Perspectives on Capital and Technology in Less-Developed Countries

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I. Introduction

AS AN OUTGROWTH of more than two decades of work in and observation of less-developed economies (principally in Latin America and Asia), I feel that I have learned a number of lessons that I would like to share with my professional colleagues. Some of the lessons are substantive, and two of them constitute the two major parts of this article. The first of these has to do with the fact that there is little tendency for rates of return to capital (either social or private) to be higher in the less-developed countries of the world than they are in the major industrial centers. The second lesson is that there is no truth in the notion that the less-developed countries are condemned by modern technology to use (in their more modern sectors) capital and labor in proportions that are very similar

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to those employed in the advanced economies. These are the substantive lessons. But there are also lessons at another level which (depending upon one's taste) might conceivably be called methodology but might alternatively be classified as relating to the spirit with which research on LDC economies is conducted. This lesson builds on a recognition that the data of LDCs are limited both in quantity and quality. Gaps exist in time series; the concepts underlying data sets change unexpectedly from time to time; and one never knows up to what point one can put faith in the actual numbers one sees. These facts of life have, singly and in combination, managed to sap the enthusiasm of many young scholars who have ventured with initial high hopes into the area of research on developing countries. I think this is unfortunate, because much can be done with data that are quite imperfect. Gaps can be bridged by the use of artful assumptions on interpolation; missing figures can be estimated on the basis of knowledge of other economies; and finally, the results of particular empirical exercises can be tested for their sensitivity to particular types of bias that might systematically affect the data being used. In what follows, there is something of each of these solutions to the data problems mentioned above. And the lesson that emerges is, I think, a reasonably hopeful one. To my mind, at least, the data problems of LDCs are better regarded as a fascinating challenge than as a dispiriting roadblock standing in the way of the advancement of our scientific knowledge.

The first major problem is the measurement and comparison of rates of return to capital across countries. In this article the measurement is effected using a methodology which is common across the countries studied. This introduces comparability (at least at a certain level) in the resulting figures. It also provides a way of checking the plausibility of particular assumptions, arbitrary in themselves, that have to be made along the way and, at the

same time, it makes possible scientific tests for the errors that may be involved in such assumptions (by seeing how different the final results of the exercises would be if one had used the actual data of a country known to have reasonably reliable figures in place of the arbitrary assumptions actually made). Needless to say, I would not be speaking in these tones if I did not feel that only small errors were introduced by the use of the particular arbitrary assumptions employed in this study.

The main calculations underlying the estimation of rates of return to capital are reviewed in sections II and III. Section II deals with the measurement of the capital stock; section III with that of the income attributable to capital (the numerator of the rate-of-return ratio). In section IV the results of these calculations are put together to form rates of return and the latter are then employed to test alternative hypotheses. In section V some sensitivity tests are applied to check the robustness of the results.

Sections VI and VII deal with the second of the substantive lessons mentioned at the outset. In section VI, a methodology is devised for deriving a "predicted" level of employment of labor, per dollar of gross return to capital in a particular industry i and country j. These "predictions" are based on the assumption (hypothesis) that factor proportions in the industry in question must be the same in country j as in a particular country of comparison (in this case the United States). Using the methodology developed in section VI, statistical tests are made in section VII of various hypotheses concerning relative factor proportions between the United States on the one hand and the LDCs on the other. In this experiment, the basic data are 727 different ratios of "predicted" to "actual" labor usage in different three-digit industries scattered across some eighteen LDCs. Viewing these 727 observations as a sample drawn from a much larger population (many more industries, many more countries) of such ratios,

we test hypotheses concerning what the underlying population from which the sample of 727 was taken might look like. The conclusion is very strong that the data are quite consistent with the notion that the median three-digit industry in the modern sector of the typical LDC uses something like four times the amount of labor that would be predicted on the basis of United States factor proportions. The data are equally strong, moreover, in rejecting the notion that this population median can be as low as 3.5 times, let alone 3.0 times the United States figure.

II. Measuring the Stock of Reproducible Capital

The measurement of capital stock is surely the most straightforward aspect of our calculations. All of our calculations were based on national accounts data (indeed, in the final analysis, our choice of countries with which to work was largely determined by the ease with which their national accounts data could be fitted into our methodology). All of the countries in question had investment broken down into components. We chose to work with only three components—buildings, machinery and equipment, and inventories. For some countries our procedure entailed our aggregating, say, their series of housing investment with their series on investment in business plants so as to produce a series on investment in buildings. Needless to say, the national accounts data that we worked with were those expressed in real terms. Thus we are not faced with the problem of finding the relevant price deflators. The basic methodology that we used was a perpetual inventory technique, applied separately to the three investment categories. In this procedure, we used arbitrary rates to reflect how time and use erode the real economic value of the assets in question.

For buildings we assumed depreciation at the rate of 2.5 percent per year; for machinery and equipment the corresponding figure was 8 percent per year. For inventories we obviously did not need a depreciation rate, as the national accounts investment figures already expressed inventory investment as the net change in stock.

