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WHAT EXPLAINS DEVELOPING COUNTRY GROWTH?

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ABSTRACT

Among developing countries, there was no gross relationship between real income per capita in 1960 and subsequent growth in per capita income. However, once other significant influences, such as education, changes in labor force participation rates, inflows of foreign investment , price structures, and fixed investment ratios are taken into account, the lower the 1960 income level, the faster the income growth. This "conditional" convergence was particularly strong among the poorest half of the developing countries, contradicting the idea of a "convergence club" confined to relatively well-off countries.

Inflows of direct investment were an important influence on growth rates for higher income developing countries, but not for lower income ones. For the latter group, secondary education, changes in labor force participation rates, and initial distance behind the United States were all major factors.

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WHAT EXPLAINS DEVELOPING COUNTRY GROWTH?[1]

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1. Introduction.

The growing literature on income and productivity convergence among countries seems to suggest that the developing countries have benefitted to a relatively small degree from being backward (see e.g. Baumol, 1986, Baumol, Blackman and Wolff, 1989, and Zind, 1991). Over the last 40 years, only a few developing countries seem to have joined the "convergence club". The majority have gained on the highest-income countries, the United States and Canada, but have lost ground relative to the industrialized countries as a group.

The failure of many poor countries to gain on the rich ones has recently received a lot of attention among economists. Some have turned to endogenous growth models, which are characterized by non-decreasing returns to the set of reproducible factors of production (see e.g. Romer, 1986 and Lucas, 1988). In such models, a country's per capita growth rate is uncorrelated with its initial level of income per person. Others, using standard neoclassical growth models with diminishing returns, still expect an inverse relation between a country's per capita income (or

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productivity) level and its rate of per capita income (productivity) growth, but only if the country has reached a threshold level of infrastructural development (see e.g. Helliwell and Chung, 1992, Mankiw, Romer and Weil, 1990, and Wolff, 1991). However, the empirical basis for both these views is still weak.

One reason for the flurry of recent studies covering many countries is the appearance of the series of articles by Heston and Summers in which they extrapolated the results of successive rounds of the U.N. International Comparison Program (ICP) to periods before the ICP began and to countries never in the ICP, covering almost all the countries in the world for the period since 1950, and even provided the results on diskettes. That seems to relieve the users of the necessity of following the arduous path of earlier writers such as Kuznets, Abramovitz, and Maddison in piecing together fragments of ill-matching national income estimates, made by different authors using different techniques and different income concepts.

The new data, convenient as they are, still contain hidden dangers for the users, because they are mostly extrapolations. A third of the developing countries have not participated in even one round of the International Comparison Program. For those countries, every real income figure is estimated from much weaker sources by relationships found in the participating countries. Even if the extrapolation method is the best possible, the

analyst of the data is in a danger of extracting the extrapolation formula rather than any independent knowledge.

Even for the countries that did participate in one or more of the ICP rounds, the estimates for other years are extrapolations. They are dependent for their reliability on the quality of their countries' national income accounts and the degree to which their weighting schemes diverge from that of the ICP. Since only 18 developing countries participated in Phase III of the ICP, for 1975, and only 7 developing countries participated in Phase II, for 1970 and 1973, all the developing country income level data for the 1950s and 1960s and almost all for the 1970s consist of extrapolations. Thus, any defects in a country's real national income estimates produce errors in the estimates of income levels: an overestimated rate of growth underestimates early-period income levels; an underestimated growth rate overestimates early income levels. Convergence could be built in to the estimating procedure.

Aside from these extrapolation problems that affect most estimates of the effect of initial income levels on growth rates, i.e. the convergence or catch-up variable, we focus on three other aspects of these studies that we thought deserved closer examination. One is the strong influence of the developed countries on most cross-country results to date. For example, Lipsey and Kravis (1987, p. 13) found a strong catch-up relationship among industrial countries from 1950 to 1984, especially when Japan was included, but none for the whole set of

115 developed and developing countries in the Summers and Heston data available at that time. Here, we wish to examine convergence and influences on growth for developing countries without combining the two groups of economies. Thus, we are concentrating our attention on countries that are still in the developing category, although they cover a wide range of income levels and rates of growth, and some are among the great success stories of the last 30 years. The exclusion or inclusion of developed countries is one aspect of the larger issue of sampling, since the results of earlier studies seem to depend considerably on which set of countries is included.

