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Equipment Investment and Economic Growth*

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We use disaggregated data from the United Nations International Comparison Project and the Penn World Table to examine the association between different components of investment and economic growth over 1960–85. We find that producers' machinery and equipment has a very strong association with growth: in our cross section of nations each percent of GDP invested in equipment raises GDP growth rate by 1/3 of a percentage point per year. This is a much stronger association than can be found between any of the other components. We interpret this association as revealing that the marginal product of equipment is about 30 percent per year. The cross nation pattern of equipment prices, quantities, and growth is consistent with the belief that countries with rapid growth have favorable supply conditions for machinery and equipment. The pattern is not consistent with the belief that some third factor both pushes up the rate of growth and increases the demand for machinery and equipment.

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, identified its beginnings in the invention and spread of those "two machines, henceforth immortal, the steam engine and the cotton-spinning [frame]." Ever since, qualitative historical discussions of growth have emphasized the role of investment in machinery 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 modern quantitative studies of economic growth have tended to downplay the role of

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mechanization. Work in the growth accounting tradition of Solow (1957)[1] has typically concluded that capital accumulation accounts for only a relatively small fraction of productivity growth.[2] The assumption underlying growth accounting calculations that capital is paid its marginal product implies that increasing the rate of capital accumulation can make only a modest contribution to accelerating growth. 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) (Kravis, Heston, and Summers, 1982; 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.

Moreover, the data strongly suggest that high equipment investment is a cause, not a consequence of rapid productivity growth. The cross nation pattern of equipment prices, equipment investment quantities, and growth rates is consistent with the belief that fast growing countries are those where equipment supply curves have shifted outwards. It is not consistent with the belief that fast growing countries are those in which other determinants of productivity growth have shifted equipment demand curves outward. We interpret the cross country evidence as suggesting social returns to equipment investment on the order of 30 percent per year.

We organize the remainder of our paper as follows. Section II motivates our emphasis on

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[1] See also Abramovitz (1956).

[2] For example, Denison (1967), Denison and Chung (1976), and Jorgenson (1988, 1990). Jorgenson's more sophisticated and much more disaggregated growth accounting exercises find substantial complementarity between equipment investment and total factor productivity growth, and thus a somewhat larger role for investment in enabling productivity growth.

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 interractions, and alternative measures of equipment investment.

Section IV addresses the issue of causality in the relationship between equipment investment and growth by examining the relation between equipment prices 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, and the effects of alternative sources of variation in equipment investment on productivity growth. 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 results.

II. Equipment Investment and Economic Structure

Equipment Investment and Economic Development

There are at least three grounds for suspecting that equipment investment might be a potent stimulant to economic growth. 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 (Usher, 1920; Landes, 1969; 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 (Rostow, 1958; Gerschenkron, 1962).

Second, discussions of economic growth in the development economics (Hirschman, 1958; Chenery *et al.*, 1986) and the new growth theory traditions (Romer, 1986) stress external economies or "linkages" as causes of growth. It is natural to think that spillovers are lager in some sectors than others. Manufacturing accounts for ninety-five percent of private-sector research and development in America, and within manufacturing the equipment sector accounts for more than half of research and development (Summers, 1990). Exploring the possibly special role of equipment investment seems worthwhile: it is a natural place to expect external economies and linkages to be important.

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 or enjoying lower equipment prices should enjoy more rapid growth.

Measuring Equipment Investment

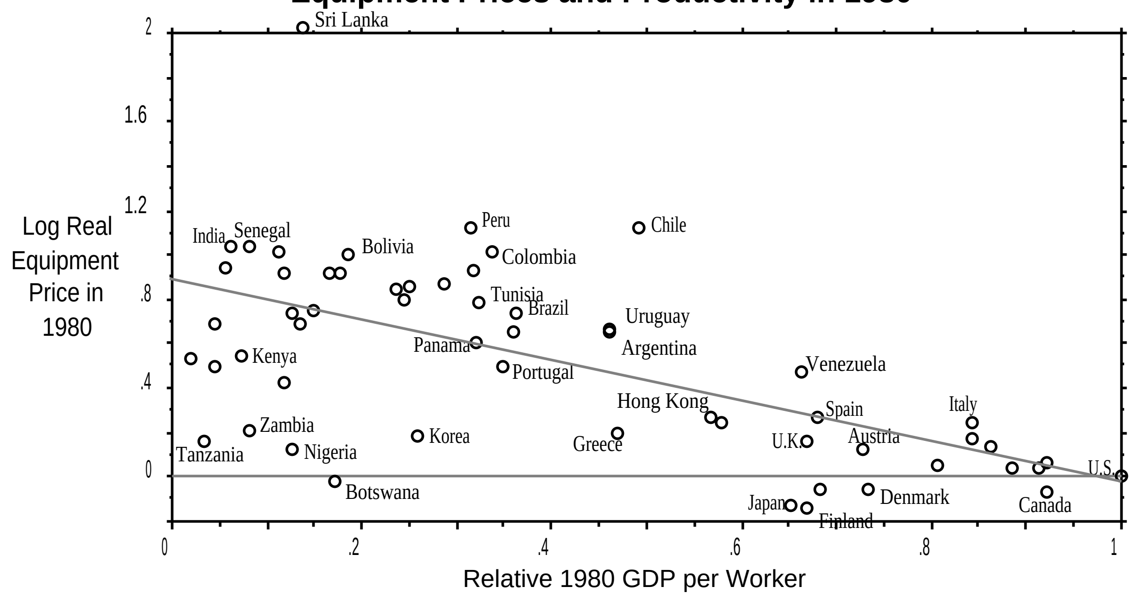
Data on the share of nominal GNP devoted to equipment have long been available from national income accounts data. However, these data would not permit an accurate assessment of the impact of equipment investment on growth unless the relative price of equipment is constant across countries. The availability 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 non-electrical machinery. In the first draft of this paper (De Long and Summers, 1990) we investigated the relationship between total producers’ durable investment—the sum of these three components—and productivity growth. In carrying out the research reported here, we realized there was little information in the producers’ transportation component of durables, and so in this paper we use an equipment aggregate comprising electrical and

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

non-electrical 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.

Figure 1
Equipment Prices and Productivity in 1980



Economic Structures and GDP per Worker Levels

The most extensive ICP data on equipment investment comes from the 1980 survey, which includes more than sixty countries.[4] Figures 1 and 2 plot, respectively, our estimates of the real price of equipment relative to the GDP deflator in 1980 and of the average 1960–85 share of real GDP devoted to real equipment investment against 1980 GDP per worker for those nations in our sample covered in the ICP Phase IV.[5] 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

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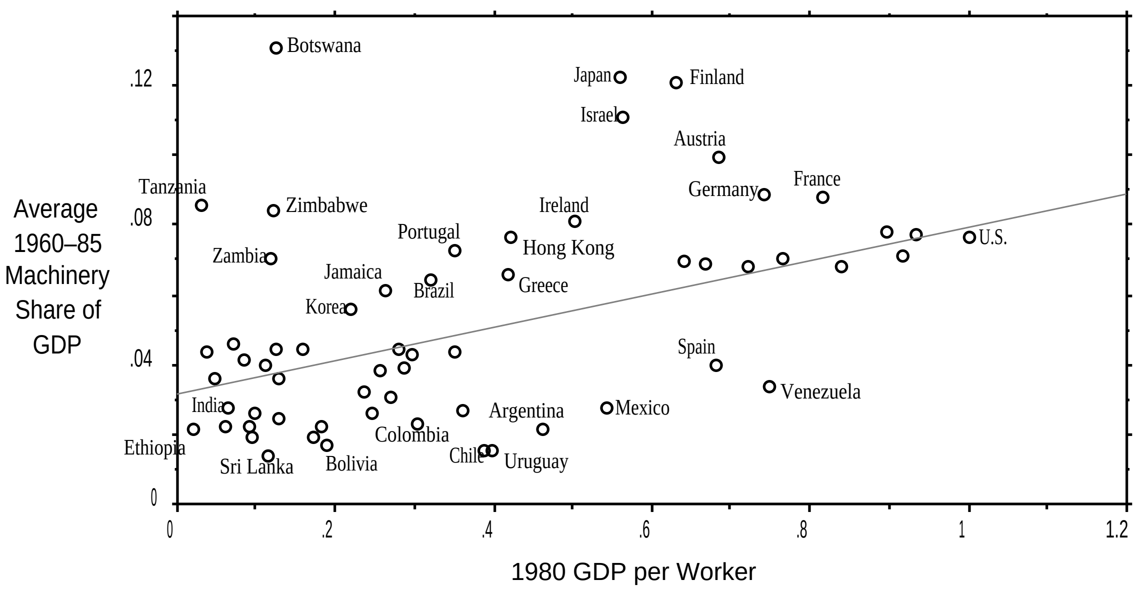
[4]ICP Phase III data is presented in Kravis, Heston, and Summers (1982). It gives relative price and quantity structures in 1975 for about half of the Phase IV country. In addition, we use 1970 data from earlier phases of the ICP, and also 1985 data which has been released only for the OECD. We have also used revisions of published ICP data kindly provided by Robert Summers. We merge these snapshots of price and quantity structures with the 1960–85 long-run growth data of Penn World Table V (see Summers and Heston, 1990). Our total sample consists of sixty-one countries.

[5]We omit high income oil exporting nations from our sample.

fall. An increase of 10 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.[6] 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 investment. Beyond the systematic 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.

