EQUIPMENT INVESTMENT AND ECONOMIC GROWTH*

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Using data from the United Nations Comparison Project and the Penn World Table, we find that machinery and equipment investment has a strong association with growth: over 1960–1985 each extra percent of GDP invested in equipment is associated with an increase in GDP growth of one third of a percentage point per year. This is a much stronger association than found between growth and any of the other components of investment. A variety of considerations suggest that this association is causal, that higher equipment investment drives faster growth, and that the social return to equipment investment in well-functioning market economies is on the order of 30 percent per year.

I. INTRODUCTION

It is no accident that the era in which European economic growth took off is called the *Industrial* Revolution. Blanqui [1837], first to use the phrase in print, identified its beginnings in the invention and spread of those "two machines, henceforth immortal, the steam engine and the cotton-spinning [water frame]." Ever since, qualitative historical discussions of growth have emphasized the role of machinery investment in augmenting labor power. Landes' [1969] statement that "the machine is at the heart of the new economic civilization" is typical of accounts that have assigned a central role to mechanization. Technology embodied in machinery has been, as Mokyr [1990] says, "the lever of riches."

Yet at least until recently modern quantitative studies of economic growth have tended to downplay the role of mechanization. Work in the aggregated growth accounting tradition of Solow [1957], Denison [1967], and Abramovitz [1956] has typically concluded that capital accumulation accounts for only a relatively small fraction of productivity growth in individual countries, or of differences across countries.[1] The assumption underlying growth

*We thank Jonathan Gruber and Douglas Hendrickson for enthusiastic and highly capable research assistance; Robert Barro, Barry Bosworth, Anne Case, David Cutler, Paul David, Jay Hamilton, Dale Jorgenson, Anne Krueger, Ian McLean, Paul Romer, Andrei Schleifer, Robert Waldmann, Jeffrey Williamson, and especially Robert Summers for helpful discussions; Alan Heston and Robert Summers for providing unpublished data, revisions of published data, and for advising us on the use of the data; and David Cutler for aid in manipulating data.

1. More disaggregated growth accounting studies like those of Jorgenson [1988], which consider different types of capital and draw a distinction between capital stocks and capital services, have typically found a larger role for accumulation in accounting for growth in some countries. We discuss the relationship between our findings and those of more disaggregated growth accounting studies in the conclusion.

The Quarterly Journal of Economics, May 1991

accounting calculations that capital is paid its marginal product, coupled with observed profit rates, implies that increasing the rate of capital accumulation can make only a modest contribution to increasing growth in net product. Even a doubling of the U. S. net private investment rate would, according to standard estimates, raise the growth rate of real income by less than half a percentage point per year.

This paper provides quantitative evidence in support of the older, traditional view that the accumulation of machinery is a prime determinant of national rates of productivity growth, and against the supposition that the private return to equipment investment mirrors its social product. Using data on the components of investment drawn from the United Nations International Comparison Project (U.N. ICP) (see Kravis, Heston, and Summers [1982] and United Nations [1985]) and Summers and Heston [1988, 1990], we demonstrate a clear, strong and robust statistical relationship between national rates of machinery and equipment investment and productivity growth. Equipment investment has far more explanatory power for national rates of productivity growth than other components of investment, and outperforms many other variables included in cross-country equations accounting for growth. High rates of equipment investment can, for example, account for nearly all of Japan's extraordinary growth performance.

Timing evidence, consideration of alternative sources of variation in equipment investment, the behavior of equipment prices, and the differing association of equipment investment with intensive and extensive growth all suggest that this association is causal, with higher equipment investment driving faster economic growth. We interpret our results as suggesting that the social return to equipment investment in well-functioning market economies is on the order of 30 percent per year.

This paper is organized as follows. Section II motivates our emphasis on equipment investment and presents information on equipment prices and quantities for our sample of countries. Section III presents the basic results linking equipment investment and productivity growth. It also explores their robustness along a number of dimensions including variations in sample period, the sample of countries, the inclusion of additional determinants of growth, various interactions, and alternative measures of equipment investment.

Section IV addresses the issue of causality in the relationship between equipment investment and growth. The pattern of equipment prices supports the claim that fast-growing countries are those with favorable supply conditions for producers' equipment, not those where some third factor has accelerated growth and shifted the demand curve for producers' equipment outward. Section IV also examines the timing of the relationship between equipment investment and growth, the effects of alternative sources of variation in equipment investment on productivity growth, and the differential association of equipment investment with that part of GDP growth generated by rising productivity and that part generated by an increasing labor force. Section V concludes by discussing the relationship between our results and previous arguments suggesting the unimportance of capital formation, and considering the normative implications of our findings.

II. Equipment Investment and Economic Structure

A. Equipment Investment and Economic Development

There are at least three grounds for suspecting that equipment investment may have higher social returns than other forms of investment.[2] First, as we have already noted, historical accounts of economic growth invariably assign a central role to mechanization. Economic historians have seen the richest countries as those that were first in inventing and applying capital-intensive technologies, in which machines embody the most advanced technological knowledge (see, for example, Usher [1920], Landes [1969], and Pollard [1982]). The history of economic growth is often written as if nations and industries either seized the opportunity to intensify their specialization in manufactures and grew rapidly, or failed to seize such opportunities and stagnated (as in Rostow [1958] or Gerschenkron [1962]).

Second, discussions of economic growth in the development economics (like Hirschman [1958] or Chenery et al. [1986]) and the new growth theory traditions (like Romer [1986]) stress external

2. Jorgenson's [1988] work highlights that equipment investment will have a larger short-run effect on growth in *gross* product than other forms of investment because of equipment's higher depreciation rate even if private and social returns to different forms of investment are equalized. In the long run, however, equipment's higher depreciation rate leads it to have a smaller effect on growth. We discuss these issues in the conclusion.

economies or "linkages" as causes of growth. Spillovers may well be larger in some sectors than in others. Manufacturing accounts for 95 percent of private-sector research and development in America, and within manufacturing the equipment sector accounts for more than half of research and development according to Summers [1990]. Hence, it is plausible that equipment investment will give rise to especially important external economies.

Third, it is often alleged that a number of countries have succeeded in growing rapidly by pursuing a government-led "developmental state" approach to development. The rationale for this policy is that countries which adopt the price and quantity structure of more affluent nations are more likely to grow than those that possess the structure of poorer countries. The government should jump-start the industrialization process by transforming economic structure faster than private entrepreneurs would.[3] As we discuss below, rates of equipment investment tend to increase, and their price tends to fall as productivity rises. If the developmental state approach is correct, countries investing more heavily in and enjoying lower equipment prices should enjoy more rapid growth.

B. Measuring Equipment Investment

Data on the share of nominal national product devoted to equipment have long been available from national income accounts. However, these data do not permit an accurate assessment of the impact of equipment investment on growth unless the relative price of equipment is constant across countries. The availability of data from the U.N. ICP, described in Kravis, Heston, and Summers [1982], provides information on the relative prices of many components of GNP at a disaggregated level for a large sample of countries for individual "snapshot" years. It is therefore possible to study in a cross section of nations the relationship between investment components and growth.

The ICP collects data on three components of producers' durable investment—producers' transportation equipment, electrical machinery, and nonelectrical machinery. In an earlier draft of this paper [De Long and Summers, 1990], we investigated the relationship between total producers' durable investment—the

3. Works taking this point of view include Cohen and Zysman [1987] and Johnson [1982].

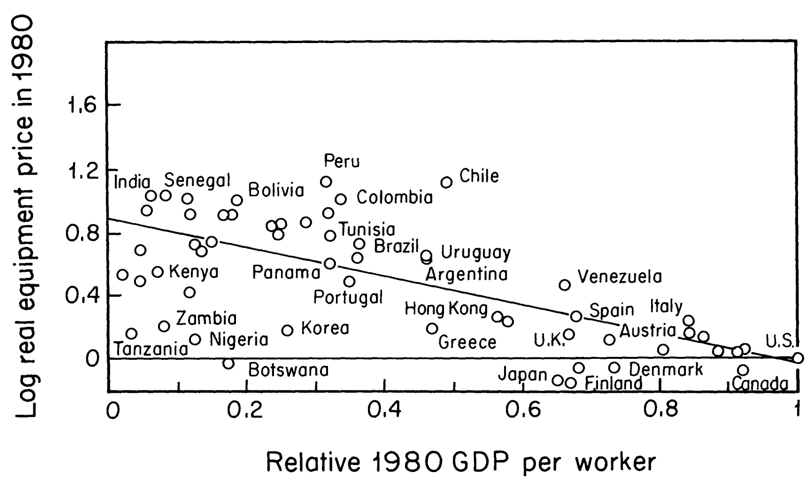

FIGURE I
Equipment Prices and Productivity in 1980

sum of these three components—and productivity growth. In carrying out the research reported here, we realized that there was little information in the producers' transportation component of durables, and so in this paper we focus primarily on an equipment aggregate comprising electrical and nonelectrical machinery. With the benefit of hindsight the exclusion of producers' transportation equipment can perhaps be justified by arguing that much variation in rates of transportation investment reflects differences in the "need" for transportation caused by differences in urbanization and population density.

C. Economic Structures and GDP per Worker Levels

The most extensive ICP data on equipment investment come from the Phase IV 1980 survey which covers more than sixty countries.[4] Figures I and II plot, respectively, our estimates of the real price of equipment relative to the GDP deflator in 1980 and of

4. Kravis, Heston, and Summers [1982] report ICP Phase III estimates of relative price and quantity structures in 1975 for 60 percent of the Phase IV countries. We merge the 1975 Phase III and 1980 Phase IV snapshots of price and quantity structures with the 1960–1985 long-run growth data of Penn World Table V (see Summers and Heston [1990]); we have adjusted the ICP estimates using revisions of published ICP data kindly provided by Robert Summers.

We also omit high-income oil-exporting countries from our regressions. Our total sample consists of 61 countries. Appendix IV presents the data series used in our regressions.

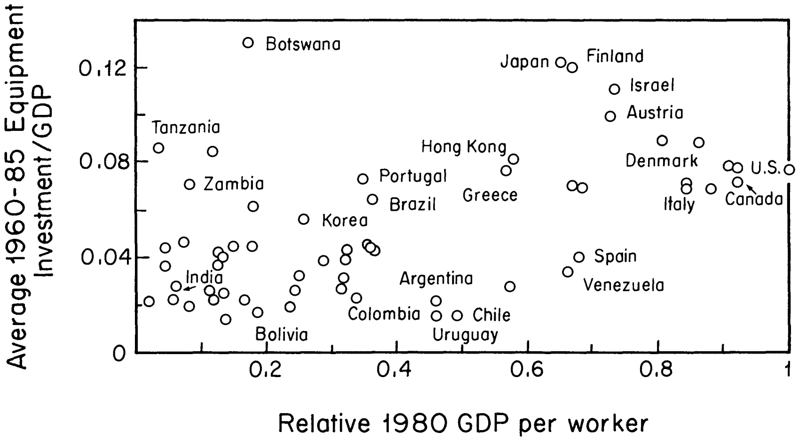

FIGURE II
Equipment Investment and GDP per Worker

the average 1960–1985 share of GDP devoted to equipment investment against 1980 GDP per worker for those nations in our sample in ICP Phase IV. We draw three principal conclusions.

First, variations in relative prices of equipment are large, and so measures of the share of nominal national product devoted to equipment investment are likely to be misleading guides to real magnitudes. As productivity levels increase, there is a tendency for the relative price of equipment to fall. An increase of ten percentage points in a country's income relative to the United States is associated with an 8 percent fall in its machinery price relative to the GDP deflator.[5] This would generate a positive relationship between the real equipment share and productivity even if there were no correlation between productivity and the nominal share of equipment. Beyond the relationship between equipment prices and productivity, there are sizeable differences in the cost and quantity of equipment investment between countries at similar levels of development.

Second, as Figure II shows, there are wide variations in national rates of equipment investment as a share of GDP. Wealthier nations tend to have higher equipment investment

5. A similar relationship holds over time: the fastest growing countries are also those that have experienced the steepest declines in relative real machinery prices. See De Long and Summers [1990].

shares: those nations with 1980 GDP per worker levels less than 10 percent of the United States have equipment shares, calculated in the "international dollar" measure of Summers and Heston, that average 3.5 percent of GDP; those nations with 1980 GDP per worker levels greater than 70 percent of the United States have equipment shares averaging 8.2 percent of GDP. The cross-section variation at given productivity levels is also substantial. Equipment investment shares in countries such as Chile and Venezuela are some five percentage points lower than would be expected given GDP per worker. Equipment investment shares in countries such as Israel, Japan, and Finland are five percentage points higher than expected.

Third, poorer nations possess very large relative variances in their equipment prices and quantities. Those nations with GDP per worker levels above 80 percent of the U. S. level have a standard deviation of producers' durables prices about the simple regression line of 10 percent; those nations with GDP per worker levels below 20 percent of the U. S. level have a standard deviation of more than 50 percent. Some, perhaps much, of this variation in prices and quantities at the low end of the productivity scale is measurement error. Much of the remainder may reflect differences in the character of investment in very poor countries. For example, Zambian investment is concentrated in copper mining and copper-based manufacturing, which employ 5 percent of its labor force and where average labor productivity is 40 times average labor productivity in agriculture; relatively small equipment investments in the copper sector will loom large in the economy as a whole; yet it is difficult to believe that this sector has significant linkages with the rest of the economy (see Young [1973] and Bates [1976, 1981]).

We are thus skeptical of what can be learned by combining in one regression very poor countries, which appear to have productivity levels less than those enjoyed in the United States before the industrial revolution,[6] with technologically sophisticated developed countries. We therefore focus heavily on a sample of countries with relatively high productivity levels: those countries with GDP per worker levels greater than 25 percent of the U. S. level in 1960.

Before analyzing the relationship between equipment invest-

6. According to Summers and Heston, the United States today has a real GDP per worker level fourteen times that of Zambia. According to Kuznets [1971], U. S. real GDP per worker increased by a factor of eight between 1870 and the present, and perhaps slightly less than doubled over the previous century.

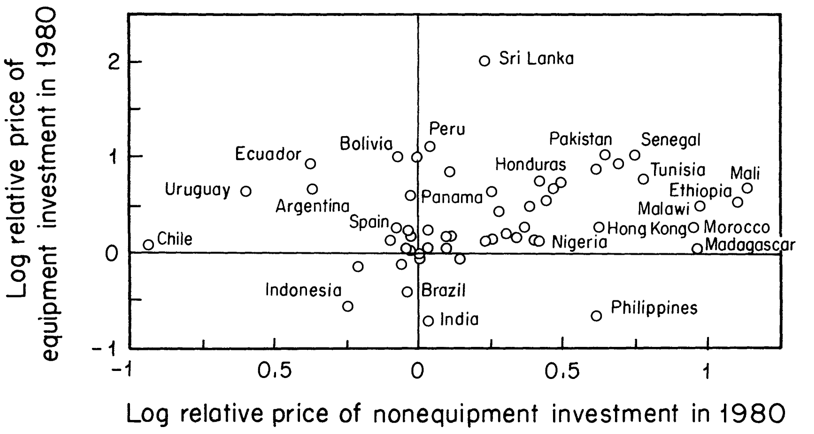

FIGURE III
Equipment and Nonequipment Investment Prices in 1980

ment and economic growth in the next section, we pause to highlight the fact that international patterns of equipment differ from patterns of nonequipment investment. In our sample, equipment investment averages 28 percent of total investment, but the composition of investment varies widely. Figure III plots the 1980 price of equipment investment against the investment deflator. Figure IV plots our estimate of equipment investment over 1960–1985 against other investment as a share of GDP. The correlations are weak: 0.203 for the prices, 0.427 for the quantity shares in our sample. In the case of prices, this should not be too surprising, for equipment is tradable, while structures—the other major component of investment—are not.[7]

The fact that equipment's share in total investment varies so widely and the centrality of machinery in historical discussions of growth suggest the importance of disaggregating investment in considering its relation to economic growth. If machinery and structures contribute differently to growth, then analyses of the relationship between total capital accumulation and growth are likely to be very misleading. Likewise, the use of an investment price deviation from a "normal" level as a proxy for the extent of distortions in an economy, as in Barro [1991], appears implausible

7. Warner [1990] notes that 31 percent of U. S. equipment purchases in 1989 were imported.

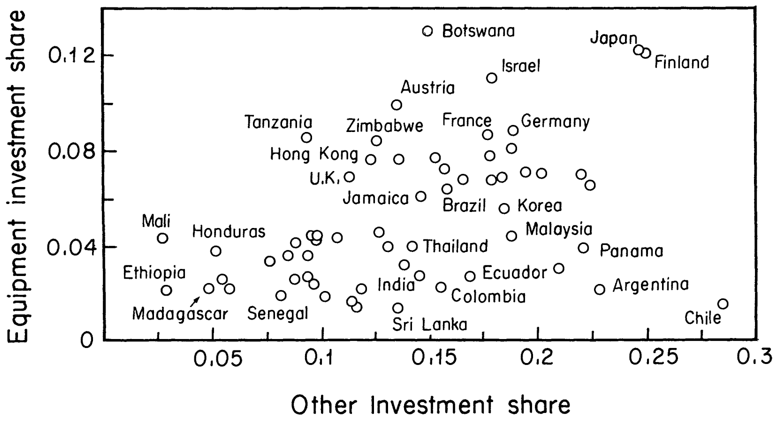

FIGURE IV
Equipment and Nonequipment Investment as Shares of GDP

given that structures are not traded and that the investment deflator depends heavily on the price of structures and on the composition of investment.

III. EQUIPMENT AND GROWTH

This section demonstrates that nations which invested heavily in equipment relative to other nations at the same stage of economic development enjoyed rapid growth over 1960–1985. Our measure of economic growth is the growth rate of GDP per worker, measured in international dollars, as reported by Summers and Heston [1990]. In evaluating the contribution of equipment investment to growth, we hold constant labor force growth rates, the share of GDP devoted to nonequipment investment, and the level of GDP per worker. For the most part, we rely on the inclusion of the initial GDP per worker gap in the regressions to control for any systematic causal relationship running from the level of GDP per worker to the level of equipment investment. We also experiment with using a gap variable from the middle of the sample, as recommended by Romer [1989].