A second issue we study is the influence of changes in the price structure on income changes. Some cross-country studies of growth and convergence have measured the initial distance from the United States in 1980 or 1985 prices, even though the prices in the initial period were vastly different. A high 1960 income measured in 1985 prices does not mean that the country was rich in 1960. This problem has been noted in relation to the oil producers and most studies have dealt with it by excluding major oil exporters from their regressions (see e.g. Barro, 1991). We were not satisfied with that approach for two reasons. One is that the list of countries excluded was rather arbitrary; it varied from study to study because there are many oil producers of varying degrees of dependence on that product. The second reason is that there have been major price changes in goods other than oil since 1960. To incorporate the effects of price

changes, including those of oil, on real income changes, we experimented with two variables. One was the ratio of oil output, measured in physical terms, to real GDP, 1985-1986. The second was the ratio of 1960 real GDP per capita relative to the U.S. in 1985 prices to that at 1960 prices. That was a measure of the effect of changes in the structure of prices in general on the level of real income. The price structure measure performed somewhat better in the equations, and is the one reported in the text tables that follow, although it omits much of the effect of price changes, because ICP price measures are based on expenditure weights rather than value added or production weights.

Finally, we examine the influence on growth of interchanges with foreign countries. There has been a wide range of views among economists over the last two centuries on the role of trade in economic development, from the optimistic assessments of Adam Smith and John Stuart Mill to the pessimism of Nurkse and many development theorists after the experience of the 1930s, at least with respect to the situation in the twentieth century. An appraisal by Kravis (1970) took a favorable view, mixed with skepticism about the importance of trade in any era.

These interchanges among countries can take many forms, such as trade, tourism, licensing of technology, foreign direct investment, and exchanges of students. In this paper we examine two of these, the inflow of direct investment capital from abroad, as a possible measure of the inflow of disembodied

technology, and imports of machinery and transport equipment, a possible measure of the inflow of technology embodied in new machinery. Neither measure is more than a rough proxy for the underlying concept. The investment flow is a purely financial measure and may not reflect actual operations in a host country of the sort likely to lead to the absorption of technology. This is most obvious for investments in finance subsidiaries, which may not operate at all in the host country, but only use it as a device for avoiding or reducing taxes. The import measure includes many consumer goods (automobiles, home appliances, TV) that do not contribute to the technological level of production in the importing country.

The paper is organized as follows. In Section 2 we examine the effects on growth of several variables not typically studied. These are changes in the world price structure and our two international variables, the inflow of foreign direct investment and imports of machinery and transport equipment. Section 3 discusses the effects of sample choice on estimates of the relation of various factors to growth. In particular, it asks whether our results differ from those of earlier studies because we concentrate on developing countries rather than on countries at all stages of development. It also asks whether there is any evidence for the idea of a "convergence club" of higher income developing countries more responsive or differentially responsive to the forces promoting growth. Section 4 investigates the possibility that biases arising from the method by which the data

provided by Summers and Heston (1991) were calculated, could account for the apparent catch-up phenomenon. Section 5 is a summary of and conclusions from the study.

2. Determinants of Economic Growth

The empirical analysis focuses on growth in real income per capita for 78 developing countries.[1] Using data from Summers and Heston (1991), supplemented with data from various other sources (see Appendix Table 1), we first compare the results for these countries and variables with those of other studies.

If we relate the convergence or catch-up variable (1960 income per capita relative to that of the United States) by itself to growth in per capita income from 1960 to 1985, no effect is visible. As Table 1 shows, there is no pure or "gross" convergence, either for the developing countries as a group, or for the whole set of countries including also 23 developed countries.

Table 1

	Coefficient for catch-up variable	t-statistic	$\bar{R}^2$	No. of Obs.
All countries	.383	.97	.00	101
Developing countries	4.54	.54	.00	78

Source: Appendix Table 1

To test for "conditional" or "net" convergence among developing countries, Equation (1) relates the growth of real per capita income from 1960 to 1985 in all developing countries in our data set to a collection of supposedly positive and negative influences. Among the ones expected to be positive are:

1. The average (1960-85) ratio of the number of students enrolled in secondary education to the numbers in the population in the "appropriate" age groups (SCND). Ratios above 100 per cent in some cases suggest that some students are attending this school level at ages outside the standard range.[2]

2. The ratio of 1960 income in 1985 prices to 1960 income in 1960 prices (PRICE). This variable measures income changes that are due to changes in the price structure and is used as an alternative to excluding oil producing countries.[3]

3. The average (1960-85) ratio of fixed capital formation to GDP, measured in current purchasing power parities (INV).

4. The change (1960-85) in the labor force participation rate, the ratio of labor force to total population (PART). This is different from the usual participation rate, which relates labor force to population of working age. It is intended to catch the effects of demographic changes, particularly birth rates, on the ratio of dependent population to working population.