The missing link at this point is an estimate of the capital stock of each of the three types of assets at some initial or base year. This, happily, was a problem that I had faced before,[1] with reasonable success. The trick in this case is to find in the past some span of a few years (say, three) during which one judges that the economy was operating in reasonably "normal" circumstances. The critical dimension in which "normality" is important is that the capital stock of the different types should be growing at the same rate as the GNP. We then take the gross investment figures, say, for machinery and equipment in these three years (say, 1955–57), and average them so as to reduce the impact of random variation. The resulting average investment we treat as if it were the investment of 1956, the middle year. The normal function of gross investment is to replace depreciating capital and to provide for the growth of the stock. The equation

$$I_t = (\delta + \gamma)K_{t-1}$$

is a familiar way of expressing this fact. Our trick, then, was to use the average investment of three years as a center estimate of I_t in the above equation. The depreciation rate, δ, was simply the one assumed for the category (.08 in the case of machinery and equipment) and the rate of growth, γ, was simply the average rate of growth of the country's GNP over the three-year period (here 1955–57) in question. Thus, if I_t would have averaged 140 over the 1955–57 period, and if GNP had grown at the rate of 6 percent over that same period, then we would have estimated

the end-of-1955 capital stock of machinery and equipment at 1,000 [= 140/(.08 + .06)].

This type of exercise was performed for all the countries in the study. The base years differed, depending on how far back the relevant national accounts series could be obtained, but in any case a base-year figure was estimated for each category in each country. It is quite clear that this procedure is much less restrictive than assuming that, over the entire period of observation, the marginal capital-output ratio is equal to the corresponding average ratio. This latter assumption is particularly dangerous in countries whose growth rates change dramatically over time. Usually capital accumulation is only one of many factors, and probably not the most important one, in causing an abrupt acceleration or deceleration of the rate of growth. The assumption that marginal and average ratios are the same imputes to capital accumulation an incredible importance (omnipotence) in the growth process. I am confident, therefore, that we are correct in avoiding the use of marginal capital-output ratios as a device for working back to capital stock figures, at least so far as the capital stock for buildings and for machinery and equipment is concerned.

I have fewer qualms about using a somewhat similar procedure in the case of inventories, however; for, frankly, I tend to see the accumulation of inventories as something which follows the growth process, not something that causes it. Certainly I do not think that there is anything immutable about the ratio of inventories to GNP, but the assumption of a rough proportionality over the ranges of variation that we have observed during the past ten to twenty years does not appear to me to be one that will lead to gross error in the final figure for global capital stock. Thus it is that initial inventories were estimated by dividing the accumulated investment in inventory over the period of observation (say, 1956 through 1975) by the

increase in GNP from 1955–75. The resulting ratio—a 20 years' accumulation of inventories divided by a 20-year change in GNP—would then be our estimate of the inventory/GNP ratio. Applying this to 1955 GNP we would obtain our estimate of the 1955 level of inventories.

Using the methodology just described, it is relatively easy to go the rest of the way and derive capital stock series for each of the three types of investment goods, year by year from the initial base period until the most recent year for which data are available. This is what was done. The methodology was the same from country to country, with the exception of the choice of base year. This choice, however, does not have any systematic influence on the figure for, say, the 1970 or 1971 capital stock of a country. What we must recognize is simply that the capital stock estimates are likely to be more accurate the farther in the past is the base year that was used. This is because, if the base year is twenty years back, much of the initial capital stock estimated for that year will have in the interim been depreciated away. The capital stock for 1970 or 1971 will accordingly be relatively insensitive to errors in estimating an initial capital stock as far back as 1952. However, if the base year is 1965, much less of the base-year stock will have been depreciated away by 1970 or 1971, and accordingly our estimate of capital stock for these latter years would be more influenced by any error that might be involved in a 1965 estimate of base-year stock.

Note that up to this point no mention has been made of land. Yet land presents problems that must be faced in any estimation of rates of return to capital based on national accounts data. The problem is that the investment figures in the national accounts cover reproducible capital only, while the income figures in the national accounts include income accruing both to reproducible capital and to land. Hence he who seeks to estimate rates of

return on the basis of national accounts data must make his choice. He may either:

(a) build up an estimate of reproducible stock in the way we have outlined in this section, then add to it an independently obtained estimate of the value of land, and finally derive a rate of return using this global capital stock as the denominator, with the numerator being the total net income assigned in the national accounts to profits, interests, rents, etc.; or

(b) estimate only the reproducible capital stock along the lines indicated above, and estimate a rate of return on it by taking out of the numerator a portion of income deemed to be attributable to land.

In the exercises being reported, the second of these two procedures was followed.[2] Thus we have no need to estimate the value of land as such, though we must find some way of separating out the income attributable to reproducible capital from that attributable to land. The methods used to achieve this end are reported in the next section.

We have so far described the procedures for estimating a country's total stock of reproducible capital. For some purposes, however (such as measuring a private rate of return), a measure of the privately held stock is required. To obtain this stock measurement we separated each year's investment into the parts effectuated by the public and private sectors. The most common problem that arose in the course of this exercise was that figures were available for total public investment but were not discriminated by type. In such cases it was assumed that the shares of "machinery and equipment" and of "inventory investment" in total public investment were equal to half of the corresponding shares (as shown in the aggregate data) for total investment. This assumption obviously im-

plies that the share of construction in public-sector investment was larger than that for private investment.