A. Basic Results

Figure V, and equation (1) beneath it, report our basic results obtained using the high productivity sample of the 25 nations with 1960 levels of GDP per worker greater than 25 percent of the U. S.

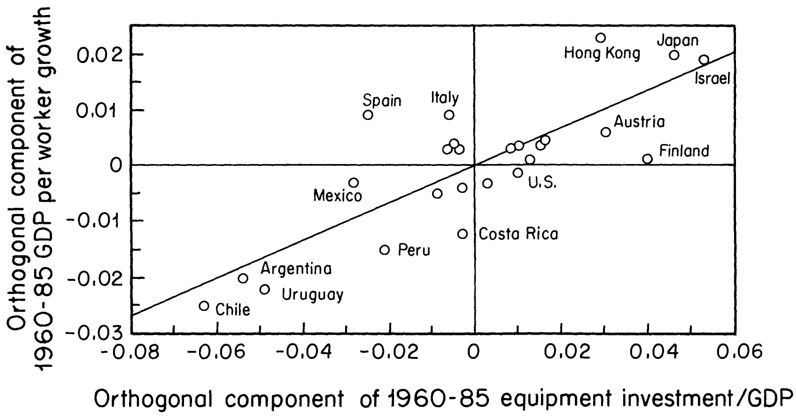

FIGURE V
Partial Scatter of Growth and Equipment Investment, 1960–1985

$$
\begin{aligned}
(1)\quad \text{GDP/wkr Gr} = &- \underset{(0.146)}{0.002}(\text{LF Growth}) + \underset{(0.009)}{0.030}(\text{Rel. GDP Gap}) \\
&+ \underset{(0.054)}{0.337}(\text{Equip}) - \underset{(0.033)}{0.015}(\text{Nonequip}) \\
n = 25 \qquad & R^2 = 0.662 \qquad \text{RMSE} = 0.008
\end{aligned}
$$

level. Figure VI reports the scatter for the same regression using the larger 61-nation sample. The figures plot that component of 1960–1985 GDP per worker growth orthogonal to 1960–1985 labor force growth, to the average 1960–1985 real nonequipment investment share of GDP, and to the 1960 relative GDP per worker gap vis-à-vis the United States against that component of the 1960–1985 real equipment investment share of GDP orthogonal to the same three variables. That is, it provides a partial scatter of equipment investment and productivity growth.

While the standard deviation of growth rates in our sample is 1.32 percent, the standard error of the equation using equipment quantities illustrated in Figure V is only 0.80 percent. Including the equipment variable reduces the variance of the residual by 47 percent compared with a similar equation containing the aggregate investment share. The equation provides strong support for the proposition that equipment investment is more closely related to growth than are other components of investment.

The regression line of equation (1) implies that an increase of three percentage points (one standard deviation) in the share of GDP devoted to equipment investment leads to an increase in the growth of GDP per worker of 1.02 percent per year, which

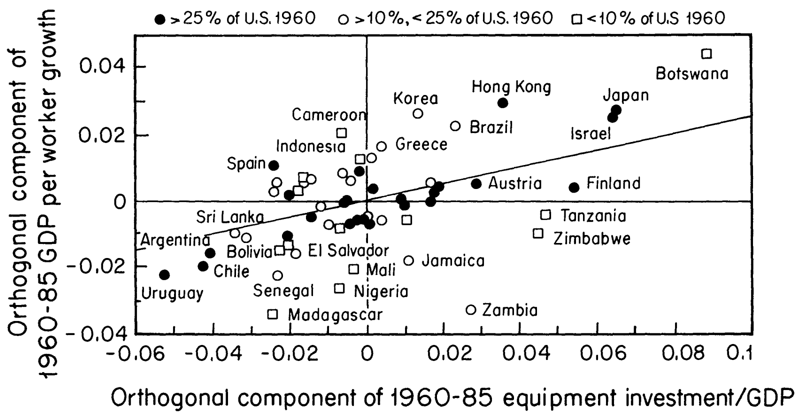

FIGURE VI
Partial Scatter of Growth and Equipment Investment, 1960–1985

$$(1') \quad \text{GDP/wkr Gr} = \underset{(0.198)}{-\,0.031}\,(\text{LF Growth}) + \underset{(0.009)}{0.020}\,(\text{Rel. GDP Gap}) + \underset{(0.065)}{0.265}\,(\text{Equip}) + \underset{(0.035)}{0.062}\,(\text{Nonequip})$$

$n = 61 \qquad R^2 = 0.291 \qquad \text{RMSE} = 0.013$

cumulates to a 29 percent difference over the 25 years of the sample. This means, for example, that differences in equipment investment account for essentially all of the extraordinary growth performance of Japan relative to the sample as a whole. Conditional on the initial GDP per worker gap and the achieved rates of growth of the labor force, Japan has achieved a relative GDP per worker growth rate edge of 2.2 percent per year over 1960–1985 relative to the average of the high productivity sample, and 5 percent per year relative to Argentina. In both cases, more than four-fifths of this difference is accounted for by Japan's high quantity of equipment investment.[8]

The shift to a larger sample in Figure VI does not materially

8. Japanese growth performance was extraordinary even before the post-World War II period. High equipment quantities and low prices characterized its economy far back into history. The argument that abnormally low equipment prices have had a strong impact on growth in Japan by significantly increasing the returns to saving is made by De Bever and Williamson [1978], who note abnormally low producers' durable prices in Japan and "suggest . . . that this unique relative price behavior has its source in the technological dynamics of Japan's capital goods industry . . . [and] deserves far more attention than Japanese analysts have given it so far." An argument that Japan has achieved high growth by concentrating investment in equipment rather than structures is made in Patrick and Rosovsky [1976].

affect the coefficient of the equipment quantity variable. We performed Chow tests to see whether the same structure holds for countries with 1960 GDP per worker levels greater than and less than 25 percent of the United States, and failed to reject the null hypothesis of a common structure of regression coefficients.[9]

B. Statistical Issues

The regression lines depicted in Figures V and VI and equations (1) and (1') were obtained using OLS. We verified that the standard errors were not appreciably affected by allowing for conditional heteroskedasticity. A more significant issue is spatial correlation.[10] If neighboring nations have similar values for significant omitted variables, the data will contain less information than the reported standard errors suggest. In a sense, country pairs like Norway and Sweden or Argentina and Uruguay seem a priori not two observations but more nearly one single observation: we would not feel that we had lost information if we had data not on Belgium and the Netherlands separately but on the Benelux aggregate instead.

However, when we examined the pattern of the residuals from the high productivity sample, we found to our surprise no sign of spatial correlation. We regressed the product $u_i u_j$ of the regression residuals for all country pairs on the distance between the capitals of country i and country j. We expected to find that the product of the residuals would tend to be high when countries had capitals that were close together. We did not: for a variety of specifications the estimated dependence of $u_i u_j$ on distance was statistically insignificant and substantively unimportant. We report some of our results on spatial correlation in an appendix.

We also examined sensitivity to outliers by dropping each of the observations in turn. There are no individual observations that, when omitted, change the equipment investment coefficient by as much as 10 percent in the sample of the 25 high-income nations.[11]

The most significant statistical issue is that the equations

9. We always reject the null hypothesis that the residual variances are the same across the 25 percent of 1960 U. S. GDP per worker divide. Nonparametric tests do reject the hypothesis of a common structure of regression coefficients.

10. See Case [1987].

11. Hong Kong is the most influential observation, having a very high growth rate, given its equipment investment share. In the larger sample of 61 countries, Botswana and Zambia are influential outliers, as we discuss below.

reported here are not the first equations we have estimated. Our earlier work explored various price variables in more detail, and also examined an equipment aggregate that included transportation equipment, unlike the aggregate used here. We thus choose the current set of specifications partially on empirical rather than on a priori grounds.

Since finishing the bulk of the empirical work for this paper, we have obtained data on equipment quantities for five additional countries.[12] Adding these five points to our basic regression raises the coefficient on equipment investment by an insignificant amount. When data from later versions of the ICP become available for a larger number of new countries, it will be possible to further check the validity of the estimates we present using a sample not available when the estimates were generated.

C. Sample Selection Issues

There are two important dimensions of sample selection involved in Figure V and equation (1): the choice of countries included in the analysis, and the choice of a sample period. These issues are addressed in Table I. It considers the 1970–1985, the 1975–1985, and the 1960–1975 periods as well as the 1960–1985 period as a whole. The results for the equipment investment variable are not sensitive to the choice of a sample period.

Table I also compares the results obtained using the high productivity sample of countries with 1960 GDP per worker greater than 25 percent of the U. S. level with results obtained using the larger 61-country sample, and with results obtained using the 61-country sample while controlling for various educational and political correlates of growth as in Barro [1991].[13] If differences in the reduced-form laws of motion followed by rich and poor countries spring from poor countries' lack of the human and political infrastructure necessary to take advantage of modern technologies and to make fixed capital-intensive investments in technologies secure, including variables such as literacy and education rates should improve the power of regressions on the larger sample.[14] The additional variables do contribute modestly to the

12. Australia, Iran, New Zealand, Turkey, and Sweden.
13. The coefficients on the correlates favored by Barro [1991] are reported in Appendix II.
14. The additional political and human capital correlates would have little effect in the high productivity sample because they do not vary much among developed countries.

TABLE I
PRODUCTIVITY GROWTH AND EQUIPMENT INVESTMENT

Period used	Lab. fce. growth	GDP/wkr. gap	Equipment[a] share	Struc. & trans. share	n	R^2 (RMSE)
			High productivity sample			
1960–1985	−0.002	0.030	0.337	−0.015	25	0.662
	(0.146)	(0.009)	(0.054)	(0.033)		(0.008)
1960–1985	0.023	0.016[b]	0.361	−0.019	25	0.507
(1975 gap)	(0.179)	(0.011)	(0.070)	(0.040)		(0.009)
1960–1975	−0.081	0.049	0.295	−0.056	25	0.492
	(0.197)	(0.013)	(0.075)	(0.043)		(0.011)
1970–1985	−0.030	0.015	0.379	−0.025	25	0.593
	(0.163)	(0.011)	(0.063)	(0.038)		(0.009)
1975–1985	−0.177	0.014	0.425	0.047	25	0.428
	(0.258)	(0.016)	(0.105)	(0.059)		(0.013)
			Larger sample			
1960–1985	−0.031	0.020	0.265	0.062	61	0.291
	(0.198)	(0.009)	(0.065)	(0.035)		(0.013)
1960–1985	0.051	0.006[b]	0.260	0.050	61	0.238
(1975 gap)	(0.209)	(0.008)	(0.070)	(0.036)		(0.014)
1960–1975	−0.088	0.013	0.181	0.035	61	0.093
	(0.243)	(0.012)	(0.083)	(0.043)		(0.017)
1970–1985	−0.076	0.023	0.256	0.068	61	0.208
	(0.236)	(0.010)	(0.075)	(0.042)		(0.016)
1975–1985	−0.372	0.026	0.291	0.112	61	0.192
	(0.305)	(0.012)	(0.101)	(0.053)		(0.020)
			Larger sample with Barro correlates			
1960–1985	−0.001	0.039	0.275	0.029	61	0.391
	(0.203)	(0.013)	(0.070)	(0.037)		(0.012)
1960–1985	0.011	0.023[b]	0.307	0.030	61	0.299
(1975 gap)	(0.206)	(0.011)	(0.074)	(0.040)		(0.013)
1960–1975	0.019	0.039	0.279	−0.011	61	0.263
	(0.233)	(0.016)	(0.086)	(0.043)		(0.015)
1970–1985	−0.217	0.038	0.276	0.040	61	0.236
	(0.270)	(0.017)	(0.082)	(0.047)		(0.016)
1975–1985	−0.537	0.037	0.262	0.097	61	0.190
	(0.356)	(0.020)	(0.112)	(0.063)		(0.020)

a. The equipment share, and the structures and producers' transportation equipment share variables were constructed as follows, using all information available. Summers and Heston [1990] report real investment as a share of GDP for each year from 1960 to 1985. The ICP reports the quantity ratio of equipment to total investment in each of its years—1970, 1975, and 1980—for the nations covered. If 1970, 1975, and 1980 quantity ratios were all available, the average equipment share was made by first multiplying the 1970 equipment share of investment by the average investment share of GDP from 1960–1972, multiplying the 1975 equipment share of investment by the average investment share of GDP from 1973–1977, and the 1980 equipment share of investment by the average investment shares from 1978–1985. Then these three values were averaged. If only 1975 and 1980 equipment share of investment ratios were available, they were multiplied by average investment share of GDP over 1960–1977 and 1978–1985, respectively, and averaged. If only the 1980 equipment share of investment was available, it was simply multiplied by the average investment share of GDP over 1960–1985.

b. Regression using the 1975 GDP per worker gap.

explanatory power of the regressions, but do not have an appreciable impact on the equipment coefficients. For the entire 1960–1985 period, our results suggest that a twenty-five-percentage-point increase in *both* primary and secondary education rates has the same partial association with growth as a one-percentage-point rise in the equipment investment share of national product. Table I also explores the effect of replacing the initial 1960 GDP per worker gap relative to the United States with the 1975, midsample period gap.[15] This replacement has no material effect on the equipment investment coefficient.

Results using the entire 61-nation sample are somewhat sensitive to outliers. The exclusion of Zambia, for example, raises the adjusted R^2 in the regression underlying Figure VI from 0.29 to 0.44; the exclusion of Botswana would reduce the adjusted R^2 from 0.29 to 0.21. Inclusion or exclusion of these two countries can move the equipment share coefficient between 0.21 and 0.31, although the coefficient remains significant at conventional levels.

Although the larger 61-nation sample is significantly affected by outliers, it is worth pointing out that it omits two outlier nations with large identifying variances that would significantly strengthen our findings. Both Singapore and Taiwan have had high equipment quantities, low equipment prices, and rapid productivity growth in the post-World War II period. Neither Singapore nor Taiwan is in our sample. Singapore surrendered and regained its independence during our sample period. The existence of Taiwan is not recognized by international organizations. The inclusion of these two observations would strengthen our conclusions.[16]

D. Additional Growth Determinants

It is natural to wonder whether the quantity of equipment is proxying for some other well-known determinant of growth omitted from our list of independent variables. Table II reports the results of adding variables measuring (i) the share of manufacturing in value added, (ii) the importance of public investment,

15. As suggested by Romer [1989].

16. It is also worth pointing out that omitting the equipment investment share variable from the regression does not materially raise the coefficient on the other investment share. With equipment investment omitted, the other investment share has a coefficient of 0.029 for the high-productivity sample and 0.105 for the larger sample; with other investment omitted, the equipment share has a coefficient in the two samples of 0.332 and 0.300, respectively.

TABLE II
PRODUCTIVITY GROWTH AND EQUIPMENT INVESTMENT WITH ADDITIONAL CORRELATES OF GROWTH

Additional variable	Equip. share (w/o add. var.)	Equip. share (with add. var.)	Coefficient on add. var.	n	R^2 (RMSE)
	High productivity sample				
Public investment[a]	0.337	0.333	0.144	23	0.659
	(0.056)	(0.058)	(0.296)		(0.008)
Mfg. share in GDP[b]	0.290	0.277	0.044	23	0.663
	(0.058)	(0.056)	(0.027)		(0.007)
Exchange rate	0.337	0.333	0.001	25	0.644
	(0.054)	(0.066)	(0.010)		(0.008)
Continent dummies					
South America	0.337	0.053	−0.010	25	0.856
	(0.054)	(0.063)	(0.004)		(0.005)
Europe			0.008		
			(0.004)		
Asia			0.026		
			(0.006)		
	Larger sample				
Public investment	0.240	0.236	0.171	52	0.254
	(0.075)	(0.075)	(0.154)		(0.012)
Mfg. share in GDP	0.288	0.287	0.012	45	0.413
	(0.062)	(0.063)	(0.025)		(0.011)
Exchange rate	0.265	0.300	−0.007	61	0.294
	(0.065)	(0.072)	(0.006)		(0.013)
Continent dummies					
South America	0.265	0.288	0.006	61	0.385
	(0.065)	(0.072)	(0.006)		(0.012)
Europe			0.011		
			(0.008)		
Asia			0.012		
			(0.006)		
Africa[c]			−0.005		
			(0.006)		

a. From Barro [1991] The ratio of real public domestic investment to real domestic investment—average over 1970–1985.
b. The ratio of real manufacturing value added to real GDP in 1980.
c. There are no African nations in the high–productivity sample.

(iii) the real exchange rate in 1980,[17] and (iv) the continent to our basic specifications. The only case in which the inclusion of an additional variable has a material impact on the coefficient of equipment investment is the case in which continent dummies are added to the regression using the high productivity sample.

The lack of effect of continent dummies in the larger sample is perhaps worth a further note. Much of the identifying variance in our regressions does come from a comparison of East Asia to South America, but there is substantial variation within continents as well. Considering islands and peninsulas along the coast of Asia, Hong Kong, Japan, and Korea have low equipment prices, high equipment quantities, and rapid growth; while Sri Lanka and the Philippines have high equipment prices, low quantities, and slow growth. Argentina, Chile, and Uruguay are poorly performing South American nations, but Brazil has performed well. In Africa, Senegal, Madagascar, and Zambia have performed badly, but the Ivory Coast, Botswana, and Tunisia have all grown relatively rapidly.

The high productivity sample lacks these within-continent contrasts. The high productivity sample contains the United States, Canada, fast-growing Asian nations, slow-growing Latin American nations, and many intermediate European nations. Within Latin America the association between growth and equipment investment is strong. Within Europe it is not. And there are many more European than Latin American data points in the sample.

A great deal of attention has been devoted in recent years to the relationship between pricing distortions—particularly protection—and growth. The 1987 *World Development Report* has provided perhaps the most powerful statement of the case that relative economic success or failure is to a significant degree a function of the government's willingness to see its industry compete with foreign producers for the domestic market on a level playing field. Unfortunately, quantitative measures of the importance of protectionist barriers are not available, and the qualitative measures available do not match the sample of countries that we have used.