A negative relation to subsequent growth rates was expected for the variable measuring 1960 real per capita income relative

to that of the United States (GDUS), if low income provided more scope to gain from the transfer of technology, already developed by the advanced countries.

$$\begin{aligned}(1)\ RGDPCG = {} & -6.98 + .024\ SCND + .356\ PRICE + .029\ INV + 6.9\ PART \\ & \quad (2.22)\ \ (3.70)\ \ \ \ (2.68)\ \ \ \ (2.49)\ \ \ \ (2.23) \\ & - 3.42\ GDUS \qquad \overline{R}^2 = .40 \\ & \quad (3.81)\end{aligned}$$

(t-statistics in parentheses)

All these expectations were met, with statistically significant coefficients, but two variables were of particular interest to us: PRICE and GDUS. PRICE had a positive coefficient that was statistically significant at the 1 per cent level in a two-tailed test. The coefficient of the catch-up variable was also significant despite the lack of association when the other variables were excluded. The initial real income level relative to the U.S. (GDUS) carried a significant negative coefficient, suggesting "conditional" catch-up.

To compare our results with those of other investigators who studied the whole range of countries, we ran the same equations for the combination of our 78 developing countries and 23 developed countries. The differences between those equations and the equations for all developing countries were small (see Table 2): lower coefficients for catch-up, price structure, and participation in the all-country equation, but all the same variables were again significant.

Table 2

Coefficients in Equations for Growth in Real GDP per Capita in Developing Countries and in All Countries, 1960-1985

	Developing Countries		All Countries	
	Coefficient	t-statistic	Coefficient	t-statistic
Constant	-6.98	2.22	-5.82	2.39
SCND	.024	3.70	.021	4.57
PRICE	.356	2.68	.271	2.51
INV	.029	2.49	.029	2.97
PART	6.90	2.23	5.98	2.48
GDUS	-3.42	3.81	-2.50	5.34

Source: Appendix Table 1

These results differed from some reported by others for the combination of developed and developing countries. For instance, Wolff (1991, Table 2.4), using a sample of 94 developed and developing countries, got positive coefficients that were strongly significant not only for the investment rate, but also for primary education (where we found either weak or no signicant coefficients).[4] Similar results were also reported in Mankiw, Romer and Weil (1990), using a sample of 98 countries.

One might suppose that the rate of economic growth of a backward country would depend on the extent of technology transfers from the leading countries and the efficiency with which they are absorbed and diffused. Technology may be transferred to developing countries (and other countries as well) through a variety of channels. In what follows, we add to our equations two of these, the flow of foreign direct investment, as

a measure of the flow of disembodied technology, and imports of machinery and transport equipment, as a measure of the inflow of technology embodied in new machinery.

Foreign direct investment by multinational corporations (MNCs) is often suggested as a vehicle for the international diffusion of technology. MNCs have undertaken a major part of the world's research and development (R&D) efforts, and today they control most of the world's advanced technologies. The developing countries, with limited indigenous resources for R&D, are particularly dependent on foreign multinationals for access to modern technology.

Foreign direct investment may influence productivity in host countries in various ways (see Blomström, 1991). Simply by setting up operations abroad that are beyond the technological capabilities of host country firms, foreign investment may increase productivity in the recipient countries. Furthermore, if the foreign affiliates' technology leaks out to local firms, foreign direct investment may also result in indirect productivity gains for host countries ("spillovers").

To analyze the influence of foreign direct investment on growth in our sample of countries, we are forced to use a crude measure of FDI based on flow data provided by the IMF. Our FDI variable measures the ratio of the inflow of foreign direct investment to GDP, measured in current dollars, averaged over the 1960-85 period. For a few countries we have the average only for a shorter period (generally 1975 to 1985), because of lack of

data for earlier periods. It would have been preferable to have measures of real FDI activity in a host country, such as employment, plant and equipment assets or expenditures, or production, but these are not widely available. Financial flows can take place with little actual production or employment resulting, and production by affiliates of MNCs can take place without substantial financial flows. It would also have been preferable to have some industry breakdown of FDI so that differences in technological content among investing industries could be taken into account.

Our import variable is the average (1960-85) ratio of imports of machinery and transport equipment (SITC 7) to GDP. This variable, denoted IMP, is intended to reflect the importation of foreign technology in embodied form.