Figure 2
Equipment Investment and GDP per Capita



Second, as figure 2 shows, there are wide variations in national rates of equipment investment as a share of GDP. Wealthier nations tend to have higher equipment investment shares: those nations with 1980 GDP per worker levels less than ten percent of the U.S. have equipment shares, measured in Summers and Heston international dollars, that average 3.5 percent of GDP; those nations with 1980 GDP per worker levels greater than ninety percent of the U.S. have equipment shares averaging 7.5 percent of GDP. The cross section variation at given productivity levels is even more substantial. Equipment investment shares in countries like Chile and Venezuela are some five percentage points lower than would be expected given GDP per worker. Equipment investment shares in countries like Israel, Japan, and Finland are more than five percentage points higher than would be expected.

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[6] A similar relationship holds over time: the fastest growing countries are also those that have experienced the steepest declines in relative real machinery prices.

Third, poorer nations possess very large relative variances in their equipment prices and quantities. Those nations with GDP per worker levels above $10,000 have a standard deviation of producers' durables prices about the simple regression line of 10 percent; those nations with GDP per worker levels below $2,500 have a standard deviation of more than 60 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 five percent of its labor force and where average labor productivity is forty 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 (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 Britain before the industrial revolution,[7] with technologically-sophisticated developed countries. We 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 investment and economic growth in the next section, we pause to highlight the fact that international patterns of equipment investment differ from patterns of non-equipment investment. In our sample, equipment investment averages 28 percent of total investment, but the composition of investment varies widely. Figure 3 plots the 1980 price of equipment investment against the investment deflator. Figure 4 plots our estimate of equipment investment over 1960–85 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 tradeable while structures—the other major component of investment—are not.[8]

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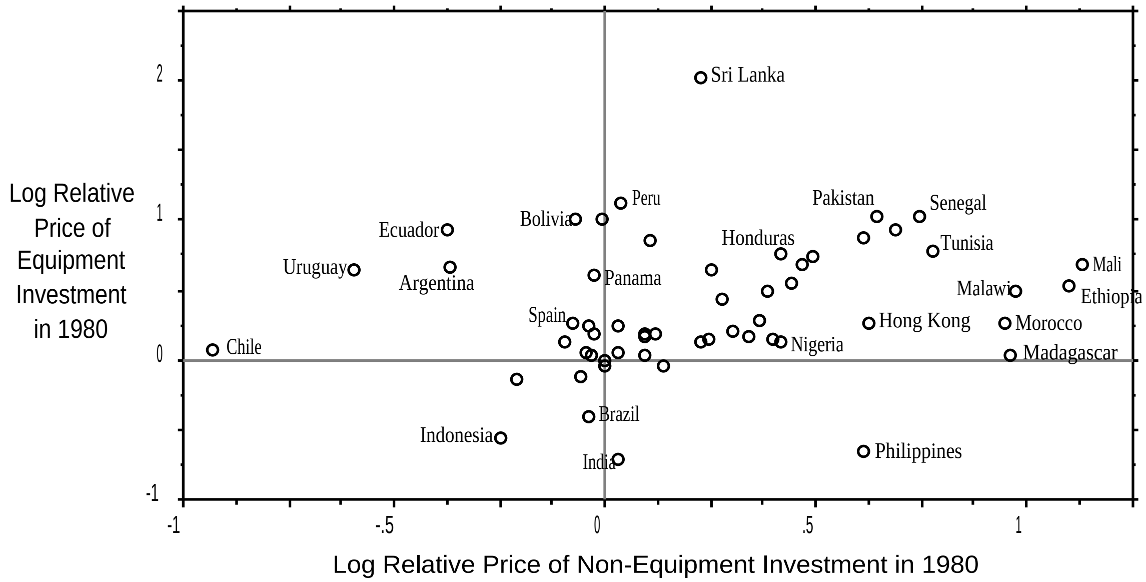
[7]According to Summers and Heston, the U.S. today has a real GDP per worker level 14 times that of Zambia. U.S. real GDP per worker increased by a factor of perhaps 8 between 1870 and the present, and perhaps slightly less than doubled over the previous century.

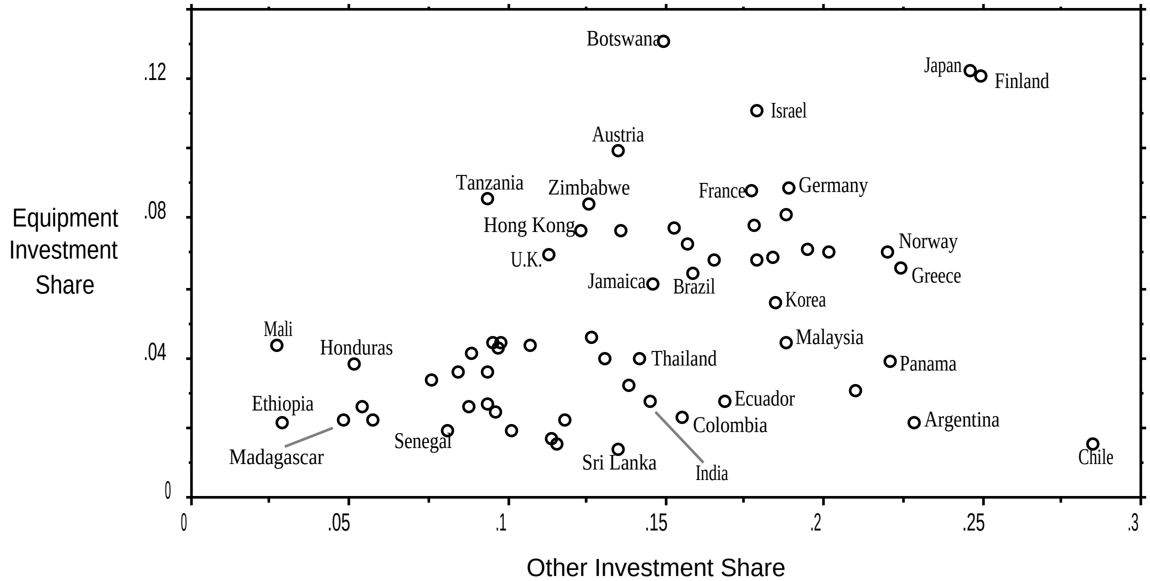
[8]Warner (1990) notes that 31 percent of U.S. equipment purchases in 1989 were imported.

Figure 3
Equipment and Non-Equipment Investment Prices in 1980



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 distorations in an economy, as in Barro (1990), appears implausible given that structures are not traded and that the investment deflator depends heavily on the price of structures and on the composition of investment.

Figure 4
Equipment and Non-Equipment Investment as Shares of GDP



III. Equipment and Growth

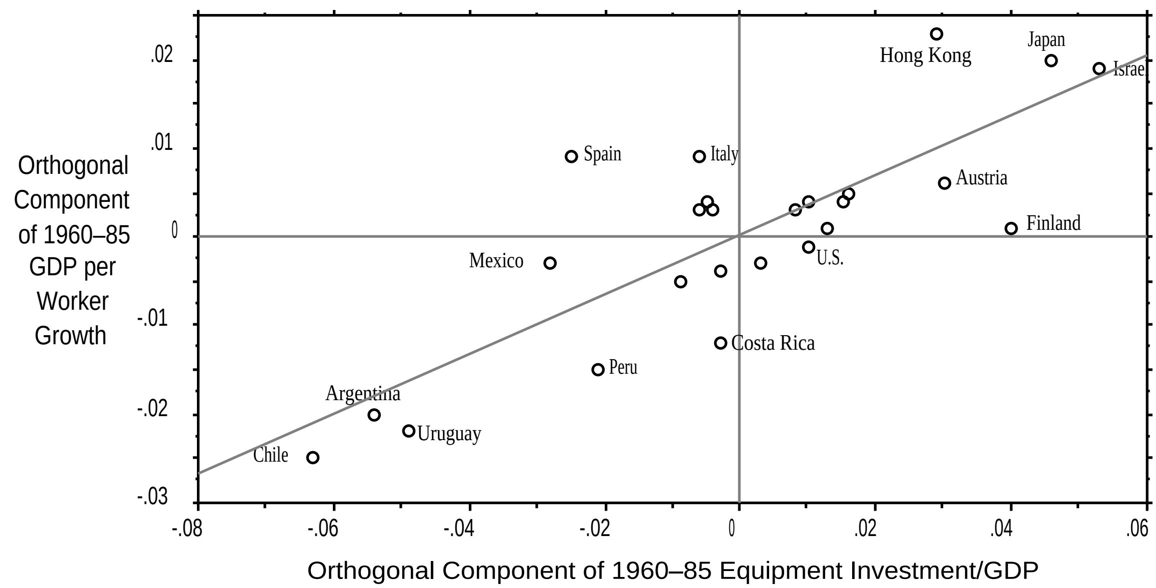
This section demonstrates that nations which invested heavily in equipment relative to other nations at the same stage of economic development enjoyed rapid growth over 1960–85. Our measure of economic growth is the growth rate of GDP per worker, measured in international dollars, as reported by Summers 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 non-equipment 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).

Basic Results

Figure 5, 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. level. The figure plots that component of 1960–85 GDP per worker growth orthogonal to 1960–85 labor force growth, to the average 1960–85 real non-equipment investment share of GDP, and to the 1960 relative GDP per worker gap vis-a-vis the United States against that component of the 1960–85 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 5 is only 0.80 percent. Including the equipment variable reduces the variance of the residual by 47 percent compared to 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.

