IMF WORKING PAPER

WP/93/51

INTERNATIONAL MONETARY FUND

Research Department

Public and Private Investment and the Convergence of Per Capita Incomes in Developing Countries*

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June 1993

Abstract

This paper examines the extent to which there has been convergence in real per capita incomes across developing countries during the last two decades. In the analysis particular emphasis is placed on the separate roles played by private and public sector investment in determining both the extent and the speed of convergence. The paper also considers the importance of the stock of human capital, trade orientation, and foreign direct investment in the long-run growth process. Empirical tests are carried out for a large sample of 95 developing countries over the period 1970-90. The results provide support for the notion of differential effects of public and private investment on long-term growth, as well as for the convergence hypothesis.

JEL Classification Numbers:

H50; 041; 047; 057

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*The authors are grateful to Bankim Chadha, David Coe, José De Gregorio, Robert Ford, Norman Loayza, and Jonathan Ostry for very helpful comments and suggestions. They would also like to thank Catherine Fleck for editorial assistance and Shahbaz Khan and Toh Kuan for excellent programming and research assistance.

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Summary

This paper examines the extent to which real per capita incomes have converged across developing countries during the last two decades, paying particular attention to the differential effect of private and public investment on growth. In addition, it investigates the role of human capital, trade orientation, and foreign direct investment in determining growth. A theoretical framework is developed within which the separate roles of private and public investment in the convergence process can be examined, and empirical tests are conducted on a sample of 95 developing countries over the period 1970-90.

The results suggest that during the last two decades, there was no relationship between initial per capita GDP and its subsequent growth, thereby rejecting the convergence hypothesis. However, once aggregate investment rate and population growth are taken into account, there is evidence of convergence, although its speed differed markedly between the two decades. The effects of private and public sector investment on growth differed significantly, with private investment being consistently more productive than public investment, especially during the 1980s. The relative effects of public and private investment also exhibited pronounced regional variations. The stock of human capital, trade orientation, and foreign direct investment had positive but generally weak direct effects on per capita GDP growth.

From the standpoint of policy, the results suggest a clear need to improve the productivity of public sector investment by identifying more rigorously the types of investment that have positive net returns and are likely to be complementary to the private sector. At the same time, measures should be undertaken to stimulate private investment, which in turn would lead to a sustainable rate of growth. An increased emphasis on education, and the adoption or maintenance of outward-oriented policies, could also help raise private investment and spur long-term economic growth.

I. Introduction

A number of recent studies have examined the determinants of long-run economic growth to test a key prediction of the neoclassical growth model (Barro (1991), Barro and Sala-i-Martin (1992) and Mankiw, Romer, and Weil (1992)). This model predicts that under certain conditions, poor countries will tend to grow faster than rich ones, implying convergence over time in the level of per capita incomes (Lucas (1988), Romer (1989a), (1989b)). The empirical evidence that has accumulated in recent years for industrial and developing countries suggests that there has been convergence only in a conditional sense. That is, only if two key variables, investment in physical and human capital, are held constant. The extent to which this evidence invalidates the basic neoclassical model is still being debated in the literature.

In testing the neoclassical model, and more broadly in examining long-run growth, most empirical studies use aggregate investment as the key determinant, without distinguishing between investment in the public and private sectors. There is, however, considerable evidence that in developing countries in particular, these two components of investment can have a differential impact on growth. Public investment in infrastructure and in human capital formation may increase the productivity of private capital and be beneficial for growth. It can also, however, crowd out private investment by using scarce resources and thus have an adverse effect on growth. 1/

Moreover, none of the existing studies have examined the process of convergence exclusively within the developing world. Such an examination is of considerable interest in view of the marked differences in the performance of developing countries during the last two decades. Asian countries, for instance, have had in general a superior performance compared to that of African or Latin American countries. To the extent that the steady-state conditions underlying the differential growth performance--reflecting, for example, the rate of technological change and population growth--are likely to be more similar across developing countries, looking specifically at these countries can yield additional insights into the process of convergence. 2/

This paper extends the analysis of the growth process in developing countries in three specific directions. First, it examines separately the effect on long-run growth of investment by the private and public sectors, and investigates the effect on the speed of convergence of differences in

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1/ For a more extended discussion of the respective roles of public and private investment in the growth process, see Khan and Reinhart (1990). Other studies on this issue include Coutinho and Gallo (1991) and Serven and Solimano (1990).

2/ Existing studies have combined developing and industrial countries, and thus their results are applicable to both groups; see Barro (1991) and Barro and Sala-i-Martin (1992).

the rates of investment in the two sectors. Second, rather than assume technological change as exogenous and invariant across countries, the paper attempts to proxy it as a function of country-specific factors, in particular foreign trade orientation and inflows of foreign direct investment. Third, the empirical analysis is based on a sample of 95 developing countries for the period 1970-90. This is the largest sample of developing countries used in any study to-date, and accounts for over 90 percent of the GDP of developing countries during the late 1980s. The large sample further allows for consideration of the hypothesis that there are significant differences in the four developing country regions--Africa, Asia, Europe and Middle East, and Latin America--both in the convergence process and in the differential effects of public and private investment. 1/

The rest of the paper is structured as follows: Section II provides a brief discussion of the convergence hypothesis and the existing empirical evidence. Section III develops the theoretical framework within which the role of private and public investment in the convergence process can be examined. Section IV discusses the main results. While the bulk of the empirical analysis is undertaken using cross-sectional data, and single equation estimation techniques, estimates using pooled-time series data, with growth computed over different time horizons, and instrumental variable techniques to take into account the simultaneity between private investment and growth, are also presented. Finally, Section V contains a summary of the main findings and some of the relevant policy implications.

II. Convergence and Growth

1. The convergence hypothesis

The convergence hypothesis states that poor countries--those with relatively low initial per capita incomes--grow faster than rich ones, so that over time income levels converge across countries. This hypothesis has received particular attention in recent years in the context of the empirical relevance of the neoclassical growth model. However, it is hardly a new notion: it was a recurring theme in the development literature of the 1950s and 1960s in terms of the factors determining the ability of developing countries to catch up with income levels of industrial ones. 2/ The recent literature on the subject has examined the evidence relating to this hypothesis in much more detail, and in addition, has provided significant theoretical contributions explaining the circumstances where there may be divergence in income levels.