The procedure just described was used to generate a breakdown of public-sector investment into the three categories here employed (construction, machinery and equipment, and inventories) for all those countries for which such a breakdown was not directly available. Once so discriminated, public-sector investment of each type was subtracted from the corresponding total investment figure in order to obtain private investment by type. Finally, the annual data on private investment by type were treated in a fashion identical to that described above for total investment, so as to generate (by a perpetual inventory technique) annual estimates of private capital stock by type of asset.

III. Measuring the Income from Reproducible Capital

In many LDCs, the national income accounts are broken down by final product classification (consumer durables, consumer nondurables, investment in buildings, investment in machinery and equipment, etc.) and by an industrial classification of value added (agriculture, manufacturing, communications, services, etc.) but not by type of income (wages, salaries, interest, rents, profits) accruing to the ultimate recipients. Such countries had automatically to be excluded from the present study, since the methodology used here for analysis requires data on national income by type.

But even among countries whose national accounts contain the appropriate classification, some difficulties still remain. Principal among these is the fact that, though most income types are easily assignable to either labor or (physical) capital, each country has one category, usually labeled "income from unincorporated enterprises" or something closely akin to that, which quite obviously

includes, apart from the return to capital, some income that should properly be imputed to the labor of the proprietors and their families.

Various methods have been employed to break the "income from unincorporated enterprises" aggregate into a part assignable to family labor and a part assignable to capital. The most common method is to evaluate the labor of proprietors and their families on the basis of the average wages paid to hired labor in the industry in question. Another is to add to the income of unincorporated enterprises the wages paid by them to hired labor, and the interest and rents paid by them for "hired capital," to obtain a "national income originating in unincorporated enterprises in a given industry or sector." This "national income originating" is then assumed to be divided between labor and capital according to some principle or rule, such as the assumption that the shares of labor and capital in the unincorporated part of an industry or sector are the same as those applying in the corporate part (for which the relevant data are easier to come by).

Unfortunately, methods like those just listed have massive data requirements. Moreover, their application is likely to give rise in particular cases to special problems (for example, an imputed labor income that systematically exceeds the total reported income of unincorporated enterprises), which then would have to be resolved on an ad hoc basis. Considerations such as these helped motivate our decision to solve the problem by imputing to labor a specified constant fraction of the income from unincorporated enterprises (or its counterpart category) in each of the countries we examined. The fraction chosen for the present study was one-half, which lies at the center of a plausible range from perhaps one-third to something like two-thirds. Sensitivity tests can then be applied to see to what extent (if any) the principal conclusions of the study are affected if the assumed fraction is varied

within this range (for individual countries or for the group as a whole).

A similar procedure was used to impute the income accruing to land. Here the assumption was made that pure land rent was equal to one-third of that national income originating in agriculture, plus one-tenth of the rental value of dwellings. Once again, these should be regarded as rough orders of magnitude, with the final estimates emerging from the exercise being subject to sensitivity tests.

In measuring the income from capital, care must be taken to be explicit about the underlying concept that one is trying to approximate. Here we have taken two alternative concepts. The first attempts to measure the marginal net productivity of capital. As such it is defined to be net of depreciation but gross of all taxes. Thus such items as corporation income taxes and property taxes are included in the income from capital. In addition, indirect business taxes such as sales taxes, value added taxes, stamp taxes, sumptuary excise taxes, etc., must be considered. Our procedures assign the yield of these taxes to capital and to labor in proportion to their contributions to gross national product, building on the principle that excise taxes are equivalent to a set of equiproportional taxes on all elements of cost (including allowances for depreciation). In our exercises, this assignment is done on an aggregate level, but there is no doubt that it would be preferable to do the job in a disaggregated way, tax by tax and industry by industry.

The second concept of return to capital is a "market rate of return." As such it is net of all taxes except the personal income tax, on the presumption that the market rate tends to be equalized across different sectors and types of capital, while the rates of return after personal tax will be different for different taxpayers, even on identical investments. In what follows we shall refer to the

market rate of return as a "private after-tax rate of return." This is simply to emphasize that it is not a measure of productivity or of social yield; it is a private rate of return in the sense of being net of all taxes that are paid before capital owners get their reward. It is not net of income taxes which are, in concept at least, paid after that reward has been received by the ultimate owners.

To measure the income accruing to private-sector capital we must eliminate not only the taxes just indicated but also whatever income accrues to capital in the public sector. Here again the necessary data were not always available in the desired form. In some countries' accounts the data given on the property income of government do not include the earnings of industrial enterprises in which the government is the principal or sole shareholder. In these countries, such enterprises are treated as autonomous and amalgamated with the private sector. Property income of government may include dividends actually paid out by these enterprises and received by the treasury, but it does not include their profits as such.