Figure 5
Partial Scatter of Growth and Equipment Investment, 1960–85



$$\text{(1)}\quad \text{GDP/Wkr Gr} = \underset{(.146)}{-.002}(\text{LF Growth}) \underset{(.009)}{+.030}(\text{Rel. GDP Gap}) \underset{(.054)}{+.337}(\text{Equip}) \underset{(.033)}{-.015}(\text{Non-Equip})$$

$n = 25 \qquad R^2=.662 \qquad \text{RMSE}=.008$

The regression line of equation 1 implies that an increase of 3 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 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 1960–85 relative to the average of the high productivity sample, and five 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.[9]

Statistical Issues

The regression line depicted in figure 5 and equation 1 was obtained using OLS. We verified that the standard errors were not appreciably affected by allowing for heteroscedasticity. 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

[9]Japanese growth performance was extraordinary even before the post-World War II period. High equipment quantities and low equipment prices may have characterized its economy far back into history. For studies of long run Japanese economic growth during early Showa, Taisho, and Meiji, see Denison and Chung (1976), Patrick and Rosovsky (1976), Ohkawa and Rosovsky (1973), and De Bever and Williamson (1977). The argument that abnormally low producers' durable equipment prices have had a strong impact on economic growth in Japan by significantly increasing the returns to saving is made by De Bever and Williamson (1977), who note "the contrast [in the behavior of producers' durable prices] between Japan on the one hand and Europe and America on the other," 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." The argument that Japan has achieved high measured economic growth by concentrating its investment in equipment rather than structures is made in Patrick and Rosovsky (1976).

[10]See Case (1987).

much as ten percent in the sample of the 25 high-income nations.[11]

The most significant statistical issue with respect to our results is that they are not the first equations we have estimated. Our first equations estimated examined the relationship between growth and the quantities of producers' durables—the aggregate of electrical equipment, non-electrical machinery, and producers' transportation equipment. Our inspection of the data led us to note that producers' transportation equipment appeared to do little more than add noise to our measures. Beyond reporting how we arrived at the specification, there is little that can be done to address the issue of the significance of specifications that have to some degree been chosen after examination of the data, except for reporting as we do below a wide variety of alternative specifications as well.

Sample Selection Issues

There are two important dimensions of sample selection involved in figure 5 and equation 1—the choice of countries included in the analysis, and the choice of a sample period. The table considers the 1970–85, the 1975–85, and the 1960–75 periods as well as the 1960–85 period as a whole. The results for the equipment investment variable are not sensitive to the choice of a sample period.

Table 1 then 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

Table 1
Productivity Growth and Equipment Investment

Period Used	Lab. Fce. Growth	GDP/Wkr. Gap	Equipment[1] 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)
1960-1975	-0.081	0.049	0.295	-0.056	25	0.492
	(0.197)	(0.013)	(0.075)	(0.043)		(0.011)
1960-1985 (1975 Gap)	0.023	0.016[2]	0.361	-0.019	25	0.507
	(0.179)	(0.011)	(0.070)	(0.040)		(0.009)
1970-1985	-0.030	0.015	0.379	-0.025	25	0.593
	(0.163)	(0.011)	(0.063)	(0.038)		(0.009)

[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.

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)
1960-1975	-0.088	0.013	0.181	0.035	61	0.093
	(0.243)	(0.012)	(0.083)	(0.043)		(0.017)
1960-1985	0.501	0.006[2]	0.260	0.050	61	0.238
(1975 Gap)	(0.209)	(0.008)	(0.070)	(0.036)		(0.014)
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)
1960-1975	0.019	0.039	0.279	-0.011	61	0.263
	(0.233)	(0.016)	(0.086)	(0.043)		(0.015)
1960-1985	0.011	0.023[2]	0.307	0.030	61	0.299
(1975 Gap)	(0.206)	(0.011)	(0.074)	(0.040)		(0.013)
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)

[1]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.
[2]Regression using the 1975 GDP per worker gap.

various educational and political correlates of growth as in Barro (1990).[12] 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 infrastructures 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.[13] The additional variables do contribute modestly to the explanatory power of the regressions, but do not have an

[12]The coefficients on the correlates favored by Barro (1990) are reported in an appendix table.
[13]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.

appreciable impact on the equipment coefficients.[14]

Table 1 also explores the effect of replacing the initial 1960 GDP per worker gap relative to the U.S. with the 1975, mid-sample period gap.[15] This replacement has no material effect on the equipment investment coefficient.

Figure 6 reports the partial scatter, analogous to figure 5, for the entire 61 country sample rather than the high productivity 25 country sample. The shift to a larger sample does not materially affect the coefficient of the equipment quantity variable. We performed Chow tests to see if the same structure holds for countries with 1960 GDP per worker levels greater than and less than 25 percent of the U.S, and failed to reject the null hypothesis of a common structure of regression coefficients.[16]

Results using the entire 61 nation sample are, however, sensitive to outliers. The exclusion of Zambia, for example, raises the adjusted R^2 in the regression underlying figure 8 from .29 to .44; the exclusion of Botswana would reduce the adjusted R^2 from .29 to .21. Inclusion or exclusion of these two countries can move the equipment share coefficient between .21 and .31, although the coefficient always 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. Singapore and Taiwan have both 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. Singapore, for example, has had a GDP per worker growth rate of 4.2% per year, of which 3.7% is accounted for by our basic regression. In the scatter of figure 6, it lies roughly halfway between Hong Kong and Finland.

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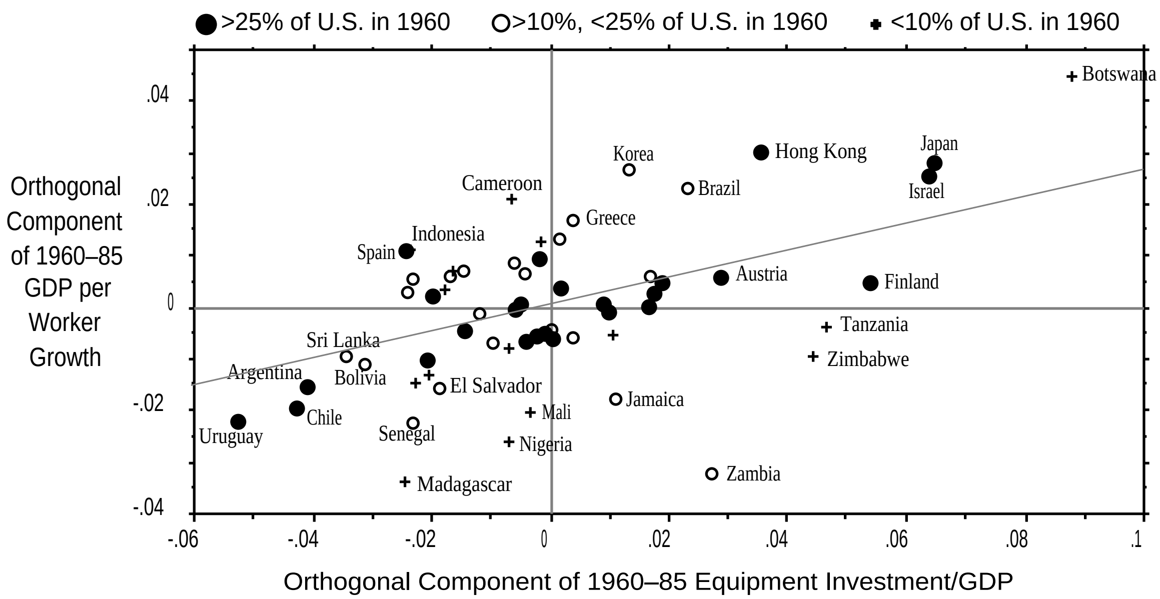
[14] The failure of literacy and education variables to reduce the coefficient on the equipment investment share is not easy to reconcile with Mankiw, Romer, and Weil's (1990) belief that high estimated effects of physical investment on growth are due to the fact that investment in physical capital also proxies for investment in human capital when human capital controls are omitted.

[15] As suggested by Romer (1989).

[16] 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. Non-parametric tests do reject the hypothesis of a common structure of regression coefficients.

Figure 6
Partial Scatter of Growth and Equipment Investment, 1960–85



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. Equipment has a high coefficient and other investment a low coefficient not because equipment is a less noisy measure of unobserved "true" accumulation than other investment, but because equipment investment is correlated, and other investment is not correlated, with economic growth.

Table 2
Productivity Growth and Equipment Investment wifh 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[1]	0.337	0.333	0.144	23	0.659
	(0.056)	(0.058)	(0.296)		(0.008)
Mfg. Share in GDP[2]	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 (0.054)	0.053 (0.063)	-0.010 (0.004)	25	0.856 (0.005)
Europe			0.008 (0.004)		
Asia			0.026 (0.006)		
		Larger Sample			
Public Investment	0.240 (0.075)	0.236 (0.075)	0.171 (0.154)	52	0.254 (0.012)
Mfg. Share in GDP	0.288 (0.062)	0.287 (0.063)	0.012 (0.025)	45	0.413 (0.011)
Exchange Rate	0.265 (0.065)	0.287 (0.072)	-0.007 (0.006)	61	0.294 (0.013)
Continent Dummies					
South America	0.265 (0.065)	0.287 (0.072)	0.006 (0.006)	61	0.385 (0.012)
Europe			0.011 (0.008)		
Asia			0.012 (0.006)		
Africa[3]			-0.005 (0.006)		

[1]From Barro (1990). The ratio of real public domestic investment to real domestic investment—average over 1970–85.
[2]The ratio of real manufacturing value added to real GDP in 1980.
[3]There are no African nations in the high productivity sample.