1/ The diversity in performance among developing country regions became particularly evident during the 1980s (see, for instance, Ossa (1990), and Kumar (1992)).

2/ See, for instance, Kuznets (1953), Johnson (1967), and Myrdal (1968).

Generally speaking, there are two main reasons for expecting there to be convergence of per capita incomes across countries. First, in the neoclassical models of Solow (1956) and Koopmans (1965), a key assumption is that there are diminishing marginal returns to physical capital. Since countries with low initial income per capita have low ratios of capital to labor, they would be expected to have a high marginal product of capital. Further, international capital would flow to areas with relatively high rates of return, that is, to where capital is relatively scarce. Therefore, capital-labor ratios will move over time to equality, and with them factor prices. This would imply that incomes in poor countries would grow faster than incomes in rich ones, and that the two would eventually converge.

Second, convergence of incomes in developing countries to industrial countries may also be expected on the basis of the technological gap between the two groups of countries. The assumption here is that technological innovations take place mainly in the rich countries and are then transmitted to, and absorbed by, the poor countries. The rate of absorption is positively related to the gap between the stock of world and domestic technological knowledge. If it is assumed that countries with lower initial income per capita have a relatively larger gap, they will tend to "catch up" with the richer countries faster, again suggesting that poor countries will grow faster than rich ones.

It is important to note that the above reasons imply that there should be convergence only in a conditional sense--that is, if other factors which determine growth are kept constant. For instance, if poor countries have significantly lower physical capital accumulation than rich ones, the impact of diminishing returns in the rich countries may be offset and there may be no convergence. The efficiency of investment, determined in part by its sectoral composition, may also be important. As will be argued in this paper, differences in the rates of public and private sector investment can have a significant impact on the overall investment efficiency, and can thus help or hinder the convergence process. Similarly, if the ability of poor countries to "imitate" or absorb innovations from the rich countries is constrained in some way, for instance due to inadequate availability of human capital, the technological gap may not narrow and could even widen, leading to a divergence of per capita incomes.

2. Empirical evidence on convergence

A number of recent empirical studies have examined the convergence hypothesis in an "unconditional" sense and found it to be inconsistent with the evidence. Barro (1991), for instance, reported that the growth rate of per capita GDP of 98 industrial and developing countries from 1960 to 1985 was not significantly related to the 1960 value of real per capita GDP (the correlation between initial income and subsequent growth was 0.09). Similarly, Mankiw, Romer, and Weil (1992) found no evidence of unconditional convergence in a sample of rich and poor countries alike, but did find a tendency toward convergence within the rich countries only.

In an earlier study Baumol (1986) summarized evidence, mainly from Maddison (1982), showing apparent convergence in income levels during this century in the sixteen richest industrial countries. However, Delong (1988) showed that this effect could be attributed to a "selection bias", arguing that Baumol had used the sample of countries that are now rich and had successfully developed. If, instead, a broader sample is taken of countries that seemed at the beginning of the period likely to converge, apparently there is divergence, with the richer countries growing faster.

The extent of unconditional convergence among a large sample of countries--116 in all, with 95 developing and 21 industrial countries--and for a later period (1970 to 1990), is illustrated in Chart 1a. 1/ For this sample of countries, there is no evidence of convergence--the correlation between the initial 1970 real per capita GDP and per capita GDP growth from 1970 to 1990 is 0.05. Similarly, as Chart 1b shows, among only developing countries, where per capita GDP in 1970 differed by as much as a factor of 30, the correlation between the initial 1970 income levels and subsequent growth rates was even lower (0.04).

The empirical finding of the independence between per capita GDP growth and the starting level of per capita income has been explained in the recent literature in two ways. The first is by Mankiw, Romer, and Weil (1992) who point out that since the evidence is "unconditional", that is, it does not take into account determinants of growth other than initial income, it does not invalidate the neoclassical model. In particular, the Solow model predicts that income per capita in a given country converges to that country's steady-state value. But countries have <u>different</u> steady states depending on the propensity to save and population growth. 2/ So across countries, the Solow model would predict convergence only after controlling for the determinants of the steady state--that is, it predicts only conditional convergence.

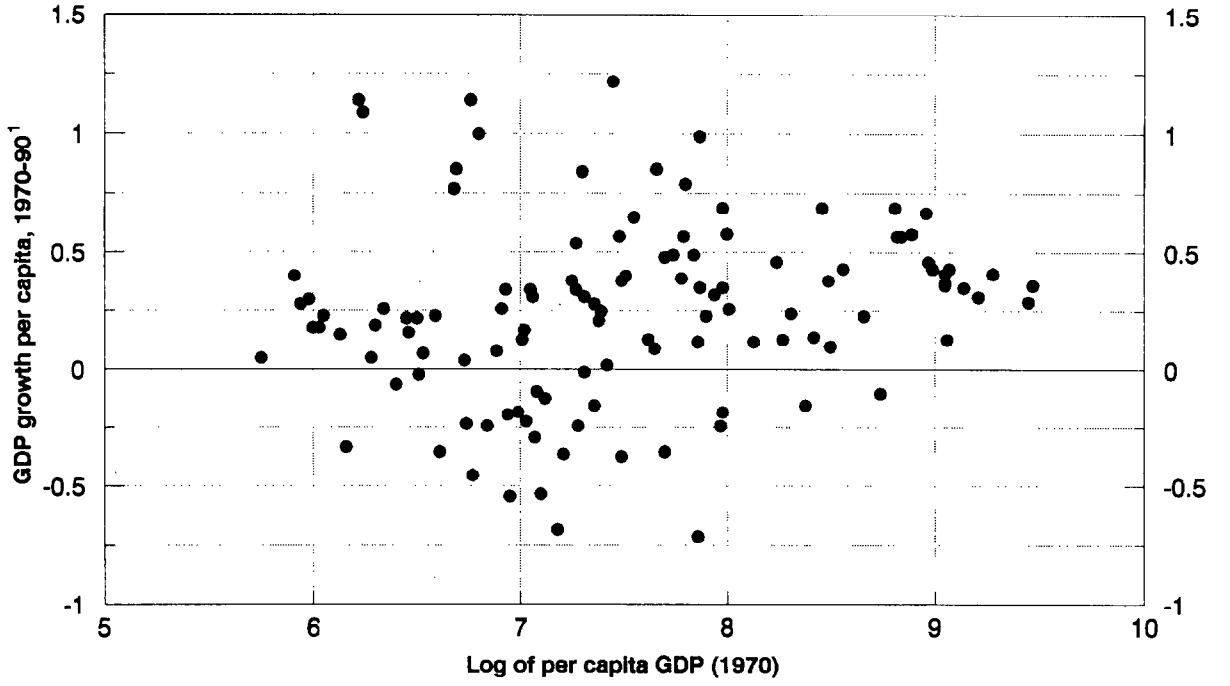
Typically, when per capita growth is regressed on the initial level of income, the investment rate, and population growth, the coefficient on the initial level of income becomes significantly negative, suggesting convergence. The inference is that if countries did not vary in their investment and population growth rates, and if technological change was constant across countries, there would be a tendency for poor countries to grow faster than rich ones. This tendency toward convergence is seen to be even stronger when, in addition to the above three variables, a human capital variable is included. Furthermore, the empirical evidence suggests that the <u>rate</u> at which this conditional convergence has taken place is roughly consistent with the predictions of the Solow model.