Table III examines the relationship between growth and

17. Since the real exchange rate is significantly related to current GDP per capita, our independent variable is the residual from a regression of the log 1980 real exchange rate on GDP per capita.

TABLE III
PRODUCTIVITY GROWTH AND EQUIPMENT INVESTMENT WITH ALTERNATIVE DISTORTION MEASURES

Additional variable	Equip. share (w/o add. var.)	Equip. share (w add. var.)	Coefficient of add. var.	n	R^2 (RMSE)
Barbone [1988]					
Coefficient in openness regression	0.033 (0.089)	0.032 (0.093)	0.001 (0.009)	17	0.633 (0.006)
World Competitiveness Report [1990]					
Exch. rate policy compet. oriented	0.229 (0.084)	0.246 (0.086)	−0.001 (0.001)	26	0.500 (0.008)
Free extent of inward trade		0.202 (0.092)	0.002 (0.002)		0.492 (0.008)
Trade legislation outward oriented		0.227 (0.096)	0.007 (0.184)		0.478 (0.008)
Jones [Barro, 1990b]					
Eff. prt. > 40 percent high pdty. sample	0.335 (0.050)	0.261 (0.052)	−0.011 (0.004)	22	0.788 (0.006)
Effective protection rate > 40 percent	0.286 (0.068)	0.209 (0.066)	−0.011 (0.004)	43	0.448 (0.010)
World Development Report 1983 [Agarwala, 1983]					
Exchange rate[a] pricing distortion	0.165 (0.178)	0.081 (0.165)	−0.010 (0.004)	26	0.270 (0.012)
Protection of manufacturing distortion		0.183 (0.173)	−0.007 (0.004)		0.169 (0.013)
Capital pricing distortion		0.332 (0.191)	−0.011 (0.006)		0.203 (0.013)
Labor pricing distortion		0.171 (0.166)	−0.006 (0.003)		0.230 (0.013)
Distortion index[b] value		0.188 (0.155)	−0.018 (0.007)		0.331 (0.012)
Distortion index ranking		0.205 (0.151)	−0.010 (0.003)		0.366 (0.011)
World Development Report 1987					
Outward trade[c] oriented 1963–1973	0.242 (0.183)	0.153 (0.145)	0.011 (0.003)	32	0.414 (0.012)
Outward trade oriented 1973–1985		0.107 (0.145)	0.012 (0.003)		0.428 (0.012)

a. Distortion indices range from 1 to 3 for low, moderate, and high distortions.
b. Average of the above distortions plus three more: agricultural protection, tariff, and inflation distortions.
c. Ranges from 1 to 4 on a scale from strongly outward oriented to strongly inward oriented.

equipment investment holding constant measures of the incidence of distortions. Measures of distortions are drawn from Barbone's [1988] assessment of OECD openness using residuals from a modified gravity trade model; from Jones's estimates of national effective protection rates, as summarized in the zero-one dummy variable for countries with effective protection rates above 40 percent used in Barro [1990]; from business leaders' perceptions of the business climate as reported in a collection of survey evidence, the *World Competitiveness Report*; from the work of Agarwala reported in the 1983 *World Development Report,* and from World Bank assessments of the "outward" orientation of trade policy as reported in the 1987 *World Development Report.*

While many of the measures of trade orientation and distortions we use suffer from being the subjective judgments of analysts who also know about growth outcomes, we nevertheless prefer them to the use of trade shares which we regard as relatively uninformative.[18] Trade share measures to a large degree pick up difference in national size and proximity to trading partners. Suppose, for example, that Belgium and Holland merged. Would the resulting entity be—in any interesting sense—less open and able to exploit economies of scale than either country was previously?

The *World Competitiveness Report* surveyed business leaders around the world, asking them to assess governmental policies and economic environments in eighteen OECD and eight developing nations. We take three "openness" variables from the *World Competitiveness Report*: businessmen's assessments from the survey of the extent to which the government's exchange rate policy is oriented toward keeping its industries competitive exporters, the extent to which inward trade is free, and the extent to which trade legislation supports businessmen who wish to export as opposed to those who fear competition from imports.

In the *World Competitiveness Report* sample, none of the three variables enters our growth equation significantly, and inclusion of each of the three does not materially affect the coefficient on equipment quantities. The failure of the *World Competitiveness Report* "openness" variables to reduce the coefficient on equipment investment gives us some confidence that equipment invest-

18. As used in, for example, Romer [1989].

ment is not simply a proxy for distortions that work against the interests of exporters. These two sets of "openness" variables have the substantial virtue of not having been constructed in the context of studies advocating free trade.

Regressions using the Barbone openness estimates for OECD countries give no signs that our equipment variables are proxies for openness or trade-reducing distortions. The residuals from his modified gravity model are ineffective as an independent variable in our growth equation. And the coefficient of the equipment quantity variable is unaffected. Regressions using the Jones high effective protection rate dummy variable show that in both the larger and high productivity samples inclusion of the variable reduces the equipment investment coefficient by one quarter, and that nations with a high effective protection rate see economic growth lower by a significant 1.1 percent per year.

The Agarwala sample is not a favorable one for our basic regressions. It contains a set of poor nations for which our specifications work relatively badly, and for which the data are least reliable. In the Agarwala sample our basic equipment share regressions produce a coefficient half as large, with a standard error three times as large, as in our basic specification. Nevertheless, five of the six Agarwala measures *increase* the equipment coefficient when they are included in the regression. Only the exchange rate distortion index appears to pick up a significant part of the equipment investment share variable.

The World Bank sample is also a poor one for our basic specification: producing an equipment share coefficient of 0.242 with a standard error of 0.183. The World Bank's outward orientation measure enters the regression significantly—the more outward oriented, the faster growth—and halves the equipment coefficient when included. The World Bank's trade orientation measure does capture a significant fraction of the factors captured by our equipment variable, in much the same way as the Agarwala exchange rate distortion variable does; the coefficient on the equipment share is reduced by about half.

We are not sure how to interpret this association between the World Bank's outward orientation measure and our equipment investment measures. Korea, for example, which the World Bank treats as strongly outward oriented, has not attained its outward orientation by keeping relative prices free, but has sought instead to promote and heavily subsidize heavy and export industry.[19] It may well be that promoting equipment investment and spurring export growth go hand in hand.[20]

E. Components of Investment

Table IV reports results using different disaggregations of investment. When producers' transportation equipment is considered separately from the "other investment" aggregate, its coefficient is large—albeit imprecisely estimated—for the high productivity sample when the initial 1960 GDP per worker gap is used as a control. When the midsample GDP per worker gap is used, or when the larger 61-country sample is considered, producers' transportation equipment has a much weaker relationship to growth than either electrical machinery or nonelectrical equipment.

Our decision to consider as our primary "equipment" measure the aggregate of electrical and nonelectrical machinery excluding producers' durable transportation equipment is open to question. The fifth line of each panel of Table IV contains the finest disaggregation of investment. In the high productivity sample, electrical and nonelectrical machinery each help to forecast growth when the other is in the regression; structures and transport equipment do not.

In the larger sample electrical machinery and nonelectrical machinery are the only components with t-statistics greater than one and positive signs, and it is not possible to reject the null that their coefficients are the same. We do not believe that any of our substantive results depend on the exclusion of producers' transportation equipment from our equipment aggregate, or on the grouping of electrical and nonelectrical machinery.[21]

We suspect that attempting to refine the analysis and estimate different effects on growth of the different components of equip-

19. See Collins and Park [1987]. The 1987 *World Development Report* holds Korea up as one of a very few examples of "strongly outward oriented" nations and critiques its governments for having interfered heavily in relative prices and so reduced growth rates.

20. Table V presents some regressions suggesting that this may indeed be the case and that equipment investment and the *World Development Report* outward orientation measures are strong complements. However, equipment investment and a low Jones effective protection rate measure appear to be, if anything, substitutes.

21. In many industries electrical machinery and nonelectrical machinery are very strong complements; efficient production requires both.

TABLE IV
PRODUCTIVITY GROWTH AND DISAGGREGATED INVESTMENT 1960–1985

Labor force growth	GDP/wkr gap	Equip. share	Non-equip. share	Machine[a] share	Elect. share	Struct. share	Trans. share	n	R^2 (*RMSE*)
				High productivity sample					
−0.002	0.030	0.337	−0.015					25	0.662
(0.146)	(0.009)	(0.054)	(0.033)						(0.008)
0.044	0.036	0.284				−0.006	0.332	25	0.675
(0.144)	(0.009)	(0.063)				(0.028)	(0.237)		(0.008)
0.036	0.019[b]	0.343				−0.021	0.106	25	0.489
(0.184)	(0.013)	(0.079)				(0.041)	(0.301)		(0.009)
0.004	0.034		−0.009	0.202	0.718			25	0.732
(0.130)	(0.008)		(0.029)	(0.072)	(0.160)				(0.007)
0.015	0.035			0.199	0.666[c]	−0.009	0.109	25	0.719
(0.135)	(0.009)			(0.074)	(0.203)	(0.030)	(0.249)		(0.007)
				Larger sample					
−0.031	0.020	0.265	0.062					61	0.291
(0.198)	(0.009)	(0.065)	(0.035)						(0.013)
−0.005	0.021	0.291				0.074	−0.078	61	0.310
(0.196)	(0.009)	(0.076)				(0.031)	(0.233)		(0.013)
0.056	0.005[b]	0.295				0.056	−0.212	61	0.234
(0.210)	(0.008)	(0.082)				(0.037)	(0.218)		(0.034)
−0.053	0.022		0.064	0.136	0.562			61	0.308
(0.197)	(0.009)		(0.034)	(0.107)	(0.206)				(0.013)
−0.049	0.021			0.162	0.637[d]	0.071	−0.237	61	0.307
(0.197)	(0.009)			(0.110)	(0.219)	(0.090)	(0.350)		(0.013)

a. Disaggregated shares were created using the same procedure as for the equipment share in Table I.
b. Regression uses 1975 GDP per worker gap instead of 1960 gap.
c. t-statistic on difference between electrical equipment and nonelectrical machinery coefficients equals 1.95.
d. t-statistic on difference between electrical equipment and nonelectrical machinery coefficients equals 1.67.

ment pushes beyond the information that the data reliably contain. Our exploration of the separate effects on growth of electrical machinery and nonelectrical equipment produced somewhat puzzling results. On the one hand, as Table IV shows, the quantity of electric machinery has a more potent impact on growth than the nonelectric machinery component. On the other hand, we have found that electrical machinery *prices* are less related to growth than nonelectrical equipment prices: the fastest growing nations are those that have the lowest nonelectrical equipment prices, not the lowest electrical machinery prices.[22] We therefore settle on our "equipment" variable.

F. Interaction Terms

It is possible that the marginal impact of equipment investment differs systematically with the rate of equipment investment or with the values of other potential independent variables. Romer [1989], in his discussion of the determinants of growth, places great emphasis on evidence using total investment that the apparent marginal product of investment declines as nations grow richer and increases as their export share increases.

Table V adds quadratic equipment terms and the interactions between investment and the initial GDP gap, the *WDR* openness rating, and the Jones effective protection rate (EPR) dummy from Barro [1990] to our basic specifications. The results are, unfortunately, inconclusive. There is some evidence in the high productivity sample that the impact of additional investment on growth declines with the initial GDP per worker level, though the result fails to be statistically significant when the 1960 GDP per worker gap is used (although substantively it is very significant). There is also some evidence for decreasing returns to equipment investment. The $(\text{investment})^2$ term is substantively significant for the high productivity sample.

But the patterns found in the high productivity sample are not robust to sample expansion. In the larger sample the interaction of GDP per worker and equipment investment is statistically and substantively insignificant. Moreover, the interaction of equipment investment with itself changes sign in our basic specification. We find very attractive the idea that a high social product of equipment investment reflects technology transfer mediated through capital goods, and thus that the social product is higher for poorer countries with more of a technology gap to bridge. But the data do not speak reliably enough on this point for us to be willing

22. We report some of the disaggregated relative investment price regressions we have performed in Appendix III.

TABLE V
PRODUCTIVITY GROWTH AND INTERACTION TERMS

Interaction variable	Labor force growth	GDP per worker gap	Equip. share	Non-equip. share	Inter-action term		Extreme marginal effect of equipment investment in: Poor/low/out country[a]	Rich/high/in country	n	R^2 (RMSE)
				High productivity sample						
GDP gap 60	−0.029	−0.028	−0.136	−0.030	0.777		0.445	−0.136	25	0.670
	(0.146)	(0.048)	(0.392)	(0.035)	(0.637)		(0.103)	(0.392)		(0.008)
GDP gap 75	−0.074	−0.087	−0.399	0.005	1.621		0.651	−0.399	25	0.683
	(0.146)	(0.031)	(0.226)	(0.033)	(0.466)		(0.100)	(0.226)		(0.007)
Equipment share	0.029	0.041	0.811	0.018	−3.680		0.698	−0.089	25	0.706
	(0.137)	(0.010)	(0.242)	(0.035)	(1.841)		(0.187)	(0.219)		(0.007)
Negative of Jones EPR	0.096	0.040	0.156	−0.002	−0.219		0.156	0.375	22	0.825
	(0.136)	(0.007)	(0.069)	(0.027)	(0.105)		(0.069)	(0.144)		(0.006)
				Larger sample						
GDP gap 60	−0.039	0.015	0.207	0.060	0.078		0.282	0.207	61	0.279
	(0.204)	(0.026)	(0.291)	(0.037)	(0.378)		(0.280)	(0.291)		(0.013)
GDP gap 75	0.017	−0.004	0.147	0.048	0.172		0.316	0.147	61	0.229
	(0.218)	(0.020)	(0.204)	(0.037)	(0.293)		(0.119)	(0.204)		(0.014)
Equipment share	−0.027	0.019	0.177	0.061	0.691		0.358	0.196	61	0.281
	(0.200)	(0.010)	(0.241)	(0.035)	(1.813)		(0.252)	(0.193)		(0.013)
Negative of Jones EPR	0.208	0.035	0.195	0.048	−0.027		0.195	0.222	43	0.433
	(0.218)	(0.009)	(0.101)	(0.036)	(0.146)		(0.101)	(0.144)		(0.010)
				Outward orientation						
Outward oriented 63–73	−0.272	0.036	−0.256	0.061	0.205	0.002	0.563	−0.051	32	0.461
	(0.381)	(0.024)	(0.264)	(0.047)	(0.112)	(0.006)	(0.265)	(0.178)		(0.012)
Outward oriented 73–83	−0.139	0.045	−0.288	0.036	0.211	0.005	0.556	−0.077	32	0.482
	(0.359)	(0.023)	(0.247)	(0.047)	(0.109)	(0.007)	(0.271)	(0.168)		(0.011)

a. These two columns give the increase in growth produced by an increase in equipment investment for the extreme countries in the sample: the first column applies to the poorest, with the lowest equipment investment, or the most outward oriented (which have the highest marginal effect of equipment investment on growth) nation; the second column applies to the richest, with the highest equipment investment, or the most inward oriented nation in the sample.

to do more than point out that the question is intriguing and potentially very important, and the evidence not conclusive.

The interaction of a high Jones effective protection rate dummy variable from Barro [1990] and equipment investment similarly produces different patterns in the two samples. And in the high productivity sample, it appears that it is strongly protectionist, not open, countries that benefit most from equipment investment.

This does not fit the fact that the interaction of equipment investment and the *WDR* trade orientation, for those developing nations with available data, is significant and important: the most outward oriented nations appear to be those that benefit the most from an increase in the equipment investment share. It is necessary to be outward oriented *and* to have a high equipment investment share in order to achieve rapid growth. And the estimated coefficients imply that the most inward oriented nations would not benefit at all from increased equipment investment. High rates of equipment investment appear to complement, not substitute for, an outward orientation as the *World Development Report* defines it. It is somewhat puzzling that they do not also appear to complement a low estimated effective rate of protection.

IV. Does Equipment Investment Cause Productivity Growth?

The relationship between equipment investment quantities and economic growth appears relatively robust, in that equipment investment does not appear to be proxying for some other widely recognized determinant of growth. This section takes up the question of whether the relationship between equipment investment and growth is causal.

One reason to believe that equipment investment causes growth, rather than that growth causes investment, is that if growth caused investment we would expect to see similar associations between equipment and structures investment and growth. Rapid economic growth certainly raises the quasi-rents earned by investments in equipment to establish and entrench market positions, but it also raises the rents earned by structures. Favorably located land is in fixed supply and larger structures economize on the use of such land, and so one might imagine that faster economic growth would tend to shift the use of savings away from producers' equipment and toward structures. Yet it is equipment, not investment and not structures, that is associated with rapid growth in our sample.

In this section we provide additional evidence against the hypothesis that equipment investment and growth are both driven by some third variable—that the same favorable conditions which raise productivity growth might also encourage equipment investment without equipment investment playing an essential direct role—in four further steps. First, we examine the association between equipment investment and the components of GDP growth driven by productivity growth and labor force growth; we find a much closer relationship between productivity growth and equipment investment than between productivity growth and labor force growth; this is hard to reconcile with a viewpoint that holds that increasing GDP drives equipment investment. Second, we consider timing evidence. Third, we consider the joint behavior of equipment prices and quantities; we regard this as the strongest of the pieces of evidence: fast growth goes with high quantities and low prices of equipment investment, and this is not easy to reconcile with the belief that the high quantity of equipment investment in rapidly growing countries is due to some other factor that has both caused fast growth and shifted the demand curve for equipment investment outward. Fourth, we consider the effects of alternative instruments for the equipment quantity variable; if the association between growth and investment were due to some additional factor causing both, it would be surprising if that additional factor were closely associated with all of the different instruments we use.

A. Equipment Investment and the Components of Total GDP Growth

If the association between equipment investment and growth arose from some sort of accelerator mechanism, and equipment investment was a consequence and not a cause of growth, one would expect increases in productivity and in the labor force to lead to increased equipment investment. Table VI reports regressions, for the high productivity and the larger samples, with equipment investment on the left-hand side and with the two different components of GDP growth—the rate of growth of GDP per worker, and the rate of growth of the labor force—on the right-hand side as well as our standard control variables of the 1960 GDP per worker gap and the share of GDP devoted to other types of investment. Table VI shows that equipment investment is strongly positively associated with increases in GDP that come from increasing productivity, and *negatively* associated with increases in GDP that come from increasing the labor force holding productivity constant. The t-statistic on the difference between the productivity growth and the labor force coefficients is more than three for the larger sample and more than five for the high productivity sample.

