. Both of these figures are significantly smaller than the corresponding estimates for the countries in Table 1 (3.0 and .60). Correspondingly the role of capital formation (narrowly defined) was larger for the Latin American countries. Two further results are of special importance. Productivity growth in the Latin American countries (LAC) appeared much higher during the first two periods shown than in the second two, while the rate of capital formation was considerably higher in the second two than in the first two. In a general sense then it seems correct to argue that in the later periods productivity growth was replaced by capital formation as the major source of the growth of output.

23. A second result of even greater importance. For the advanced countries (AG) of Table 1 the assumption of full utilization of resources is fairly accurate. (For the United States data are computed on the basis of "potential output" rather than actual output, thus reducing the effects of underutilization on $\Delta A/_A$. See the Nelson paper cited earlier.) The estimates of $\Delta A/_A$ for AG then seem to represent genuine increases in the productivity of capital and labor. For LAC on the other hand, underutilization of both inputs was of great importance. In this case then $\Delta A/_A$ measures the extent to which the economy is able to exploit its available

20/ See the Bruton paper cited as a source of the data in Table 1.

Table 2

Annual Average Growth Rates of Total Output and Inputs in Certain Latin American Countries

Country and Period	$\frac{\Delta P}{P}$	$\frac{\Delta A}{A}$	$\frac{\Delta A}{A} \div \frac{\Delta P}{P}$
Argentina			
1940-45	2.9	1.6	.55
1946-51	3.4	.4	.12
1955-59	1.7	-.6	-.35
1960-64	1.2	-.6	-.50
Brasil			
1940-45	3.2	1.3	.41
1947-53	5.6	1.6	.29
1955-59	5.6	1.7	.30
1960-63	5.0	1.2	.24
Chile			
1940-45	2.7	1.4	.52
1945-53	3.9	1.4	.36
1955-59	3.0	.1	.03
1960-64	4.0	.9	.23
Colombia			
1940-45	2.8	1.1	.39
1946-53	5.2	2.3	.44
1955-59	4.0	.4	.10
1960-64	4.5	1.5	.33
Mexico			
1940-45	9.0	6.7	.74
1946-53	5.0	1.2	.24
1955-59	5.7	2.0	.35
1960-64	6.2	2.8	.45

Source: Bruton paper cited as source to Table 1.

resources as well as the kind of "genuine" productivity increments discussed in the previous section. By a series of regressions involving data for various time periods, results are obtained which suggest that virtually all of the variation in $\Delta A/A$ after 1955 is accounted for variations in output, i.e., "genuine" productivity growth seems to have fallen to virtually zero.

24. That productivity growth in LAC seemed much higher during the war years and immediately after than it has been over the last decade or so is an important result. During the war years real capital formation was decidedly hampered by the limitation on imports. Thus the frequently encountered argument linking productivity growth to capital inflow is not supported. Indeed regressions of $\Delta A/A$ on the rate of growth of capital and on the growth of a combined capital and labor index indicates that for neither LAC nor AG are the direct inputs a very important carrier of productivity growth.

25. The explanation offered for these results as to productivity growth in LAC rests on three major points: (1) a growing inappropriateness of the input mix in production due in large part to internal policies with respect to exchange rates, interest and wage rates, and monetary and fiscal matters; (2) a growing inappropriateness of the composition of output in the sense that productive activity was not based on cost or potential cost considerations, but rather evolved in reference to the incentives generated by protectionist policies designed largely to meet balance of payments crises; (3) a decline in competition. The empirical results and the explanation offered for them suggest that the import substitution strategy currently popular in LAC has created an economic environment inconsistent with continuing growth of productivity. At the same time this strategy has created numerous gaps in the capital structure that has produced obvious investment opportunities These opportunities have been exploited, keeping the rate of capital formation generally quite high - despite widespread underutilization of existing physical capital. That this sequence of events had and has now considerable relevance in LAC's development difficulties seems evident, and is commented on below.

III. INTERPRETING THE LATIN AMERICAN EXPERIENCE

A. Productivity Growth and Import Substitution 21/

26. There are many sides to an import substitution strategy of development. The paper referred to here considers only one side, that having to do with productivity growth. The central element in import substitution strategy is the protection (by one means or another) of certain activities from foreign competition and their consequent growth within the country. Evidently, the fact that some form of protection is necessary means that the products of these activities cannot be produced as cheaply domestically as they can be abroad. What then can an import substitution strategy hope to accomplish? One way of thinking about a "successful" strategy is in terms of the rate of growth

21/ See Henry J. Bruton, "Productivity Growth and Import Substitution," forthcoming in The Journal of Development Studies.

of productivity in the import substituted activity. The argument can be easily made.

27. Suppose that productivity is growing more rapidly in the protected activity in the developing country than it is in the country currently able to produce at the lower cost. At some point in the future, therefore, costs (and prices, if price follows costs) in the former country will in fact be lower than in the latter country. Thus if an activity is protected where productivity growth is relatively high then the protection can be expected to produce an industry which may eventually be able to survive without protection. But this mere fact is not a sufficient condition to justify protection. In the period during which the economy could obtain, via imports, the protected product more cheaply than it can be produced domestically, the economy is obviously suffering a loss, i.e., has available a smaller quantity of this good (or this good and some others). This loss cumulated over the several periods in which it is incurred may then be thought of as an investment in the same sense as an investment in a factory. The economy is foregoing current output in anticipation of a larger output in the future. This larger output then is the return - the benefit - on the investment. One may then calculate the present value of the total cost of this "investment", the present value of the return, and hence the "rate of return" on this type of investment. Only if the rate of return so calculated is higher than that obtainable from alternative uses of investible resources, can "investment in import substitution" be justified on this criteria. If activities were established which required permanent protection, then the economy would be saddled with a dead weight from which it would reap only losses.

28. The preceding argument has a strong link with a conventional "infantry industry argument" for tariffs. The term "infant" seems to imply that productivity is low (costs are high) because an activity is small or because it is young, and consequently costs will fall merely with increased scale or increased age. This may be, but the bit of evidence noted in Section A disputes it. Costs cannot be "too high" solely because of a scale effect, for if this were true then the activity could be expanded, and exports would be (by definition) possible.22/ A pure learning effect can be adequate, of course, but for reasons already noted, it seems unlikely that in most instances its effect will be great enough and continue long enough to produce the necessary increase in productivity. For these reasons then it seems better to use the language of productivity growth rather than that of infant industry.23/

29. For empirical work two variations on the preceding argument are made. In the first place it is convenient to turn the focus of the argument a bit and ask what differential between domestic and imported costs can be

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22/ Transportation costs may complicate this argument a bit.

23/ The notion of interpreting the costs of protection in the infant industry argument as an investment was suggested long ago by C. F. Bastable. See Murray C. Kemp, "The Mill-Bastable Infant Indusgry Dogma," Journal of Political Economy, February 1960.

permitted at the outset of the import substitution effort (at the beginning of protection) if these costs are to be equal in a given number of years. In this case the number of years allowable would be a datum for the problem, which datum would have in turn been determined by reference to such factors as interest rates, inflation threats, balance of payments conditions, and the like. Suppose a period of 10 years is set, then on the basis of estimates of productivity growth and change in import prices one may easily calculate the allowable initial difference in costs.

30. The second variation has to do with the type of production function employed. Since most import substitution has to do with manufacturing activities, attention in the empirical work is limited to these activities. For this group of activities it seemed justifiable to use what was called earlier the Leontief production function.24/ It will be recalled that the assumptions underlying this function permit one to use labor productivity in making international comparisons of the consequences of productivity growth.