Our procedure in handling this difficulty is as follows. Where we could piece together, from different sources, estimates of the income from public enterprises as well as investments in them, we defined the public sector broadly, including investments in public sector enterprises as additions to the public sector's capital stock and simultaneously counting the full profits of public-sector enterprises as part of the income from capital of that sector.

On the other hand, where the available data gave us only investment in the government sector—the buildings, parks, roads, vehicles, etc., built and/or owned and used by the various ministries and agencies—we sequestered these figures out of the total capital stock and took from the earnings of capital only such profits as may have been generated in the government sector, thus narrowly defined.

The column showing private after-tax rates of return

therefore varies in its precise meaning from country to country. In all cases some part of the total income from capital has been taken out of the numerator of the aggregate national rate of return, and some part of the total capital stock has been taken out of its denominator. However, in some cases that part has been narrowly defined to be that corresponding to the government sector, while in others it was defined more broadly so as to include all public sector enterprises. Where the data permitted a choice, we opted for the broad definition; but in all cases the definition of the public sector used in dealing with the capital stock was followed in defining the portion of income to be sequestered in the process of deriving the return to private-sector capital.

IV. Rates of Return and Factor Proportions

Once the results of the calculations outlined in the preceding sections have been obtained, it is an easy step to compute the relevant rates of return. For the present study, it was decided to work with data that were averages of three years (1969, 1970, and 1971) to moderate the influence of transitory factors. For each country, therefore, the ratios of income from capital to beginning-of-year capital stock were taken for 1969, 1970, and 1971. These ratios were then averaged to obtain the rates of return shown in Table 1.

It is notable how modest are the differences between the rates of return of the more advanced countries on the one hand and the LDCs on the other. The average national aggregate rate of return of the richest seven countries was 6.7 percent; that of the poorest seven was 8.4 percent. If Korea (a clear outlier) is excluded from the latter group, their average rate of return falls to 7.1 percent. Note that

TABLE 1

REAL RATES OF RETURN TO CAPITAL, 1969-71

Country	*National Aggregate Rate of Return*	*Private After-tax Rate of Return*
United States	0.085	0.076
Sweden	0.044	0.031
Canada	0.084	0.064
Germany	0.071	0.056
Belgium	0.079	0.058
Finland	0.057	0.048
United Kingdom	0.050	0.044
Greece	0.100	0.059
Argentina	0.098	0.106
Panama	0.065	0.039
Jamaica	0.108	0.094
Portugal	0.055	0.057
Costa Rica	0.057	0.048
Colombia	0.078	0.089
Honduras	0.065	0.077
Korea	0.163	0.152
Thailand	0.073	0.102
Sri Lanka	0.097	0.068

Sources: Based on national accounts data given in the United Nations *National Accounts Yearbook* and in publications of the World Bank, the OECD, and the Statistical Yearbooks of each country, and using capital stock figures generated from National Accounts Investment Series.

the 8.4 percent average for the poorest seven is just about equal to those for the United States and Canada, and that the 7.1 percent rate obtained by excluding Korea is equaled or exceeded by Germany and Belgium as well as by the United States and Canada.

With respect to the private after-tax rate of return the results are similar. The richest seven countries had an average real private rate of return of 5.4 percent; the poorest six (excluding Korea) had an average rate of 7.3 percent

which compares with a rate of 7.6 percent for the United States.

These findings immediately bring to mind the question whether relative factor endowments have much to do with the rate of return that capital yields in different places. To inquire into this question we fitted regressions in which the rate of return to capital was the dependent variable and the capital-labor ratio the independent variable. For this purpose we would have liked to make a careful adjustment of the data on labor force for each country so as to define labor in terms of units of more or less constant quality. Various possible quality corrections were explored, such as constructing indexes in which workers with different educational levels were given different quality weights, but the data requirements of such corrections proved insurmountable. In the end, we settled for a rough quality measure calibrated to the per capita income of the countries. Taking unity as a central value for a quality index, Sri Lanka was assigned an index of 0.5 and Sweden one of 1.5. The quality indices for the remaining countries were then interpolated between these two, on the basis of the logarithm of their per capita income.

The results of this exercise are shown in the first two columns of Table 2. There it is seen that the adjusted labor force of Sri Lanka is 2,209 thousand, exactly half of the 4,418 thousand given for the actual number of workers. Similarly, the adjusted figure for Sweden is 5,119 thousand, or 50 percent more than the actual number of workers (3,413 thousand). Costa Rica, Portugal, and Jamaica are close to the point where the interpolated quality index is equal to unity.

The meaning of this adjustment is as follows: If a representative sample of the Sri Lanka labor force were to go to Sweden (and somehow surmount linguistic and cultural barriers), those workers should be able to earn an average

income equal to one-third that of the average Swedish workers. If a similarly representative sample of the Costa Rican labor force were to appear in Sweden, those workers should be able to earn an average income equal to two-thirds of the Swedish average. I leave it to each reader to decide how apt he considers this choice of a quality calibration. Certainly I have no basis to argue that it is the "right" one, only that it is probably not very far wrong. For example, I would think it absurd that a representative sample of workers from Sri Lanka could earn in Sweden no more than one-sixth of the average Swedish wage, and equally absurd that they could earn as much as two-thirds of the Swedish average. Likewise, I would be very surprised if a representative sample of Costa Rican workers could not earn in Sweden more than half the Swedish average, and equally surprised if they could earn as much as 80 percent of it. Thus, while the particular weights assigned for Sri Lanka and Costa Rica (relative to Sweden) are admittedly not "accurate," they are certainly toward the center of a plausible range. When similar hypothetical exercises are carried out for the other countries on the list, they lead me to a similar conclusion. Thus I suggest that the quality correction made here should be broadly acceptable as yielding the very rough sort of approximation that it was intended to give.