Adding IMP and FDI to the variables used above in Equation (1), we get the following results (t-statistics in parantheses):

	IMP	FDI	$\overline{R}^2$
All countries	-.015 (.67)	.278 (2.42)	.46
Developing countries	-.001 (.05)	.321 (2.43)	.45

Source: Appendix Table 1

These regressions suggest that inflows of foreign direct investment encourage more rapid economic growth. Adding FDI to

the other variables in Equation (1) tends to lower the influence of the coefficient for the fixed investment ratio, particularly in the developing countries, quite substantially (see Appendix Table 1).

We found no evidence for an effect of our other possible channel of technology imports, viz. the purchase from abroad of machinery and transport equipment. The IMP variable never had any significant influence on our dependent variable. Thus, we conclude that of our two international variables, it is mainly foreign investment that has a significant positive impact on income growth.

One possible objection to this conclusion is that the opposite causal relationship may be present, i.e. that foreign investment is not causing higher growth, but that higher growth is attracting multinationals. This cannot be tested by means of cross-section analysis, but as an alternative to the long-period analysis, we examined changes over successive five-year periods in order to determine lines of influence and their timing. We found that growth rates of GDP per capita over five-year periods were associated with direct investment flow ratios only in preceding and current five-year periods, but not with direct investment in the following periods. This suggests that the causation runs from foreign direct investment to growth rather than the other way around. A similar test for the ratio of fixed investment to GDP found a stronger association between income growth in a period and the investment rate of the following

period than between income growth and the investment ratios for the preceding or contemporary periods.

Another possibility that we explored was that there were interactions among the independent variables, particularly between the education investment (SCND) and the physical investment ratio (INV) and between education and the foreign interchange variables (IMP and FDI). None of these showed any significant relation to rates of economic growth and they have not been included here.

3. Is There a "Convergence Club?"

The belief or suspicion is often expressed that the developing countries are not at all homogeneous in the factors that influence their growth. The idea is that there is a "convergence club" of better off developing countries that are in a good position to catch up to the leaders, while other developing countries are so far behind that they are not able to gain from their backwardness by absorbing technology from the leaders. Furthermore, the lagging countries may gain relatively little from educational or physical investment, or from contacts with foreign firms, because there is so little local infrastructure for absorbing foreign influences.

The proposition is difficult to test, because it is not clear what characteristics of a country would place it inside or outside the club. We have divided the developing countries into higher- and lower-income countries, simply by dividing the group

in half on the basis of their initial per capita income. The question we have then asked is whether the two groups differ with respect to the relationship between their growth rates and the independent variables discussed earlier.

With respect to the gross catch-up, the results for the two groups essentially agree. As Table 3 shows, the coefficient is negative for both groups, but not statistically significant, and the variable explains almost none of the cross-country variation in income growth.

Table 3

	Coefficient for catch-up variable	t-statistic	$\bar{R}^2$	No. of Obs.
Higher income	-1.20	1.16	.01	39
Lower income	-.49	.09	.00	39

Source: Appendix Table 1

If we run Equation (1) for the two income groups separately, we find that the coefficient for "conditional" catch-up is significant only in the poorer half (see Table 4). This contradicts the idea that there is a "convergence club" of higher-income developing countries that are close enough to the developed countries to absorb their technology and thus grow rapidly, but that the poorest countries are too far behind the advanced countries to gain from their backwardness. Given their

levels of education, investment and so on, the poorer half have still benefitted, in terms of growth rate, from being backward.

Table 4

Comparing Developing Countries with Different Income

	Lower Income		Higher Income	
	Coefficient	t-statistic	Coefficient	t-statistic
Constant	-8.54	1.95	-6.93	1.65
SCND	.049	6.97	.002	.18
PRICE	.208	1.42	.034	.16
INV	.008	.60	.054	2.87
PART	9.22	2.12	7.81	1.93
GDUS	-6.72	2.24	-.988	.69
$\overline{R}^2$	.73		.18	
No. obs.	39		39	

Source: Appendix Table 1.

The equations for the two groups of developing countries differ sharply in other respects.[5] Secondary education and price structure were of no importance for the higher income group, while the investment rate was important only for the higher income countries.

The effects of the foreign contact variables could also differ between the income groups. For example, the effects of foreign investment on productivity may differ among host countries depending on their level of development. The "least developed countries" may learn little from the multinationals, because local firms are too far behind in their technological levels to be either imitators or suppliers to the multinationals.

Any foreign operations are likely to be enclaves detached from most of the host-country economy. Moreover, the multinationals invest little in such countries, if they do not have important natural resources.