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 2 reports the results of adding variables measuring (i) the share of manufacturing in value added, (ii) the size of the

public sector, (iii) the importance of public investment, (iv) the real exchange rate in 1980,[17] and (v) the continent to our basic specifications. In no case does the inclusion of an additional variable have a large impact on the coefficient of equipment investment in the larger sample. In only one case—that of continent dummies—does the inclusion of the controls materially reduce the equipment investmentcoefficient in the high productivity sample.

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[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.

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 U.S., Canada, fast-growing Asians, slow-growing Latin Americans, 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 3
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)
World Competitiveness Report					
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)
Barbone (1988)					
Coefficient in Openness Regression	0.033 (0.089)	0.032 (0.093)	0.001 (0.009)	17	0.633 (0.006)

World Development Report 1983 (Agarwala)					
Exchange Rate[1]	0.165	0.081	-0.010	26	0.270
Pricing Distortion	(0.178)	(0.165)	(0.004)		(0.012)
Protection of Manu-		0.183	-0.007		0.169
facturing Distortion		(0.173)	(0.004)		(0.013)
Capital Pricing		0.332	-0.011		0.203
Distortion		(0.191)	(0.006)		(0.013)
Labor Pricing		0.171	-0.006		0.230
Distortion		(0.166)	(0.003)		(0.013)
Distortion Index[2]		0.188	-0.018		0.331
Value		(0.155)	(0.007)		(0.012)
Distortion Index		0.205	-0.010		0.366
Ranking		(0.151)	(0.003)		(0.011)
World Development Report 1987					
Outward Trade[3]	0.242	0.153	0.011	32	0.414
Oriented 1963-1973	(0.183)	(0.145)	(0.003)		(0.012)
Outward Trade		0.107	0.012		0.428
Oriented 1973-1985		(0.145)	(0.003)		(0.012)

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

Table 3 examines the relationship between growth and equipment investment holding constant various measures of the incidence of distortions. Measures of distortions are drawn from the work of Agarwala, as reported in the *World Development Report* for 1983, from World Bank assessments of the “inward” or “outward” orientation of trade policies as reported in the *World Development Report* for 1987, from “business leaders” perceptions of the business climate in different nations as reported in a collection of survey evidence called the *World Competitiveness Report*, and from a statistical analysis by Luca Barbone (1987) that assesses OECD nation openness using residuals from a modified gravity trade model. 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.[18] Trade share measures to a large degree pick up difference in national size and proximity to trading partners. Suppose, for example, that Belguim 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?

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

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

modified gravity model are ineffective as an independent variable in our growth equation. And the coefficient of the equipment quantity variable is unaffected.

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 investment 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.

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 .242 with a standard error of .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]

Components of Investment

Table 4 reports results using different disaggregations of investment. Breaking up equipment into its electrical machinery and non-electrical equipment gives somewhat puzzling and hard to interpret results. On the one hand, the quantity of electric machinery appears to have a more potent impact on growth than the non-electric machinery component. On the other hand, electrical machinery *prices* are less related to growth than non-electrical equipment prices—the fastest growing nations are those that have the lowest non-electrical equipment prices, not the lowest electrical machinery prices. We suspect that the breakdown into the components of equipment pushes beyond the information that the data reliably contain.

Table 4
Productivity Growth and Disaggregated Investment 1960–85

Labor Force Growth	GDP/Wkr Gap	Equip. Share	Non-Equip. Share	Machine[1] 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[2]	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[3]	-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)

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[19]See Collins and Park (1987). The 1987 *World Development Report* both 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 5 below presents regressions suggesting that this is indeed the case, and that equipment investment and the *World Development Report* outward orientation measures are strong complements.

0.056	0.005[2]	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[4]	0.071	-0.237	61	0.307
(0.197)	(0.009)			(0.110)	(0.219)	(0.090)	(0.350)		(0.013)

[1]Disaggregated shares were created using the same procedure as for the equipment share in table 1.
[2]Regression uses 1975 GDP per worker gap instead of 1960 gap.
[3]T-statistic on difference between electrical equipment and non-electrical machinery coefficients equals 1.95.
[4]T-statistic on difference between electrical equipment and non-electrical machinery coefficients equals 1.67.

When producers' transportation equipment is broken out of 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 mid-sample 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 non-electrical equipment.

Table 5
Productivity Growth and Interaction Terms

Interaction Variable	Labor Force Growth	GDP per worker Gap	Equip. Share	Non-Equip. Share	Interaction Term	Outward Orientation	*Extreme Coefficients* Poor/Low/Out Country[1]	*Extreme Coefficients* 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)
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)
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)
				Larger Sample						
GDP Gap60	-0.039	0.015	0.207	0.060	0.078		0.019	0.015	61	0.279
	(0.204)	(0.026)	(0.291)	(0.037)	(0.378)		(0.080)	(0.026)		(0.013)
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)
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)
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)

[1]These two columns give the increase in growth produced by a 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 nationin the sample.

Our decision to define the relevant “equipment” measure as including both electrical and non-electrical machinery, but as excluding producers’ durable transportation equipment, is clearly open to dispute. The fifth line of each panel of table 4 contains the finest disaggregation of investment. In the high productivity sample, electrical and non-electrical 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 non-electrical 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 coefficient 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 non-electrical machinery.[21]

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 5 adds quadratic equipment terms and the interaction between investment and the inital GDP gap 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

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[21] In many industries electrical machinery and non-electrical machinery are very strong complements; efficient production requires both.

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

The interaction of equipment investment and *WDR* trade orientation for those 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 both 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 increaed equipment investment. High rates of equipment investment appear to complement, not substitute for an outward orientation as the *WDR* defines it.

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. We argue that there is a strong case that it is. We conclude that shifts in equipment investment are predominantly due to shifts in the equipment supply curve and moves downward along the equipment demand curve, not to exogenous shifts in growth shifting equipment demand and producing movements along the equipment supply curve.

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 that raise productivity growth might also encourage equipment investment without equipment investment playing an essential direct role—in three further steps. First, we consider timing evidence. Second, we consider the joint behavior of equipment prices and quantities. Third, we consider the effects of alternative instruments for the equipment quantity variable. All three sets suggest a causal relation running from equipment investment to growth.

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 6 therefore adds growth over the 1960-1975 period to equations relating 1975-1985 growth to equipment investment for both our high productivity and full samples. The inclusion of past growth does not add much explanatory power. The estimated impact of equipment investment on growth is only marginally affected.

Table 6 also includes regressions of growth over 1975-1985 on contemporaneous labor force growth, non-equipment investment, on the 1975 GDP per worker gap, on 1960–75 growth, and on the total investment share over 1960–75 multiplied 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. This finding makes it harder to argue that growth causes equipment investment, rather than the other way round.

Table 6
1975–85 Productivity Growth as a Function of the Lagged
1960–75 Investment Share

Lagged

Specification	Lab. Fce. Growth	GDP/Wkr. Gap	Equip. Share	Non-Equip. Share	1960–75 GDP/Wkr. Growth	n	R^2 (RMSE)
			High Productivity Sample				
Current Shares	-0.177 (0.258)	0.014 (0.016)	0.425 (0.105)	0.047 (0.059)		25	0.428 (0.013)
Current Shares	-0.174 (0.264)	0.015 (0.016)	0.447 (0.132)	0.044 (0.062)	-0.060 (0.218)	25	0.400 (0.013)
Lagged Shares[1]	-0.056 (0.264)	0.018 (0.015)	0.390 (0.096)	0.027 (0.051)		25	0.449 (0.013)
Lagged Shares	-0.053 (0.271)	0.018 (0.016)	0.399 (0.118)	0.026 (0.054)	-0.030 (0.207)	25	0.421 (0.013)
			Larger Sample				
Current Shares	-0.372 (0.305)	0.026 (0.012)	0.291 (0.101)	0.112 (0.053)		61	0.192 (0.020)
Current Shares	-0.415 (0.306)	0.027 (0.012)	0.230 (0.114)	0.098 (0.054)	0.201 (0.178)	61	0.196 (0.020)
Lagged Shares	-0.421 (0.348)	0.010 (0.013)	0.117 (0.110)	-0.017 (0.057)		61	-0.018 (0.022)
Lagged Shares	-0.533 (0.332)	0.016 (0.013)	0.044 (0.108)	-0.025 (0.054)	0.453 (0.167)	61	0.086 (0.021)

[1]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.

Equipment Prices and Growth

Figures 7 and 8 relate the component of the relative price of equipment orthogonal to GDP per worker[22] to national growth rates, partialing out labor force growth, the relative price of other investment, and initial productivity levels for both the full and high productivity samples. There is a strong *negative*—not positive—association between equipment prices and growth.

[22]The “orthogonalized” equipment price used as the independent variable is the residual from log real relative equipment price regressed on contemporaneous 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.