Tables 3 and 4 present the results of regressions in which the independent variable is the amount of capital per adjusted worker. Table 3 shows how insensitive is the estimated rate of return to changes in K/L. On the other hand the tight correlation between real wages and the ratio of capital to adjusted labor is dramatic. When the relative factor price (p/ω) is the dependent variable, the coefficient is simply the sum of the coefficients of the two absolute factor prices, but, interestingly, the correlation coefficients for relative factor prices are lower than those for the real wage rate.

TABLE 2

BASIC DATA FOR 1970

Country	Labor (thousands)	Adjusted Labor Force (thousands)	Capital Stock per Adjusted Worker (thousands of 1970 dollars)	Annual Earnings per Adjusted Worker (thousands of 1970 dollars)
United States	82,897	129,236	21.5	6.37
Sweden	3,413	5,119	20.3	4.84
Canada	8,813	13,193	17.8	4.50
Germany	26,610	37,893	12.0	3.26
Belgium	3,638	5,125	14.6	3.34
Finland	2,118	2,901	13.2	2.21
United Kingdom	25,715	34,715	9.6	2.86
Greece	3,235	3,872	6.1	1.89
Argentina	9,011	10,487	5.3	1.41
Panama	488	517	3.6	1.40
Jamaica	767	796	3.3	0.79
Portugal	3,395	3,490	2.8	1.33
Costa Rica	547	531	3.4	1.38
Colombia	6,225	5,273	3.1	0.72
Honduras	689	542	3.4	0.94
Korea	12,080	9,507	1.5	0.58
Thailand	16,850	11,562	0.9	0.33
Sri Lanka	4,418	2,209	1.3	0.94

Source: Labor force data from United Nations, *Demographic Yearbook*, 1970, supplemented where necessary by the statistical yearbooks of each country.

Note: Earnings and capital stock were converted into U.S. dollars using the average exchange rate for 1970 as given by the International Monetary Fund in *International Financial Statistics*. Where multiple rates prevailed, the principal trade rate was used.

TABLE 3

REGRESSIONS ON THE *K/L* RATIO

(Log dependent variable on log *K/L*)

Dependent Variable	*Including Korea*		*Excluding Korea*	
	Coefficient	R^2	*Coefficient*	R^2
National aggregate rate of return (ρ)	-0.116	0.128	-0.059	0.046
Private after-tax rate of return (r)	-0.214	0.281	-0.161	0.200
Earnings per adjusted worker (ω)	0.780	0.900	0.770	0.890
Relative factor prices (ρ/ω)	-0.897	0.822	-0.840	0.819

TABLE 4

PREDICTED RATES OF RETURN

Country	*National Aggregate Rate of Return*	*Private After-tax Rate of Return*
Canada	6.7	5.2
United Kingdom	7.0	5.7
Costa Rica	7.4	6.7
Sri Lanka	7.9	7.9
Range including predicted rates for 15 countries	6.7-7.5	5.0-6.9

The simplest hypothesis for explaining these findings is that there is an international capital market which tends to equalize rates of return to capital across countries in much the same manner as a national capital market tends to equalize rates of return across activities and regions. We certainly do not expect to observe that capital-intensive activities within a country have significantly lower rates of return than labor-intensive ones. The reason is that we presume that the various activities draw their funds from the same general capital market.

If, then, the capital market extends across national boundaries, as it surely does, should we not expect to find a similar (if perhaps somewhat weaker) tendency for equalization of yields to occur? Table 4 shows dramatically how little variation of yields is explained by variations in the *K/L* ratio. In fact, the regression values of the rate of return for fifteen countries lie between the limits of 6.5 to 7.5 percent for the aggregate rate of return and of 5.0 to 6.9 percent of the private after-tax rate of return. This indicates how little influence very strong differences in *K/L* ratios have in generating differences in the yield on capital. In sharp contrast to these results is the predictive power of the regressions for real wages and for *relative* factor rewards. Here the range of predicted values exceeds a factor of 10, and even the narrowest range including fifteen observations, spans a factor of more than 5.

The hypothesis explaining these results thus not only says that the rate of return to capital is brought to rough equalization through the international capital market, but also that the relative abundance or scarcity of labor (which does not move so readily across national boundaries) has a great deal to do with the determination of real wages.

V. Some Sensitivity Tests

In this section we first explore the sensitivity of the results with respect to the arbitrary assumptions made in the course of estimating the rates of return to capital. Later, we test for sensitivity to the possibility of a systematic understatement of capital investment.