31. So with all these assumptions estimates were made of the growth of labor productivity in 15 or 20 manfuacturing activities in four Latin American countries (Brazil, Colombia, Chile, Venezuela) over a period of four to six years. These estimates were then compared with estimates for similar activities in the United States. Finally, it was assumed that these calculated productivity growth rates would continue indefinitely - or at least over a period of 10 years. Then the final calculation is simply the difference in original costs that is consistent with cost equality at the end of the 10 years.

32. One consequence of this approach to the formulation of an import substitution strategy is immediately evident. The policies implementing this strategy must be consistent with - preferably, must encourage - productivity growth. If, as was suggested earlier, the very low rates of productivity growth observed with respect to GDP are due (in large part) to the import substitution policies pursued in recent years, then the difficulties are clear. On the other hand, it is quite possible that low productivity growth at the GDP level is consistent with - perhaps even due to - high rates of growth of productivity in specific sectors of the system. At any rate we are again pushed to the question of the sources of productivity growth.

33. Although the actual computations are open to many questions, the results are not without meaning and have important policy implications. The single most important result has to do with the variation among the sectors. For the manufacturing sector taken as a whole the difference in "initial costs" (as defined above) consistent with most equality within

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24/ Some further data supporting this approach are offered in the paper cited in footnote 22. As indicated in footnote 8 others have challenged the validity of Leontief's assumptions.

10 years is as follows: Brazil 20 percent (i.e., given the calculated rate of growth of labor productivity in Brazil and in the United States, a 20 percent excess of costs in Brazil over those in the United States at the outset of the import substitution program is consistent with cost equality at the end of 10 years), Colombia 10, Chile 4, and Venezuela 20. Within each manufacturing sector there is also great variation, and for a number of sectors the permitted difference is negative, i.e., productivity growth in the United States in this sector exceeds that in the Latin American country. In other sectors the cost differential is over 50 percent indicating a very high rate of growth of productivity. This large variation among sectors not only indicates something about the nature of productivity growth, as noted previously, but also about an approach to a successful import substitution strategy, namely, a policy that protects activities irrespective of productivity growth is almost sure to run into difficulties. Equally important is the finding that productivity growth in a given sector varies from country to country. Part of the task of an import substitution strategy therefore is to seek to isolate those activities which have the greatest potential for productivity growth. Whatever the rationale of the protection policies in the Latin American countries,25/ there is no doubt that such policies have not considered the productivity potential of the sheltered activities. There is also no doubt that many activities have been created by protection that have no prospect of becoming able to survive without protection. The consequence is that these countries find themselves with industries that are drags on the economy and that tend to create all kinds of distortions in the system that slow down overall growth in the manner alluded to in the previous section.

B. Productivity Growth and Exports

35. The corollary to the discussion of the role of productivity growth in the import substitution strategy is its role in encouraging exports. This study is not yet complete and only two points can be made here. In the first place the preliminary calculations suggest that productivity growth is an important explanatory variable accounting for variations among countries in export growth. The conclusion then is the fairly obvious (but no less important) one that a good part of the difficulties that the Latin American countries are having with their exports is due to their low productivity growth relative to that in competing countries.

35. The second point is of a more general nature. The argument is frequently made that countries that can export (or obtain unrequited imports) are able to grow. The substance of this argument is simply that developing countries must have imports of physical capital goods in order to maintain their growth over extended periods. There is of course substantial evidence that capital imports shoot up rapidly as development efforts are accelerated,

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25/ That any sort of economic development rationale underlies the protectionist policies may be doubted. See, Santiago Marcario, "Protectionism and Industrialization in Latin America," Economic Bulletin for Latin America, March 1964.

and hence that a favorable import capacity encourages, if it does not actually constitute the major source of, growth. The argument and data summarized in the preceding sections cast doubt on this argument. Note the following: productivity growth accounts for a substantial part of total growth and capital formation little, productivity growth does not appear to be "carried" by capital formation (narrowly defined), productivity growth rates (capital and labor combined or labor only) vary widely among manufacturing activities within a country and among countries for the same activity, and tentative findings that suggest a significant relationship between export growth and productivity growth. This accumulation of evidence leads to an argument contrary to that just stated: rather than a country growing because it can export (and hence import), the evidence suggests that because a country can grow it will export. More specifically, to the extent that a country can create an environment in which productivity growth is relatively rapid it will grow and will export. Even more specifically, to the extent that a country can concentrate its investible resources on activities in which productivity is relatively high, then it will grow and export.26/ This latter alternative seems especially helpful in trying to understand the development process in Latin America.

C. Productivity Growth and Structural Change

1. The Nature of Structural Change

36. Economic growth is rarely characterized by an expansion of all sectors at the same rate. Rather we know that the sources of growth produce different effects on the different sectors. Growth of productivity varies markedly among sectors, price and income elasticities of demand are different, degree of competition also is different, and so on. Growth then not only means increased aggregate output, but it also produces and in turn is induced by changes in the relative sizes of the various sectors. An important aspect of the development process therefore is the extent to which the economy can respond to the demands for the reallocation of resources and other adaptations that are imposed by continuing growth. Little is known about what makes an economy flexible and responsive to new opportunities, and this is not the place to explore the question in general. Some few aspects of this general problem can, however, be investigated in the context of a productivity study. In particular, attention will be given to the relationship between productivity growth and structural change.

37. "Structural change" is one of the vague but often used terms in development economics. There seems no generally accepted definition, and it will be used here to mean simply a change in the composition of output and hence in the distribution of resources.27/ The general question is

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26/ This is not to assert of course that other conditions for growth are not relevant (e.g., price inflation, etc.). The point in the text is to seek to understand the role of productivity growth, not to develop a theory of growth.

27/ Perhaps the most satisfactory definition has to do with the parameters of a system of equations that describe an economy. The equations and their parameters define the structure of the system, and hence a change in these parameters is a "structural change." As used in the text, however, the term is less specific, but hopefully clear.

what role does productivity growth play in affecting the output composition and why does it matter? 28/

38. Consider first a specific example. Suppose we have two sets of data: estimates of the rate of growth of labor productivity for twenty or so activities and earning per worker for the same activities. What effect does the relationship between these two series have on structural change?

39. Note has already been taken of the considerable variation in productivity growth rates among activities within a country. On usual assumptions as to a more or less homogeneous labor market from which all manufacturing activities draw their labor, the variation in earnings per worker is expected to be much smaller than variation in productivity growth and more or less unrelated to the latter. If this is true labor cost per unit of output will tend to be negatively associated with productivity growth. A simple developmental sequence then emerges. Those activities with relatively high rates of productivity growth are experiencing falling labor costs relative to other activities in the economy.29/ Their falling costs permit falling relative prices which tend to attract demand from those activities where relative costs have risen. Thus there is a tendency for labor to move from the low productivity growth activities to the high. Wage rates may be bid up somewhat thus further dampening the profitability of the slow growing activities, but also tending to move labor where its productivity is highest. The result then is a contribution to the overall growth of the system.

40. Demand conditions can modify this result. If demand is very inelastic with respect to price and very elastic with respect to income in the activities where productivity growth is slight, then the flow of resources out of these activities will be slight compared to that which would prevail if the demand elasticities were opposite to that just stated. Similarly, if price and income elasticities are quite low in the progressive sectors, they can actually expel rather than attract resources. Construction, an activity in which productivity growth seems relatively low in virtually all countries, is an example of an activity that is probably immune to changing relative costs because of the low price and high income

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28/ There is a widespread feeling in Latin America that dynamic growth can come only through structural change. Western Europe is sometimes cited as an example with its growing empahsis on, e.g., regional integration and on research and technology. This in turn produces an anxiety that unless Latin America moves deliberately towards new structures, its relatively low industrial power will deteriorate further.