Figure 7
Partial Scatter of 1960–85 Growth and Equipment Relative Price

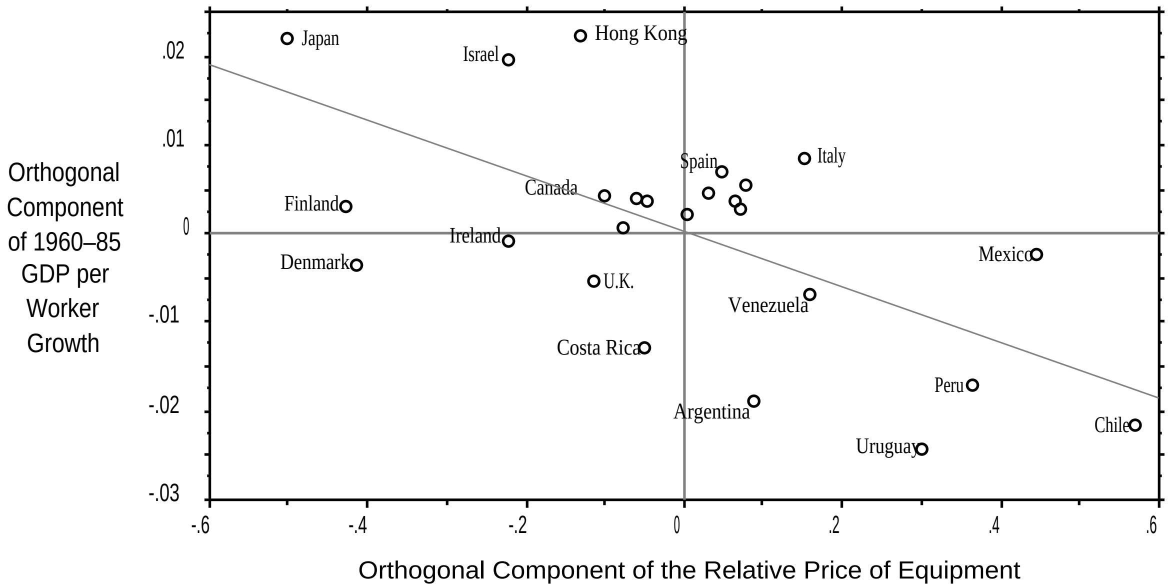
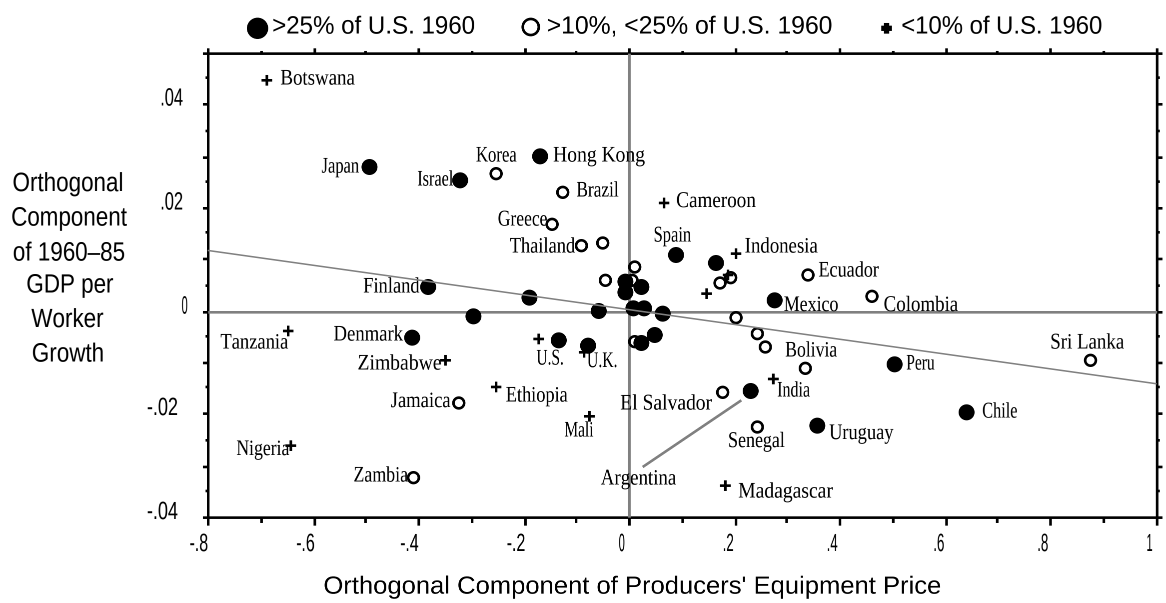


Figure 8
Partial Scatter of Growth and Equipment Prices, All Countries



We interpret the association of growth with high equipment quantities and low equipment prices as strong evidence that equipment investment drives growth. If high rates of equipment investment were a consequence rather than a cause of growth, one would expect that because of strong demand the price of equipment at a given level of productivity would be high in rapidly

Table 7

Productivity Growth and Equipment Prices

Lab. Fce. Period	GDP/Wkr. Growth	Total Invest. Gap	Equip.[1] Rate	Price	R^2 n	(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)

[1]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.

growing countries. Fast growth would shift the equipment demand curve to the right, and move the economy upward and outward along the equipment supply curve. Instead, fast growth is associated with a move down and to the right in an equipment price-equipment quantity graph, suggesting that the supply of equipment is shifting out in high-growth countries and moving the economy along an equipment demand curve.[23]

Table 8
Productivity Growth, Equipment Quantities, and Equipment Prices

[23]It is conceivable that the association between low equipment prices and growth occurs because growth causes equipment investment, and high equipment investment makes it possible to take advantage of economies of scale in production. We discount this argument because a high fraction of equipment—30 percent—is imported even in the United States.

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)

The relationship between equipment prices and growth is explored in more detail in Table 7, 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 Ethipia, 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 8 shows, when equipment investment is included in the productivity equation the coefficient on equipment prices declines, and in many cases becomes insignificant.[24]

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[24]When it does attain statistical significance, its sign is anomalous: conditional on the quantity of equipment investment, it appears that a high rather than a low durables price may be associated with more rapid growth.

This bears on the "liberalization" hypothesis discussed above. If high equipment investment's large coefficient in a growth regression arose because it proxied for the presence of a *laissez faire* attitude towards 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.

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. 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 is an exogenous variable.

Table 9
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 (0.209)	0.016 (0.010)	0.180 (0.085)	0.043 (0.046)		0.257
OLS	-0.029 (0.201)	0.020 (0.009)	0.265 (0.066)	0.062 (0.035)	60	0.291
Savings Rate	-0.248 (1.643)	0.011 (0.068)	-0.162 (3.173)	0.131 (0.511)		
OLS	0.161 (0.165)	0.034 (0.007)	0.229 (0.084)	0.013 (0.050)	26	0.503
WCR Variables	0.440 (0.479)	0.034 (0.015)	0.268 (0.320)	0.298 (0.474)		

For both the high productivity and full samples, Table 9 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* 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 *World Competitiveness Report* 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 standard error) in the full sample when national saving rates are used as an instrument. Perhaps national saving is a poor instrument for equipment investment in low income countries, given the importance of net capital inflows.

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.

Comparisons with Other Work

Our findings raise a number of questions. First, can they be reconciled with earlier research downplaying the role of accumulation? Research in the growth accounting tradition has assumed away the possibility of external effects from accumulation. But studies which 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 4, it is not surprising that studies that have focused on total capital accumulation have understated the potential contribution of investment to growth.

A point often made (for example, Krueger, 1990) is that India has had a high savings rate 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 6. While India has a relatively high savings rate, a large proportion of savings has been channeled into structures, and 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 non-equipment 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 used its savings effectively.

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 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 grown slowly. These examples are not clear cut—the Soviet Union in the 1950’s 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.

Social Returns to Investment

A second question is the social return to equipment investment. It is tempting but wrong to interpret the coefficient on the share of equipment investment in our regressions as a measure of the rate of return 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. Those countries with higher capital formation rates will have lower rates of return to investment; they will not grow faster in steady state. The negative correlation between the level and rate of return to investment biases the coefficient on investment in the cross section *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 new investment is r^i, so that (partialing out the effects of other sources of growth):

$$(2) \qquad \Delta Y_t^i = r^i \left(I_t^i - \delta K_t^i \right)$$

The average growth rate of output g^i over the sample will then be:

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

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 the average across countries of investment shares and capital/output ratios, and r* for the average marginal 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:

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

The second of the major terms in (4) shows that as long as there is a negative correlation between equipment investment and net social returns, the estimated coefficient will tend to underestimate the social return to equipment. In the comparison across Solow steady states, diminishing returns to capital make the marginal product r^i of investment sufficiently lower in countries with higher investment shares $(I/Y)^i$ so that all countries grow at the rate of exogenous technological progress and the expected value of the estimated β is zero.

Our interaction regressions suggest that there are diminishing returns to investment, and that countries with higher equipment investment receive lower returns. We believe that diminishing returns to investment lead our estimated coefficients to understate the magnitude of the average social return to equipment investment. The alternative hypothesis is that some third factor shifts the demand for equipment investment out and leads to high returns, high investment, and a positive $\mathrm{cov}[r^i, (I/Y)^i]$. We are led to discount this possibility by the association of high equipment investment and growth with low equipment prices.

In addition, depreciation reinforces the downward bias. The effects of depreciation appear in the $r^*\delta(\mathrm{cov}[K/Y, I/Y]/\mathrm{var}(I/Y))$ term in equation (4). Countries that invest heavily will have a high capital output ratio and devote a large share of national product to replacement investment. Differences in rates of *gross* investment overstate differences in net investment. If what matters is net investment, our use of gross rather than net equipment investment will bias our cross section regression coefficient further below social returns to equipment.

A potential factor working in the other direction is that a unit of equipment invetment 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:

$$g_t^i = \sum_{j=0}^{J} \rho_j (I_{t-j}^i / Y_{t-j}^i) \tag{5}$$

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:

$$E(\beta) = \sum_{j=0}^{J} \rho_j > \sum_{j=0}^{J} (1 - d)^j \rho_j \tag{6}$$

where d is the appropriate discount rate. We have little insight into the lag structure with which equipment investment affects output. We suspect that the relatively high economic depreciation rates of equipment investment give it a relatively small mean lag in its effect on output.