1/ Data on per capita GDP in constant U.S. dollars (based on purchasing power parities) are drawn from Summers and Heston (1988, 1991), and for some low income countries from Ahmad (1992).

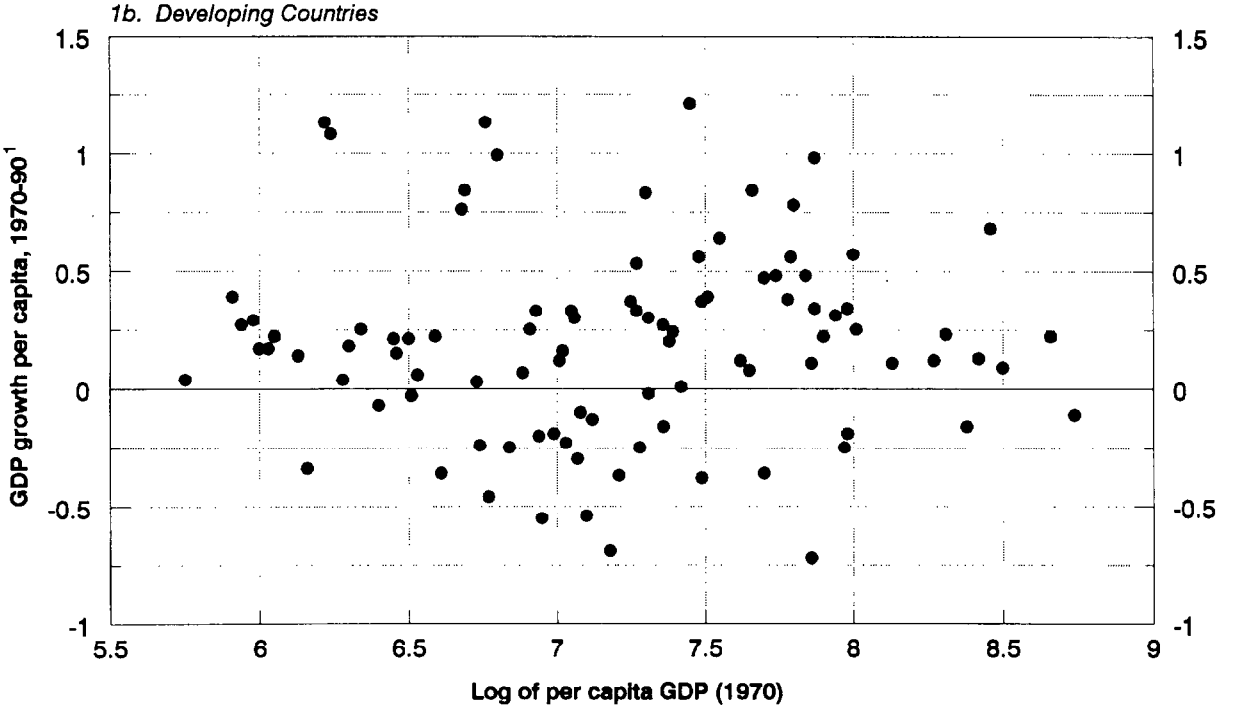
2/ For a detailed discussion, see Haache (1979). This point is taken up more formally in Section III.

Chart 1. GDP Growth Per Capita and GDP Per Capita

1a. All Countries



1b. Developing Countries



[1] Growth per capita is measured by the difference in the log of GDP per capita.

A second approach is to view the evidence of a lack of convergence in the unconditional sense as supporting the recent "endogenous growth" models which assume constant or increasing returns to a broad concept of reproducible capital. 1/ The key feature of many endogenous growth models is the role played by human capital, which, according to Lucas (1988), affects the productivity of all other factors of production. In Romer (1989b) human capital is a key input to the research sector which generates new products or ideas that underpin technological progress. Lucas (1988) develops two types of models: in one, the decision to accumulate human capital is equivalent to a decision to withdraw effort from production; in the second model, all human capital accumulation is by on-the-job-training or learning by doing. In both types of models, and in their various extensions, it is assumed that the marginal cost of accumulating human capital is constant--a given percentage increase in this stock requires the same effort, irrespective of the existing level of human capital.

More importantly, constant or increasing returns to human capital imply that the marginal product of all reproducible capital tends to a constant, irrespective of the accumulated stock of capital. This implies in turn that countries that are initially poor, and have a low stock of human capital, can remain poor in relative terms, with their long-run rate of growth being the same as or even lower than that of initially wealthier countries with a higher stock of human capital.

In summary, the issue of whether there will be convergence of real per capita incomes across countries is as yet unresolved. There are perhaps strong theoretical arguments not to expect unconditional convergence, but at the same time conditional convergence is not ruled out. As such, in the remainder of this paper convergence will be interpreted solely in the conditional sense.

III. Determinants of Growth

The salient features of the growth process in developing countries during the last two decades are contained in Table 1. While there has been a significant variation in growth of both GDP and GDP per capita across the four developing country regions during the 1970s and 1980s, the data tend, if anything, to support the earlier impression of a lack of unconditional convergence. For instance, during the 1980s, per capita GDP was stagnant in Africa and declined by an average of 1 percent per annum in Latin America--

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1/ The more important example of papers on this approach include those by Romer (1986, 1989a), Lucas (1988), Helpman (1988) and King and Rebelo (1989).