29/ For reasons examined later it is to be expected that activities with falling labor costs will also have falling total costs. If unit labor costs are falling while (or because) other costs are rising, the argument in the text may be modified.

elasticity of demand. Agriculture in the United States has experienced a high rate of growth of productivity, and demand conditions are such that this sector is a labor supplier rather than absorber. In the analysis below some attention is given to the demand side although primary attention is given to the cost side.

41. Suppose at the other extreme that, for a variety of possible reasons, growth in productivity and growth in earnings per worker, is closely and positively related. Then the unit labor costs of the more progressive sectors would not fall relative to costs in other sectors and the structural change described above would not take place. In general one would expect that the overall growth of the system to be less than in the previous case. Suppose again, however, that earnings per worker followed productivity because the latter was due to workers working harder or because they had acquired new skills and new ability. In this case the consequences for structural change of a positive relationship between earning and productivity are quite different from those described above. In all events to trace through the full implications and explanation of such a set of empirical results is a delicate and difficult task.

42. The example just given is only one of many strands of the structural change problem. One might proceed by developing a more general model within which to explore the role of productivity growth in this complex problem. Given our current stage of thinking on the subject, however, it appears somewhat more rewarding to examine some bits and pieces of available data, and to try to derive from this examination some ideas as to the flexibility and responsiveness of Latin American countries to productivity growth. This approach is made easier also by virtue of a study of similar problems for Great Britain by W. E. G. Salter.30/ The approach below follows that in Salter, and it is convenient to use the results of his study of Great Britain as a bench mark in the present study of Latin America. This investigation also leads to further observations about the sources of productivity growth.

2. Some Findings from Latin America*

43. In evaluating these data, two types of warnings are appropriate in addition to the warnings noted in Section A of Chapter I. Quantity indices for the various sectors are often based on incomplete information, and doubtless other sources of errors are also present. Labor input data are even more suspect and consequently estimates of labor productivity are also open to question. It is likely, however, that indices of change used in the following analysis, are more accurate than the absolute values themselves. Except in a couple of places (to be noted) therefore the data seem

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* See the Appendix for details and qualifications.

30/ W. E. G. Salter, Productivity and Technical Change, Cambridge, Second Edition, 1966.

to warrant use. The second point has to do with the time span covered by the data. Many of the arguments to be applied in discussing the data are "long run" in the sense that their effects will be evident only over a considerable time period. For the Latin American countries data are available for not more than a 10-12 year period, and consequently, the evidence is less clear than it might be with a longer period. Some evidence as to how important this point is is available from the Salter data on Britain. He has data for a 26 year period (1924-50) and a nine-year interval (1954-63), and differences in results for these two periods may help a bit in distinguishing a significant relationship from an imaginary one in the case of the Latin American countries.

44. The data around which the analysis for three Latin American countries 31/ is built consists of index numbers for a series of variables (output, employment, earnings of labor, labor productivity, unit labor cost, and unit gross margin) describing each of the ISIC two-digit sectors of manufacturing activity. Gross margin is used here as a "proxy" for the cost of capital per unit of output. A somewhat finer industrial classification would have been preferred, but this breakdown is workable. For Great Britain Salter uses a somewhat different classification, but this fact does not impede the use of the British results as a basis of comparison. In a number of cases it was also possible to calculate relationships for the United States based on activities very similar to that used for Great Britain.

45. Generally the data refer to the period 1923-1950 for the United Kingdom and the United States and to a recent ten-year period for the three Latin American countries. However, the United Kingdom series have also been divided into two sub-periods to explore how this would affect the conclusions. The manufacturing sector has been divided in 27-48 activities for the two industrial countries and varying between 15 and 20 activities for the three Latin American countries. The complete results are given in the Appendix. Here we shall try only to summarize the major findings. Table 3 shows a marked variation in growth experience (output and employment) for different sectors. There is also considerable variation in productivity growth. In contrast, excepting only Argentina, the spread of growth rates for wage earnings has been far less which has also tended to reduce inter-industry differentials in growth rates for labor costs. Variations in unit material costs and unit gross margins are more difficult to comment upon since, in an across-the-board comparison, these are subject to greater ambiguities than the other variables. For one thing, there is a price element which cannot be factored out.

> Wage Earnings - Labor Productivity (Table 4). The relative variation defined in the following as the percentage of the standard deviation of a series to its mean in the growth rates for wage earnings is higher for all three Latin American countries (15.2-35.2) than for the United Kingdom and the United States which show very similar figures (10.9 and 11.7) respectively. This strongly suggests that the labor market in

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31/ Usable data for Mexico and Chile were not available.

Table 3

Relative Variation in Selected Series
(Standard deviation divided by mean)

	United States	United Kingdom	Colombia	Brazil	Argentina
Gross Output	55.0	87.2	82.8	53.63	61.27
Employment	39.5	50.1	51.19	51.62	35.85
Earnings	11.7	10.9	22.19	15.17	35.19
Productivity	30.8	35.7	52.71	20.69	40.07
Unit labor cost	27.3	34.6	34.45	21.36	17.68
Unit material cost		29.5	13.29	9.15	32.29
Unit gross margin cost		58.2	22.75	11.74	53.77

Sources: For the United States and United Kingdom figures taken from the Salter reference cited in footnote 30.

For Colombia, Brazil, and Argentina data for calculations obtained from Anuario Estatistico do Brasil: United Nations Analyses and Projections of Economic Development, Vols. II and III: Contas Nacionales do Brasil, Fundacao Vargas: The Process of Industrialization in Latin America, Statistical Annex, ECLA: Boletin Estatistico de America Latina: Anuario Estatistico de Colombia: and unpublished data that I have collected from various official statistical agencies in these countries.

Time Period:			
	United Kingdom	1926-1950	28 activities
	United States	1923-1950	27 activities
	Colombia	1953-1963	20 activities
	Brazil	1949-1959	18 activities
	Argentina	1950-1962	15 activities

Table 4

Relationship Between Earnings per Worker (W) and Productivity (P) for Selected Countries

Country	Equation	r^2
United Kingdom (1)	W = 244.44 + .0015P (.09)	neg
United Kingdom (2)	W = 155.75 + .024P (.08)	neg
United States	W = 235.55 + .11P	neg
Colombia	W = 379.07 + .34P (.22)	.07
Brasil	W = 686.79 + .49P (.92)	neg
Argentina	W = 477.27 + 8.57P (1.17)	.77

Source: See Table 3. The (1) and (2) applied to the United Kingdom refer to the 1923-30 period and the 1954-63 period respectively. Neg means negligible. The figure in parenthesis under the regression coefficient is the standard error of the regression coefficient. Standard errors for regression coefficients and r^2 for the United Kingdom and the United States are not given in Salter and have been computed by me from his data.

Latin America functions less perfectly than in industrialized countries (less information, less mobility, etc.). One would then expect a more pronounced positive relationship between productivity and earnings in Latin America. Instead we find that, except for Argentina, increases in earnings per worker seem to bear no relationship at all to productivity growth. Theoretically, the strong correlation in the case of Argentina could be due either to differential growth of skills in industries showing large increases in productivity or to a failure of the labor market to adjust quickly to the change, giving workers in industries showing great productivity wage increases out of proportion to the rest of the economy.

Labor Productivity and Unit Labor Costs (Table 5). If earnings do not move with productivity then the cost of labor will fall as its productivity rises. Table 5 shows that this relationship is a fairly significant one. Moreover, the two sets of data for the United Kingdom are consistent with the notion that the longer the time span the more clearly the relationship shows.