An alternative route to the same conclusion that the social return to equipment investment is very high is to look at the differences between equipment and the other investment coefficients. If one assumes that the private returns to these investments are equated, then it may be reasonable to treat the difference between the coefficients as an estimate of external benefits from equipment investment. Depending on just what specification is selected and what assumption is made about the private cost of capital, this yields results modestly higher than the regression coefficients for the total (private plus external) return to increased equipment investment.

Implications for Economic Policy

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 non-neutralities 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 allocation.

Our finding that equipment investment is so important for growth suggests that the key difference between countries ruled by “interventionist” governments in Latin America and East Asia—despite the similarities in the rhetoric used to justify intervention—lies in their quantities of equipment investment. The interventionist programs are all rationalized by similar appeals to “Schumpeterian” rather than “Ricardian” advantage and to the crucial role of industry in economic development (Sheahan, 1987; Johnson, 1982). But “industrial policies” in Latin America (aside from Brazil) and Africa have 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.

Views of Economic Growth

Fourth, what do these results say about alternative theories of economic growth? Beyond calling into question views which overemphasize human capital accumulation through formal education, we doubt that they help in choosing between alternative theoretical formulations. 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.

In a way, it is somewhat disturbing that much of economists’ analysis of growth has been carried out in the context of single-good models. Economists are keenly aware that relative prices have a powerful role to play in guiding resources to efficient uses. One would have expected that their conceptions of economic growth would have a sufficiently rich structure of goods to give the price mechanism a powerful role to play in bringing quantities into balance, yet the aggregation assumptions often made rob the price system of any utility. We suspect that most of what can be said about the characteristics of growth at the aggregate level of national product and very broad sectors was said by Kuznets (1971), and that further powerful generalizations about comparative economic growth will require analysis at a much finer degree of disaggregation.

Our exploration of the links between equipment investment and growth leaves many questions unaddressed. Two 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 have been conducted (for example, Abramovitz, 1986; De Long, 1988; McLean and Nguyen, 1989), but they view growth from a highly aggregative perspective, their data is 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 non-electrical 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. Moreover, the shifting sectoral composition of demand and of inventive activity raises the issue of the process by which “leading sectors” (as in Rostow, 1990) replace one another, of how the technologically and externality generating dynamic edge of the economy shifts over time, and of how private entrepreneurs and public agencies are to determine where the dynamic edge lies.

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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. An appendix table presents the matrix of distances used.

The first functional form tried was:

$$\frac{E(u_i u_j)}{\sigma^2} = \alpha + \frac{1}{1 + \lambda\delta_{ij}} + \varepsilon \tag{7}$$

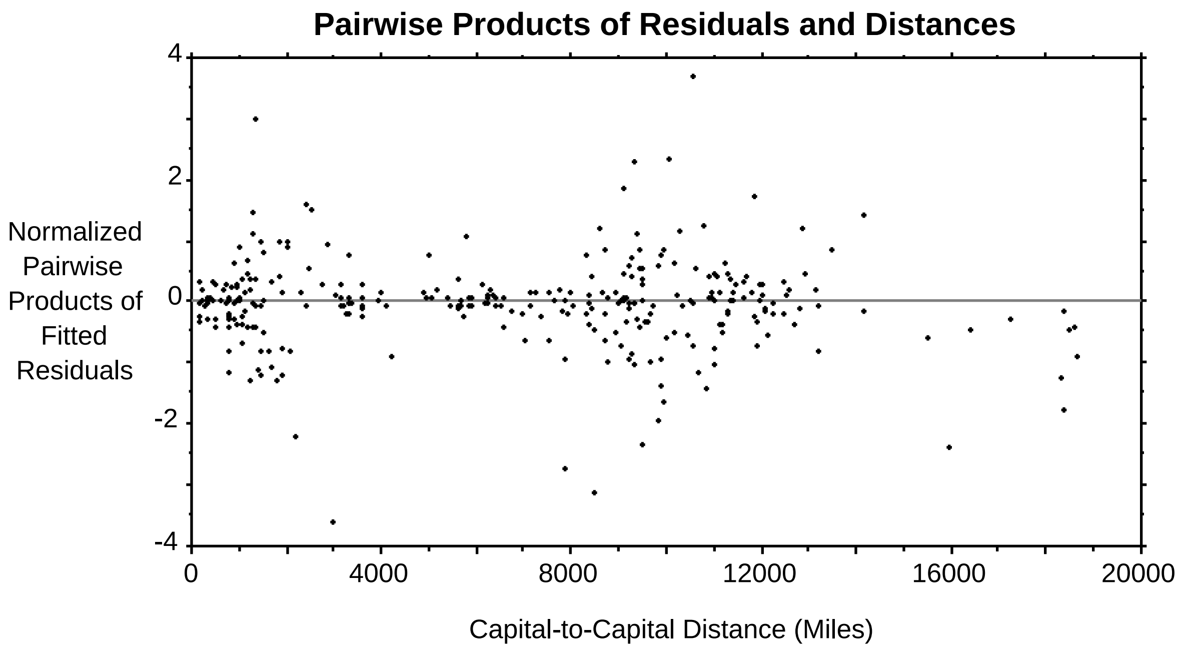
It yielded an adjusted R^2 of -.0003, an estimated α of -.974 (with an uncorrected OLS reported t statistic of -11.69), and an estimated λ of .0095569 for every thousand miles (with an uncorrected OLS reported t statistic of .76). The estimated correlation between residuals varies from .03 for countries with adjacent capitals to -.05 for countries with capitals 10,000 miles apart.

A second functional form tried was:

$$\frac{E(u_i u_j)}{\sigma^2} = \alpha + \exp[-\lambda\delta_{ij}] + \varepsilon \tag{8}$$

It also produced an adjusted R^2 less than zero and a small estimate of λ. The estimated α was -.971 (with an uncorrected OLS reported t statistic of -11.96), and an estimated λ of .00969 for every thousand miles (with an uncorrected OLS reported t statistic of .87). Once again, the estimated correlation between residuals varies from .03 for countries with adjacent capitals to -.05 for countries with capitals 10,000 miles apart.

The figure below 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.



A further figure 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.

Geographical Residual Distribution for the High-Productivity Sample

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 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.

A final table presents the matrix of distances between national capitals used.

Matrix of Distances Between National Capitals

	U.S.	Lux	Can	Den	Ven	Ger	Nor	U.K.	Net	Fra	Bel	Fin	Aus	Uru	Ita	Arg
Luxembourg	6404	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Canada	733	5869	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Denmark	6531	803	5926	•	•	•	•	•	•	•	•	•	•	•	•	•
Venezuela	3302	7906	3960	8392	•	•	•	•	•	•	•	•	•	•	•	•
Germany	6417	144	5869	660	7987	•	•	•	•	•	•	•	•	•	•	•
Norway	6250	1186	5616	486	8315	1048	•	•	•	•	•	•	•	•	•	•
U.K.	5915	491	5379	958	7500	512	1157	•	•	•	•	•	•	•	•	•
Netherlands	6209	318	5651	623	7858	235	916	359	•	•	•	•	•	•	•	•
France	6180	288	5664	1029	7621	401	1344	341	428	•	•	•	•	•	•	•
Belgium	6233	188	5691	769	7795	195	1089	320	174	262	•	•	•	•	•	•
Finland	6951	1675	6292	887	9105	1534	791	1827	1507	1914	1655	•	•	•	•	•
Austria	7143	766	6587	870	8650	728	1354	1238	936	1038	918	1443	•	•	•	•
Uruguay	8446	11191	9108	11957	5149	11327	12151	11021	11334	10935	11190	12842	11678	•	•	•
Italy	7235	987	6747	1531	8363	1065	2008	1434	1294	1108	1173	2204	764	11010	•	•
Argentina	8359	11289	9031	12046	5071	11423	12227	11105	11424	11029	11282	12930	11793	210	11135	•
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	Isr	Ire	Spa	Jap	Mex	H.K.	Per
Israel	13226	•	•	•	•	•	•	•
Ireland	11442	4077	•	•	•	•	•	•
Spain	10682	3602	1451	•	•	•	•	•
Japan	17234	9171	9611	10789	•	•	•	•
Mexico	6585	12552	8489	9083	11319	•	•	•
Hong Kong	18679	7740	9873	10561	2893	14155	•	•
Peru	2458	12811	9839	9504	15493	4240	18379	•
Costa Rica	5007	12093	8320	8491	13185	1930	15933	2553

(Distances taken from Fitzpatrick and Modlin, 1986.)

Appendix II: Regression Coefficients of All Independent Variables in Panel 3 of Table 1

Variable	Period: 1960–85	1960–75	1975–85	1970–85
	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)
Non-Equipment 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: Data

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

	Equip. Share	Non-Equip.	Non-Equip.	Non-Equip.	Non-Equip.	GDP/Wkr	GDP/Wkr	GDP/Wkr	GDP/Wkr	Primary Educ.

Country	75–85	Share 60–85	Share 60–75	Share 70–85	Share 75–85	Gap 1960	Gap 1970	Gap 1975	Gap 1980	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

	Sec. Educ.	Government			Manufacturing	Public	Real Exch.	WDR Distort.	Survey: Exch.	Survey: Nat.