Table 5 presents, for a sample of countries, the national aggregate rate of return as initially estimated. Then what that estimate would be if we had imputed to capital only one-third (rather than one-half) of the income from unincorporated enterprises. Finally, the third column shows how the results would be modified if we imputed to land a quarter rather than a third of agricultural GDP and 5 rather than 10 percent of dwelling rents.

As can be seen from the table, the basic pattern of rates of return does not change in any major way as one moves from column 1 to columns 2 and 3. If anything, column 2 exhibits a narrowing of the range of variation.

Our final sensitivity test concerns the possibility that investment may be systematically understated in the national accounts of most countries. Tax laws in particular give individuals and business firms strong incentives to carry out under the label of current expense acts that are in an economic sense acts of investment. Farmers digging irrigation canals, building fences, or planting orchards are unlikely to report these activities in such a way that they will be reflected as investment in the national accounts. Similarly, businessmen regularly make minor plant alterations or additions without reporting the sums concerned first as income, then as investment. What is actually classified as investment tends to be activity involving major construction projects on the one hand or the purchase of machinery and equipment whose function is too obvious to be disguised.

TABLE 5

NATIONAL AGGREGATE RATES OF RETURN

Country	As Estimated (1)	Imputing to Capital 1/3 of Income from Unincorporated Enterprises (2)	Imputing to Land 1/4 of Agricultural GDP plus 5 Percent of Dwelling Rent (3)
Sweden	0.044	0.039	0.046
Belgium	0.079	0.070	0.081
Finland	0.057	0.052	0.060
United Kingdom	0.050	0.045	0.051
Greece	0.100	0.070	0.106
Portugal	0.055	0.049	0.074
Thailand	0.073	0.045	0.074
Sri Lanka	0.097	0.069	0.111

To allow for the possibility of systematic understatement of investment in the national accounts of the various countries, we have recalculated the rates of return to capital on the assumption that the actual investment figures were 20 percent higher than the stated ones. This modification not only augments the capital-stock figures for any year by 20 percent, it also increases the income from capital by 20 percent of that year's stated net investment (the part that, by our hypothesis, was treated in the national accounts as a current expense rather than as an investment). Thus if $0.2\,I_n$ represents more that 20 percent of the unadjusted income from capital, the numerator of the rate of return ratio will rise by more than 20 percent, and the rate of return itself will consequently rise as a result of the adjustment. Thus in Table 6, which presents the rate of return estimates resulting from this adjustment, some of the rates of return exceed, while others fall short of, their counterparts in Table 1.

Tables 7 and 8 replicate Tables 3 and 4, using the adjusted capital-stock and rate-of-return estimates. The principal conclusions remain unmodified. Regressions of rates of return on the capital-labor ratio fit poorly; regressions of real wages fit very well. Regressions with relative factor prices as the dependent variable also fit well, owing to the close relationship between real wages and the K/L ratio.

The regression values of the rate of return again fall in a narrow range (see Table 8), with fifteen countries falling within a range defined by a factor of 1.3 for the national aggregate rate of return and 1.4 for the private after-tax rate. By way of contrast, the narrowest range spanning fifteen regression values for relative factor prices is defined by a factor of 6.5 to 7.0, depending on which rate of return is used. The basic conclusion—relative insensitivity of the rate of return and strong sensitivity of real wages to relative factor endowments—thus remains unaltered if not reinforced as a consequence of the sensitivity tests.

TABLE 6

ADJUSTED REAL RATES OF RETURN

Country	*National Aggregate Rate of Return*	*Private After-tax Rate of Return*
United States	0.075	0.068
Sweden	0.043	0.042
Canada	0.078	0.061
Germany	0.070	0.057
Belgium	0.072	0.049
Finland	0.049	0.042
United Kingdom	0.048	0.041
Greece	0.085	0.062
Argentina	0.089	0.096
Panama	0.071	0.049
Jamaica	0.101	0.086
Portugal	0.059	0.061
Costa Rica	0.063	0.055
Colombia	0.074	0.083
Honduras	0.060	0.069
Korea	0.161	0.149
Thailand	0.099	0.093
Sri Lanka	0.092	0.062

Source: Capital stock figures and other data generated using 1.2 x National Accounts Investment Series.

VI. Methodology for Testing the Technology Hypothesis

In the present section we turn to the second substantive lesson mentioned in the introduction to this article. This concerns the degree to which LDCs are "condemned" to use technologies, invented in more advanced countries, which are (a) inappropriate to their factor endowments and (b) inflexible.

The approach we follow takes the U.S. Census of Manufactures as a base, and then predicts, industry by industry,

TABLE 7

REGRESSIONS ON THE K^*/L RATIO

Dependent Variable	*Including Korea* Coefficient	R^2	*Excluding Korea* Coefficient	R^2
National aggregate rate of return (ρ^*)	-0.181	0.32	-0.131	0.25
Private after-tax rate of return (r^*)	-0.206	0.36	-0.152	0.29
Earnings per adjusted worker (ω)	0.780	0.90	0.77	0.89
Relative factor prices (ρ^*/ω)	-0.966	0.87	-0.91	0.86

Note: Log dependent variable on log K^*/L is given, with data adjusted to incorporate the assumption that actual $I_t^* = 1.2 \times$ stated I_t.