TABLE VI
EQUIPMENT INVESTMENT AND THE COMPONENTS OF TOTAL GDP GROWTH

Sample	Other investment share	GDP/ wkr gap	GDP/wkr growth	Labor force growth	n	R^2 (RMSE)
High productivity sample	0.073 (0.078)	−0.063 (0.023)	1.965 (0.314)	−0.176 (0.351)	25	0.645 (0.019)
Larger sample	0.070 (0.064)	−0.033 (0.017)	0.858 (0.211)	−0.361 (0.354)	61	0.371 (0.023)

Table VI is thus an additional piece of evidence against the claim that our results arise because rapid growth leads naturally to rapid investment through an accelerator mechanism. Rapid total GDP growth driven by increasing productivity is closely associated with high equipment investment. Rapid total GDP growth driven by an increasing labor force is not. It is hard to reconcile this differential association of equipment investment with intensive and extensive growth without invoking a causal role for equipment investment in producing productivity growth.

B. Timing

If some unobserved attribute—perhaps national culture or the structure of institutions—causes rapid productivity growth, there is the possibility that it would also induce an increase in equipment investment. In this case the association and equipment investment and growth would be driven by some deeper country-specific attribute. If such an attribute is persistent, a plausible proxy would be past growth rates. Table VII therefore adds growth over the 1960–1975 period to equations relating 1975–1985 growth to equipment for both our high productivity and full samples. The inclusion of past growth does not add much explanatory power. The impact of equipment investment on growth is only marginally affected.

Table VII also replaces current equipment investment with an estimate of the lagged investment share over 1960–1975 in the list of the determinants of 1975–1985 growth. If high investment is a consequence and not a cause of growth, it is hard to imagine how lagged investment could be a better proxy for unobserved determinants of growth than lagged growth itself. Lagged equipment investment is estimated by multiplying the total investment share

TABLE VII
1975–1985 PRODUCTIVITY GROWTH AS A FUNCTION OF LAGGED 1960–1975 PRODUCTIVITY GROWTH AND THE LAGGED INVESTMENT SHARE

Specification	Lab. fce. growth	GDP/wkr gap	Equip. share	Non-equip. share	Lagged 1960–1975 GDP/wkr growth	n	R^2 (RMSE)
			High productivity sample				
Current eq. shares	−0.177	0.014	0.425	0.047		25	0.428
	(0.258)	(0.016)	(0.105)	(0.059)			(0.013)
Current eq. shares	−0.174	0.015	0.447	0.044	−0.060	25	0.400
	(0.264)	(0.016)	(0.132)	(0.062)	(0.218)		(0.013)
Lagged eq. shares[a]	−0.056	0.018	0.390	0.027		25	0.449
	(0.264)	(0.015)	(0.096)	(0.051)			(0.013)
Lagged eq. shares	−0.053	0.018	0.399	0.026	−0.030	25	0.421
	(0.271)	(0.016)	(0.118)	(0.054)	(0.207)		(0.013)
			Larger sample				
Current eq. shares	−0.372	0.026	0.291	0.112		61	0.192
	(0.305)	(0.012)	(0.101)	(0.053)			(0.020)
Current eq. shares	−0.415	0.027	0.230	0.098	0.201	61	0.196
	(0.306)	(0.012)	(0.114)	(0.054)	(0.178)		(0.020)
Lagged eq. shares	−0.421	0.010	0.117	−0.017		61	−0.018
	(0.348)	(0.013)	(0.110)	(0.057)			(0.022)
Lagged eq. shares	−0.533	0.016	0.044	−0.025	0.453	61	0.086
	(0.332)	(0.013)	(0.108)	(0.054)	(0.167)		(0.021)

a. Lagged shares were constructed by multiplying the average of ICP observations of the equipment shares of investment by the investment share of GDP from 1960 to 1975, and then averaging over years.

over 1960–1975 by ICP observations of the equipment share of investment. This lagged equipment variable has strong predictive power in the high productivity sample, and weak predictive power in the larger sample. It has strong predictive power in the high productivity sample even with 1960–1975 growth also included.[23]

23. We have also attempted to estimate fixed-effects models relating changes in equipment investment rates to changes in growth rates without success. Our failure might be due to an errors-in-variables problem arising from our lack of direct data on the equipment proportion of investment before 1975 for most countries.

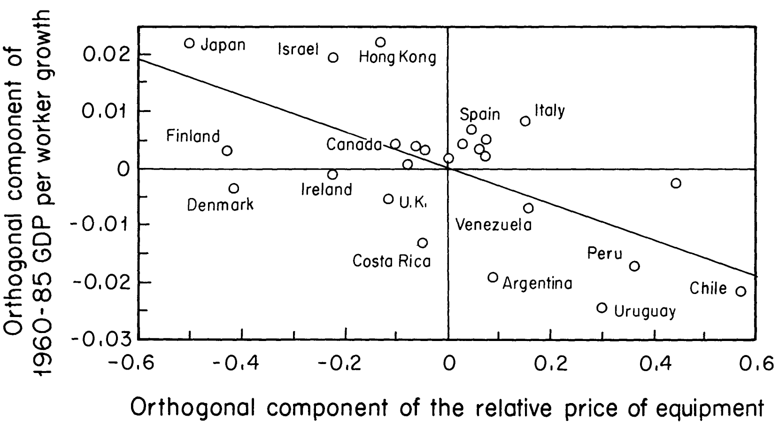

FIGURE VII
Partial Scatter of 1960–1985 Growth and Equipment Relative Price

C. Equipment Prices and Growth

Figures VII and VIII plot the component of the equipment price orthogonal to GDP per worker[24] to growth rates, partialing out labor growth, relative prices of other investment, and initial productivity for both the full and high productivity samples. There is a strong *negative* association between equipment prices and growth. We see the association of growth with high quantities and low prices of equipment as strong evidence that equipment investment drives growth. If high rates of investment were a consequence rather than a cause of growth, one would expect that because of strong demand the price of equipment would be high in rapidly growing countries.

Fast growth would shift demand to the right, and move the economy upward and outward along the equipment supply curve.

24. The "orthogonalized" equipment price used as the independent variable is the residual from log real relative equipment price regressed on GDP per capita relative to the United States, measured in international dollars. For nations covered in both the 1975 and 1980 ICP phases, the two observations are averaged to obtain an estimate of the characteristic relative price structure in the post-World War II period. Since equipment prices are markedly low in richer countries, it is important to consider only that portion of relative prices orthogonal to the country's level of GDP per worker. If we used the unadjusted and not the "orthogonalized" equipment price in a regression, it would be close to including the end-of-sample-period level of GDP per worker as an independent variable. Since the beginning-of-sample-period level of GDP per worker has already been included as an independent variable, such a regression would come close to reproducing the identity that change = final − initial.

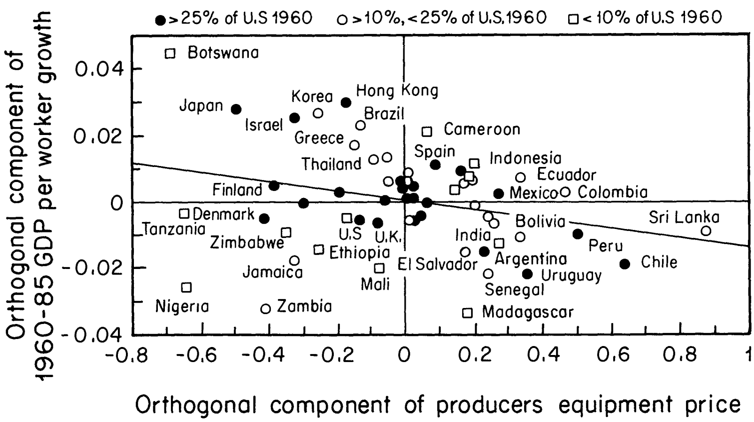

FIGURE VIII
Partial Scatter of Growth and Equipment Prices, All Countries

Instead, growth is associated with a move down and to the right in an equipment price-quantity graph, suggesting that supply is shifting out in high-growth countries and moving the economy along the equipment demand curve.[25]

The relationship between equipment prices and growth is explored in more detail in Table VIII, which reports equations relating equipment prices and growth for both our samples. The relationship between equipment prices and growth is almost as robust as the relation between quantities and growth for the high productivity sample. It is less robust for the larger 61-nation sample. Many African countries, including Ethiopia, Madagascar, Mali, Nigeria, Senegal, and Zambia, report low real producers' equipment prices, and yet have exhibited disappointing long-run productivity growth rates.

In large part, low equipment prices operate to promote growth by increasing the quantity of equipment investment. As Table IX shows, when equipment investment is included in the productivity equation, the coefficient on equipment prices declines and is never both significant and negative. This bears on the "liberalization" hypothesis discussed above. If high equipment investment's large

25. The association between low prices and growth does not arise because high investment makes it possible to take advantage of economies of scale in production. A high fraction of equipment—30 percent—is imported even in the United States. In Colombia 80 percent of equipment is imported.

TABLE VIII
PRODUCTIVITY GROWTH AND EQUIPMENT PRICES

Period	Lab. fce. growth	GDP/wkr gap	Tot. inv. rate	Equip.[a] price	n	R^2 (RMSE)
		High productivity sample				
1960–1985	0.004	0.020	0.050	−0.024	25	0.414
	(0.192)	(0.012)	(0.037)	(0.009)		(0.010)
1960–1975	0.049	0.045	0.008	−0.005	25	0.428
	(0.212)	(0.014)	(0.004)	(0.014)		(0.012)
1970–1985	0.040	−0.007	0.031	−0.033	25	0.404
	(0.198)	(0.013)	(0.040)	(0.010)		(0.011)
1975–1985	−0.061	−0.006	0.104	−0.025	25	0.309
	(0.288)	(0.016)	(0.056)	(0.013)		(0.014)
		Larger sample				
1960–1985	−0.086	0.017	0.099	−0.004	61	0.181
	(0.213)	(0.010)	(0.030)	(0.007)		(0.014)
1960–1975	−0.075	0.011	0.007	−0.005	61	0.119
	(0.239)	(0.012)	(0.002)	(0.008)		(0.017)
1970–1985	−0.093	0.021	0.123	0.001	61	0.157
	(0.245)	(0.011)	(0.036)	(0.080)		(0.017)
1975–1985	−0.393	0.025	0.146	0.006	61	0.138
	(0.317)	(0.013)	(0.044)	(0.009)		(0.021)
		Larger sample with Barro correlates				
1960–1985	0.003	0.040	0.059	−0.009	61	0.290
	(0.219)	(0.014)	(0.035)	(0.007)		(0.013)
1960–1975	0.029	0.032	0.034	−0.016	61	0.257
	(0.234)	(0.017)	(0.036)	(0.009)		(0.015)
1970–1985	−0.224	0.034	0.109	−0.001	61	0.163
	(0.284)	(0.018)	(0.043)	(0.009)		(0.017)
1975–1985	−0.555	0.034	0.146	0.011	61	0.159
	(0.365)	(0.019)	(0.052)	(0.011)		(0.020)

a. The equipment price used is the average of that component of the 1975 and 1980 ICP observations orthogonal to GDP per worker. For countries where there was no 1975 price, the 1980 orthogonalized price was used alone, and vice versa.

TABLE IX
PRODUCTIVITY GROWTH, EQUIPMENT QUANTITIES, AND EQUIPMENT PRICES

Period	Labor force growth	GDP/wkr gap	Equip. price	Equip. share	Non-equip. share	n	R^2 (RMSE)
			High productivity sample				
1960–1985	−0.008	0.033	0.007	0.384	−0.018	25	0.651
	(0.149)	(0.010)	(0.011)	(0.092)	(0.034)		(0.008)
1960–1975	−0.081	0.051	0.016	0.338	−0.060	25	0.470
	(0.201)	(0.014)	(0.015)	(0.130)	(0.045)		(0.011)
1970–1985	−0.026	0.014	−0.002	0.367	−0.024	25	0.572
	(0.171)	(0.013)	(0.013)	(0.118)	(0.039)		(0.009)
1975–1985	−0.229	0.020	0.012	0.523	0.040	25	0.408
	(0.279)	(0.019)	(0.021)	(0.205)	(0.062)		(0.013)
			Larger sample				
1960–1985	−0.033	0.028	0.015	0.404	0.050	61	0.318
	(0.194)	(0.010)	(0.009)	(0.101)	(0.035)		(0.013)
1960–1975	−0.087	0.011	−0.004	0.149	0.040	61	0.079
	(0.245)	(0.013)	(0.012)	(0.129)	(0.046)		(0.017)
1970–1985	−0.145	0.034	0.024	0.453	0.052	61	0.257
	(0.231)	(0.011)	(0.011)	(0.117)	(0.042)		(0.016)
1975–1985	−0.551	0.044	0.040	0.670	0.078	61	0.298
	(0.290)	(0.013)	(0.013)	(0.155)	(0.051)		(0.019)
			Larger sample with Barro correlates				
1960–1985	−0.017	0.042	0.011	0.377	0.028	61	0.397
	(0.202)	(0.013)	(0.009)	(0.109)	(0.037)		(0.012)
1960–1975	0.023	0.035	−0.008	0.207	−0.003	61	0.256
	(0.234)	(0.017)	(0.011)	(0.129)	(0.044)		(0.015)
1970–1985	−0.292	0.046	0.024	0.472	0.036	61	0.283
	(0.264)	(0.017)	(0.012)	(0.123)	(0.046)		(0.016)
1975–1985	−0.743	0.049	0.044	0.659	0.083	61	0.312
	(0.334)	(0.018)	(0.014)	(0.162)	(0.058)		(0.018)

coefficient in a growth regression arose because it proxied for the presence of a *laissez-faire* attitude toward trade, one would expect the equipment price variable, a direct measurement of distortions, to be a more important determinant of growth than the equipment quantity.

D. Alternative Sources of Variation in Equipment Investment

The evidence in the previous subsection suggested that low equipment prices are associated with rapid subsequent productivity growth, and that the mechanism through which the association operates is high rates of equipment investment; we now consider various sources of variation in equipment investment, and their impact on productivity growth. More generally, an assertion that differences in equipment investment cause differences in productivity growth is a claim that changes in equipment investment, however engineered, will influence growth. The next best thing to direct experimental evidence is to examine whether different sources of variation in equipment have similar impacts on growth. To do this, we instrument equipment investment with a number of alternative variables and check whether its estimated impact changes. This procedure can be viewed as an informal Hausman-Wu test of the proposition that equipment investment can be treated as an exogenous variable.

For both the high productivity and full samples, Table X reports OLS estimates of the relation between equipment investment and growth, along with estimates obtained by instrumenting with equipment prices, with rates of national saving, and with measures of trade liberalization. The results for the high productivity sample are supportive of a causal relation between equipment investment and growth. The coefficient using either prices or the national saving rate as an instrument is close to that obtained using OLS. Using *World Competitiveness Report* survey measures of trade orientation as an instrument yields an imprecise estimate of the impact of equipment on growth, lower by six percentage points than the OLS estimate in the high productivity sample.

The results for the larger sample are almost as strong. Instrumenting equipment with its price or with the *WCR* survey variables yields results that are similar to the OLS results, although the *WCR*-instrumented coefficient is once again imprecise. However, the coefficient turns negative (with an enormous

TABLE X
PRODUCTIVITY GROWTH AND EQUIPMENT INVESTMENT INSTRUMENTED WITH EQUIPMENT PRICES, SAVINGS RATES, AND *WORLD COMPETITIVENESS REPORT* TRADE ORIENTATION VARIABLES

Instruments used	Labor force growth	GDP/ wkr gap	Equip. share	Non-equip. share	n	R^2
		High productivity sample				
OLS	−0.002	0.030	0.337	−0.015	25	0.662
	(0.146)	(0.009)	(0.054)	(0.033)		
Equip. prices	−0.063	0.031	0.318	−0.048		0.638
	(0.158)	(0.009)	(0.068)	(0.041)		
OLS	0.009	0.032	0.339	−0.017	24	0.667
	(0.149)	(0.009)	(0.055)	(0.033)		
Savings rate	0.100	0.034	0.505	−0.039		0.506
	(0.206)	(0.011)	(0.191)	(0.047)		
OLS	0.092	0.042	0.161	−0.019	18	0.661
	(0.155)	(0.008)	(0.079)	(0.045)		
WCR variables	−0.009	0.046	0.104	−0.103		0.480
	(0.342)	(0.014)	(0.215)	(0.298)		
		Large sample				
OLS	−0.031	0.020	0.265	0.062	61	0.291
	(0.198)	(0.009)	(0.065)	(0.035)		
Equip. prices	−0.112	0.016	0.180	0.043		0.257
	(0.209)	(0.010)	(0.085)	(0.046)		
OLS	−0.029	0.020	0.265	0.062	60	0.291
	(0.201)	(0.009)	(0.066)	(0.035)		
Savings rate	−0.248	0.011	−0.162	0.131		
	(1.643)	(0.068)	(3.173)	(0.511)		
OLS	0.161	0.034	0.229	0.013	26	0.503
	(0.165)	(0.007)	(0.084)	(0.050)		
WCR variables	0.440	0.034	0.268	0.298		
	(0.479)	(0.015)	(0.320)	(0.474)		

standard error) in the full sample when national saving rates are used as an instrument.[26]

Five out of six regressions produce no material difference when the equipment investment coefficient is estimated by instrumental variables rather than by ordinary least squares. It is easy to construct arguments that the instruments used here are endogenous. This makes the similarity of the estimates obtained with different instruments to each other and to the OLS estimates more surprising. The different components of variation in equipment investment associated with equipment prices, with the nominal savings rate, and with the *WCR* variables all have the same association with the rate of growth. Such similarity would be a remarkable coincidence unless the association between equipment investment and growth is the result of structural causation running from equipment to growth.