Unit Labor Costs and Unit Gross Margins. We have already noted that the unit gross margin may be used as an (albeit imperfect) proxy for capital costs per unit of output. One would expect perhaps that higher labor productivity and lower labor costs would result in part from greater capital intensity and hence would be reflected in some increase in the unit gross margin. Instead Salter found that, in the long period, in the United States and the United Kingdom, reductions in unit labor costs were positively correlated with reductions in unit gross margins, suggesting that improved management, technical progress, and a larger volume of output would lower the costs of both labor and capital. For the three Latin American countries there is no such positive relationship. Neither is there, however, a significant tendency for lowered labor costs to be associated with higher costs for capital. In this respect, the Latin American experience is similar to the short-period (1954-1963) experience in the United Kingdom.

Productivity and Output (Table 6). In all countries except Brazil there was a significant relationship for the sectors studied between changes in output and changes in productivity. Analytical and statistical evidence advanced in the Appendix suggest that, particularly in the United Kingdom and Argentina, this relationship was due to fuller utilization of a labor force which, at times, was very much underemployed. In Brazil and Colombia one would expect similar forces to be at work since some time would normally elapse before newly created industries achieve normal capacity utilization. The observed positive relationship between output and productivity could also reflect economies of scale. Yet, if economies of scale were important, one would expect a clear tendency for the

Table 5

Relationship Between Unit Labor Cost (ULC) and Productivity (P) for Selected Countries

Country	Equation	r^2
United Kingdom (1)	ULC = 305.3 - .82P (.07)	.82
United Kingdom (2)	ULC = 236.8 - .84P (.12)	.63
Colombia	ULC = 401.3 - .70P (.14)	.54
Brazil	ULC = 910.7 - 2.58P (.62)	.51
Argentina	ULC = 1306.4 - .92P (.61)	.08

Source: See Tables 3 and 4. The r^2 for the United States is .80 using the Salter data.

Table 6

Relationship Between Productivity (P) and Output (Q) for Selected Countries

Country	Equation	$\bar{r}^2$
United Kingdom (1)	$P = 113.3 + .23Q$ (.03)	.65
United Kingdom (2)	$P = 72.3 + .41Q$ (.08)	.46
Colombia	$P = 101.1 + .23Q$ (.05)	.51
Brazil	$P = 130.8 + .08Q$ (.05)	.06
Argentina	$P = 92.7 + .63Q$ (.11)	.68

Source: See Tables 3 and 4. Salter's data for the United States yield an $\bar{r}^2$ of .36 for the 1923-1950 period.

unit gross margin to fall together with falling labor costs which did not occur in the three South American countries. A more substantial explanation might be that factors which make for growth in production also make for growth in productivity. For example, an activity in which entrepreneurs are alert and cost-conscious is quite likely to be one in which both output and productivity are growing. Expanding industries attract better personnel and have better access to credit, etc. This argument, though prima facie appealing, needs further formalization and empirical support.32/ It agrees with the experience of the United Kingdom and the United States but cannot be applied in an unqualified manner to Latin American countries. Attention has already been drawn to Brazil's maverick status (for which no satisfactory explanation has been suggested) and to the role of underemployment in Argentina. In South America, therefore, only Colombia seems - at the moment - to fit the argument.

Employment and Output Growth (Table 7). For both industrialised and developing countries this relationship is quite significant. The exception is Argentina which is consistent with the previously suggested explanation of the role of underemployment in that country. All regression coefficients appear "small" reflecting the marked lag of employment growth behind output growth in all countries.

3. An Attempted Interpretation

46. No clear cut, unambiguous picture emerges from the preceding regressions, but some findings of a heuristic nature deserve emphasis.

(a) Perhaps the most important of such findings is that of the difference between the United Kingdom and United States on the one hand, and the three South American countries on the other, with respect to the relationship between labor costs and other costs. The evidence seems convincing enough that for the United States and United Kingdom all costs fall together, i.e., the productivity of all inputs rise more or less together.33/ The evidence is less clear with respect to capital costs than to materials costs, but even here there is no indication that capital costs

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32/ C. F. Carter and B. R. Williams, Investment in Innovation London, Oxford University Press, 1958 develop this hypothesis in an effective, although non-rigorous fashion. There is considerable other evidence also. See, for example, Henry G. Aubrey, "Investment Decisions in Underdeveloped Countries," in Capital Formation and Economic Growth, Princeton, New Jersey, Princeton University Press, and the various papers in The Rate and Direction of Inventive Activity, Richard R. Nelson (editor), Princeton, New Jersey, Princeton University Press, 1962.

33/ There is evidence supporting this notion for other European countries as well. See the Bruton paper cited in the sources to Table 1.

Table 7

Relationship Between Employment (E) and Output (Q) in Selected Countries

Country	Equation	r^2
United Kingdom (1)	$E = 61.1 + \underset{(.02)}{.28Q}$	.85
United Kingdom (2)	$E = 44.1 + \underset{(.07)}{.46Q}$	.53
Colombia	$E = 105.2 + \underset{(.05)}{.23Q}$	.51
Brazil	$E = 15.8 + \underset{(.05)}{.60Q}$	.87
Argentina	$E = 52.2 + \underset{(.06)}{.18Q}$	.39

Source: See Tables 3 and 4. For the United States the rank correlation coefficient is .82 significant at the .01 level for the Salter data.

rise with increasing labor productivity. In the three South American countries, only the latter negative generalization is supported by the equations. A possible interpretation of the United Kingdom - United States results has already been suggested, namely, that the sources of productivity growth affect all inputs more or less simultaneously. If, as in Latin America, only labor productivity rises with no indication of a link between it and the productivity of other inputs, a different argument is necessary. Two lines of inquiry are suggested. In the first place there is the possibility that labor productivity growth in the South American countries is explained in terms of improved (not more) capital that adds to labor productivity and offsets any decline in capital productivity attributable to a rising capital/labor ratio. Since a large part of the physical capital used in these countries is imported, this would mean that their major source of productivity growth was also imported.

47. In the second place (and not independent of the first place there is the possibility that the economic environment of Colombia, Brazil, and Argentina is not conducive to general increases in productivity. One reason why this might in fact be the case for the entire economy was suggested in Section B of Chapter II, as due to the particular type of import substitution policies followed in the countries considered there. Now another source of difficulty may be noted, namely, that the physical capital that is imported (and that does produce the higher labor productivity in certain activities) is also "alien" to Latin American countries. The alien nature not only accentuates the employment problem, but also imposes additional demands on the economy that it has more difficulty in meeting (e.g., raw material inputs, skilled labor, maintenance performance, etc.) than does the economy in which the capital was constructed. This latter situation adds to the magnitude of the process of adjustment to new processes, and thereby contributes to the problem of raising the productivity of all inputs. In this sense the adjustment task imposed by the new "alien" capital for the importing country is greater than it is for the originating country, while (it seems safe to say) their capacity to adjust is less (as reflected for example in the relative variations shown in Table 3). This suggested hypothesis as to the interpretation of the results therefore has two important implications: (1) that the three South American countries have had great difficulty in establishing and maintaining an economic environment conducive to productivity growth, and (2) have had varied success in adopting imported technology without creating considerable distortion, which in turn impedes productivity growth. That this interpretation is of a heuristic nature and in no sense a logical consequence of our equations is to be emphasized.