TABLE 8

PREDICTED RATES OF RETURN

Country	*National Aggregate Rate of Return*	*Private After-tax Rate of Return*
Canada	6.1	5.1
United Kingdom	6.7	5.7
Costa Rica	7.5	6.6
Sri Lanka	8.5	7.7
Range including predicted rates for 15 countries	5.9–7.6	5.0–6.8

the ratio of wage and salary payments to the gross earnings of capital for various LDCs. The comparisons are made for 68 three-digit industries, which were selected on the basis of

two criteria: (1) they had to be industries for which there was a presumption that they would belong to the "modern" sector in an LDC (i.e., they could not include industries susceptible of including traditional handicraft activities), and (2) they had to be industries for which counterparts could be established between the United States industrial classification and that employed by the LDCs.

For each such industry the average wage paid was obtained by taking the ratio wage-and-salary payments as reported in the industrial census to the number of employed persons as reported in the same source. It was then assumed that if the same technological processes were employed in the LDC as in the United States for the same 3-digit industry, its wages bill (WN) per dollar of gross return to capital ($\rho_g K$) would be equal to:

$$\left[\frac{W\hat{N}}{\rho_g K}\right]_{\text{LDC}} = \left[\frac{WN}{\rho_g K}\right]_{\text{US}} \times \frac{W_{\text{LDC}}}{W_{\text{US}}}$$

This assumes, in a sense, that the gross rate of return ρ_g is the same in the LDC as in the United States. The previous sections of this article lend credence to the view that rates of return in the LDCs tend to be close to those of the United States. If anything, it is likely that they may be slightly higher, in which case the prediction of LDC employment per dollar of capital return $(W\hat{N}/\rho_g K)_{\text{LDC}}$ would tend to be too high.

The next step is to compare the actual ratio of $(WN/\rho_g K)_{\text{LDC}}$ with the predicted one. This gives us, for each industry, the multiple by which actual employment exceeds that predicted by the constant-technology, no-substitution hypothesis.

The results of this exercise are presented in Table 9. Eighteen LDCs are represented in that table, and for each LDC the number of three-digit industries that were compared with their U.S. counterparts is given. Note that not all of

TABLE 9

DISTRIBUTIONS OF RATIOS OF ACTUAL TO "PREDICTED" LABOR PAYMENTS: 727 INDUSTRIES IN 18 LDC'S

Country	*Number of Industries*	*First Quartile*	*Median*	*Third Quartile*	*Ninth Decile*	*Year*
Singapore	32	5.0	6.5	9.1	15.6	1967
Argentina	40	1.5	2.1	3.1	8.0	1963
Venezuela	44	1.2	2.3	3.2	3.9	1963
Chile	43	4.5	7.4	11.9	19.8	1957
Mexico	41	1.7	2.1	3.2	6.9	1971
Costa Rica	34	1.1	1.6	3.0	3.9	1964
Peru	41	1.9	4.4	7.8	53.9	1963
Zambia	26	2.1	3.7	6.4	12.0	1972
Turkey	56	2.6	3.8	6.5	12.7	1964
Ecuador	41	3.4	5.8	13.8	19.8	1965
El Salvador	39	2.2	4.8	11.2	32.6	1961
Honduras	23	2.5	4.0	5.6	12.7	1966
Paraguay	36	1.4	3.3	9.9	40.3	1965
Korea	54	5.1	8.0	11.9	20.8	1967
Ghana	32	1.2	1.5	1.8	4.7	1967
Philippines	47	4.0	6.4	12.8	78.0	1961
Pakistan	49	3.1	4.5	7.0	19.6	1965
India	48	12.0	21.4	39.0	93.7	1966

Source: Industrial census (censuses of manufactures) of the listed countries. (Exchange rates used in the comparison of wages were those given by the International Monetary Fund in *International Financial Statistics* for the year in question. Where multiple rates prevailed, the principal trade rate was used.)

Note: "Predicted" payments are based on U.S. (1963) factor proportions plus actual wages in the given LDC industry.

the 68 U.S. industries had counterparts in any one of the LDCs. Note, too, that the dates of the industrial census used in the exercise vary from one LDC to another. These

modest variations of date are not thought to impart any significant bias to the results. The hypothesis we are "testing" concerns the fundamental structure of industrial activity and employment in LDCs; this is not something which suffers dramatic changes over a year or a quinquennium.

In Table 9 an effort is made to convey, for each country, a sense of the distribution of the ratios of actual to predicted employment per dollar of return to capital. Toward this end, the third quartile observations are demarcated, as well as the ninth decile (that value which is exceeded by barely 10 percent of the observations).

VII. Discussion and Testing of the Results

It is clear from Table 9 that there are a great many three-digit industries in which relative factor use in the LDCs is found to be 5, 6, even 10 and 20 times as labor-intensive as in the United States. This should not be taken to suggest that these countries use very different machines than the United States, or that more workers operate a particular machine when it is running. We have not yet found a convenient way to have two typists simultaneously working at a given typewriter or two chauffeurs simultaneously driving a given car. That is simply not the way capital-labor substitution takes place.