V. Implications and Conclusions

We think that this paper makes a persuasive case for a strong association between equipment investment and growth. The relationship between rates of equipment investment and growth is very different from the relationship between structures investment and growth. It accounts for a substantial part of the variation in rates of growth. While there are a few anomalies, we suspect that the results are very robust by the standards of research on cross-country growth. Tests of robustness performed here have been more extensive than in other efforts (for example, Romer [1989]) to draw conclusions about investment-growth correlations. Given the small number of observations, the large number of independent variables, and the poor quality of much data underlying the larger sample regressions, anomalies are inevitable. What is of interest is not that some specifications do not support our interpretation, but that many do.

A. Comparisons with Other Work

Our findings raise a number of questions. First, can they be reconciled with earlier research, especially research downplaying the role of capital accumulation? Research in the growth accounting tradition has assumed away the possibility of external effects

26. Perhaps national savings is a poor instrument for equipment investment in low-income countries, given the importance of net capital inflows.

from accumulation. But studies that took a more catholic viewpoint have also tended to downplay links between accumulation and growth. Dowrick and Nguyen [1989], for example, analyzed a sample close to our high productivity sample, yet found a coefficient of growth on the total investment share of only 0.12 or so.

We believe that many previous studies have been carried out at an inappropriate level of aggregation. We see no reason to expect that investments in structures should carry with them the same external effects as plausibly attach to investments in equipment. We are not aware of previous work that has separated the components of aggregate investment and studied their differential impacts on growth in a cross section of nations. Given the clear differences in the composition of investment depicted in Figure IV, it is not surprising that studies that have focused on total capital accumulation have understated the potential contribution of investment to growth.

One series of studies that has led to conclusions qualitatively similar to ours is the research project of Jorgenson [1988, 1990]. Jorgenson estimates sectoral production functions and uses them for sophisticated and highly disaggregated growth accounting exercises. He finds substantial complementarity between equipment investment on the one hand and total factor productivity growth on the other. In most industries technological change is capital using: at given prices, isoquants with higher levels of total factor productivity lead to higher ratios of capital to labor (a point made for the nineteenth century by David [1977]).

Jorgenson thus finds a larger role for equipment investment in supporting productivity growth than is found in growth accounting work using aggregate production functions. The relative shares of industries differ across countries and since the magnitude of the capital-using bias in total factor productivity growth may well not be independent of the level of productivity. Qualitatively, however, his stress on the importance of disaggregation in measuring capital inputs is the same as ours.

B. Equipment Investment and Aggregate Production Functions

Before seeking explanations involving external economies for our findings, it is important to ask whether they can be reconciled with the presence of a standard neoclassical aggregate production function and the restriction that capital is paid its marginal product. In neoclassical models steady-state growth rates are independent of investment rates. However, investment rates may influence growth rates as shifts in investment rates cause economies to transit between steady-state growth paths. Moreover, since equipment and structures have different depreciation rates, the neoclassical model predicts that with equal net private rates of return there will nevertheless be differences in the relationship between shifts in investment shares and shifts in the rate of growth of *gross* output including depreciation. This is the essential point behind Jorgenson's distinction between the stock of capital and the flow of capital services.

To evaluate the potential magnitude of these effects, we calculated the effects of increased equipment and structures investment on growth in GDP and NDP, over short and long runs. For simplicity, we assumed an aggregate net product production function with the form of

$$Y = (K_{eq} + K_{st})^{\alpha} L^{1-\alpha}. \tag{2}$$

We begin the economy in steady state growth with the rate of growth of the effective labor force $(n + g)$ equal to 2 percent per year, with the initial shares of GDP devoted to equipment and structures investment at 7.5 percent each, and with the rate of depreciation on structures equal to 2 percent per year. We consider capital shares (α) of 40 and 60 percent, and we consider depreciation rates on equipment (δ^{eq}) of 15 and 25 percent. For these various sets of parameter values, Table XI reports the marginal impact on growth rates in percentage points per year of a one-percentage point shift in the GDP share of equipment or structures investment.

Two clear conclusions emerge. First, within the aggregate production function framework it is not possible to account for an association between investment and output growth of the magnitude suggested by the empirical cross-country results. Even assuming a capital share of 60 percent, a Cobb-Douglas production function produces a long-run effect of equipment investment on growth little more than half as large as our empirical estimates support. Allowing for a lower elasticity of substitution in production would reinforce this conclusion. So would recognizing that differences in investment rates are persistent and that nations' capital-output ratios had already diverged by 1960 because of differential previous investment shares.

Second, the simulations illustrate that in the long run neoclassical models predict that increases in the share of output devoted to gross *structures* investment rather than equipment investment

TABLE XI

EFFECT OF A ONE-PERCENTAGE-POINT SHIFT IN THE PROPORTION OF GDP DEVOTED TO INVESTMENT ON OUTPUT GROWTH RATES

	Percentage point change in output growth rates				
	over 1 year		*over 25 years*		
Shift in:	GDP	NDP	GDP	NDP	Parameters
Equipment investment	0.23	0.15	0.10	0.06	$\alpha = 0.4$ $\delta^{eq} = 0.15$
Structures investment	0.16	0.16	0.14	0.13	
Equipment investment	0.39	0.27	0.17	0.13	$\alpha = 0.6$ $\delta^{eq} = 0.15$
Structures investment	0.28	0.28	0.24	0.23	
Equipment investment	0.33	0.16	0.09	0.05	$\alpha = 0.4$ $\delta^{eq} = 0.25$
Structures investment	0.17	0.17	0.15	0.14	

should have the most potent effect on growth. The effect of a once-and-for-all shift Δi_{eq} in the equipment investment share asymptotically changes the equipment capital-output ratio by

$$\Delta \left(\frac{K_{eq}}{Y} \right) = \frac{\Delta i_{eq}}{n + g + \delta^{eq}} \tag{3}$$

and similarly for a shift in structures investment. Because structures have a lower depreciation rate, adding to structures investment ultimately raises capital intensity and therefore gross output more than adding to equipment investment. A given increase in structures investment corresponds, in the long run, to a larger increase in cumulative net investment than does a given increase in the equipment investment rate. This pattern is even more apparent in net than in gross product growth.

C. Social Returns to Investment

We therefore interpret our results as suggesting that the private return to equipment investment is below the social return, and that the social return to equipment investment is very high. This raises the question of how to move from our coefficient estimates to estimates of the social returns to equipment investment.

We believe that our coefficients *understate* the true social return to equipment. Consider economies moving along steady-state paths as in Solow [1956]. A regression of growth on capital formation will yield a zero coefficient even though capital has a positive rate of return. The negative correlation between the level of and rate of return to investment biases the coefficient on investment *down* below the rate of return in the average country.

To formalize this argument, consider a cross-section of nations i in each of which the marginal social product of *net* investment is r^i, so that

$$\Delta Y_t^i = r^i\,(I_t^i - \delta K_t^i)\,. \tag{4}$$

The average growth rate of output g^i over the sample is

$$g^i = r^i\left\{(I/Y)^i - \delta(K/Y)^i\right\}. \tag{5}$$

where $(I/Y)^i$ and $(K/Y)^i$ without time subscripts are the average investment shares of national product and capital-output ratios over the sample period in country i. Writing i^* and k^* for averages across countries of investment shares and capital-output ratios, and r^* for the average social product of net investment in the sample, the expected value of the coefficient β from the cross-country regression of growth rates on gross investment shares will be

$$\beta = r^* + [i^* - \delta k^*]\frac{\operatorname{cov}[r^i,(I/Y)^i]}{\operatorname{var}((I/Y)^i)} - r^*\delta\frac{\operatorname{cov}[(K/Y)^i,(I/Y)^i]}{\operatorname{var}((I/Y)^i)} + \{\text{higher order terms}\ldots\} \tag{6}$$

The second of the major terms in (6) shows that a negative correlation between investment and social returns leads the coefficient to underestimate the true return. Our interaction regressions suggest some diminishing returns to investment, which would generate a negative $\operatorname{cov}[r^i,(I/Y)^i]$. The alternative is that some third factor shifts demand for equipment and leads to high returns, high investment, and a positive $\operatorname{cov}[r^i,(I/Y)^i]$. We discount this possibility because of the association of high equipment investment and growth with low equipment prices.

We have used gross rather than net investment in this study; there is a strong case that it is gross rather than net investment that matters for productivity growth. If gross investment is the key determinant of growth, then the third term in equation (6) is not present. But if net investment is the relevant variable, then depreciation further biases the coefficient downward. Depreciation appears in the third, the $r^*\delta(\text{cov}[K/Y,I/Y]/\text{var}(I/Y))$ term in equation (6). Countries that have a high capital-output ratio devote a large share of national product to replacement investment. Differences in rates of *gross* investment can be correlated with but overstate differences in rates of net investment.

A factor in the other direction is that a unit of equipment investment has an effect on output that does not come all in the first year but that instead has some lag structure. If year-to-year output growth rates are determined by a distributed lag on equipment investment like,

$$g_t^i = \sum_{j=0}^{J} \rho_j \left(\frac{I_{t-j}^i}{Y_{t-j}^i} \right), \tag{7}$$

then our cross-section regression of average growth rates on average equipment investment shares would produce a coefficient estimate greater than the true social return to investment:

$$E(\beta) = \sum_{j=0}^{J} \rho_j > \sum_{j=0}^{J} (1-d)^j \rho_j, \tag{8}$$

where d is the appropriate discount rate. We have little insight into the relevant lag structure, but suspect that the rapid economic depreciation of equipment implies that its effect on output has a relatively small mean lag.

D. Implications for Economic Policy

A point often made (for example, Krueger [1990]) against the position that investment has a high marginal product is that India has had a high savings rate—Krueger estimates that it has risen from 14 to 22 percent over the post-independence period—and yet has exhibited poor growth performance, so the key to growth is not so much the accumulation as the effective use of resources. We would not disagree: India appears to be very close to the regression line relating equipment investment and productivity growth depicted in Figure VI. India has a relatively high savings rate, but equipment is expensive: more than twice as expensive in relative terms as in Korea in 1980. As a result, equipment investment as a share of GDP is about half of the sample average, even though Indian real nonequipment investment as a share of GDP is slightly greater than the sample average. From our standpoint according to which *equipment* investment is crucial, India does not appear to have made good use of its high savings rate.

This argument—that it is not only the volume of savings but also whether the savings are efficiently used to "buy" appropriate equipment—may have a wide range of application. Another often cited counterexample to the view that mechanization is the key to growth is the experience of planned economies, which have emphasized equipment to the exclusion of consumption and residences and have grown slowly. These examples are not clear-cut; the Soviet Union in the 1950s and earlier appears to have seen rapid growth in industrial production, especially in military goods, albeit at the price of immense human misery. While our results suggest that high rates of equipment investment may be necessary for rapid growth, we certainly do not regard them as sufficient.

At a minimum, equipment must be directed to the most productive uses. A growth strategy based on equipment investment must be market conforming, not market replacing, to realize the very high social rates of return on equipment investment that appear in the cross section of nations. The strong interaction between equipment investment and outward orientation in Table V may arise because an outward-oriented economy conforms to market forces, and does not try to replace them.

For these reasons, we interpret our results as implying that the social rate of return to equipment investment is 30 percent per year, or higher. Much of this return is not captured by private investors. If these results stand up to scrutiny, they have obvious implications. The gains from raising equipment investment through tax or other incentives dwarf losses from any nonneutralities that would result. A 20 percent wedge between the social return to equipment and other investment has implications for all policies affecting saving and capital allocations.

Our finding that equipment investment is so important for growth suggests an explanation for the striking differences in economic performance realized by nations with "interventionist" governments that have tried to jump start economic growth. From our perspective, the key difference between countries ruled by "interventionist" governments in South America and East Asia—despite the similarities in the rhetoric used to justify intervention—lies in their quantities of equipment investment. All the programs are all rationalized by similar appeals to "Schumpeterian" rather than "Ricardian" advantage and to the crucial role of industry in economic development (see, for example, Sheahan [1987] and Johnson [1982]). But "industrial policies" in South America (aside from Brazil) and Africa have for the most part turned out so badly, while activist governments in East Asia have done well.

We suggest that the poor performers have confused support for *industrialization* with support for *industrialists*. Policies that try to increase the health of the equipment sector by enriching producing industrialists end up raising prices and reducing quantities, and so are counterproductive, even though existing industrialists are happy with such policies. Frameworks that increase the quantity of equipment investment by encouraging purchases appear to have been more successful. The divergence between Latin American and East Asian outcomes and the divergence in their relative quantity and price structures carries an important insight into what a successful "industrial policy" is, and how it should be implemented.

E. Views of Economic Growth

Yet another question is what do these results say about alternative theories of economic growth. Beyond calling into question views that overemphasize human capital accumulation through formal education, we doubt that they help in choosing between alternative theoretical formulations—almost all of which allow for some type of important external economy. Instead they point out the importance of disaggregation. This calls into question the utility of research programs directed at spelling out alternative mechanisms driving all of aggregate growth in single-good models as if relative prices (and relative quantities) of different products did not matter. Economists' emphasis on single-good models is odd given that these models offer almost no scope for the relative price effects economists stress in most contexts.

Our exploration of the links between equipment investment and growth leaves many questions unaddressed. Three sets of issues strike us as particularly important. First, are our results an artifact of the particular natural experiment we have studied? We have examined growth and equipment investment during the post-World War II period which contains the largest boom and the largest expansion of trade and manufacturing that the world economy has ever seen. Would equipment investment have been so strongly correlated with growth if, say, the post-World War II period had been more like the interwar period, with falling commodity trade and protectionist pressures generated by unemployment in the industrial core? Some studies of the pre-World War II period have been conducted (for example, Abramovitz and David [1973], Abramovitz [1986], De Long [1988], and McLean and Nguyen [1989]); but they view growth from a highly aggregative perspective; their data are unreliable; and much remains to be done.

Second, just what is the right measure of externality generating investment? X-ray machines and large turbine generators are both classified as electrical machinery; oil drilling rigs and personal computers are both classified as nonelectrical machinery. Yet in each of these sets of goods investment in one good may well have a very different impact on growth than investment in the other. Much more disaggregated equipment investment information is available in national income accounts data and the ICP, but the problem of finding appropriate price deflators remains, and plausible statistical procedures would soon run out of degrees of freedom. It may be possible to explore these issues using information on productivity at the industry, firm, or regional level.

Third, how does equipment investment contribute to growth? As we have just emphasized, aggregate production functions suggest much smaller effects of equipment investment on growth than those that appear in the post-WWII comparative cross section. Presumably some important external economies operate. But we have little insight into exactly what they are, or what their relative quantitative importance is.

APPENDIX I: SPATIAL CORRELATION

Many comparative cross-country regressions have assumed that there is no dependence across residuals, and that each country provides as informative and independent an observation as any other. Yet it is difficult to believe that Belgian and Dutch economic growth would ever significantly diverge, or that substantial productivity gaps would appear within Scandinavia. The omitted variables that are captured in the regression residuals seem ex ante likely to take on similar values in neighboring countries. This suggests that residuals in nearby nations will be correlated, and that the sample contains less information than OLS regressions and standard errors report.

To investigate the possibility and significance of spatial correlation [Case, 1987], we formed, for all country pairs i and j, the product $u_i u_j / \sigma^2$ of the two fitted residuals from our basic regression on the high productivity sample, normalized by the estimate of the residual variance. We then regressed, using various functional forms $u_i u_j/\sigma^2$ on the distance δ_{ij} (in miles) between the capitals of nations i and j. Table XII presents the matrix of distances used.

The first functional form tried was

$$\text{(A.1)} \qquad \frac{E(u_i u_j)}{\sigma^2} = \alpha + \frac{1}{1 + \lambda\delta_{ij}} + \epsilon.$$

It yielded an adjusted R^2 of -0.0003, an estimated α of -0.974 (with an uncorrected OLS reported t-statistic of -11.69), and an estimated λ of 0.0095569 for every thousand miles (with an uncorrected OLS reported t-statistic of 0.76). The estimated correlation between residuals varies from 0.03 for countries with adjacent capitals to -0.05 for countries with capitals 10,000 miles apart.

A second functional form tried was

$$\text{(A.2)} \qquad \frac{E(u_i u_j)}{\sigma^2} + \alpha + \exp\left[-\lambda\delta_{ij}\right] + \epsilon.$$

It also produced an adjusted R^2 less than zero and a small estimate of λ. The estimated α was -0.971 (with an uncorrected OLS reported t-statistic of -11.96), and an estimated λ of 0.00969 for

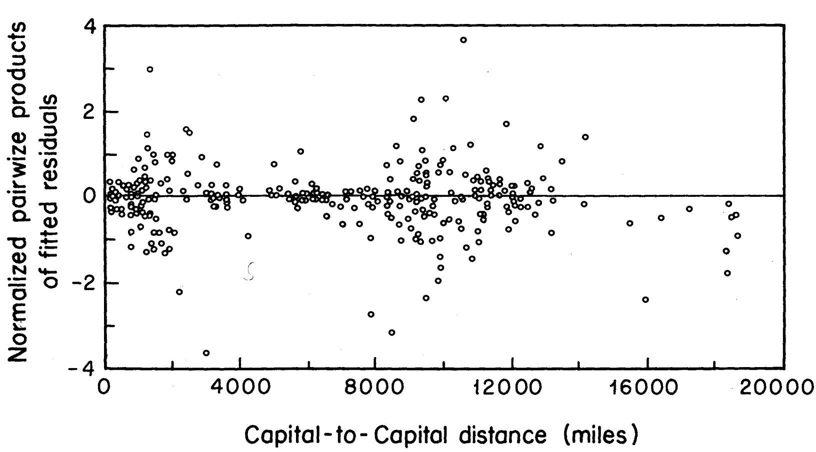

FIGURE IX
Pairwise Products of Residuals and Distances

every thousand miles (with an uncorrected OLS reported t-statistic of 0.87). Once again, the estimated correlation between residuals varies from 0.03 for countries with adjacent capitals to 0.05 for countries with capitals 10,000 miles apart.