Country	1960	Consumption	Assassination	Revolutions	Share	Investment	Rate	Index	Rate Policy	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	.	.	.
	Survey: Trade	Barbone	Transport	Structures	Elec. Mach.	Non-El. Mach.		Equipment X	Equipment X	Equipment X

Country	Legislation	Openness	Share 60–85	Share 60–85	Share 60–85	Share 60–85		Equipment	1960 Gap	1975 Gap
Argentina	.	.	0.0086	0.2271	0.0025	0.0189	0.0214	0.0005	0.0130	0.0115
Austria	60	0.024	0.0215	0.1043	0.0245	0.0746	0.0991	0.0098	0.0576	0.0312
Belgium	66.4	0.427	0.0230	0.1522	0.0232	0.0452	0.0684	0.0047	0.0281	0.0110
Bolivia	.	.	0.0054	0.0971	0.0039	0.0128	0.0167	0.0003	0.0144	0.0135
Botswana	.	.	0.0241	0.1250	0.0598	0.0712	0.1310	0.0172	0.1241	0.1144
Brazil	46.5	.	0.0191	0.1619	0.0136	0.0510	0.0646	0.0042	0.0549	0.0440
Cameroon	.	.	0.0272	0.0613	0.0069	0.0346	0.0415	0.0017	0.0387	0.0379
Canada	69.4	0.013	0.0254	0.1401	0.0237	0.0535	0.0771	0.0060	0.0138	0.0050
Chile	.	.	0.0138	0.3205	0.0020	0.0134	0.0154	0.0002	0.0083	0.0094
Colombia	.	.	0.0125	0.1481	0.0125	0.0104	0.0229	0.0005	0.0176	0.0159
Costa Rica	.	.	0.0210	0.0748	0.0074	0.0359	0.0433	0.0019	0.0305	0.0281
Denmark	59.5	-0.277	0.0273	0.1708	0.0117	0.0571	0.0688	0.0047	0.0280	0.0228
Dominican Republic	.	.	0.0065	0.1403	0.0065	0.0256	0.0321	0.0010	0.0266	0.0245
Ecuador	.	.	0.0153	0.2351	0.0017	0.0286	0.0303	0.0009	0.0249	0.0221
El Salvador	.	.	0.0141	0.0436	0.0043	0.0181	0.0223	0.0005	0.0188	0.0183
Ethiopia	.	.	0.0069	0.0219	0.0019	0.0193	0.0212	0.0004	0.0208	0.0208
Finland	64.5	-0.121	0.0148	0.2276	0.0210	0.0996	0.1206	0.0145	0.0674	0.0447
France	49	-0.19	0.0305	0.1646	0.0190	0.0689	0.0879	0.0077	0.0414	0.0161
Germany	72.7	0.043	0.0337	0.1810	0.0285	0.0604	0.0890	0.0079	0.0408	0.0231
Greece	38.8	-0.256	0.0255	0.2278	0.0114	0.0542	0.0655	0.0043	0.0519	0.0381
Guatemala	.	.	0.0085	0.0339	0.0065	0.0319	0.0384	0.0015	0.0303	0.0286
Honduras	.	.	0.0206	0.0748	0.0071	0.0375	0.0446	0.0020	0.0395	0.0390
Hong Kong	84.6	.	0.0218	0.1143	0.0306	0.0461	0.0767	0.0059	0.0573	0.0444
India	46.3	.	0.0094	0.1372	0.0091	0.0187	0.0278	0.0008	0.0260	0.0260
Indonesia	54.3	.	0.0029	0.1151	0.0006	0.0215	0.0221	0.0005	0.0204	0.0201
Ireland	62.9	0.055	0.0303	0.1589	0.0090	0.0724	0.0814	0.0066	0.0526	0.0406
Israel	.	.	0.0108	0.1749	0.0114	0.0997	0.1112	0.0124	0.0758	0.0485
Italy	48.9	-0.031	0.0273	0.1780	0.0214	0.0469	0.0683	0.0047	0.0371	0.0189
Ivory Coast	.	.	0.0242	0.0715	0.0047	0.0196	0.0243	0.0006	0.0224	0.0212
Jamaica	.	.	0.0340	0.1116	0.0138	0.0471	0.0609	0.0037	0.0501	0.0449
Japan	61	0.086	0.0355	0.2313	0.0471	0.0753	0.1223	0.0150	0.0916	0.0540
Kenya	.	.	0.0240	0.0911	0.0103	0.0359	0.0462	0.0021	0.0435	0.0430
Korea	61.6	.	0.0297	0.1389	0.0112	0.0445	0.0557	0.0031	0.0490	0.0434
Luxembourg	66.4	.	0.0246	0.1619	0.0203	0.0508	0.0711	0.0051	0.0204	0.0060
Madagascar	.	.	0.0053	0.0427	0.0017	0.0202	0.0219	0.0005	0.0202	0.0206
Malawi	.	.	0.0123	0.0782	0.0081	0.0279	0.0361	0.0013	0.0347	0.0343
Malaysia	66.5	.	0.0128	0.1751	0.0056	0.0389	0.0446	0.0020	0.0350	0.0321
Mali	.	.	0.0094	0.0172	0.0041	0.0392	0.0433	0.0019	0.0411	0.0417
Mexico	50.8	.	0.0145	0.1542	0.0087	0.0185	0.0273	0.0007	0.0161	0.0124
Morocco	.	.	0.0153	0.0386	0.0045	0.0215	0.0260	0.0007	0.0219	0.0197
Netherlands	70.9	0.033	0.0313	0.1554	0.0224	0.0554	0.0778	0.0061	0.0281	0.0081
Nigeria	.	.	0.0162	0.0680	0.0122	0.0236	0.0358	0.0013	0.0307	0.0312
Norway	50.5	0.229	0.0317	0.1459	0.0158	0.0543	0.0701	0.0049	0.0263	0.0164
Pakistan	.	.	0.0066	0.0773	0.0034	0.0228	0.0263	0.0007	0.0241	0.0237
Panama	.	.	0.0207	0.2072	0.0107	0.0282	0.0388	0.0015	0.0311	0.0277
Paraguay	.	.	0.0135	0.0723	0.0075	0.0115	0.0189	0.0004	0.0160	0.0157
Peru	.	.	0.0055	0.0858	0.0040	0.0227	0.0267	0.0007	0.0198	0.0171
Philippines	.	.	0.0155	0.0795	0.0109	0.0336	0.0445	0.0020	0.0389	0.0374
Portugal	46.3	0.055	0.0260	0.1312	0.0135	0.0593	0.0729	0.0053	0.0585	0.0474
Senegal	.	.	0.0081	0.0726	0.0039	0.0155	0.0193	0.0004	0.0172	0.0175
Spain	50.8	-0.197	0.0183	0.1375	0.0120	0.0277	0.0397	0.0016	0.0262	0.0126
Sri Lanka	.	.	0.0083	0.1477	0.0023	0.0114	0.0138	0.0002	0.0118	0.0122
Tanzania	.	.	0.0209	0.0730	0.0160	0.0700	0.0860	0.0074	0.0840	0.0835
Thailand	61.7	.	0.0221	0.1191	0.0080	0.0315	0.0395	0.0016	0.0363	0.0352
Tunisia	.	.	0.0239	0.0733	0.0102	0.0326	0.0428	0.0018	0.0336	0.0301
U.K.	61.4	0.087	0.0290	0.0846	0.0181	0.0513	0.0694	0.0048	0.0299	0.0249
U.S.	51.5	-0.027	0.0288	0.1309	0.0262	0.0500	0.0762	0.0058	0.0000	0.0000
Uruguay	.	.	0.0046	0.1021	0.0015	0.0140	0.0155	0.0002	0.0089	0.0093
Venezuela	.	.	0.0148	0.0680	0.0084	0.0256	0.0340	0.0012	0.0169	0.0085
Zambia	.	.	0.0446	0.1058	0.0207	0.0496	0.0702	0.0049	0.0611	0.0619
Zimbabwe	.	.	0.0264	0.0993	0.0165	0.0679	0.0843	0.0071	0.0749	0.0741

Equipment X	Equipment X	Investment	Investment	Investment	Investment	“Orthog’zed”	“Orthog’zed”	“Orthog’zed”	“Orthog’zed”	National