Table 1. Investment and Growth in Developing Countries, 1970-90 1/

	No. of Countries	1970-80 GDP Growth	1970-80 GDP Growth per Capita	1970-80 Investment as a Ratio of GDP Total	1970-80 Investment as a Ratio of GDP Public	1970-80 Investment as a Ratio of GDP Private	1970-80 Pop. Growth	1980-90 GDP Growth	1980-90 GDP Growth per Capita	1980-90 Investment as a Ratio of GDP Total	1980-90 Investment as a Ratio of GDP Public	1980-90 Investment as a Ratio of GDP Private	1980-90 Pop. Growth	1970-90 GDP Growth	1970-90 GDP Growth per Capita	1970-90 Investment as a Ratio of GDP Total	1970-90 Investment as a Ratio of GDP Public	1970-90 Investment as a Ratio of GDP Private	1970-90 Pop. Growth
Developing Countries	(95)	4.6	2.3	20.4	10.4	10.1	2.4	2.8	0.3	20.2	9.8	10.6	2.4	3.7	1.3	20.3	10.0	10.2	2.5
Africa	(46)	4.0	1.3	19.7	10.9	8.8	2.7	2.7	-0.1	19.9	10.4	9.5	2.8	3.4	0.6	19.7	10.6	9.1	2.7
Asia	(14)	5.3	3.5	18.8	7.8	11.0	2.0	5.0	2.8	22.4	9.5	12.8	2.1	5.2	3.2	20.5	8.6	11.9	2.1
Latin America	(24)	4.8	2.5	20.4	8.4	12.0	2.3	1.0	-1.0	18.3	7.4	11.0	2.1	2.9	0.7	19.3	7.9	11.4	2.2
Europe and Middle East	(11)	6.0	4.2	25.3	15.8	9.5	1.8	3.8	1.9	25.3	12.3	11.4	2.0	4.8	3.0	24.5	14.1	10.4	1.9

1/ Unweighted averages. For sample of countries, see Appendix.

both regions with relatively low initial per capita GDP--while in Asia it increased by over 2 1/2 percent per annum. 1/

One striking feature of Table 1 is the share of public investment, which accounts for nearly half of total investment in developing countries. In industrial countries, by contrast, public sector investment accounts for less than one fifth of the total (of around 18 percent of GDP). 2/ To the extent that the needs of developing countries for infrastructural and related capital are greater than those of the industrial countries, and given the indivisibilities and risks involved in the provision of such capital, the share of public investment might be expected to be higher. Nevertheless, these data raise one of the central questions of this paper concerning the efficiency of public investment relative to private investment and its contribution to long-run growth in developing countries.

In general, public investment in infrastructure, by being complementary to private investment, could increase the marginal product of private capital. 3/ This is most likely to be true in those developing countries where the existing stock of infrastructure capital is inadequate. In this regard, it is worth noting in Table 1 that the share of public investment in African and Europe and Middle East countries is higher than that of private investment; in Asian and Latin American countries private investment has a higher share. It is increasingly acknowledged, however, that public investment in infrastructure may not automatically have a beneficial impact on private investment and growth. In many of the Latin American countries, for instance, public infrastructure investment projects in the late 1970s were of dubious quality. There were examples of this in the 1980s in Asia and Africa as well; for instance, electric power plants, built at enormous cost, were either not operated or were operated far below capacity; similarly, many countries undertook ambitious transportation projects, including roads and railways, which were either not completed or were grossly underutilized. 4/

1/ Since the main objective of the paper is to analyze the determinants of performance across individual countries, these data are unweighted averages. However, the broad picture remains unchanged if weighted averages, with weights corresponding to the countries' relative income levels, are used.

2/ This is based on an unweighted average for the OECD countries (excluding Turkey) for the 1980s.

3/ See Blejer and Khan (1984). For industrial countries, Aschauer (1989a, 1989b) finds that investment in infrastructure has had a very strong positive effect on private sector productivity. However, these findings remain controversial largely because the marginal productivity of infrastructure implied by the estimates is implausibly high (see, for example, Ford and Poret (1991), and Rubin (1991)).

4/ See Krueger and Orsmond (1990).

In addition to investment in infrastructure, a large part of public investment is undertaken by public sector enterprises. In most developing countries, industrial policy and the regulatory framework have linked private sector production directly to public sector activities in both the goods and the factor markets. For instance, an expansion of the capacity of public enterprises to produce industrial inputs--including production of basic metals, chemicals, and so on--is necessary before the private sector can undertake investments in sectors that are dependent on these basic inputs. Given the pervasive role of public enterprises in many countries, capacity expansion by such enterprises can lead to an increase in private sector investment undertaken for the purpose of satisfying the additional demand. This complementarity may have been encouraged through the granting of selective incentives for directing private investment to fulfill public investment plans. 1/

The above considerations suggest that while the public sector capital stock may be complementary to the private sector and have a positive effect on growth, its efficiency may be questionable. Moreover, in many developing countries public sector enterprises compete directly with the private sector in the provision of goods and services. In these cases, an increase in public investment could have an adverse effect on private investment both directly, and indirectly via the public sector budget constraint. In the case of the latter, each of the different modes of financing public sector investment can have an effect on private investment. If, for example, public investment is financed by increasing taxes, it may further exacerbate distortions in the economy and increase the costs of inputs, leading to an adverse effect on expected output growth and private investment. Where it is financed by market borrowing, public investment could have an adverse effect on the availability of credit, as well as on the real cost of capital to the private sector. Finally, in the case of monetization of deficits, crowding out occurs less directly via an increase in inflation rate, which engenders uncertainty with regard to the expected returns from investment.

The above discussion suggests that in examining the determinants of growth and the process of convergence in the case of developing countries, it would be important to distinguish between the impact of private and public sector investment. This is done using the basic neoclassical growth framework in which capital accumulation, population growth, and technical change are the key determinants of growth of per capita income.