Figure IX plots the pairwise products of fitted residuals, normalized by the residual variance, against the distance between national capitals for the high productivity sample. There is a tendency for countries located on opposite sides of the earth (Latin America and East Asia) to have negatively correlated residuals, but the scatter is not supportive of the hypothesis that neighboring countries have similar residuals.

Figure X maps the fitted residuals from the high productivity sample, classifying them into four groups by whether they are positive and negative and whether they are greater or less in absolute value than the standard error of the estimate. The nations in the southern cone of South America all have similar residuals, but the many European countries exhibit no geographical pattern, and dominate the estimated coefficients in our spatial correlation regressions.

We are quite surprised at the apparent absence of a significant degree of spatial correlation in our sample, for much discussion tends to speak of economic growth in terms of regions sharing a common growth path: the southern cone, East Asia, southern

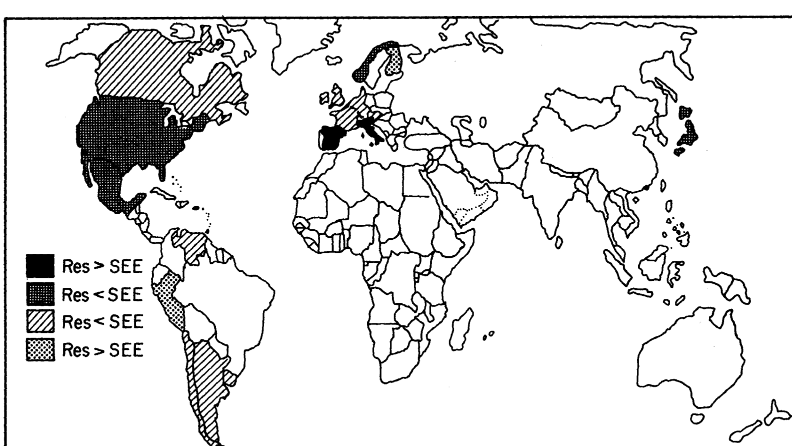

FIGURE X
Geographical Residual Distribution for the High-Productivity Sample

Europe, Scandinavia, and so on. The absence of spatial correlation in the fitted residuals raises the possibility that the factors that lead countries within a region to follow similar growth paths work through the rate of equipment investment.

Table XII presents the matrix of distances between national capitals used.

TABLE XII
MATRIX OF DISTANCES BETWEEN NATIONAL CAPITALS

	U. S.															
Luxembourg	6404	Lux														
Canada	733	5869	Can													
Denmark	6531	803	5926	Den												
Venezuela	3302	7906	3960	8392	Ven											
Germany	6417	144	5869	660	7987	Ger										
Norway	6250	1186	5616	486	8315	1048	Nor									
U. K.	5915	491	5379	958	7500	512	1157	U. K.								
Netherlands	6209	318	5651	623	7858	235	916	359	Net							
France	6180	288	5664	1029	7621	401	1344	341	428	Fra						
Belgium	6233	188	5691	769	7795	195	1089	320	174	262	Bel					
Finland	6951	1675	6292	887	9105	1534	791	1827	1507	1914	1655	Fin				
Austria	7143	766	6587	870	8650	728	1354	1238	936	1038	918	1443	Aus			
Uruguay	8446	11191	9108	11957	5149	11327	12151	11021	11334	10935	11190	12842	11678	Uru		
Italy	7235	987	6747	1531	8363	1065	2008	1434	1294	1108	1173	2204	764	11010	Ita	
Argentina	8359	11289	9031	12046	5071	11423	12227	11105	11424	11029	11282	12930	11793	210	11135	Arg
Chile	8036	11904	8749	12609	4880	12029	12710	11651	11992	11628	11868	13466	12490	1344	11894	1135
Israel	9519	3124	8993	3191	10537	3127	3615	3615	3350	3339	3302	3247	2421	12062	2310	12236
Ireland	5458	954	4916	1243	7149	959	1269	464	760	779	776	2032	1686	10896	1887	10966
Spain	6106	1280	5708	2075	7000	1421	2391	1264	1482	1054	1316	2955	1812	9921	1365	10024
Japan	10925	9513	10342	8714	14179	9371	8428	9585	9315	9738	9476	7839	9154	18575	9881	18365
Mexico	3033	9437	3603	9529	3598	9448	9213	8947	9236	9213	9264	9864	10172	7531	10260	7366
Hong Kong	13137	9369	12446	8688	16380	9250	8608	9646	9300	9650	9416	7843	8749	18326	9300	18463
Peru	5639	10535	6365	11081	2734	10629	11034	10162	10521	10246	10442	11826	11251	3292	10858	3127
Costa Rica	3294	9191	4014	9518	1882	9244	9326	8734	9074	8923	9049	10081	9957	5766	9818	5622

	Chi							
Israel	13226	Isr						
Ireland	11442	4077	Ire					
Spain	10682	3602	1451	Spa				
Japan	17234	9171	9611	10789	Jap			
Mexico	6585	12552	8489	9083	11319	Mex		
Hong Kong	18679	7740	9873	10561	2893	14155	H.K.	
Peru	2458	12811	9839	9504	15493	4240	18379	Per
Costa Rica	5007	12093	8320	8491	13185	1930	15933	2553

Note. Distances taken from Fitzpatrick and Modlin [1986].

Appendix II: Regression Coefficients of Omitted Independent Variables in Panel 3 of Table I

TABLE XIII
Coefficients of All Variables, Including Barro Variables

Variable	1960–1985	1960–1975	1975–1985	1970–1985
		Larger sample		
Labor force growth	−0.001 (0.203)	0.019 (0.233)	−0.217 (0.270)	−0.537 (0.356)
GDP/wkr. gap	0.039 (0.013)	0.039 (0.016)	0.038 (0.017)	0.037 (0.020)
Equipment invest. share	0.275 (0.070)	0.279 (0.086)	0.276 (0.082)	0.262 (0.112)
Nonequipment invest. share	0.029 (0.038)	−0.011 (0.043)	0.040 (0.047)	0.097 (0.063)
Primary sch. enrollment 1960	0.011 (0.009)	0.023 (0.011)	0.009 (0.011)	−0.003 (0.015)
Secondary sch. enrollment 1960	0.003 (0.015)	−0.004 (0.018)	−0.005 (0.019)	−0.001 (0.238)
Government cons./GDP	−0.086 (0.030)	−0.104 (0.039)	−0.084 (0.040)	−0.080 (0.051)
Assassinations/ year	−0.001 (0.003)	0.001 (0.042)	−0.003 (0.004)	−0.003 (0.006)
Revolutions/ year	−0.013 (0.010)	−0.004 (0.013)	−0.013 (0.014)	−0.027 (0.017)
n	61	61	61	61
R^2 (RMSE)	0.391 (0.012)	0.264 (0.015)	0.236 (0.016)	0.190 (0.020)

APPENDIX III: EFFECTS ON GROWTH OF THE PRICES OF DISAGGREGATED COMPONENTS OF INVESTMENT

For the high productivity sample, Table XIV shows that—whether or not the aggregate investment rate is included in the regression—the price of electrical equipment has a weaker relationship to growth than does the price of nonelectrical machinery. When both price measures are included in the regression, the nonelectrical machinery price swamps the electrical equipment

TABLE XIV
HIGH-PRODUCTIVITY SAMPLE

Price elec.	Price mach.	"Orthogonalized" Price equip.	Price trans.	Invest. rate	R^2	*SEE*
−0.017 (0.008)					0.213	0.012
−0.012 (0.008)				0.075 (0.037)	0.311	0.011
	−0.029 (0.009)				0.362	0.011
	−0.023 (0.009)			0.054 (0.037)	0.395	0.010
		−0.030 (0.008)			0.369	0.010
		−0.024 (0.009)		0.050 (0.037)	0.414	0.010
−0.003 (0.009)	−0.026 (0.012)				0.335	0.011
−0.003 (0.009)	−0.020 (0.012)			0.054 (0.036)	0.366	0.011
−0.004 (0.010)	−0.029 (0.013)		0.002 (0.007)		0.378	0.011
−0.001 (0.010)	−0.022 (0.014)		−0.003 (0.008)	0.059 (0.047)	0.338	0.011

Note. Dependent variable is the 1960–1985 GDP per worker growth rate; all regressions include the 1960 relative GDP per worker gap and the 1960–1985 labor force growth rate as additional independent variables.

price (and swamps the price of producers' transport equipment when it is included as well). When the price variables are included in the regression one at a time, the coefficient on the nonelectrical price is twice the coefficient on the price of electrical equipment. And the shift from including the electrical price to including the nonelectrical price raises the adjusted R^2 by three quarters.

For the larger sample (see Table XV) the prices of electrical equipment and nonelectrical machinery have identical coefficients in accounting for growth when entered into the regression sepa-

TABLE XV
LARGER SAMPLE

Price elec.	"Orthogonalized" Price mach.	Price equip.	Price trans.	Invest. rate	R^2	*SEE*
−0.011					0.047	0.015
(0.005)						
−0.004				0.098	0.181	0.014
(0.005)				(0.031)		
	−0.011				0.020	0.015
	(0.007)					
	−0.002			0.103	0.176	0.014
	(0.007)			(0.030)		
		−0.013			0.043	0.015
		(0.007)				
		−0.004		0.099	0.181	0.014
		(0.007)		(0.030)		
−0.010	−0.002				0.031	0.015
(0.008)	(0.010)					
−0.004	0.001			0.099	0.167	0.014
(0.007)	(0.009)			(0.031)		
−0.010	−0.003		0.002		0.015	0.015
(0.008)	(0.011)		(0.007)			
−0.004	0.002		−0.001	0.099	0.151	0.014
(0.008)	(0.010)		(0.006)	(0.032)		

Note. Dependent variable is the 1960–1985 GDP per worker growth rate; all regressions include the 1960 relative GDP per worker gap and the 1960–1985 labor force growth rate as additional independent variables.

rately. But the relationship between growth rates and prices is very weak in the larger sample. When the *total* investment rate is included as an independent variable, the relative price variables are never statistically significant or substantively important.

The fact that the nonelectrical machinery price is more closely associated with growth than the electrical equipment price is somewhat anomalous. In Table IV the quantity of electrical equipment had a much stronger association with growth than the quantity of nonelectrical machinery. The disparity of coefficients in Table IV might be taken to suggest that it is electrical equipment, not equipment in general, that has the most powerful association with growth. But this pattern in prices is not mirrored in quantities: the electrical equipment price has a relatively unimpressive association with growth.

If the only data available were the quantities data, it would be natural to hypothesize that electrical equipment played a very special role in economic growth. If the only data available were the price data, it would be natural to hypothesize that it was nonelectrical machinery that generated the largest productivity gains. Both sets of data are available and point in different directions. We therefore use the "equipment" aggregate of electrical and nonelectrical machinery as the major independent variable.

APPENDIX IV: DATA

TABLE XVI

VARIABLES USED IN REGRESSIONS

Country	GDP/wkr growth 60–85	GDP/wkr growth 60–75	GDP/wkr growth 70–85	GDP/wkr growth 75–85	Labor force growth 60–85	Labor force growth 60–75	Labor force growth 70–85	Labor force growth 75–85	Equip. share 60–85	Equip. share 60–75	Equip. share 70–85
Argentina	0.0089	0.0242	−0.0033	−0.0135	0.0118	0.0128	0.0103	0.0104	0.0214	0.0222	0.0219
Austria	0.0332	0.0471	0.0195	0.0129	0.0014	−0.0030	0.0079	0.0080	0.0991	0.0986	0.1023
Belgium	0.0256	0.0374	0.0151	0.0082	0.0061	0.0048	0.0084	0.0081	0.0684	0.0657	0.0684
Bolivia	0.0124	0.0350	−0.0024	−0.0206	0.0209	0.0189	0.0230	0.0240	0.0167	0.0190	0.0167
Botswana	0.0676	0.0741	0.0656	0.0580	0.0239	0.0182	0.0319	0.0326	0.1310	0.1166	0.1766
Brazil	0.0437	0.0655	0.0307	0.0119	0.0306	0.0319	0.0307	0.0288	0.0646	0.0697	0.0672
Cameroon	0.0458	0.0303	0.0533	0.0695	0.0169	0.0169	0.0164	0.0168	0.0415	0.0348	0.0464
Canada	0.0169	0.0220	0.0131	0.0092	0.0261	0.0284	0.0256	0.0228	0.0771	0.0800	0.0772
Chile	0.0021	0.0018	−0.0151	0.0025	0.0216	0.0192	0.0249	0.0251	0.0154	0.0154	0.0154
Colombia	0.0239	0.0323	0.0198	0.0113	0.0266	0.0265	0.0263	0.0269	0.0229	0.0243	0.0227
Costa Rica	0.0121	0.0251	0.0000	−0.0071	0.0354	0.0358	0.0361	0.0348	0.0433	0.0412	0.0448
Denmark	0.0187	0.0214	0.0112	0.0145	0.0115	0.0129	0.0105	0.0093	0.0688	0.0798	0.0694
Dominican Republic	0.0199	0.0355	0.0130	−0.0031	0.0280	0.0248	0.0322	0.0328	0.0321	0.0289	0.0391
Ecuador	0.0283	0.0411	0.0305	0.0094	0.0274	0.0265	0.0280	0.0287	0.0303	0.0301	0.0323
El Salvador	0.0046	0.0225	−0.0088	−0.0217	0.0316	0.0331	0.0296	0.0295	0.0223	0.0220	0.0230
Ethiopia	0.0094	0.0156	0.0015	0.0000	0.0206	0.0218	0.0193	0.0187	0.0212	0.0234	0.0221
Finland	0.0301	0.0376	0.0235	0.0190	0.0083	0.0082	0.0082	0.0084	0.1206	0.1295	0.1168
France	0.0292	0.0430	0.0170	0.0089	0.0089	0.0089	0.0089	0.0089	0.0879	0.0812	0.0911
Germany	0.0259	0.0346	0.0138	0.0130	0.0047	0.0036	0.0059	0.0063	0.0890	0.0910	0.0892
Greece	0.0446	0.0618	0.0267	0.0194	0.0044	0.0029	0.0069	0.0066	0.0655	0.0702	0.0668
Guatemala	0.0149	0.0259	0.0082	−0.0014	0.0242	0.0237	0.0239	0.0250	0.0384	0.0364	0.0392
Honduras	0.0148	0.0192	0.0075	0.0082	0.0303	0.0271	0.0339	0.0351	0.0446	0.0433	0.0451
Hong Kong	0.0484	0.0484	0.0391	0.0484	0.0359	0.0367	0.0377	0.0346	0.0767	0.0730	0.0762
India	0.0115	0.0118	0.0089	0.0110	0.0170	0.0159	0.0181	0.0186	0.0278	0.0298	0.0282
Indonesia	0.0345	0.0254	0.0507	0.0484	0.0213	0.0203	0.0222	0.0227	0.0221	0.0164	0.0273
Ireland	0.0288	0.0369	0.0219	0.0167	0.0081	0.0041	0.0131	0.0140	0.0814	0.0729	0.0867
Israel	0.0452	0.0526	0.0392	0.0341	0.0305	0.0342	0.0261	0.0250	0.1112	0.1219	0.1036
Italy	0.0362	0.0449	0.0237	0.0233	0.0038	0.0023	0.0055	0.0060	0.0683	0.0717	0.0673
Ivory Coast	0.0278	0.0462	0.0185	0.0009	0.0274	0.0282	0.0261	0.0264	0.0243	0.0224	0.0281
Jamaica	0.0055	0.0044	−0.0276	−0.0445	0.0201	0.0157	0.0292	0.0293	0.0609	0.0731	0.0527
Japan	0.0535	0.0686	0.0347	0.0312	0.0117	0.0141	0.0077	0.0081	0.1223	0.1135	0.1295
Kenya	0.0146	0.0260	0.0157	−0.0024	0.0346	0.0340	0.0358	0.0355	0.0462	0.0476	0.0494
Korea	0.0479	0.0555	0.0500	0.0365	0.0282	0.0296	0.0261	0.0262	0.0557	0.0422	0.0597
Luxembourg	0.0236	0.0303	0.0143	0.0138	0.0064	0.0045	0.0113	0.0094	0.0711	0.0762	0.0693
Madagascar	−0.0102	−0.0026	−0.0213	−0.0217	0.0203	0.0201	0.0210	0.0206	0.0219	0.0223	0.0225
Malawi	0.0153	0.0304	0.0096	−0.0068	0.0226	0.0215	0.0237	0.0243	0.0361	0.0389	0.0396
Malaysia	0.0332	0.0291	0.0352	0.0361	0.0316	0.0306	0.0348	0.0335	0.0446	0.0375	0.0519
Mali	0.0044	−0.0071	0.0223	0.0218	0.0184	0.0166	0.0199	0.0212	0.0433	0.0481	0.0453
Mexico	0.0198	0.0310	0.0074	0.0005	0.0349	0.0301	0.0400	0.0380	0.0273	0.0265	0.0285
Morocco	0.0243	0.0428	0.0016	−0.0030	0.0281	0.0244	0.0339	0.0336	0.0260	0.0218	0.0329
Netherlands	0.0231	0.0363	0.0107	0.0036	0.0146	0.0147	0.0146	0.0145	0.0778	0.0881	0.0784
Nigeria	−0.0047	0.0068	−0.0075	−0.0217	0.0283	0.0280	0.0295	0.0287	0.0358	0.0250	0.0475
Norway	0.0260	0.0272	0.0244	0.0242	0.0150	0.0157	0.0160	0.0140	0.0701	0.0721	0.0716
Pakistan	0.0295	0.0259	0.0178	0.0348	0.0258	0.0229	0.0293	0.0300	0.0263	0.0263	0.0263
Panama	0.0295	0.0385	0.0186	0.0160	0.0279	0.0284	0.0263	0.0271	0.0388	0.0426	0.0414
Paraguay	0.0261	0.0202	0.0314	0.0350	0.0299	0.0277	0.0339	0.0333	0.0189	0.0137	0.0223
Peru	0.0107	0.0355	−0.0104	−0.0254	0.0271	0.0243	0.0321	0.0313	0.0267	0.0294	0.0250
Philippines	0.0179	0.0295	0.0136	0.0007	0.0253	0.0254	0.0249	0.0250	0.0445	0.0423	0.0445
Portugal	0.0318	0.0530	0.0148	0.0007	0.0118	0.0081	0.0201	0.0175	0.0729	0.0729	0.0725
Senegal	−0.0011	0.0017	−0.0069	−0.0053	0.0274	0.0286	0.0281	0.0257	0.0193	0.0194	0.0194
Spain	0.0373	0.0617	0.0162	0.0017	0.0069	0.0048	0.0092	0.0101	0.0397	0.0438	0.0402
Sri Lanka	0.0137	−0.0030	0.0230	0.0391	0.0207	0.0213	0.0208	0.0197	0.0138	0.0130	0.0148
Tanzania	0.0184	0.0281	0.0083	0.0039	0.0276	0.0272	0.0284	0.0283	0.0860	0.0848	0.0954
Thailand	0.0341	0.0351	0.0305	0.0357	0.0278	0.0285	0.0270	0.0265	0.0395	0.0377	0.0377
Tunisia	0.0279	0.0351	0.0275	0.0172	0.0256	0.0201	0.0351	0.0341	0.0428	0.0386	0.0445
U. K.	0.0189	0.0214	0.0163	0.0153	0.0048	0.0048	0.0048	0.0049	0.0694	0.0748	0.0699
U. S.	0.0133	0.0133	0.0081	0.0133	0.0189	0.0196	0.0197	0.0178	0.0762	0.0770	0.0763
Uruguay	0.0041	0.0091	0.0019	−0.0032	0.0052	0.0058	0.0035	0.0042	0.0155	0.0111	0.0158
Venezuela	0.0120	0.0407	−0.0012	−0.0296	0.0378	0.0351	0.0441	0.0417	0.0340	0.0253	0.0441
Zambia	−0.0110	0.0071	−0.0244	−0.0375	0.0275	0.0260	0.0288	0.0297	0.0702	0.1356	0.0696
Zimbabwe	0.0110	0.0182	0.0115	0.0002	0.0309	0.0329	0.0281	0.0279	0.0843	0.0975	0.0778