48. Attention may also be called to the fact that $\bar{r}^2$'s of Table 5 (the relationship between unit labor costs and productivity) for the three South American countries are well below that for the United Kingdom (1) and the United States. Part of this difference is doubtless due to the difference in the time spans, but not all of it, and we are entitled to conclude from this that the developing countries are less successful in transferring the increased labor productivity into lower labor costs than are the United States and the United Kingdom. And this, as pointed out earlier, handicaps the process of the kind of structural change considered in this paper.

(b) The picture for Argentina is a bit clearer than that for Brazil and Colombia. The close relationship between productivity and earnings per worker indicates rather convincingly a rather severely distorted labor market. The equations in Tables 6 (between productivity and output) and 7 (employment and output) both are consistent with an explanation of measured productivity growth in terms simply of under-employment with little or no "pure" productivity growth. Argentina with,, an older and possibly more sophisticated manufacturing sector, has also been more obviously a victim of the kind of distortions referred to earlier than have the other countries.

49. It may also be noted, in passing, that the rate of growth of capital formation has been as high (or higher) in Argentina (investment as averaged between 18 and 22 percent of GNP over the last decade according to the national accounts) as in other countries. This fact suggests that whatever productivity increasing source is carried in new capital cannot affect the nullifying effects that arise from continued distortions of the kind summarized in Chapter II and analyzed in more detail here in Chapter III.

(c) The Brazilian picture is more clouded. The chief puzzle is the relationship between productivity and output shown in Table 6. The large (relative to the mean) vertical intercept and insignificant regression coefficient suggest strongly that measured productivity growth is not affected by changing levels of underemployment, so too does the fact that r^2 is .87, and the vertical intercept is very low in the relationship between employment and output. These equations plus those in Tables 4 and 5 suggest a rather pretty picture: a high rate of growth of labor productivity (about 2.8 percent per annum for the decade reviewed here, assuming that all the measured productivity growth associated with growth of output is due to changing levels of underemployment), little underemployment, and a labor market acceptably undistorted. There is no doubt that Brazil has managed to avoid a number of the difficulties which Argentina has not, but still there is the point of sub-heading a above that no evidence exists as to other input costs falling along with labor costs. What it does seem acceptable to conclude, given the results of the equations, is that Brazil was - at least during the 1950's - much more successful than Argentina in adapting to the demands created by the import substitution process.34/ This adaptation in the present context seems to be an important element in Brazil's favorable showing relative to that of Argentina.

(d) Colombia falls somewhat between Argentina and Brazil. Her equations in Tables 4 and 5 suggest a reasonably efficient labor market. The equation in Table 6 suggests that some of the observed increase in

34/ For a recent survey of Brazil's industrializing experiences, see Werner Baer, Industrialization and Economic Development in Brazil, Homewood, Illinois, Richard D. Irwin, Inc. 1965. There is little doubt that the picture has changed considerably since 1959. Indeed some tentative calculations for the post-1959 years in Brazil suggest a picture very much like that described for Argentina.

productivity is an underemployment phenomenon. The vertical intercept intthis equation is just barely in excess of 100, which (as already noted) suggests that the increment in productivity over the period would have been slight had output not risen. Then in Table 7 the intercept slightly in excess of 100 im-'es that productivity in fact declined. Both these pieces of evidence suggest that increases in "pure" productivity were not great over the 1953-63 decade. The bits and pieces of data on underutilization of capacity indicate that Colombian manufacturing did not suffer from this malady to the extent that Argentina did, but there is evidence that Colombia was experiencing increasing difficulties in this respect in the early 1960's.35/ A mild negative conclusion might be risked to the effect that the Colombian equations are not consistent with clear cut success of an industrialization effort, while at the same time not showing a disarray as evident as that in Argentina. A question well worth further inquiry for both Colombia and Brazil is that of whether their picture as described by the various equations would be altered if data were available to extend the period of analysis to 1966.

D. Summary

50. This chapter has attempted to say something about sources of productivity growth and the process of adjustment to increased productivity in Argentina, Brazil, and Colombia. The study of the series of regressions, though open to many questions, did suggest some generalizations about the nature and source of the development difficulties that these countries face. A final chapter now seeks to suggest a way or two by which these results and those summarized in Chapter II are related to policy matters.

IV. SOME POLICY IMPLICATIONS

51. This paper began by noting that growth of output cannot be satisfactorily explained in terms of growth of inputs as these latter are conventionally measured, and that increased productivity is an important part of the growth story in almost all of the currently rich countries. It was further noted that explanations of the sources of increased productivity were usually in terms of improved skills, embodied technical change, increased health standards, etc., and that none of these sources of growth is free but must be acquired by expenditure of investible resources. It seems useful, therefore, to think in terms of a generalized capital formation model that recognizes the various sources of productivity growth and that the creation of these sources requires the use of investible resources.

52. Then a series of empirical studies were reported on that suggested two general conclusions with respect to several Latin American countries: (1) that productivity growth in general has, since 1950 or so, been quite

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35/ See, for example, John B. Sheahan "Imports, Investment, and Growth: Colombian Experience Since 1950" forthcoming in the collection of papers presented at the Bellagio Conference of the Harvard Development Advisory Service.

modest, and below that of the 1940's, and (2) that there is little evidence of the existence of an economic environment conducive to a high rate of productivity growth. Indeed a variety of policies common to most countries seem to impede the process of adaptation that would facilitate the exploitation of the possibilities for increasing productivity.

53. Once it is accepted that increases in productivity are important in understanding growth and structural change and that they do not fall freely from the heavens on all sectors in all countries with equal intensity, then it is evident that there are major policy issues involved. A full scale review is not possible here, but some of the more general (and obvious) points may be noted.

1. Size of Investments in Infrastructure

54. The most evident point to make is that the investment allocation problem is extended to include the range of activities affecting productivity. One must ask about the productivity of expenditures on education or on technical research or on health as well as on steel mills and chemical plants. Rates of capital formation (conventionally defined) appear generally acceptable in Latin America, and one possible explanation of the difficulties observed in these countries is the simple point that "too much" has been given to the building of plant and equipment and "too little" has been left for productivity-increasing activity.

2. Efficiency of Investments in Infrastructure

55. The previous point must be qualified to some extent by noting that the efficiency of resources in productivity-increasing activities may be quite low. Thus it may be that trained labor will result in greater labor productivity than untrained labor but it may also be that the quality of the educational establishment is such that it is unable to teach what students need to learn. For example, students attend school to learn to read and write but do not learn to do this. The difficulty here then is the quality of the educational establishment, not the numbers sent through the mill, and the allocation problem is that of improving this quality. This latter is, of course, much more difficult than simply constructing more school buildings. There is some evidence that the education bottleneck is of this sort in a number of the Latin American countries.

3. Difficulties in Policy Changes

56. Emphasis was placed in Chapters I and II on the hypothesis that the particular nature of the development strategy followed in Latin America has had adverse effects on both productivity growth and adjustments thereto. Economic policy springs from a variety of considerations, and one cannot claim policy is wrong simply because it hampers productivity growth - granting that it in fact does in a number of countries of Latin America. It does seem clear, however, that examining the effects of specific policies on

productivity growth - given the demonstrated importance of the latter - is a fruitful approach. Suppose one were convinced that the relationships between productivity growth and development policy summarized in this paper were valid. Could one then conclude that all the countries had to do was to eliminate some of their more damaging policies, and productivity growth would jump upward? It is probably correct to argue that correcting policy is not a completely free alternative. For example, suppose one argued that the tariff structure was "too high" (or the exchange rate wrong, etc.). It is surely correct in many instances that reduction of tariffs (or devaluation, etc.) can impose a temporary cost on the society. This corrective action may then be recognized but postponed indefinitely because of these short-run costs incurred in its implementation. Then aid may be profitably used as a vehicle for carrying out policy changes, i.e., in meeting the costs involved in shifting from a "wrong" to a "right" policy.