The higher income developing countries are the major recipients of FDI in the developing world, and they are also the likeliest candidates for spillovers. They have local firms that are advanced enough to learn from the foreigners. Thus, we expect the growth effects of foreign investment to be more important in higher-income countries than in the lower income countries. The results for these variables from the two halves of the distribution are as follows:

	IMP		FDI			
	Coeff.	t-stat.	Coeff.	t-stat.	$\bar{R}^2$	No. of Obs.
Higher income	.031	1.09	.437	2.69	.44	39
Lower income	.034	.76	.100	.52	.73	39

Source: Appendix Table 1

The coefficient for FDI is positive and significant only in the equation for higher-income countries, as predicted. Thus, from this comparison, one might conclude that there is a threshold level of income below which foreign investment has no significant effect.

The story told by the other coefficients is not very different from that in the equations without the international

variables. The effects of low initial income, of secondary education levels, and of participation rates are all shown as much stronger among the lower income countries, while that of inflows of foreign direct investment is important only among the higher income countries (Appendix Table 1).

4. The Quality of Data.

Given the large extent to which the underlying data we and others use depend on extrapolation, as discussed in the introduction, we were concerned that some of the results might be artifacts built in by the construction of the data. The variable most subject to this danger is the catch-up measure, the initial distance behind the U.S., because, as mentioned earlier, any errors in the dependent variable would have a corresponding reflection in this independent variable. Ideally, the quality grading of the data should reflect the coverage and character of each country's national income and product accounts, but a judgment on these is beyond our competence. What we did do was to grade a country's data quality by whether it had participated in any phase of the ICP, on the ground that the income level estimate for a country that had never participated rested on a flimsier foundation than that of a country that had participated at least once. Summers and Heston included a quality measure in their article, but used a different criterion. They gave a country their lowest quality rating, "D", if it never

participated in the U.N. International Comparison Program or if it was initially a low income country.

As before, we first relate the catch-up variable (GDUS) by itself to growth in income per capita for the high quality and low quality sub-samples of countries. This is a test for "gross" convergence, but as Appendix Table 1 shows, no such effect is visible. This lack of relationship is reassuring in one sense, because it suggests that the previously discussed bias in initial income measures may not be as strong as seems possible from the method used.

A comparison of the corresponding equations used in the above sections for the two subgroups of developing countries with different data qualities is shown in Table 5. A Chow test showed no significant difference in the equations between "low" and "high" quality data countries. The most important, and reassuring, result was that the catch-up effect was not associated with low-quality of data. In fact, it was stronger in the countries with higher quality data. The degree of explanation was larger for the countries whose data were of a lower quality, but that was mainly due to a strong impact of the foreign investment variable. Excluding FDI, the degree of explanation between the two samples becomes more similar (see Appendix Table 1). Both equations showed a positive effect of secondary education on growth rates and included negative coefficients for levels of initial (1960) income, but only the one in the equation for countries with higher data quality was

statistically significant. That equation had also a significant positive effect for the participation rate, but no such effect was seen in the countries with lower data quality. Neither equation gave much weight to imports of machinery and transport equipment, or to fixed investment.

Table 5

Comparing Developing Countries with Different Data Qualities

	Lower Quality		Higher Quality	
	Coefficient	t-statistic	Coefficient	t-statistic
Constant	-2.75	.47	-10.3	2.58
SCND	.031	2.53	.020	2.42
PRICE	.366	1.98	.465	1.45
INV	.013	.65	.013	.76
PART	2.18	.38	10.0	2.61
IMP	-.021	.55	.047	1.45
FDI	.510	2.41	.080	.43
GDUS 60	-2.13	1.56	-4.10	3.32
$\overline{R}^2$	.52		.38	
No. obs.	29		49	

Source: Appendix Table 1.

In sum, the worry that Summers and Heston's extrapolations might be responsible for some of the reported catch-up results is not confirmed here. While the coefficient for initial income was negative in the equations for both groups of countries, it was significantly different from zero only in the equation for the countries whose data were of a higher quality.

5. Conclusions and Further Directions For Research

Most research on growth and convergence has concentrated on developed countries or on some mixture of developed and developing countries. On the theory that the factors determining growth rates might be different between developed and developing countries, we have focussed on the latter group.