1. Steady-state income per capita

Assume a Cobb-Douglas production function, with production at time t given by:

1/ See, for instance, Chibber and van Wijnbergen (1988), who discuss the case of Turkey in the 1980s where, despite very high real interest rates, private investment boomed because of investment by public sector enterprises.

$$Y(t) = Kg(t)^{\alpha} Kp(t)^{\beta} (A(t)L(t))^{1-\alpha-\beta} \qquad \alpha+\beta<1 \tag{1}$$

where Y, L and A denote output, labor and the level of technology, respectively; Kg and Kp denote public and private sector capital stock. L and A are assumed to grow exogenously at rates n and γ; N=LA, which can be interpreted as effective labor or labor measured in efficiency units. Therefore, N grows at a rate $n+\gamma$, i.e.,

$$\frac{\dot{N}}{N} = n+\gamma \tag{2}$$

Let Sg and Sp be the share of income invested in public and private capital respectively. Following Blejer and Khan (1984), assume that both types of capital stock depreciate at the same rate δ. 1/ That is,

$$\dot{Kg} = Ig - \delta Kg \tag{3a}$$

$$\dot{Kp} = Ip - \delta Kp \tag{3b}$$

where Ig and Ip denote public and private sector investment respectively.

In equilibrium, aggregate savings equal aggregate investment. Define kg and kp as the stock of public and private capital per effective unit of labor, i.e., kg = Kg/AL and Kp = Kp/AL; and let y be the level of output per effective unit of labor, y = Y/AL. The evolution of kg and kp is given by the following:

$$\dot{kg} = SgY - (n+\gamma+\delta)kg \tag{4a}$$

$$\dot{kp} = SpY - (n+\gamma+\delta)kp \tag{4b}$$

1/ It might be argued that public capital stock, especially in infrastructure, depreciates at a different rate compared with the private capital stock. While such an extension complicates the analysis, it does not change the conclusions significantly. For simplicity, therefore, the restriction of equality of depreciation rates is maintained.

In steady state, $\dot{k}g = \dot{k}p = 0$ and the two types of capital stock converge to k_g^* and k_p^*. That is,

$$k_g^* = \left[\frac{S_g^{1-\beta} S_p^{\beta}}{n+\gamma+\delta}\right]^{(1/1-\alpha-\beta)} \tag{5a}$$

$$k_p^* = \left[\frac{S_g^{\alpha} S_p^{1-\alpha}}{n+\gamma+\delta}\right]^{(1/1-\alpha-\beta)} \tag{5b}$$

Substituting 5(a) and 5(b) in the production function and taking logs gives the following equation for income in the steady state:

$$Ln(y^*) = \frac{\alpha}{1-\alpha-\beta} Ln(Sg) + \frac{\beta}{1-\alpha-\beta} Ln(Sp) - \frac{\alpha+\beta}{1-\alpha-\beta} Ln(n+\gamma+\delta) \tag{6}$$

To obtain an estimating equation in terms of income per capita, rather than in terms of income per unit of effective labor as above, note that $A(t) = A(o)\, e^{\gamma t}$. In the standard framework, γ, which reflects primarily the advancement of knowledge, is assumed to be constant across countries. In contrast, A(o) reflects, in addition to technology, resource endowments, institutions and other variables likely to differ across countries. So $Ln\ A(o) = a + \epsilon$, where a is a constant and ϵ is a country-specific variable. Substituting for A in $y = Y/AL$, gives:

$$Ln\left(\frac{Y}{L}\right) = a + gt + \frac{\alpha}{1-\alpha-\beta} Ln(Sg) + \frac{\beta}{1-\alpha-\beta}(Sp) - \frac{\alpha+\beta}{1-\alpha-\beta} Ln(n+\gamma+\delta) + \epsilon \tag{7}$$

Thus, income per capita depends on public and private investment, population growth and technological progress. This type of formulation was utilized by Khan and Reinhart (1990) to test the relative effects of public and private investment on growth in developing countries.

If there is no distinction between private and public sector investment, equation (7) reverts to the basic Solow model. In such a case income per capita is simply a function of the aggregate saving rate, population growth, and exogenous technological change. That is,

$$Ln(\frac{Y}{L}) = a + gt + \frac{\alpha}{1-\alpha}Ln(S) - \frac{\alpha}{1-\alpha}Ln(n+\gamma+\delta) + \epsilon \quad (8)$$

where α now refers to the share of aggregate capital in income, and S is the aggregate saving (and investment) rate. This equation has become the mainstay of empirical growth analysis.

2. Transition to steady-state and speed of convergence

The specification of equations (7) and (8) is based on the rather strong assumption that all countries are at their steady states. Typically these types of equations are therefore estimated using cross-country data averaged over some relevant time period to proxy the steady state. However, it is also possible to utilize a more general framework that examines the predictions of the Solow model for behavior of per capita income out of steady state. Such a framework allows estimation of the effect of various explanatory variables on per capita growth rates (rather than on the cross-sectional variation in income per capita) as well as a calculation of the speed of convergence.

Following Mankiw, Romer, and Weil (1992) the transition to the steady-state is approximated by the following equation:

$$\frac{dLn(y(t))}{dt} = \lambda[(Ln(y^*(t)) - Ln(y(t))] \quad (9)$$

where $\lambda = (n+\gamma+\delta)(1-\alpha-\beta)$ is the speed of convergence; y(t) is the actual output per effective worker at time t; and y^* is the steady-state level of income at time t as given by equation (7). Equation (9) can be rewritten as follows:

$$Ln(y(t)) = (1-e^{-\lambda t})Ln(y^*) + e^{-\lambda t}Ln(y(o)) \quad (10)$$

where y(o) is income per effective worker at some initial date.

Subtracting Ln y(o) from both sides gives:

$$Ln(y(t)) - Ln(y(o)) = (1-e^{-\lambda t})Ln(y^*) - (1-e^{-\lambda t})Ln(y(o)) \quad (11)$$

Substituting for y^* from equation (7), yields:

$$Ln(y(t)) - Ln(y(o)) = (1-e^{-\lambda t})[\frac{\alpha}{1-\alpha-\beta} Ln(Sg) + \frac{\beta}{1-\alpha-\beta} Ln(Sp) - \frac{\alpha+\beta}{1-\alpha-\beta} Ln(n+\gamma+\delta) - Ln(y(o))] \quad (12)$$

The left-hand side of the equation is the growth of per capita income, and it can be seen that the equation does not predict unconditional convergence. Rather, it predicts that the initially poorer economy may be expected to grow faster than a richer one in per capita terms, given the accumulation of public and private capital, population growth, and technological change.