It is more accurate to think that factors of production are employed with contingencies in mind. The guest-room furniture may be used only a few days per year, yet the family feels it is worthwhile to have it. The function of the telephone is in considerable measure simply to be there in the event a call comes in, or someone wants to make an outgoing call. Skiers find that if they do more than three or four days' skiing in a year, it pays to own the capital equipment (skis, boots, poles, etc.) rather than to rent it.

These homely examples are meant to put the reader in the right frame of mind to appreciate how capital-labor substitution really takes place as one moves from capital-rich to labor-abundant countries. In capital-rich countries it is worthwhile to have equipment around which may not be actually used very often, but which justifies its presence because it saves expensive man-hours. In labor-abundant countries, menial labor is so cheap that it often does not pay to buy labor-saving machines. Moreover, the differences in relative scarcity of menial versus highly qualified labor means that much saving of the latter takes place through the intensive use of the former. It is likely, for example, that the peons (runners) who sit outside executive offices in India can earn their meager daily pay simply by one or two errands for their boss. Their marginal productivity is measured in the value of the time they save their boss in running to get cigarettes, to buy a newspaper, to take a message down the hall.

These examples more aptly give the flavor of capital-labor substitution in LDCs than does the image of many workers piled up at a given machine, or even of any strong tendency to multiple-shift work (which is actually not much more prevalent in LDCs than in advanced countries).

As a final exercise, let us attempt to generalize, statistically, on the basis of the observations summarized in Table 9. For the present purpose, I would like to imagine those 727 observations as a sample drawn from a much larger universe of all possible comparisons between industry i in less-developed country j, and its counterpart in the United States.

Let the population of industry-country comparisons cover all modern industries (excluding again those which are traditional handicraft activities in the LDCs), and even all less-developed countries. Instead of 68 three-digit industries there might be 200 or more that fit these requirements, and instead of 18 LDCs we surely would have well

over 100. So the universe from which our "sample" of 727 was drawn might be perhaps as large as 10,000 (recalling that not all industries are represented in a given LDC).

Thinking now about that universe, consider the variable in question to be the ratio of "predicted" to actual employment in industry i and LDC j, per dollar of gross return to capital. That variable obviously has some median value in the universe we are dealing with. Our hypotheses and our tests will deal with that median.

If that median were 4.0, what is the probability that a sample of 727 would contain as many as 51.9 percent (or as few as 48.1 percent) of observations in excess of 4.0? The answer is about a 30-percent probability. We therefore cannot plausibly reject the hypothesis that the true median is 4.0.

However, suppose the median of the universe were 3.5. What then would be the chance that a sample of 727 observations would have as high a percentage of observations in excess of (or below) the median as we observe in our sample? *That* probability is less than one in a thousand.

Finally, suppose the population median were 3.0. Then the chance of a sample of 727 yielding results as extreme as those we observe would be *less than one in a billion!*

These results are presented in Table 10. The conclusion, then, is that the typical LDC, if it is constrained by modern machinery at all, is put in a position where on the whole, in modern industrial activities, it uses on the average 4 times the amount of labor used in similar activities in the United States per dollar of return to capital. To say that that figure is as low as 3.5 or 3.0 is grossly inconsistent with the evidence. To pretend that, somehow, fixed proportions reign, industry by industry, across countries is erroneous beyond belief.

TABLE 10

TESTS OF HYPOTHESES CONCERNING FACTOR PROPORTIONS

Hypothesis: Median Factor Payments Ratio for all 3-digit LDC Industries is: (1)	Proportion of 727 Sample Observations above Median Defined in Col. (1) (2)	Probability (two-tailed) of an Occurrence as Extreme as (2) if Hypothesis of (1) were True (3)
4.0	0.519	~.30
3.5	0.569	< .001
3.0	0.632	< .000000001

Note: Standard error of sample proportion $\sqrt{pq}/N = .0185$.

NOTES

1. Arnold C. Harberger, "On Estimating the Rate of Return to Capital in Colombia," in *Project Evaluation* (London: Macmillan; and Chicago: Markham, 1972), chap. 6, pp. 132-156; and "Private and Social Rates of Return to Capital in Uruguay" (with Daniel Wisecarver), *Economic Development and Cultural Change* 25, no. 3 (April 1977): 411-445.

2. In my two previous attempts at estimation of this type, I took the opposite tack and tried to obtain independent estimates for land. I found this line of approach not only to require a great deal of search for adequate data, but also to be quite country-specific. That is to say, the ways of attacking the problem which seem most reasonable for Colombia were quite different from those that seemed best in the case of Uruguay. In the light of this I could not feel at all comfortable trying to impose a single uniform methodology for estimating the value of land across countries that were very different in nearly all relevant respects. I feel much more comfortable with the use of common procedures for attributing income to land. As will be seen, these procedures are flexible in the sense that they attribute more income to land in countries in which agriculture is more important, etc.