We have attempted to answer several questions. An initial one was whether the factors found to be important in studies covering all types of countries played the same role when only developing countries were studied. Our main interest, however, was to introduce several variables that had not typically been studied. Two of them were intended to measure the acquisition of technology through international contacts. One of these was the inflow of direct investment capital and the other was the import of machinery and transport equipment. A third new variable was a measure of the gains (or losses) from changes in the structure of prices. It was intended to obviate the need to arbitrarily eliminate some countries from the analysis because they were to some extent oil producers and to find a more general indicator of gains from price changes that was not confined to oil.

Finally, we began the study with the worry that some of the findings of convergence may have reflected the fact that very few of the initial relative per capita income levels used to represent a country's distance from the leaders had been measured directly. Virtually all that had any direct comparison of income levels as part of the calculation were extrapolations over time

from the periods when direct measures were made. The rest were extrapolations over space, extended to other years by extrapolations over time. If individual countries' national income and product accounts were used in these extrapolations, and if they were biased in their trends over time relative to those that would result from frequent and universal income level measurements, bias in the income growth rates would produce opposite biases in estimated initial income levels and, therefore, spurious convergence coefficients. We examined this possibility by investigating whether the convergence results arose mainly from the countries with poorer quality data or whether these countries showed particularly strong convergence tendencies.

Our results supported earlier findings that backwardness by itself is not associated with rapid growth; there was no pure or "gross" convergence. On the other hand, we confirmed the existence of what has been called "conditional" or "net" convergence. When other factors were taken into account, we found that the lower the initial (1960) per capita income relative to that of the U.S., the faster the subsequent growth in per capita income. The "net" convergence was particularly strong among the poorest half of the developing countries, which contradicts the idea of a "convergence club" confined to relatively well-off countries. This provides some basis for optimism with respect to the poorer countries in the world, in the sense that even they are not so far from the frontier that

they cannot gain from the availability of technology and other knowledge developed by others. Finally, we did not find that apparent evidence of conditional or net convergence reflected only the effects of extrapolation; in fact, the conditional convergence was strongest for the countries in which the quality of the data was relatively good.

Of the two variables intended as measures of the potential for technology transfer, the imports of machinery and transport equipment did not seem to have any impact. However, the inflow of foreign direct investment had a significant positive influence on income growth rates. The influence seemed to be confined to higher-income developing countries. It was not evident among the poorer countries. These results may therefore imply that inward FDI is a source of more rapid growth only for a country already at a relatively high level of development. We suggest that a certain threshold level of development is needed if the host countries are to absorb new technology from investment by foreign firms.

Changes in the price structure were a significant influence on growth rates for the developing countries as a whole, although their significance faded when the countries were divided into higher-income and lower-income groups. That is, countries for which the 1985 price structure was much more favorable than the 1960 price structure, as shown by a high ratio of 1960 income in 1985 prices to 1960 income in 1960 prices, tended to have faster real income growth. Although this price structure measure is

correlated with a measure of the importance of oil production to a country (r = .63), it probably omits some of the effects of price gains because the real income in the ICP is built up from consumption and investment, rather than from the production side of the account.

Among the other variables, the degree of enrollment in secondary education and the participation rate generally showed the expected positive relation to income growth and were mostly significant.

One surprise was the small influence of the variable for the fixed investment ratio, particularly once the inflow of foreign direct investment was included in the equation. Even without the FDI variable, the fixed investment ratio was, at best, marginally significant.[6] Ambiguity about the role of fixed investment runs through much of the recent development literature, but even critics of the earlier "capital fundamentalism", that attributed all growth to physical capital investment (see the discussion in e.g. Yotopoulos and Nugent, 1976, and Sen, 1983), would probably expect a stronger relationship than we found.

An unresolved question in all studies, including our own, relating income or productivity change over long periods to average fixed investment, imports, education, capital flows, or other variables, is the uncertainty about directions of causation. That question is raised particularly with respect to the fixed investment ratio, in Lipsey and Kravis (1987), where it is suggested that there is as much or more evidence that the

investment ratio in a period depends on earlier period output growth rates as there is that the growth rate depends on earlier or contemporaneous fixed investment. We confirmed that finding with some further experiments, using the present set of developing countries, but did not find the same ambiguity for the FDI variable. While the idea that growth spurts may precede increases in investment ratios is not common in the development literature, examples of such timing were cited by Kuznets (1973). That "acceleration principle" explanation of fixed investment is a basic feature of many studies of capital investment in developed economies, such as Eisner (1978). In that case, for example, "Capital expenditures are taken as a freely estimated distributed lag function of past changes in sales, profits, and depreciation charges" (ibid, p. 69). We believe that some effort is needed to model the sequence of developments and the two way interactions between growth and the many independent variables that have been included in the long-period studies.