57. This point has a variety of implications, but only one will be noted, namely, that having to do with international grants and loans. One of the implications of item (1) above is that aid (meaning all kinds of public capital flows) could profitably be used to support productivity-increasing activities. Now added is the point that aid can also facilitate (or thwart) the implementation of major policy changes. Indeed foreign aid used for construction physical capital or simply to relieve a balance of payments crisis can, in fact, impede the implementation of corrective policy measures. The income from the physical capital becomes a substitute for productivity growth! And resources are provided to support policies (or institutions, practices, and so on) inimical to productivity growth but difficult and painful to change. This is a complicated issue but the central point of relevance in the present context is simple enough: certain policies effect productivity growth adversely enough that an alternative policy is recognized and accepted as desirable. The policy change imposes certain short-run economic costs (e.g., capital may become obsolete, distribution of income may alter, etc.) as well as imposing other, more intractable social and personal costs. Aid then may have a very high productivity if it is used to facilitate policy changes by covering the economic costs involved in the change. The danger is, however, that as such, policy changes often impose difficult and troublesome social and institutional changes, aid may be used to ride over a balance of payments problem without eliminating its ultimate source. To repeat the key point here: policy changes (e.g., reducing a tariff schedule) can impose short-run costs while yielding long-run gains. Aid to finance these short-run costs may then be a productive use of such resources.

4. Resource Allocation and Productivity Growth:

58. Much of the argument of this paper has led to conclusions that misallocation of resources had adverse effects on productivity growth and that defective markets created difficulties for the spreading out over the economy of the rewards of productivity growth. Recently a number of economists have argued that elimination of the misallocation of resources can add little

to the capacity of an economy.36/ These studies have, however, looked at only the static consequences of misallocation. If misallocation does dampen productivity growth, then the allocation question may well be crucial to the achievement of sustained growth. This conclusion, one may emphasize, is not equivalent to saying that if a country solves its allocation problems (and prevents inflation) it will, thereby, enjoy sustained growth.

36/ This material is summarized in Harvey Leibenstein, "Allocation Efficiency vs 'X-Efficiency'," American Economic Review, June 1966.

APPENDIX

STRUCTURAL CHANGE AND PRODUCTIVITY IN LATIN AMERICA
STATISTICAL FINDINGS AND DETAILED COMMENTS

A Survey of Variation

1. Table 3 /37 contains estimates of the relative variation (the standard deviation of a series divided by its mean) of the series to which attention will be directed. It is evident at once that for each country the variation in gross output exceeds that of all other series. Also generally high is the variation in employment, though Argentina appears to be an exception in this respect. More importantly earnings per worker indicate decidedly less variation than either output or employment (for Argentina variation in earnings and employment is about equal). It should, however, be noted that the relative variation of earnings in the three Latin American countries is markedly higher than it is in the United States and the United Kingdom. Of equal relevance to the present argument and to other aspects of productivity analysis is the observed variation in productivity growth. If the variation in this series were quite small, this fact would suggest that the sources of productivity growth (whatever they are) act more or less equally on all sectors. Considerable variation, among activities on the other hand, suggests that productivity-increasing forces are not equally strong among sectors or that reaction to such forces varies from activity to activity. Indeed, it is this variation in productivity growth that makes the kind of analysis undertaken here useful.

2. The final three rows in Table 3 have to do with costs per unit of output for the three identified inputs that make up gross output. Unit labor cost (equals earnings per worker divided by productivity) show a variation that is due to that of its two components already mentioned. Unit material input cost (value of material input divided by gross output) is an attempt to measure the extent to which this component of total inputs changes as output changes. Since all sectors use certain common inputs - e.g. fuel - the variation among activities of this item is expected to be relatively small. The gross margin is defined as total gross output minus the wage bill minus material inputs (or value added minus the wage bill), and this divided by output is gross margin cost per unit of output. In a very rough and ready way it can be thought of as a measure of the cost of capital per unit of output. Variations of this item differ markedly among the countries shown. This figure is the second highest in the United Kingdom and Argentine columns, the second lowest for Brazil, and the third lowest for Colombia. It may be specifically noted that unit materials costs and unit gross margins are not measures of productivity. In both there is a price element that cannot be factored out.

37/ For convenience, Tables 3-7 already shown in the main text are reproduced here, with identical numbering.

Table 3

Relative Variation in Selected Series
(Standard deviation divided by mean)

	United States	United Kingdom	Colombia	Brazil	Argentina
Gross output	55.0	87.2	82.8	53.63	61.27
Employment	39.5	50.1	51.19	51.62	35.35
Earnings	11.7	10.9	22.19	15.17	35.12
Productivity	30.8	35.7	52.71	20.69	40.07
Unit labor cost	27.3	34.6	34.45	21.36	17.68
Unit material cost		29.5	13.29	9.15	32.29
Unit gross margin cost		58.2	22.75	11.74	53.77

Sources: For the United States and United Kingdom figures taken from the Salter reference cited in footnote 30.

For Colombia, Brazil, and Argentina data for calculations obtained from Anuario Estatistico do Brasil: United Nations Analyses and Projections of Economic Development, Vols. II and III: Contas Nacionales do Brasil, Fundacao Vargas: The Process of Industrialization in Latin America, Statistical Annex, ECLA: Boletin Estatistico de America Latina: Anuario Estatistico de Colombia: and unpublished data that I have collected from various official statistical agencies in these countries.

Time Period:			
	United Kingdom	1926-1950	28 activities
	United States	1923-1950	27 activities
	Colombia	1953-1963	20 activities
	Brazil	1949-1959	18 activities
	Argentina	1950-1962	15 activities

3. The task now is to try to explain some of this observed variation, especially that associated with productivity and to explore a few consequences of these explanations for the developmant process in Latin America.

The Earnings - Productivity Relationship

4. The most obvious and most convenient place to begin is with the relationship between earning per worker and the rate of growth of output per worker. As noted above this relationship may suggest something about the nature of the labor market and possibly something about the sources of productivity growth. This relationship for the countries under consideration is presented in Table 4.

5. The only maverick in the table is Argentina. For all the other countries variation in earnings per worker seems to bear no relationship at all to variation in productivity growth. The higher intercept values for the three Latin American countries than those for the United Kingdom and the United States reflect the fact that money wage rates have risen more rapidly in Latin America than in the United Kingdom and the United States. This in turn reflects the inflation in these countries.

6. Attention was called earlier to the fact that the calculations shown in Table 3 indicate that the relative variation in earnings per worker is greater in each of the three Latin American countries than in the United Kingdom and the United States. This result is not surprising, although the differences in this variation between the Latin American countries and the United Kingdom and the United States is probably less for the manufacturing sector than would be the case if the whole economy were considered. Part of the explanation of this difference is to be found in the general characteristics of the labor markets - in South America less mobility, less information about wage rates and job opportunities, less spill-over effects from one sector to another, more variation in the extent to which firms conform to labor laws defining social security payments and other non-wage contributions, etc.38/ Thus the labor market, like almost all markets, functions less well in the Latin American (and most other developing) countries than in the more advanced economies, and this fact is reflected in the greater variation in earnings per worker shown in Table 3. For essentially similar reasons one might have expected that relationship between earnings and productivity would have been somewhat higher in all the Latin American countries than in the United Kingdom and the United States. Instead we find that Brazil and Colombia present a picture virtually identical to that for the United Kingdom and Argentina markedly different from everyone.