Country	Outward 63–73	Outward 73–85	Share 60–85	Share 60–75	Share 70–85	Share 75–85	Equip. Price	Equip. Price	Other Price	Other Price	Savings Rate
Argentina	0.0214	0.0214	0.25	0.2594	0.2560	0.2458	0.0801	0.2084	-0.2779	-0.5546	16
Austria	.	.	0.23	0.2327	0.2423	0.2369	-0.0607	-0.0732	0.2241	0.2405	27.5
Belgium	.	.	0.23	0.2482	0.2261	0.2144	0.0438	0.0141	-0.0410	0.0315	21
Bolivia	0.0333	0.0167	0.13	0.1482	0.1305	0.1180	.	0.2914	.	-0.4399	9.5
Botswana	.	.	0.28	0.2493	0.3777	0.3443	.	-0.7429	.	0.0266	-13
Brazil	0.1938	0.1938	0.23	0.2469	0.2311	0.2185	.	-0.1136	.	-0.1732	22.5
Cameroon	0.1244	0.0830	0.13	0.1091	0.1454	0.1578	.	-0.0229	.	0.0840	13.5
Canada	.	.	0.23	0.2384	0.2303	0.2273	0.0003	-0.1113	0.0480	0.2438	24
Chile	0.0154	0.0462	0.3	0.3000	0.3000	0.3000	0.5788	0.6917	-0.8479	-1.0945	18.5
Colombia	0.0686	0.0457	0.18	0.1850	0.1759	0.1719	.	0.4716	.	-0.3163	21.5
Costa Rica	0.1300	0.0867	0.15	0.1425	0.1550	0.1540	-0.0823	0.0994	0.3798	-0.0022	13.5
Denmark	.	.	0.27	0.2901	0.2547	0.2295	-0.3719	-0.3754	-0.0582	-0.0621	16.5
Dominican Republic	0.0321	0.0321	0.17	0.1636	0.2069	0.2133	.	0.2038	.	-0.2229	6
Ecuador	.	.	0.24	0.2387	0.2559	0.2562	.	0.3390	.	-0.6543	14
El Salvador	0.0447	0.0447	0.08	0.7871	0.0825	0.0835	.	0.1937	.	0.3028	10
Ethiopia	0.0212	0.0212	0.05	0.5528	0.0522	0.0530	.	-0.3337	.	0.6186	7.5
Finland	.	.	0.37	0.3972	0.3582	0.3352	-0.4253	-0.4061	-0.1942	-0.2561	25.5
France	.	.	0.26	0.2703	0.2641	0.2504	0.0552	0.0278	-0.0877	-0.0228	23.5
Germany	.	.	0.29	0.3058	0.2680	0.2525	-0.0471	-0.0719	-0.1162	-0.0675	21.5
Greece	.	.	0.29	0.3108	0.2955	0.2695	.	-0.2588	.	-0.2040	11.5
Guatemala	0.1151	0.0768	0.09	0.8535	0.0918	0.0922	.	0.2537	.	0.3074	8.5
Honduras	0.0892	0.0892	0.14	0.1358	0.1415	0.1416	.	0.0081	.	0.0232	14
Hong Kong	0.3069	0.3069	0.2	0.1904	0.1986	0.2103	-0.1740	-0.1008	0.6751	0.5069	30
India	0.0278	0.0278	0.17	0.1605	0.1783	0.1801	.	0.1850	.	-0.2729	19
Indonesia	0.0662	0.0441	0.14	0.1070	0.1732	0.1877	.	0.1407	.	-0.6617	18.5
Ireland	.	.	0.26	0.2402	0.2861	0.2859	-0.2389	-0.2418	-0.0073	-0.0368	22
Israel	.	.	0.29	0.3160	0.2704	0.2440	-0.2482	-0.2626	0.1278	0.1321	13
Italy	.	.	0.25	0.2678	0.2348	0.2195	0.1594	0.1220	-0.0673	0.0036	22.5
Ivory Coast	0.0729	0.0486	0.12	0.1105	0.1389	0.1451	.	-0.0715	.	0.0625	24
Jamaica	.	.	0.2064	0.2478	0.1785	0.1497	.	-0.3601	.	0.0397	23
Japan	.	.	0.36	0.3529	0.3827	0.3713	-0.5446	-0.5577	0.0042	0.0033	31
Kenya	0.0925	0.0925	0.17	0.1827	0.1763	0.1591	.	-0.1647	.	0.0036	17.5
Korea	0.2226	0.2226	0.22	0.1758	0.2774	0.2962	.	-0.2624	.	-0.1222	23
Luxembourg	.	.	0.27	0.2829	0.2578	0.2458	0.1354	0.1085	0.0459	0.1243	.
Madagascar	0.0438	0.0219	0.07	0.7135	0.0719	0.0708	.	0.1173	.	0.4988	5.5
Malawi	.	.	0.13	0.1388	0.1431	0.1289	.	-0.1484	.	0.3478	6
Malaysia	0.1337	0.1337	0.2323923	0.1956	0.2704	0.2862	.	-0.0160	.	-0.4518	30.5
Mali	.	.	0.07	0.7763	0.0732	0.0674	.	-0.1561	.	0.6647	2.5
Mexico	0.0545	0.0545	0.1959269	0.1903	0.2051	0.2065	0.4405	0.3814	-0.3051	-0.2221	18
Morocco	.	.	0.08	0.6683	0.1010	0.1120	.	0.1457	.	0.6165	13
Netherlands	.	.	0.26	0.2919	0.2446	0.2096	0.1242	0.0960	0.0009	0.0789	19
Nigeria	0.0716	0.0358	0.12	0.8389	0.1593	0.1794	.	-0.6457	.	0.0071	16
Norway	.	.	0.29	0.2983	0.2963	0.2879	0.1273	0.0555	0.0477	0.1648	28
Pakistan	0.0263	0.0525	0.12	0.1200	0.1143	0.0012	.	0.1536	.	0.1509	12
Panama	.	.	0.26	0.3029	0.2769	0.2465	.	0.0219	.	-0.3059	16
Paraguay	.	.	0.12	0.8689	0.1414	0.1613	.	0.1818	.	0.0324	16
Peru	0.0267	0.0267	0.12	0.1321	0.1120	0.1076	0.3225	0.5270	0.1806	-0.2464	27
Philippines	0.0890	0.0890	0.15	0.1500	0.1419	0.0946	.	0.2158	.	0.3807	18.5
Portugal	.	.	0.23	0.2300	0.2287	0.2122	.	-0.0700	.	0.1243	19
Senegal	0.0386	0.0386	0.1	0.1005	0.1006	0.0918	.	0.2278	.	0.3023	7
Spain	.	.	0.18	0.1904	0.1722	0.1610	0.0270	0.0263	-0.0253	-0.0327	23
Sri Lanka	0.0138	0.0275	0.15	0.1454	0.1606	0.1611	.	0.8287	.	-0.2225	13
Tanzania	0.0860	0.0860	0.18	0.1775	0.1995	0.1877	.	-0.6898	.	-0.1315	5
Thailand	0.1186	0.1186	0.1807538	0.1774	0.1724	0.1869	.	-0.1148	.	-0.0054	22.5
Tunisia	0.0856	0.1285	0.14	0.1261	0.1456	0.1585	.	0.1986	.	0.4952	17
U.K.	.	.	0.18	0.1973	0.1765	0.1640	-0.0788	-0.0829	0.1688	0.1621	19
U.S.	.	.	0.21	0.2112	0.2132	0.2113	0.0991	0.0644	-0.0285	0.0773	15.5
Uruguay	0.0155	0.0464	0.12	0.9074	0.1332	0.1572	0.2996	0.3111	-0.1371	-0.2101	14.5
Venezuela	.	.	0.11	0.8181	0.1427	0.1645	0.1772	0.2002	0.4154	0.3458	29.5
Zambia	0.0702	0.0702	0.32	0.4221	0.2680	0.1737	.	-0.4218	.	-0.0702	30
Zimbabwe	.	.	0.21	0.2428	0.1937	0.1724	.	-0.3464	.	-0.1368	22.5

	Exchange	Manufac. Prot.	Capital Price	Labor Price	Distortion	Outward	Outward

Country	Rate Distort.	Distort.	Distort.	Distort	Ranking	Oriented 63–73	Oriented 73–85
Argentina	3	2	3	1	23	1	1
Austria	.	.	.	.	.	.	.
Belgium	.	.	.	.	.	.	.
Bolivia	3	2	3	1	21	2	1
Botswana	.	.	.	.	.	.	.
Brazil	1	2	3	1	14	3	3
Cameroon	1	1	2	2	3	3	2
Canada	.	.	.	.	.	.	.
Chile	3	1	3	3	24	1	3
Colombia	1	2	2	1	9	3	2
Costa Rica	.	.	.	.	.	3	2
Denmark	.	.	.	.	.	.	.
Dominican Republic	.	.	.	.	.	1	1
Ecuador	.	.	.	.	.	.	.
El Salvador	.	.	.	.	.	2	2
Ethiopia	2	3	1	1	10	1	1
Finland	.	.	.	.	.	.	.
France	.	.	.	.	.	.	.
Germany	.	.	.	.	.	.	.
Greece	.	.	.	.	.	.	.
Guatemala	.	.	.	.	.	3	2
Honduras	.	.	.	.	.	2	2
Hong Kong	.	.	.	.	.	4	4
India	1	3	2	2	12	1	1
Indonesia	2	2	2	1	11	3	2
Ireland	.	.	.	.	.	.	.
Israel	.	.	.	.	.	.	.
Italy	.	.	.	.	.	.	.
Ivory Coast	1	2	2	3	16	3	2
Jamaica	2	2	3	3	19	.	.
Japan	.	.	.	.	.	.	.
Kenya	1	3	2	2	8	2	2
Korea	1	1	2	1	4	4	4
Luxembourg	.	.	.	.	.	.	.
Madagascar	.	.	.	.	.	2	1
Malawi	1	1	2	1	1	.	.
Malaysia	1	1	2	2	5	3	3
Mali	.	.	.	.	.	.	.
Mexico	1	1	3	2	15	2	2
Morocco	.	.	.	.	.	.	.
Netherlands	.	.	.	.	.	.	.
Nigeria	3	2	3	3	26	2	1
Norway	.	.	.	.	.	.	.
Pakistan	2	3	2	3	18	1	2
Panama	.	.	.	.	.	.	.
Paraguay	.	.	.	.	.	.	.
Peru	1	3	3	2	22	1	1
Philippines	1	2	2	1	6	2	2
Portugal	.	.	.	.	.	.	.
Senegal	2	2	2	2	17	2	2
Spain	.	.	.	.	.	.	.
Sri Lanka	1	2	2	3	13	1	2
Tanzania	1	3	3	3	25	1	1
Thailand	1	2	1	1	2	3	3
Tunisia	1	2	2	1	7	2	3
U.K.	.	.	.	.	.	.	.
U.S.	.	.	.	.	.	.	.
Uruguay	3	3	3	1	20	1	3
Venezuela	.	.	.	.	.	.	.
Zambia	.	.	.	.	.	1	1
Zimbabwe	.	.	.	.	.	.	.