Notes

1. A list of countries included in the study is provided in the appendix.

2. A variable for primary education was also tried, but since it never had any impact (probably because of too little variance) it is not shown.

3. We also tried a continous "oil-variable", based on the average oil production 1985-86 (from Energy Statistics Yearbook) divided by average real GDP for the same period, but that did not change the results, except that the explanatory power of the regressions was lowered somewhat.

4. Wolff's import variable, defined as total merchandise imports to GDP, also carried a strongly significant coefficient, while our somewhat narrower defined import variable, as discussed below, did not.

5. The Chow test rejected the hypothesis that the equations for the two groups of developing countries were identical.

6. Also Eichengreen and Uzan (1992), studying a different period from ours, find only a marginal growth effect of fixed investment.

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Appendix Table 1

Regressions of Growth in Real GDP per Capita (RGDPCG), 1960-1985

Const.	GDUS	SCND	PRICE	INV	PART	IMP	FDI	$\bar{R}^2$	Obs.
All Countries									
1.73	.381							.00	101
(13.5)	(.97)								
-5.82	-2.50	.021	.271	.029	5.98			.43	101
(2.39)	(5.34)	(4.57)	(2.51)	(2.97)	(2.48)				
-6.05	-2.43	.020	.299	.024	6.13	-.015	.278	.46	101
(2.37)	(5.25)	(4.46)	(2.81)	(2.33)	(2.41)	(.67)	(2.42)		
All Developing Countries									
1.64	4.54							.00	78
(9.81)	(.54)								
-6.98	-3.42	.024	.356	.029	6.90			.40	78
(2.22)	(3.81)	(3.70)	(2.68)	(2.49)	(2.23)				
-7.56	-3.28	.021	.391	.018	7.38	-.001	.321	.45	78
(2.39)	(3.81)	(3.29)	(3.05)	(1.52)	(2.35)	(.05)	(2.43)		
Higher Income Developing Countries									
2.22	-1.20							.01	39
(7.95)	(1.16)								
-6.93	-.988	-.002	.034	.054	7.81				
(1.65)	(.69)	(.18)	(.16)	(2.87)	(1.93)			.18	39
-2.98	-1.68	-.003	.255	.017	3.45	.031	.437	.44	39
(.77)	(1.40)	(.28)	(1.27)	(.97)	(.93)	(1.09)	(2.69)		
Lower Income Developing Countries									
1.54	-.492							.00	39
(3.33)	(.09)								
-8.54	-6.72	.049	.208	.008	9.22			.73	39
(1.95)	(2.24)	(6.97)	(1.42)	(.60)	(2.12)				
-10.70	-8.01	.050	.165	-.004	11.57	.034	.100		
(2.20)	(2.49)	(6.40)	(1.08)	(.22)	(2.34)	(.76)	(.52)	.73	39

Appendix Table 1 (concluded)

Const.	GDUS	SCND	PRICE	INV	PART	IMP	FDI	$\bar{R}^2$	Obs.
Developing Countries with Higher Quality Data									
1.68	.298							.00	49
(8.2)	(.27)								
-10.9	-4.36	.021	.504	.020	10.70			.38	49
(2.74)	(3.55)	(2.66)	(1.58)	(1.21)	(2.83)				
-10.31	-4.10	.020	.465	.013	10.00	.047	.080	.38	49
(2.58)	(3.32)	(2.42)	(1.45)	(.76)	(2.61)	(1.45)	(.43)		
Developing Countries with Lowest Quality Data									
1.60	.587							.00	29
(5.21)	(.43)								
-.219	-2.16	.037	.260	.030	-1.55			.42	29
(.04)	(1.43)	(2.83)	(1.30)	(1.50)	(.03)				
-2.75	-2.13	.031	.366	.013	2.18	-.021	.510	.52	29
(.47)	(1.56)	(2.53)	(1.98)	(.65)	(.38)	(.55)	(2.41)		

t-ratios in parentheses

APPENDIX

List of Countries Included and Characterization by Type of Country and Quality of Data