38/ H. A. Turner, Wage Trends, Wage Policies, and Collective Bargaining: The Problems for Underdeveloped Countries, Cambridge, 1965 has a good, brief discussion of the structure of wages in a number of underdeveloped economies.

Table 4

Relationship Between Earnings per Worker (W) and Productivity (P) for Selected Countries

Country	Equation	r^2
United Kingdom (1)	$W = 244.44 + .0015P$ (.09)	neg
United Kingdom (2)	$W = 155.75 + .024P$ (.08)	neg
United States	$W = 235.58 + .11P$	neg
Colombia	$W = 379.07 + .34P$ (.22)	.07
Brazil	$W = 686.79 + .49P$ (.92)	neg
Argentina	$W = 477.27 + 8.57P$ (1.17)	.77

Sources: See Table 3. The (1) and (2) applied to the United Kingdom refer to the 1923-50 period and the 1954-63 period respectively. Neg. means negligible. The figure in parenthesis under the regression coefficient is the standard error of the regression coefficient. Standard errors for regression coefficients and r^2 for the United Kingdom and the United States are not given in Salter and have been computed by me from his data.

7. Can one say that in Argentina the observed relationship implies that in this country productivity growth is due to greater skill differential among the workers? Although one cannot be completely sure, it seems quite unlikely given the clear-cut picture for the other countries. Indeed, accepting the relationship as shown, one can hardly avoid the conclusion that in Argentina the labor market for some reason or other was such that workers in sectors where labor productivity had risen more than the average were able to gain higher than average increases in earnings. There are several possible explanations of why the relationship shows the way it does, but it is not possible in the present context to trace down what seems to be the principal explanation. One point may be mentioned here as it comes up again later. To the extent that all wage rates do follow labor productivity, activities which have experienced little or no increases in productivity face difficulties and under rather evident conditions would find it unprofitable to continue to operate. We can say rather confidently that, given the variation in productivity growth in Argentina shown in Table 3 and earnings-productivity relationship of Table 4, that the wage structure in Argentina did, over the period covered by the data, experience considerably more distortion than that which occurred in the other countries.

Productivity and Unit Labor Costs

8. If earnings do not move with productivity, then labor costs per unit of output must fall as labor productivity rises. Table 5 presents the equations describing the relationship between these two variables for the various countries. The lower r^2 for Colombia and Brazil compared to that for the United Kingdom and the United States is due to the larger variation in growth of earnings per worker shown in Table 3 in the former countries than in the latter. The fact that the relationship for Argentina explains a negligible proportion of the variation in ULC follows, of course, from the result shown in the previous table that earnings per worker in Argentina move closely with average labor productivity. Again the evidence indicates that this aspect of the process of adjustment to changing productivity did not function at all well in Argentina, and probably less well in Brazil and Colombia than in the United Kingdom and the United States. The two sets of data for the United Kingdom are at least consistent with the notion that the longer the time span the clearer the relationship appears.

Labor Costs and Costs of Other Inputs

9. The preceding discussion was concerned with labor productivity and unit labor costs. There are, of course, other costs, and it is convenient (and possible) to distinguish the cost of material inputs and a residual that, following Salter, is identified as gross margin cost. As already noted this latter is an extremely crude guide to capital costs (more accurately, to non-labor, non-material cost). There are two specific, closely related questions that can be asked with respect to materials and "capital" costs:39/ first, is there any evidence that all three costs move

39/ To compute an index of materials productivity and capital productivity in the same manner that labor productivity has been compiled would be most desirable. To do this, however, in the present exercise was not possible as price data suitable for deflating the two series were not readily at hand.

Table 5

Relationship Between Unit Labor Cost (ULC) and Productivity (P) for Selected Countries

Country	Equation	$\bar{r}^2$
United Kingdom (1)	ULC = 305.3 - .82P (.07)	.82
United Kingdom (2)	ULC = 236.8 - .84P (.12)	.63
Colombia	ULC = 401.3 - .70P (.14)	.54
Brazil	ULC = 910.7 - 2.58P (.62)	.51
Argentina	ULC = 1306.4- .92P (.61)	.08

Source: See Tables 3 and 4. The $\bar{r}^2$ for the United States is .80 using the Salter data.

together with the consequent reduction in price, and second, if the non-labor costs do not move with the labor costs, can we interpret this to mean that labor costs fall (rise) because the other costs rise (fall) - i.e., because of a substitution effect - or can one find reason to conclude that other forces are producing the changed labor productivity.

10. Consider first Salter's findings for the United Kingdom. One of the more striking results of Salter's computations is the finding for the 1926-1950 period of an $\bar{r}^2$ of .61 for the relationship between unit materials cost and labor productivity. The relationship is, of course, negative.40/ For the shorter period the relationship is less impressive ($\bar{r}^2$ = .21), but still suggests that even over this shorter period there appears enough evidence to justify consideration of the view that a common source seems to act on both labor and materials costs. One can say then rather confidently that these results do not support the notion that the rising labor productivity can be explained in terms of an increasing use of (e.g.) fuels or a more extravagant use of raw materials.41/ A corresponding (positive) relationship is found between ULC and UMC.

11. Suppose for a moment that unit gross margin costs (UGMC) were an acceptable measure of the input of capital services, that might one expect as to the relationship between UGMC and labor productivity? The simplest (and oldest) argument is that a strong positive relationship should exist between the two series indicating that capital was being substituted for labor and thereby pushing up the productivity of labor. Similarly, one would expect a significant negative relationship between UGMC and ULC. Salter's data for 1926-50 for the United Kingdom show the opposite sign to that indicated by these expectations, and in each equation about 12 percent of the variation of the dependent variable is explained. For the shorter period the $\bar{r}^2$'s are negligible in both equations. Given the residual and hence nebulous character of UGMC, perhaps the least dangerous interpretation of the results is the negative one that there is no evidence here to support the assumption that labor productivity rose because of an increased use of capital in the productive process. The stronger conclusion to the effect that UGMC fell as labor productivity rose (and as ULC fell) is consistent with the evidence for the 1926-1950 period, but not for the shorter, second period.

12. Given the preceding results, it follows that there is a negative and significant relationship between the rate of growth of labor productivity and price. For the two periods $\bar{r}^2$ is .77 and .27 respectively.

40/ The complete equation is UMC = 334.9 - .78P where UMC is unit materials cost. Data are not available for the United States.

41/ Price of materials input could move in such a way as to contradict the argument in the text, but this appears so improbable that the possibility may be ignored here.

13. For the three Latin American countries the results are less clear. For none of the three is there a statistically meaningful relationship among the variables just reviewed for the United Kingdom. The calculated regression between unit materials cost and unit labor cost or between the former and labor productivity show R^2's of virtually zero in all cases. The same holds for regressions between UGMC and ULC and productivity. The nearest exception is for Colombia where the regression

$$UGMC = 237.9 + \underset{(.14)}{.26P} \qquad R^2 = .12$$

is not inconsistent with the notion that labor productivity rises, at least to some extent, because of a substitution effect. The results then for Colombia, Brazil, and Argentina are essentially the same as those for the United Kingdom with respect to UGMC and labor productivity and labor costs. The Latin American countries show a quite different situation with respect to materials costs and the labor variables. Consequently, nothing specific can be deduced about the relationship between labor productivity and prices, although we do have enough information to conclude that in general this relationship should be quite insignificant. Price indices, however, are not such that one can compute a productivity-price regression directly.