In estimating equation (12), an attempt is made to allow for cross-country differences in γ, reflecting technical change. It is sometimes suggested that in the long-run, both the "disembodied" and the "embodied" technical change in a country are related to its exposure to foreign trade and investment. Several recent theoretical and empirical contributions link such exposure to foreign markets, managerial techniques, etc., not only to a one-time shift in production possibilities, but also to sustained increases in growth rates due to dynamic scale economies and learning by doing (Ram (1985), Lal and Rajapatirana (1987), Grossman and Helpman (1990), Edwards (1992), and Coe and Moghadam (1993)). 1/

In the empirical estimation, instead of assuming γ to be constant across countries, it is allowed to vary as a function of a country's trade orientation and the inflow of foreign direct investment. The procedure adopted is to assume that for the average of the sample the value for γ assumed by Mankiw, Romer and Weil (1992)--2 percent a year--holds. Deviations from this average value are then related to trade orientation, measured by the average share of exports and imports to GDP, and to the inflows of foreign direct investment relative to GDP. 2/

1/ As Lucas (1988) points out, level effects can be drawn out through adjustment costs of various kinds, but not so as to produce increases in growth rates that are both large and sustained. Although Harberger (1984) identifies dynamic effects, it is only the recent literature that provides a formal rationale of how the removal of inefficiencies sets in train factors that have growth effects.

2/ There is, in general, a negative relationship between the export ratio and country size as measured by GDP, reflecting, in part, the greater need of smaller countries to engage in foreign trade. In view of this, an alternative measure used the residual from the regression of export share on GDP (involving both linear and quadratic terms).

IV. Empirical Results

In the empirical analysis, equations (7) and (8) for the level of per capita real income are two of the main estimating equations. The latter equation provides a "reference" by which the significance of the estimates obtained from equation (7) of the impact of private and public sector investment can be assessed. Estimates were also obtained for several variants of equation (12), which describes the variations in per capita growth of incomes.

1. Determinants of per capita GDP

The Ordinary Least Squares (OLS) estimates of equations (7) and (8) are given in Table 2. These results show the role of aggregate as well as of public and private investment, population growth, and technological change during the last two decades, in explaining the cross-country differences in the levels of per capita GDP in 1990. As noted earlier, while this framework assumes that countries were in their respective steady-states in 1990, still the estimates do provide a useful starting point for an assessment of both the relevance of the neoclassical model for developing countries, and of the relative importance of public and private sector investment. The sample of countries and the data are described in the Appendix.

The first two columns in Table 2 correspond to equation (8), while columns (3) and (4) correspond to equation (7). Consider first the former set of results, which provide estimates of the basic neoclassical model with aggregate investment. Column (1) shows that two basic variables--the investment ratio and population growth--account for over 40 percent of the variation in real per capita GDP in 1990 across the full sample of developing countries. 1/ The coefficients of the investment ratio as well as of population growth have the expected signs and are highly significant. The restriction that these coefficients be equal and opposite in sign is also not rejected using the standard "F" test. However, using this restriction, the coefficient suggests that capital's share in income is over 50 percent; this is considerably higher than that generally accepted in the industrial countries, where it is assumed to be around one third. While there may appear to be a prima-facie argument for assuming that this share should be higher in the developing countries compared to the industrial

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1/ Standard errors based on White's (1980) heteroscedasticity-consistent covariance matrix differed little from those obtained by OLS and reported here.

Table 2. Determinants of Real Income Per Capita 1/

	(1)	(2)	(3)	(4)		
Constant	-3.20	-0.32	-2.63	0.41		
	(1.40)	(1.29)	(1.34)	(1.19)		
Investment (total)	1.40[a]					
	(0.20)					
Investment (public)			0.39[a]			
			(0.14)			
Investment (private)			0.86[a]			
			(0.11)			
Population and technical change	-2.49[a]	-1.44[a]	-2.80[a]	-1.63[a]		
	(0.52)	(0.47)	(0.50)	(0.44)		
Investment dummies		(Total)			(Public)	(Private)
Africa		1.21[a]			0.41[a]	0.67[a]
		(0.18)			(0.15)	(0.12)
Asia		1.35[a]			0.20	1.00[a]
		(0.18)			(0.23)	(0.19)
Latin America		1.48[a]			0.20	1.17[a]
		(0.18)			(0.18)	(0.16)
Europe and Middle East		1.46[a]			0.85[a]	0.54[a]
		(0.17)			(0.17)	(0.20)
$\bar{R}^2$	0.45	0.62	0.50	0.67		
S.E.E.	(0.60)	(0.51)	(0.59)	(0.47)		

1/ For detailed description of the data see the Appendix. Standard errors are given in brackets; [a] denotes statistically significant at the 5 percent level.

ones, the degree of difference suggests that the neoclassical framework needs to be extended. 1/

The extent to which the importance of capital investment differs across the four developing country regions of Africa, Asia, Latin America (including Caribbean countries), and Europe and Middle East is examined by including slope dummies for total investment for each of the regions. 2/ The results in Column 2, which allow for slope differences, indicate a considerable improvement in the overall fit of the equation, which now explains over 60 percent of the variation in the 1990 per capita income. While each of the slope dummy variables is statistically significant, the coefficients across the regions show large variation. For instance, for Africa the coefficient of investment is around 1.20, whereas for Europe and Middle East and Latin America it is around 1.45, suggesting a marked difference both in the efficiency of investment, and in the share of capital in total income.

The differential effect of public and private sector investment is examined in columns (3) and (4) of Table 2. The first of these columns shows that there is a very large difference between public and private investment in explaining the cross-country difference in per capita GDP. Specifically, the coefficient on private investment is twice as large as that on public investment, and highly significant, whereas public sector investment has a limited impact. Not surprisingly, the restriction that public and private sector investment have a similar impact is decisively rejected. 3/

The extent to which the two components of investment have a differential impact across the four developing country regions is examined in column (4) by introducing slope dummies for each of the regions for both public and private sector investment. The equation now explains over two-thirds of the cross-country variation in per capita real GDP. The impact of private sector investment is statistically significant for all regions, although it differs widely across them, with the largest impact in Asian and Latin American countries. On the other hand, in all regions, except Europe and Middle East, public sector investment has a markedly smaller impact, which is insignificant for Asian and Latin American countries.

1/ Mankiw, Romer, and Weil (1992) obtain virtually an identical estimate for capital share, which they also consider suggests a problem for the basic model. Their sample consists of a large number of industrial countries, and for these such a figure may be regarded as exceptionally high. See also Levine and Renelt (1992).