TABLE XVI
(CONTINUED)

Country	Equip. share 75–85	Non-equip. share 60–85	Non-equip. share 60–75	Non-equip. share 70–85	Non-equip. share 75–85	GDP/wkr gap 1960	GDP/wkr gap 1970	GDP/wkr gap 1975	GDP/wkr gap 1980	Primary educ. 1960
Argentina	0.0210	0.2286	0.2372	0.2341	0.2248	0.6079	0.5820	0.5396	0.5388	0.98
Austria	0.1013	0.1349	0.1341	0.1401	0.1384	0.5809	0.4236	0.3145	0.2737	1.05
Belgium	0.0596	0.1653	0.1824	0.1653	0.1626	0.4109	0.2809	0.1611	0.1158	1.09
Bolivia	0.0151	0.1133	0.1292	0.1138	0.1029	0.8634	0.8437	0.8123	0.8133	0.64
Botswana	0.1610	0.1490	0.1327	0.2010	0.1833	0.9474	0.9154	0.8738	0.8273	0.42
Brazil	0.0693	0.1588	0.1772	0.1639	0.1679	0.8498	0.7740	0.6808	0.6386	0.95
Cameroon	0.0503	0.0885	0.0743	0.0990	0.1074	0.9333	0.9239	0.9143	0.8741	0.65
Canada	0.0762	0.1529	0.1584	0.1530	0.1511	0.1783	0.1651	0.0650	0.0799	1.04
Chile	0.0154	0.2846	0.2846	0.2846	0.2846	0.5402	0.5065	0.6127	0.5095	1.09
Colombia	0.0225	0.1553	0.1606	0.1544	0.1479	0.7695	0.7486	0.6952	0.6640	0.77
Costa Rica	0.0445	0.1067	0.1013	0.1102	0.1095	0.7043	0.6755	0.6481	0.6410	0.96
Denmark	0.0662	0.1834	0.2103	0.1853	0.1761	0.4079	0.3541	0.3320	0.3186	1.03
Dominican Republic	0.0403	0.1379	0.1241	0.1679	0.1730	0.8293	0.8130	0.7635	0.7490	0.98
Ecuador	0.0324	0.2097	0.2086	0.2236	0.2239	0.8205	0.8134	0.7304	0.6814	0.83
El Salvador	0.0233	0.0577	0.0567	0.0594	0.0602	0.8414	0.8353	0.8184	0.8344	0.80
Ethiopia	0.0225	0.0288	0.0318	0.0301	0.0306	0.9805	0.9805	0.9798	0.9796	0.05
Finland	0.1092	0.2494	0.2678	0.2415	0.2259	0.5589	0.4696	0.3703	0.3301	0.97
France	0.0762	0.1767	0.1891	0.1817	0.1773	0.4708	0.3144	0.1833	0.1378	1.44
Germany	0.0749	0.1885	0.2148	0.1889	0.1768	0.4585	0.3212	0.2595	0.1933	1.33
Greece	0.0609	0.2245	0.2405	0.2287	0.2086	0.7924	0.6617	0.5811	0.5295	1.05
Guatemala	0.0393	0.0516	0.0490	0.0527	0.0529	0.7885	0.7804	0.7454	0.7130	0.45
Honduras	0.0451	0.0954	0.0925	0.0964	0.0965	0.8850	0.8796	0.8745	0.8513	0.67
Hong Kong	0.0807	0.1233	0.1173	0.1224	0.1296	0.7471	0.6237	0.5781	0.4334	0.87
India	0.0333	0.1448	0.1307	0.1485	0.1457	0.9356	0.9391	0.9370	0.9385	0.61
Indonesia	0.0296	0.1179	0.0875	0.1459	0.1581	0.9243	0.9316	0.9095	0.8831	0.67
Ireland	0.0844	0.1879	0.1673	0.1993	0.1943	0.6457	0.5774	0.4993	0.4215	1.10
Israel	0.0935	0.1788	0.1962	0.1667	0.1505	0.6816	0.5616	0.4362	0.2659	0.98
Italy	0.0591	0.1790	0.1961	0.1767	0.1624	0.5441	0.3669	0.2775	0.1561	1.11
Ivory Coast	0.0294	0.0957	0.0881	0.1108	0.1157	0.9207	0.9029	0.8718	0.8639	0.46
Jamaica	0.0441	0.1455	0.1747	0.1258	0.1055	0.8229	0.7490	0.7372	0.8193	0.82
Japan	0.1191	0.2464	0.2393	0.2595	0.2512	0.7484	0.5491	0.4415	0.3475	1.03
Kenya	0.0413	0.1268	0.1351	0.1347	0.1167	0.9415	0.9460	0.9294	0.9276	0.47
Korea	0.0702	0.1842	0.1337	0.2027	0.2156	0.8807	0.8501	0.7799	0.7427	0.94
Luxembourg	0.0651	0.1944	0.2067	0.1885	0.1749	0.2863	0.1603	0.0843	0.0800	1.25
Madagascar	0.0222	0.0481	0.0490	0.0494	0.0487	0.9217	0.9322	0.9382	0.9449	0.52
Malawi	0.0382	0.0935	0.0999	0.1035	0.0998	0.9628	0.9617	0.9522	0.9550	0.63
Malaysia	0.0549	0.1878	0.1581	0.2186	0.2313	0.7853	0.7654	0.7203	0.6436	0.96
Mali	0.0417	0.0267	0.0296	0.0279	0.0257	0.9478	0.9660	0.9615	0.9562	0.10
Mexico	0.0287	0.1687	0.1638	0.1765	0.1778	0.5921	0.5156	0.4563	0.4277	0.80
Morocco	0.0365	0.0540	0.0451	0.0681	0.0755	0.8405	0.7700	0.7545	0.7553	0.47
Netherlands	0.0675	0.1781	0.2030	0.1794	0.1564	0.3605	0.2175	0.1043	0.0871	1.05
Nigeria	0.0535	0.0842	0.0589	0.1118	0.1259	0.8579	0.8853	0.8709	0.8742	0.36
Norway	0.0696	0.2199	0.2262	0.2247	0.2183	0.3755	0.3285	0.2334	0.1562	1.18
Pakistan	0.0263	0.0880	0.0880	0.0880	0.0880	0.9180	0.8944	0.9012	0.8877	0.30
Panama	0.0368	0.2212	0.2424	0.2355	0.2097	0.8015	0.7475	0.7129	0.6806	0.96
Paraguay	0.0254	0.1011	0.0732	0.1191	0.1359	0.8458	0.8502	0.8293	0.7628	0.98
Peru	0.0240	0.0933	0.1027	0.0871	0.0836	0.7406	0.6787	0.6409	0.6848	0.83
Philippines	0.0423	0.0974	0.0996	0.0974	0.0996	0.8747	0.8704	0.8409	0.8225	0.95
Portugal	0.0672	0.1571	0.1571	0.1563	0.1450	0.8033	0.7200	0.6500	0.6525	1.31
Senegal	0.0177	0.0807	0.0811	0.0812	0.0740	0.8884	0.9021	0.9060	0.9183	0.27
Spain	0.0399	0.1305	0.1466	0.1320	0.1313	0.6613	0.4602	0.3177	0.3207	1.10
Sri Lanka	0.0156	0.1352	0.1275	0.1458	0.1535	0.8555	0.8829	0.8866	0.8632	0.95
Tanzania	0.0897	0.0940	0.0926	0.1042	0.0980	0.9762	0.9731	0.9704	0.9672	0.28
Thailand	0.0377	0.1412	0.1347	0.1347	0.1347	0.9174	0.9011	0.8896	0.8672	0.83
Tunisia	0.0485	0.0972	0.0875	0.1011	0.1100	0.7838	0.7677	0.7025	0.6768	0.66
U. K.	0.0633	0.1132	0.1225	0.1141	0.1048	0.4307	0.4201	0.3587	0.3325	0.95
U. S.	0.0760	0.1356	0.1342	0.1358	0.1321	0.0000	0.0000	0.0000	0.0000	1.18
Uruguay	0.0177	0.1154	0.0796	0.1174	0.1295	0.5782	0.6311	0.6038	0.5391	1.11
Venezuela	0.0509	0.0760	0.0565	0.0985	0.1136	0.4974	0.4409	0.2503	0.3376	1.00
Zambia	0.0574	0.2012	0.2865	0.1984	0.1491	0.8695	0.8837	0.8809	0.9176	0.48
Zimbabwe	0.0693	0.1257	0.1453	0.1159	0.1032	0.8875	0.8990	0.8790	0.8821	0.98

TABLE XVI
(CONTINUED)

Country	Sec. educ. 1960	Government consumption	Assassination	Revolutions	Manufacturing share	Public investment	Real exch. rate	WDR distort. index	Survey: exch. rate policy	Survey: nat. protection
Argentina	*0.32*	0.09	2.19	0.73	0.2211	0.0496	0.2240	2.43	.	.
Austria	*0.5*	0.16	0.00	0.00	0.2979	0.0361	0.1066	.	57.5	63.8
Belgium	*0.69*	0.13	0.00	0.00	0.2478	0.0316	0.1774	.	69.1	68.2
Bolivia	*0.12*	0.18	0.23	0.85	0.1631	0.0119	−0.4677	2.29	.	.
Botswana	*0.01*	0.26	0.00	0.00	0.0477	.	0.2787	.	.	.
Brazil	*0.11*	0.14	0.08	0.08	0.2535	.	−0.5044	1.86	52.6	47.1
Cameroon	*0.02*	0.19	0.00	0.08	.	0.0180	0.0210	1.57	.	.
Canada	*0.52*	0.14	0.08	0.00	0.1928	0.0293	−0.0545	.	60.6	53.1
Chile	*0.24*	0.19	0.46	0.15	0.2155	0.0529	−0.5315	2.43	.	.
Colombia	*0.12*	0.11	0.38	0.04	0.2238	.	−0.8548	1.71	.	.
Costa Rica	*0.21*	0.21	0.00	0.00	0.2197	0.0184	−0.3452	.	.	.
Denmark	*0.65*	0.20	0.00	0.00	0.1721	0.0344	0.2527	.	57.6	67
Dominican Republic	*0.07*	0.12	0.23	0.23	.	0.0066	−0.4636	.	.	.
Ecuador	*0.12*	0.16	0.00	0.35	0.1816	0.0104	−0.5258	.	.	.
El Salvador	*0.11*	0.19	1.81	0.46	.	0.0238	−0.6425	.	.	.
Ethiopia	*0.01*	0.17	0.46	0.69	0.0986	.	−0.9019	1.86	.	.
Finland	*0.74*	0.14	0.00	0.00	0.2514	0.0448	0.2107	.	64.5	62.5
France	*0.46*	0.13	0.35	0.00	0.2902	0.0333	0.1524	.	52.9	64
Germany	*0.53*	0.16	0.19	0.08	0.3265	0.0348	0.2209	.	63.6	73.2
Greece	*0.41*	0.14	0.12	0.15	0.1882	0.0151	−0.0512	.	44.2	57
Guatemala	*0.07*	0.08	2.85	0.38	0.1665	0.0202	−0.5888	.	.	.
Honduras	*0.08*	0.15	0.04	0.15	0.1429	0.0079	−0.4740	.	.	.
Hong Kong	*0.24*	0.04	0.00	0.00	.	0.0329	−0.2999	.	82.8	75.4
India	*0.2*	0.21	0.85	0.12	0.1392	.	−1.0103	1.86	56.6	44
Indonesia	*0.06*	0.12	0.12	0.23	0.1526	0.0428	−0.7357	1.86	66.7	44.8
Ireland	*0.35*	0.17	0.08	0.00	0.0858	0.0374	−0.0500	.	72.2	46.1
Israel	*0.48*	0.35	0.08	0.00	.	0.0230	−0.1617	.	.	.
Italy	*0.34*	0.15	1.38	0.04	0.3156	0.0327	−0.1104	.	52.4	53.2
Ivory Coast	*0.02*	0.21	0.00	0.00	.	0.0273	0.1232	2.14	.	.
Jamaica	*0.43*	0.17	0.21	0.00	0.1565	.	−0.2030	2.29	.	.
Japan	*0.74*	0.09	0.23	0.00	0.2926	0.0560	−0.0087	.	49.1	59.8
Kenya	*0.02*	0.23	0.11	0.05	0.1076	0.0335	−0.5428	1.71	.	.
Korea	*0.27*	0.16	0.12	0.31	0.2830	.	−0.6726	1.57	31	49
Luxembourg	*0.29*	0.10	0.00	0.00	0.2845	0.0426	0.1381	.	69.1	68.2
Madagascar	*0.04*	0.18	0.00	0.08	0.1998	.	−0.4562	.	.	.
Malawi	*0.01*	0.26	0.05	0.00	0.1168	.	−0.7918	1.14	.	.
Malaysia	*0.19*	0.15	0.04	0.04	0.1998	.	−0.6643	1.57	78	56.5
Mali	*0.01*	0.29	0.00	0.19	.	.	−0.3621	.	.	.
Mexico	*0.11*	0.08	0.12	0.00	0.2498	.	−0.5185	1.86	46.9	56.8
Morocco	*0.05*	0.18	0.04	0.08	0.1718	.	−0.2680	.	.	.
Netherlands	*0.58*	0.13	0.00	0.00	0.2574	0.0350	0.1820	.	70.9	67.8
Nigeria	*0.03*	0.11	0.08	0.42	0.0722	0.0192	0.1848	2.71	.	.
Norway	*0.53*	0.18	0.00	0.00	0.1561	0.0506	0.2373	.	46.3	54.2
Pakistan	*0.11*	0.17	0.31	0.23	0.0047	0.0266	−1.1217	2.29	.	.
Panama	*0.29*	0.25	0.08	0.12	0.1043	0.0199	−0.3754	.	.	.
Paraguay	*0.11*	0.12	0.04	0.08	0.1759	0.0599	−0.2855	.	.	.
Peru	*0.15*	0.15	0.15	0.15	0.2500	.	−0.7234	2.29	.	.
Philippines	*0.26*	0.17	0.73	0.46	0.2504	0.0338	−0.8533	1.57	.	.
Portugal	*0.2*	0.16	0.00	0.23	0.3042	0.0467	−0.4096	.	54.2	53.2
Senegal	*0.03*	0.27	0.08	0.04	0.2307	0.0210	−0.3579	2.29	.	.
Spain	*0.23*	0.10	1.58	0.08	0.3179	0.0187	−0.1903	.	47	55.3
Sri Lanka	*0.27*	0.25	0.08	0.08	0.2003	0.0314	−1.3792	1.86	.	.
Tanzania	*0.02*	0.31	0.05	0.05	.	.	−0.2887	2.47	.	.
Thailand	*0.12*	0.12	0.04	0.31	0.2069	.	−0.9596	1.43	68.3	55
Tunisia	*0.12*	0.17	0.04	0.00	0.1179	0.0366	−0.3034	1.57	.	.
U. K.	*0.67*	0.22	0.35	0.19	0.2351	0.0299	0.0015	.	47.6	64.9
U. S.	*0.86*	0.16	0.50	0.00	0.2405	0.0203	0.0000	.	65.1	62.1
Uruguay	*0.37*	0.16	0.19	0.00	0.2005	0.0144	−0.5078	2.29	.	.
Venezuela	*0.21*	0.11	0.12	0.31	0.1801	0.0163	−0.1623	.	.	.
Zambia	*0.01*	0.32	0.00	0.05	.	0.0100	−0.1886	.	.	.
Zimbabwe	*0.06*	0.17	0.37	0.32	0.2329	0.0250	−0.1617	.	.	.