14. Before considering some implications of these results it is helpful to look at two additional sets of relationships.42/

42/ It was not possible to obtain data and carry out the formal computations for the United States with respect to the relationship between productivity growth and capital and materials costs. Preliminary calculations, however, indicate a picture virtually identical to that of the United Kingdom (1). With Kendrick's data for 33 manufacturing activities a rank correlation of -.59 is found between "total productivity" and materials cost per unit of output for the period 1899 to 1953 and coefficients only slightly lower for sub-periods within this long period. (A .01 significance level requires a rank correlation of .43.) The same general result holds if one uses only labor (instead of labor and capital) productivity. Similarly, a significant negative rank correlation coefficient is found between labor productivity growth and "unit value" (i.e., price) and total productivity growth and price. Thus the evidence seems quite convincing, despite the crudity of the rank correlation coefficient, that productivity of all inputs moves together, and the rate of growth of productivity of labor cannot therefore be explained in terms of a substitution argument in the United States and the United Kingdom. See the Kendrick volume previously cited, especially Chapter 7.

Productivity and Output

15. Table 6 presents the regressions between the indices of productivity growth and those of output. In this table Brazil is the maverick case, as all the other countries show a significant relationship between the two variables. The first question to ask is simply why should one expect a relationship of any kind between productivity growth and output growth. There are several possible explanations.

16. The most obvious - and least interesting - explanation is in terms of changes in the degree of the utilization of the employed labor. If all labor were not used full time all the time then labor's average product would vary with output simply because output could increase from a position of underutilization with no increase in employment. This would mean that some part of the observed increases in productivity did not represent "true" increases in labor's productive capacity. A clue as to the importance of this effect is provided by the vertical intercept values. These values indicate what the productivity index would have been on the average had output not increased at all. An intercept value below 100 is most easily understood therefore in terms of an underutilization argument, since it is difficult to believe that "pure" labor productivity - i.e., labor productivity corrected for any underutilization effect - declined over a period as long as a decade or so.

17. For both the United Kingdom (2) and Argentina the vertical intercept is less than 100, and what we know from other sources about these two countries in the period covered is consistent with an underemployment interpretation of these equations. In the United Kingdom 1963 output suffered from the aftermath of the balance of payments induced restrictive policies of 1962 and the effects of some bad weather. In Argentina underutilization of both capital and labor has long been a major problem, although specific data on the changing degree of underemployment over the period covered by the data are not available, there is little doubt that it was substantially greater in most activities in 1962 than it was in 1950, and that it was greater in Argentina than in Brazil and Colombia.43/ The argument further requires that employment not move exactly with output (this is what underemployment in contrast to unemployment means) and as shown below output and employment were less closely associated in Argentina than in the other countries under review. The regression coefficients for Argentina and United Kingdom (2) in Table 6 are substantially higher than the other regression coefficients. Argentina's .63 especially is decidedly higher than the others. The regression coefficient, of course, indicates the extent to which productivity increases with an increase in output. A larger coefficient for Argentina therefore is also consistent with the notion that the relationship between productivity and output in this country is due to changes in

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43/ Some data on underutilization of labor and capital in Latin America are found in the statistical annex to ECLA's Process of Industrialization of Latin America, United Nations, 1966.

Table 6

Relationship Between Productivity (P) and Output (Q) for Selected Countries

Country	Equation	r^2
United Kingdom (1)	$P = 113.3 + .23Q$ (.03)	.65
United Kingdom (2)	$P = 72.3 + .41Q$ (.08)	.46
Colombia	$P = 101.1 + .23Q$ (.05)	.51
Brazil	$P = 130.8 + .08Q$ (.05)	.06
Argentina	$P = 92.7 + .63Q$ (.11)	.68

Source: See Tables 3 and 4. Salter's data for the United States yield an r^2 of .36 for the 1923-1950 period.

the degree of underemployment. A similar argument would apply to United Kingdom (2). All these bits and pieces of information plus the equation in Table 6 suggest rather strongly that a major part of the average observed increase in productivity in Argentina is due to changes in the degree of underemployment. The same seems true of United Kingdom (2). No doubt this argument is applicable in some degree to Colombia and Brazil as well, but obviously not sufficient so to produce a vertical intercept below 100 or to produce a very high regression coefficient.

18. The observed relationship between productivity growth may also be due to economies of scale.44/ One would expect, however, if the scale effect were predominant, it would be reflected in all inputs, not just labor. As already noted non-labor costs do not move with labor costs for the three South American countries, and less clearly so with United Kingdom (2) than with United Kingdom (1). The scale effect than seems less apparent than one would expect if it were carrying substantial weight in the explanation of P.

19. A more substantial explanation of the relationship between growth of productivity and of output has to do with the argument developed above that productivity growth is not only an important source of growth but factors that make for rapid growth of output also make for rapid growth of productivity. For example, an activity in which enterpreneurs are alert and cost-conscious is likely to be one in which both output and productivity are growing.45/ In a similar vein, it is probably correct to assume that activities which are achieving high rates of growth of output attract better trained labor and have better access to finance than do the slower growing activities. This general argument is appealing in a variety of ways, but it obviously needs further formalization and further empirical support. Some evidence has been cited above (e.g., the absence of evidence that increments of labor productivity are due to the substitution of other inputs for labor, the absence of a relationship between the rate of growth of inputs and the rate of growth of productivity, etc.), and considerable additional evidence is available.46/ It is at once evident, however, that the argument cannot be applied in an unqualified manner to the Latin American countries. Attention has already been called to the role of underemployment in the case of Argentina and to Brazil's maverick status in Table 6. Only Colombia in South America seems - at the moment - to fit the argument, while the evidence for the United Kingdom and the United States is considerably more consistent. It is useful to look at one final set of relationships.

44/ One might argue that the scale effect was simply another side of the underemployment effect, but it is rarely so considered.

45/ There are bits of evidence on this point. See, for example, Choice of Technologies in the Latin American Textile Industry, Economic Commission for Latin America (mimeographed) 1966. This argument does not imply, of course, anything about the suitability of the more advanced technology from the standpoint of the entire economy.

46/ See footnote 32

Employment and Output Growth

20. In Table 7 regression equations between indices of employment and output are shown. Each equation represents a significant relationship, and as indicated in the note to the table, there is doubtless a significant relationship between the two variables for the United States as well. That such a relationship exists is of course not surprising. For there to be no relationship would mean that labor productivity grew at the same rate as output, and this is quite unlikely. The equations in this table also reveal some of the points made in the discussion of earlier tables. The low regression coefficient and low R^2 for Argentina are consistent with the role of underemployment in this country noted earlier. Similarly, the high regression coefficient and high R^2 for Brazil is to be expected, given the low correlation between productivity and output for this country in Table 6. The higher regression coefficient for United Kingdom (2) than for United Kingdom (1) is also consistent with previous argument. A puzzle does appear, however, with respect to the vertical intercept for Colombia. The 105.2 indicates that employment would have risen even if output had not, and this is difficult to accept. Taken literally it would mean that labor productivity declined over the period considered, and while this result might be made consistent with other evidence, extended argument would be required. Some note, however, will be taken of this possibility in a later discussion. It may be noted in passing that all regression coefficients appear "small" - even that for Brazil. This result reflects the well-known fact that employment lags markedly behind manufacturing output in all countries.

Table 7

Relationship Between Employment (E) and Output (Q) in Selected Countries

Country	Equation	$\bar{r}^2$
United Kingdom (1)	E = 61.1 + .28Q (.02)	.85
United Kingdom (2)	E = 44.1 + .46Q (.07)	.53
Colombia	E = 105.2+ .23Q (.05)	.51
Brazil	E = 15.8 + .60Q (.05)	.87
Argentina	E = 52.2 + .18Q (.06)	.39

Source: See Tables 3 and 4. For the United States the rank correlation coefficient is .82 significant at the .01 level for the Salter data.