			Developing Country			
		Developed Country	Income		Data Quality	
			Higher	Lower	Higher	Lower
1	ALGERIA		X			X
2	ARGENTINA		X		X	
3	AUSTRALIA	X				
4	AUSTRIA	X				
5	BANGLADESH			X	X	
6	BARBADOS		X		X	
7	BELGIUM	X				
8	BENIN			X	X	
9	BRAZIL		X		X	
10	CAMEROON			X	X	
11	CANADA	X				
12	CENTRAL AFRICAN REPUBLIC			X		X
13	CHAD			X		X
14	CHILE		X		X	
15	COLOMBIA		X		X	
16	CONGO			X	X	
17	COSTA RICA		X		X	
18	CYPRUS		X			X
19	DENMARK	X				
20	DOMINICAN REPUBLIC		X		X	
21	ECUADOR		X		X	
22	EGYPT			X	X	
23	EL SALVADOR		X		X	
24	ETHIOPIA			X	X	
25	FIJI		X			X
26	FINLAND	X				
27	FRANCE	X				
28	GABON		X			X
29	GAMBIA			X		X
30	GERMANY	X				
31	GHANA			X		X
32	GREECE	X				
33	GUATEMALA		X		X	
34	GUYANA		X			X
35	HAITI			X		X
36	HONDURAS			X	X	
37	HONG KONG		X		X	
38	ICELAND	X				
39	INDIA			X	X	
40	IRAN		X		X	
41	IRAQ		X			X
42	IRELAND	X				
43	ISRAEL		X		X	

Appendix (cont.)

		Developed Country	Developing Country			
			Income		Data Quality	
			Higher	Lower	Higher	Lower
44	ITALY	X				
45	IVORY COAST			X	X	
46	JAMAICA		X		X	
47	JAPAN	X				
48	JORDAN		X			X
49	KENYA			X	X	
50	KOREA, SOUTH			X	X	
51	LIBERIA			X		X
52	MADAGASCAR			X	X	
53	MALAWI			X	X	
54	MALAYSIA		X		X	
55	MALI			X	X	
56	MALTA		X			X
57	MAURITANIA			X		X
58	MAURITIUS		X		X	
59	MEXICO		X		X	
60	MOROCCO			X	X	
61	NETHERLANDS	X				
62	NEW ZEALAND	X				
63	NICARAGUA		X			X
64	NIGER					X
65	NIGERIA			X	X	
66	NORWAY	X				
67	PAKISTAN			X	X	
68	PANAMA		X		X	
69	PAPUA NEW GUINEA			X		X
70	PARAGUAY		X		X	
71	PERU		X		X	
72	PHILIPPINES		X		X	
73	PORTUGAL	X				
74	RWANDA			X	X	
75	SAUDI ARABIA		X			X
76	SENEGAL			X	X	
77	SIERRA LEONE			X	X	
78	SINGAPORE		X			X
79	SOMALIA			X		X
80	SOUTH AFRICA			X		X
81	SPAIN	X				
82	SRI LANKA		X		X	
83	SUDAN			X		X
84	SURINAME		X			X
85	SWEDEN	X				
86	SWITZERLAND	X				
87	TAIWAN			X		X
88	TANZANIA			X	X	
89	THAILAND			X	X	
90	TOGO			X		X

APPENDIX (CONT.)

		Developed Country	Developing Country			
			Income		Data Quality	
			Higher	Lower	Higher	Lower
91	TRINIDAD & TOBAGO		X			X
92	TUNISIA			X	X	
93	TURKEY	X				
94	U.K.	X				
95	U.S.A.	X				
96	UGANDA			X		X
97	URUGUAY		X		X	
98	VENEZUELA		X		X	
99	ZAIRE			X		X
100	ZAMBIA			X	X	
101	ZIMBABWE			X	X	

Key:

RGDPCG: Real income per capita growth, 1960-85. Data Source: Summers and Heston (1991).

GDUS: 1960 income per capita relative to that of the United States. Data Source: Summers and Heston (1991).

SCND: The average (1960-85) ratio of secondary education to the number in the "appropriate" age group. Data Source: UNESCO Yearbook, various issues.

PRICE: Ratio of 1960 income in 1985 prices to 1960 income in 1960 prices. Data Source: Summers and Heston (1991).

INV: Ratio of fixed capital formation to GDP, measured in current purchasing power parities, averaged over the 1960-85 period. Data Source: Summers and Heston (1991).

PART: The change (1960-85) in the labor force participation rate, the ratio of labor force to total population. Data Sources: ILO, Labor Statistics Yearbook and Summers and Heston (1991).

IMP: The average (1960-85) ratio of imports of machinery and transport equipment (SITC 7) to GDP. Data Sources: United Nations, Yearbook of International Trade Statistics, various issues and Summers and Heston (1991).

FDI: Ratio of inflow of foreign direct investment to GDP, measured in current dollars, averaged over the 1960-85 period (for some countries, lack of data forced us to use shorter periods). Data Sources: IMF Balance of Payments tape and UNCTC (1988).