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.