2/ The slope dummies take the value of the investment ratio for countries in the given region and zero otherwise.

3/ These results are consistent with those reported by Khan and Reinhart (1990) for a smaller sample of 24 developing countries for the 1970s.

2. Determinants of per capita growth

A more realistic framework is to consider the transition to the steady state and the roles played by public and private sector investment. This is undertaken by estimating equation (12), which allows for an investigation of the convergence issue. The dependent variable now is the growth of per capita GDP across developing countries.

The basic results obtained by estimating equation (12), with aggregate investment as the main explanatory variable and technological change invariant across countries, for different periods--1970-90, 1970-80, and 1980-90--are provided in Table 3. Column (1) shows that for the 1970-90 period as a whole, the fit of this equation is quite good; nearly a third of the cross-country variation in per capita GDP growth over the 20-year period is explained by the variation in the investment ratio, initial per capita income, and population growth. All the variables have the expected signs and are statistically significant. The first variable of key interest is the initial income variable, which yields a rate of convergence of 0.010. This last result implies that once the cross-country variation in the investment and population growth variables is taken into account, the poorer developing countries (measured by their per capita income in 1970) narrowed the gap between them and the richer countries at a rate of roughly 1 percent a year. 1/ This is a somewhat higher rate than that obtained in existing studies which are based on a combined sample of developing and industrial countries. 2/

The second variable of special interest is the investment ratio. The coefficient of this variable suggests that a one percent increase in the investment ratio across developing countries is associated with an increase in per capita GDP growth of three-quarters of a percent. This is again somewhat larger than in the earlier studies.

The results for the two sub-periods--1970-80 and 1980-90--provided in columns (2) and (3) of Table 3 indicate a marked contrast between the two decades. The results for the 1970s show that the coefficient on the initial 1970 income variable is not significantly different from zero; that is, initial income had no relationship with the subsequent per capita growth during the decade and there was no convergence during this period. The results in column (3) show that during the 1980s, however, the initial income variable (that is, 1980 per capita GDP) had a highly significant negative coefficient, implying a high degree of convergence during the last decade. To some extent, this difference between the two decades probably reflects the international debt crisis, which affected middle-income

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1/ See Barro (1991) for the relationship between the rate of convergence, and the speed with which the gap between rich and poor countries is narrowed.

2/ See, for example, Mankiw, Romer, and Weil (1992).

Table 3. Determinants of Per Capita Growth: Single Equation Estimates 1/

	(1)	(2)	(3)	(4)	(5)	(6)
Average per capita growth during	1970-90	1970-80	1980-90	1970-90	1970-80	1980-90
Constant	3.06[a] (0.78)	-1.55[a] (0.52)	-1.61[a] (0.48)	-2.76[a] (0.77)	-1.23[a] (0.51)	-1.45[a] (0.47)
Initial per capita GDP	-0.18[a] (0.06)	-0.04 (0.04)	-0.14[a] (0.03)	-0.20[a] (0.06)	-0.03 (0.05)	-0.15[a] (0.04)
Implied rate of convergence	0.010	0.004	0.015	0.011	0.003	0.016
Investment (total)	0.75[a] (0.12)	0.44[a] (0.09)	0.35[a] (0.08)			
Investment (public)				0.28[a] (0.08)	0.21[a] (0.06)	0.13[a] (0.05)
Investment (private)				0.43[a] (0.07)	0.21[a] (0.05)	0.21[a] (0.05)
Population and technical change	-0.90[a] (0.30)	-0.30 (0.19)	-0.61[a] (0.19)	-1.08[a] (0.31)	-0.29 (0.19)	-0.70[a] (0.19)
R^2	0.33	0.24	0.27	0.34	0.23	0.28
S.E.E.	(0.34)	(0.25)	(0.23)	(0.34)	(0.25)	(0.23)

1/ For detailed description of the data see the Appendix. Standard errors are in brackets; [a] denotes statistically significant at the 5 percent level.

developing countries much more severely than the low income ones, leading to relatively higher growth among the latter group of countries.

Next consider the separate role played by public and private sector investment in determining per capita growth. As indicated in column (4) of Table 3, for the period 1970 to 1990, while both types of investment had a positive impact, their magnitude differed considerably, with private investment having a much stronger impact than public sector investment. However, the two sub-periods diverge markedly: during the 1970s, both public and private investment had a similar effect and it was only during the 1980s that the greater impact of private sector investment emerged. One explanation for this difference could be that in the earlier period the stock of infrastructural capital was lower in most developing countries, and thus the returns from such investment were higher. Apparently there was much more complementarity between private and public investment than was the case during the last decade.

The extent to which the above results change when regional differences, as captured by the investment slope dummies, are taken into account is shown in Table 4. As column (1) in this table shows, for the 1970-90 period, the regional slope dummies increase considerably the explanatory power of the equation, which now accounts for over half the cross-country variation in GDP growth per capita. An "F" test of no differences in the efficiency of public and private sector investment is clearly rejected. The regional differences are interesting. For Africa, and to some extent for Europe and Middle East, both types of investment exercise a similar impact, while in Latin America, public investment appears to have had, on average, very limited impact and private investment a pronounced positive effect. In Asia, public investment, although statistically significant, has an elasticity with respect to growth about half that of private investment.

A somewhat different picture emerges for the two sub-periods. During the 1970s, public investment had a statistically insignificant impact in both Asia and Latin America, but a significant one in Africa, where the magnitude of the coefficient exceeded that on private investment, and in Europe and the Middle East. During the 1980s, for both Africa and Europe and Middle East the size and significance of the coefficients on public investment declines sharply while for the Asian region, in particular, there is no noticeable change. This evidence shows that the difference between the impact of private and public investment across all developing countries during the last two decades is largely due to variations in the effects in the African and European and Middle Eastern regions.