TABLE XVI
(CONTINUED)

Country	Survey: trade legislation	Barbone openness	Transport share 60–85	Structures share 60–85	Elec. mach. share 60–85	Nonel. mach. share 60–85	Jones eff. pro. rate dummy	Equipment X equipment	Equipment X 1960 gap	Equipment X 1975 gap
Argentina	.	.	0.0086	0.2271	0.0025	0.0189	1	0.0005	0.0130	0.0115
Austria	60	0.024	0.0215	0.1043	0.0245	0.0746	0	0.0098	0.0576	0.0312
Belgium	66.4	0.427	0.0230	0.1522	0.0232	0.0452	0	0.0047	0.0281	0.0110
Bolivia	.	.	0.0054	0.0971	0.0039	0.0128	0	0.0003	0.0144	0.0135
Botswana	.	.	0.0241	0.1250	0.0598	0.0712	.	0.0172	0.1241	0.1144
Brazil	46.5	.	0.0191	0.1619	0.0136	0.0510	1	0.0042	0.0549	0.0440
Cameroon	.	.	0.0272	0.0613	0.0069	0.0346	0	0.0017	0.0387	0.0379
Canada	69.4	0.013	0.0254	0.1401	0.0237	0.0535	0	0.0060	0.0138	0.0050
Chile	.	.	0.0138	0.3205	0.0020	0.0134	1	0.0002	0.0083	0.0094
Colombia	.	.	0.0125	0.1481	0.0125	0.0104	1	0.0005	0.0176	0.0159
Costa Rica	.	.	0.0210	0.0748	0.0074	0.0359	.	0.0019	0.0305	0.0281
Denmark	59.5	−0.277	0.0273	0.1708	0.0117	0.0571	0	0.0047	0.0280	0.0228
Dominican Republic	.	.	0.0065	0.1403	0.0065	0.0256	.	0.0010	0.0266	0.0245
Ecuador	.	.	0.0153	0.2351	0.0017	0.0286	1	0.0009	0.0249	0.0221
El Salvador	.	.	0.0141	0.0436	0.0043	0.0181	.	0.0005	0.0188	0.0183
Ethiopia	.	.	0.0069	0.0219	0.0019	0.0193	1	0.0004	0.0208	0.0208
Finland	64.5	−0.121	0.0148	0.2276	0.0210	0.0996	0	0.0145	0.0674	0.0447
France	49	−0.19	0.0305	0.1646	0.0190	0.0689	0	0.0077	0.0414	0.0161
Germany	72.7	0.043	0.0337	0.1810	0.0285	0.0604	0	0.0079	0.0408	0.0231
Greece	38.8	−0.256	0.0255	0.2278	0.0114	0.0542	.	0.0043	0.0519	0.0381
Guatemala	.	.	0.0085	0.0339	0.0065	0.0319	.	0.0015	0.0303	0.0286
Honduras	.	.	0.0206	0.0748	0.0071	0.0375	.	0.0020	0.0395	0.0390
Hong Kong	84.6	.	0.0218	0.1143	0.0306	0.0461	0	0.0059	0.0573	0.0444
India	46.3	.	0.0094	0.1372	0.0091	0.0187	1	0.0008	0.0260	0.0260
Indonesia	54.3	.	0.0029	0.1151	0.0006	0.0215	1	0.0005	0.0204	0.0201
Ireland	62.9	0.055	0.0303	0.1589	0.0090	0.0724	0	0.0066	0.0526	0.0406
Israel	.	.	0.0108	0.1749	0.0114	0.0997	1	0.0124	0.0758	0.0485
Italy	48.9	−0.031	0.0273	0.1780	0.0214	0.0469	.	0.0047	0.0371	0.0189
Ivory Coast	.	.	0.0242	0.0715	0.0047	0.0196	1	0.0006	0.0224	0.0212
Jamaica	.	.	0.0340	0.1116	0.0138	0.0471	1	0.0037	0.0501	0.0449
Japan	61	0.086	0.0355	0.2313	0.0471	0.0753	0	0.0150	0.0916	0.0540
Kenya		.	0.0240	0.0911	0.0103	0.0359	1	0.0021	0.0435	0.0430
Korea	61.6	.	0.0297	0.1389	0.0112	0.0445	0	0.0031	0.0490	0.0434
Luxembourg	66.4	.	0.0246	0.1619	0.0203	0.0508	0	0.0051	0.0204	0.0060
Madagascar	.	.	0.0053	0.0427	0.0017	0.0202	.	0.0005	0.0202	0.0206
Malawi	.	.	0.0123	0.0782	0.0081	0.0279	.	0.0013	0.0347	0.0343
Malaysia	66.5	.	0.0128	0.1751	0.0056	0.0389	0	0.0020	0.0350	0.0321
Mali	.	.	0.0094	0.0172	0.0041	0.0392	.	0.0019	0.0411	0.0417
Mexico	50.8	.	0.0145	0.1542	0.0087	0.0185	0	0.0007	0.0161	0.0124
Morocco	.	.	0.0153	0.0386	0.0045	0.0215	.	0.0007	0.0219	0.0197
Netherlands	70.9	0.033	0.0313	0.1554	0.0224	0.0554	0	0.0061	0.0281	0.0081
Nigeria	.	.	0.0162	0.0680	0.0122	0.0236	1	0.0013	0.0307	0.0312
Norway	50.5	0.229	0.0317	0.1459	0.0158	0.0543	0	0.0049	0.0263	0.0164
Pakistan	.	.	0.0066	0.0773	0.0034	0.0228	1	0.0007	0.0241	0.0237
Panama	.	.	0.0207	0.2072	0.0107	0.0282	.	0.0015	0.0311	0.0277
Paraguay	.	.	0.0135	0.0723	0.0075	0.0115	.	0.0004	0.0160	0.0157
Peru	.	.	0.0055	0.0858	0.0040	0.0227	1	0.0007	0.0198	0.0171
Philippines	.	.	0.0155	0.0795	0.0109	0.0336	1	0.0020	0.0389	0.0374
Portugal	46.3	0.055	0.0260	0.1312	0.0135	0.0593	.	0.0053	0.0585	0.0474
Senegal	.	.	0.0081	0.0726	0.0039	0.0155	1	0.0004	0.0172	0.0175
Spain	50.8	−0.197	0.0183	0.1375	0.0120	0.0277	0	0.0016	0.0262	0.0126
Sri Lanka	.	.	0.0083	0.1477	0.0023	0.0114	1	0.0002	0.0118	0.0122
Tanzania	.	.	0.0209	0.0730	0.0160	0.0700	1	0.0074	0.0840	0.0835
Thailand	61.7	.	0.0221	0.1191	0.0080	0.0315	1	0.0016	0.0363	0.0352
Tunisia	.	.	0.0239	0.0733	0.0102	0.0326	1	0.0018	0.0336	0.0301
U. K.	61.4	0.087	0.0290	0.0846	0.0181	0.0513	0	0.0048	0.0299	0.0249
U. S.	51.5	−0.027	0.0288	0.1309	0.0262	0.0500	0	0.0058	0.0000	0.0000
Uruguay	.	.	0.0046	0.1021	0.0015	0.0140	1	0.0002	0.0089	0.0093
Venezuela	.	.	0.0148	0.0680	0.0084	0.0256	.	0.0012	0.0169	0.0085
Zambia	.	.	0.0446	0.1058	0.0207	0.0496	.	0.0049	0.0611	0.0619
Zimbabwe	.	.	0.0264	0.0993	0.0165	0.0679	.	0.0071	0.0749	0.0741

TABLE XVI
(CONTINUED)

Country	Equipment X outward 63–73	Equipment X outward 73–85	Investment share 60–85	Investment share 60–75	Investment share 70–85	Investment share 75–85	"Orthog'zed" equip. price	"Orthog'zed" equip. price	"Orthog'zed" other price
Argentina	0.0214	0.0214	0.25	0.2594	0.2560	0.2458	0.0801	0.2084	−0.2779
Austria	.	.	0.23	0.2327	0.2423	0.2369	−0.0607	−0.0732	0.2241
Belgium	.	.	0.23	0.2482	0.2261	0.2144	0.0438	0.0141	−0.0410
Bolivia	0.0333	0.0167	0.13	0.1482	0.1305	0.1180	.	0.2914	.
Botswana	.	.	0.28	0.2493	0.3777	0.3443	.	−0.7429	.
Brazil	0.1938	0.1938	0.23	0.2469	0.2311	0.2185	.	−0.1136	.
Cameroon	0.1244	0.0830	0.13	0.1091	0.1454	0.1578	.	−0.0229	.
Canada	.	.	0.23	0.2384	0.2303	0.2273	0.0003	−0.1113	0.0480
Chile	0.0154	0.0462	0.3	0.3000	0.3000	0.3000	0.5788	0.6917	−0.8479
Colombia	0.0686	0.0457	0.18	0.1850	0.1759	0.1719	.	0.4716	.
Costa Rica	0.1300	0.0867	0.15	0.1425	0.1550	0.1540	−0.0823	0.0994	0.3798
Denmark	.	.	0.27	0.2901	0.2547	0.2295	−0.3719	−0.3754	−0.0582
Dominican Republic	0.0321	0.0321	0.17	0.1636	0.2069	0.2133	.	0.2038	.
Ecuador	.	.	0.24	0.2387	0.2559	0.2562	.	0.3390	.
El Salvador	0.0447	0.0447	0.08	0.7871	0.0825	0.0835	.	0.1937	.
Ethiopia	0.0212	0.0212	0.05	0.5528	0.0522	0.0530	.	−0.3337	.
Finland	.	.	0.37	0.3972	0.3582	0.3352	−0.4253	−0.4061	−0.1942
France	.	.	0.26	0.2703	0.2641	0.2504	0.0552	0.0278	−0.0877
Germany	.	.	0.29	0.3058	0.2680	0.2525	−0.0471	−0.0719	−0.1162
Greece	.	.	0.29	0.3108	0.2955	0.2695	.	−0.2588	.
Guatemala	0.1151	0.0768	0.09	0.8535	0.0918	0.0922	.	0.2537	.
Honduras	0.0892	0.0892	0.14	0.1358	0.1415	0.1416	.	0.0081	.
Hong Kong	0.3069	0.3069	0.2	0.1904	0.1986	0.2103	−0.1740	−0.1008	0.6751
India	0.0278	0.0278	0.17	0.1605	0.1783	0.1801	.	0.1850	.
Indonesia	0.0662	0.0441	0.14	0.1070	0.1732	0.1877	.	0.1407	.
Ireland	.	.	0.26	0.2402	0.2861	0.2859	−0.2389	−0.2418	−0.0073
Israel	.	.	0.29	0.3160	0.2704	0.2440	−0.2482	−0.2626	0.1278
Italy	.	.	0.25	0.2678	0.2348	0.2195	0.1594	0.1220	−0.0673
Ivory Coast	0.0729	0.0486	0.12	0.1105	0.1389	0.1451	.	−0.0715	.
Jamaica	.	.	0.2064	0.2478	0.1785	0.1497	.	−0.3601	.
Japan	.	.	0.36	0.3529	0.3827	0.3713	−0.5446	−0.5577	0.0042
Kenya	0.0925	0.0925	0.17	0.1827	0.1763	0.1591	.	−0.1647	.
Korea	0.2226	0.2226	0.22	0.1758	0.2774	0.2962	.	−0.2624	.
Luxembourg	.	.	0.27	0.2829	0.2578	0.2458	0.1354	0.1085	0.0459
Madagascar	0.0438	0.0219	0.07	0.7135	0.0719	0.0708	.	0.1173	.
Malawi	.	.	0.13	0.1388	0.1431	0.1289	.	−0.1484	.
Malaysia	0.1337	0.1337	0.2323923	0.1956	0.2704	0.2862	.	−0.0160	.
Mali	.	.	0.07	0.7763	0.0732	0.0674	.	−0.1561	.
Mexico	0.0545	0.0545	0.1959269	0.1903	0.2051	0.2065	0.4405	0.3814	−0.3051
Morocco	.	.	0.08	0.6683	0.1010	0.1120	.	0.1457	.
Netherlands	.	.	0.26	0.2919	0.2446	0.2096	0.1242	0.0960	0.0009
Nigeria	0.0716	0.0358	0.12	0.8389	0.1593	0.1794	.	−0.6457	.
Norway	.	.	0.29	0.2983	0.2963	0.2879	0.1273	0.0555	0.0477
Pakistan	0.0263	0.0525	0.12	0.1200	0.1143	0.0012	.	0.1536	.
Panama	.	.	0.26	0.3029	0.2769	0.2465	.	0.0219	.
Paraguay	.	.	0.12	0.8689	0.1414	0.1613	.	0.1818	.
Peru	0.0267	0.0267	0.12	0.1321	0.1120	0.1076	0.3225	0.5270	0.1806
Philippines	0.0890	0.0890	0.15	0.1500	0.1419	0.0946	.	0.2158	.
Portugal	.	.	0.23	0.2300	0.2287	0.2122	.	−0.0700	.
Senegal	0.0386	0.0386	0.1	0.1005	0.1006	0.0918	.	0.2278	.
Spain	.	.	0.18	0.1904	0.1722	0.1610	0.0270	0.0263	−0.0253
Sri Lanka	0.0138	0.0275	0.15	0.1454	0.1606	0.1611	.	0.8287	.
Tanzania	0.0860	0.0860	0.18	0.1775	0.1995	0.1877	.	−0.6898	.
Thailand	0.1186	0.1186	0.1807538	0.1774	0.1724	0.1869	.	−0.1148	.
Tunisia	0.0856	0.1285	0.14	0.1261	0.1456	0.1585	.	0.1986	.
U. K.	.	.	0.18	0.1973	0.1765	0.1640	−0.0788	−0.0829	0.1688
U. S.	.	.	0.21	0.2112	0.2132	0.2113	0.0991	0.0644	−0.0285
Uruguay	0.0155	0.0464	0.12	0.9074	0.1332	0.1572	0.2996	0.3111	−0.1371
Venezuela	.	.	0.11	0.8181	0.1427	0.1645	0.1772	0.2002	0.4154
Zambia	0.0702	0.0702	0.32	0.4221	0.2680	0.1737	.	−0.4218	.
Zimbabwe	.	.	0.21	0.2428	0.1937	0.1724	.	−0.3464	.

TABLE XVI
(CONTINUED)

Country	"Orthog'zed" other price	National savings rate	Exchange rate distort.	Manufac. prot. distort.	Capital price distort.	Labor price distort.	Distortion ranking	Outward oriented 63–73	Outward oriented 73–85
Argentina	−0.5546	16	3	2	3	1	23	1	1
Austria	0.2405	27.5	.	.	.	.	.	.	.
Belgium	0.0315	21	.	.	.	.	.	.	.
Bolivia	−0.4399	9.5	3	2	3	1	21	2	1
Botswana	0.0266	−13	.	.	.	.	.	.	.
Brazil	−0.1732	22.5	1	2	3	1	14	3	3
Cameroon	0.0840	13.5	1	1	2	2	3	3	2
Canada	0.2438	24	.	.	.	.	.	.	.
Chile	−1.0945	18.5	3	1	3	3	24	1	3
Colombia	−0.3163	21.5	1	2	2	1	9	3	2
Costa Rica	−0.0022	13.5	.	.	.	.	.	3	2
Denmark	−0.0621	16.5	.	.	.	.	.	.	.
Dominican Republic	−0.2229	6	.	.	.	.	.	1	1
Ecuador	−0.6543	14	.	.	.	.	.	.	.
El Salvador	0.3028	10	.	.	.	.	.	2	2
Ethiopia	0.6186	7.5	2	3	1	1	10	1	1
Finland	−0.2561	25.5	.	.	.	.	.	.	.
France	−0.0228	23.5	.	.	.	.	.	.	.
Germany	−0.0675	21.5	.	.	.	.	.	.	.
Greece	−0.2040	11.5	.	.	.	.	.	.	.
Guatemala	0.3074	8.5	.	.	.	.	.	3	2
Honduras	0.0232	14	.	.	.	.	.	2	2
Hong Kong	0.5069	30	.	.	.	.	.	4	4
India	−0.2729	19	1	3	2	2	12	1	1
Indonesia	−0.6617	18.5	2	2	2	1	11	3	2
Ireland	−0.0368	22	.	.	.	.	.	.	.
Israel	0.1321	13	.	.	.	.	.	.	.
Italy	0.0036	22.5	.	.	.	.	.	.	.
Ivory Coast	0.0625	24	1	2	2	3	16	3	2
Jamaica	0.0397	23	2	2	3	3	19	.	.
Japan	0.0033	31	.	.	.	.	.	.	.
Kenya	0.0036	17.5	1	3	2	2	8	2	2
Korea	−0.1222	23	1	1	2	1	4	4	4
Luxembourg	0.1243	.	.	.	.	.	.	.	.
Madagascar	0.4988	5.5	.	.	.	.	.	2	1
Malawi	0.3478	6	1	1	2	1	1	.	.
Malaysia	−0.4518	30.5	1	1	2	2	5	3	3
Mali	0.6647	2.5	.	.	.	.	.	.	.
Mexico	−0.2221	18	1	1	3	2	15	2	2
Morocco	0.6165	13	.	.	.	.	.	.	.
Netherlands	0.0789	19	.	.	.	.	.	.	.
Nigeria	0.0071	16	3	2	3	3	26	2	1
Norway	0.1648	28	.	.	.	.	.	.	.
Pakistan	0.1509	12	2	3	2	3	18	1	2
Panama	−0.3059	16	.	.	.	.	.	.	.
Paraguay	0.0324	16	.	.	.	.	.	.	.
Peru	−0.2464	27	1	3	3	2	22	1	1
Philippines	0.3807	18.5	1	2	2	1	6	2	2
Portugal	0.1243	19	.	.	.	.	.	.	.
Senegal	0.3023	7	2	2	2	2	17	2	2
Spain	−0.0327	23	.	.	.	.	.	.	.
Sri Lanka	−0.2225	13	1	2	2	3	13	1	2
Tanzania	−0.1315	5	1	3	3	3	25	1	1
Thailand	−0.0054	22.5	1	2	1	1	2	3	3
Tunisia	0.4952	17	1	2	2	1	7	2	3
U. K.	0.1621	19	.	.	.	.	.	.	.
U. S.	0.0773	15.5	.	.	.	.	.	.	.
Uruguay	−0.2101	14.5	3	3	3	1	20	1	3
Venezuela	0.3458	29.5	.	.	.	.	.	.	.
Zambia	−0.0702	30	.	.	.	.	.	1	1
Zimbabwe	−0.1368	22.5	.	.	.	.	.	.	.

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