It is also worth noting that the coefficient on initial per capita GDP in Table 4 increases considerably and becomes statistically significant for both sub-periods. This implies that when regional differences in public and private sector investment are taken into account, there is evidence of convergence even during the 1970s, and that during the 1980s its speed was faster than emerges from the analysis with aggregate investment. For instance, during the last decade, the convergence rate of 0.019 implies that

Table 4. Regional Variation in the Impact of Investment on Growth 1/

	(1) 1970-1990		(2) 1970-1980		(3) 1980-1990	
Constant	-1.51[a]		-0.49		-0.88	
	(0.77)		(0.53)		(0.50)	
Initial per capita GDP	-0.24[a]		-0.12[a]		-0.17[a]	
	(0.07)		(0.06)		(0.04)	
Implied rate of convergence	0.014		0.012		0.019	
Population and technical change	-0.72[a]		-0.21		-0.53[a]	
	(0.29)		(0.19)		(0.19)	
Investment ratio dummies	Public	Private	Public	Private	Public	Private
Africa	0.32[a]	0.32[a]	0.23[a]	0.18[a]	0.14[a]	0.16[a]
	(0.10)	(0.08)	(0.07)	(0.06)	(0.07)	(0.06)
Asia	0.26[b]	0.51[a]	0.14	0.31[a]	0.12	0.27[a]
	(0.14)	(0.12)	(0.11)	(0.10)	(0.10)	(0.09)
Latin America	0.01	0.65[a]	0.12	0.35[a]	0.02	0.28[a]
	(0.11)	(0.11)	(0.09)	(0.09)	(0.07)	(0.07)
Europe and Middle East	0.37[a]	0.48[a]	0.27[a]	0.29[a]	0.19[a]	0.19[a]
	(0.11)	(0.12)	(0.09)	(0.09)	(0.08)	(0.09)
R^2	0.53		0.38		0.42	
S.E.E.	(0.30)		(0.24)		(0.22)	

1/ For detailed description of the data see the Appendix. Standard errors in brackets; [a] and [b] denote statistically significant at the 5 and 10 percent levels, respectively.

the gap between the rich and the poorest developing countries narrowed at a rate of around 2 percent a year.

Next consider two additional sets of variables, which the earlier discussion suggests could be expected to have an impact in explaining the cross-country differences in per capita GDP. The first is the stock of human capital, which is measured by the proportion of the population with school enrollment at the primary or secondary school level at the beginning of the period. 1/ As Table 5 shows, for the period 1970-90, both variables have a positive coefficient suggesting that the higher the school enrollment, other things given, the higher the subsequent growth in per capita income; however, in neither case, is the effect statistically significant. Nevertheless, a notable aspect is that the introduction of these variables increases the magnitude of the coefficient on the initial income variable, so that there is a small increase in the rate of convergence.

The effect of the human capital variable is stronger for the first sub-period, where the secondary school variable is highly significant (column 6). During this period, the introduction of human capital also has a noticeable effect on the speed of convergence, which more than doubles as compared to when it is not included. During the 1980s, however, this variable again has no significant effect on the cross-country variation in growth rates. The generally weak results obtained for the human capital variable may simply reflect the inadequacy of the proxy being used, although other studies using it have obtained stronger results. 2/

Second, an attempt was made to investigate whether technological change could be proxied by specifying it as a function of export orientation and foreign direct investment. The procedure adopted was discussed in Section III above. Assuming a given average rate of technological change, it was postulated that technological change was a function of a country's trade orientation, and the flow of foreign direct investment, and a country-specific proxy was accordingly constructed. In none of the estimates of equation (12) did this proxy appear significant, or lead to an improvement in the goodness-of-fit of the equation, compared to the original assumption of no cross-country variation. This lack of improvement could be due to the fact that in the original specification of equation (12) there is an implicit restriction that the coefficient on technological change (in conjunction with population growth) is equal, but opposite, in size to the sum of the coefficients on public and private investment. The lack of any statistical significance of this proxy may simply reflect a rejection of this restriction. When the trade and the direct investment ratios were entered independently in the regression equation, they had a positive but statistically insignificant effect.

1/ This is similar to the proxy used by Barro (1991).

2/ See, for example, Barro (1991) and Knight, Loayza, and Villanueva (1993).

Table 5. Determinants of Growth: Human Capital and Outward Orientation 1/

	1970-90				1970-80		1980-90	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	-2.61[a]	-2.59[a]	-2.36[a]	-2.16[a]	-1.29[a]	-1.19[a]	-1.44[a]	-1.72
	(0.84)	(0.85)	(0.86)	(0.06)	(0.53)	(0.53)	(0.50)	(0.51)
Initial per capita GDP	-0.22[a]	-0.22[a]	-0.23[a]	-0.20[a]	-0.08[b]	-0.10[a]	-0.16[a]	-0.13[a]
	(0.06)	(0.07)	(0.07)	(0.06)	(0.05)	(0.05)	(0.04)	(0.04)
Implied rate of convergence	0.012	0.012	0.013	0.010	0.008	0.011	0.017	0.014
Investment (total)	0.74[a]	0.76[a]			0.44[a]	0.46[a]	0.34[a]	0.35[a]
	(0.12)	(0.12)			(0.09)	(0.09)	(0.08)	(0.08)
Public investment			0.29[a]	0.28[a]				
			(0.08)	(0.08)				
Private investment			0.42[a]	0.43[a]				
			(0.07)	(0.07)				
Population and technical change	-0.22[a]	-0.23[a]		-0.76[a]	-0.26	-0.26	-0.57[a]	-0.63[a]
	(0.06)	(0.07)		(0.22)	(0.19)	(0.19)	(0.19)	(0.20)
Human capital (primary education)	0.22		0.13		0.20[a]		0.13	
	(0.16)		(0.22)		(0.11)		(0.12)	
Human capital (secondary education)		0.29	(0.09)			0.32[a]		0.08
		(0.21)	(0.29)			(0.15)		(0.13)
Trade orientation				0.09				
				(0.21)				
Foreign direct investment				0.50				
				(1.11)				
R^2	0.35	0.35	0.35	0.34	0.27	0.28	0.28	0.27
S.E.E.	(0.33)	(0.33)	(0.30)	(0.34)	(0.25)	(0.25)	(0.23)	(0.23)

1/ For detailed description of the data see the Appendix. Standard errors are in brackets; [a] and [b] denote statistically significant at the 5 and 10 percent levels, respectively.

3. Two-Stage Least Squares estimates, and panel data

There are two types of criticisms that could be levied at the above results. The first is econometric, namely, that since the estimation procedure does not take into account the correlation between the right-hand side variables such as private investment and the error term, the estimates could be biased and inconsistent. The reason for using OLS is that, as Madalla (1977), and Chow (1983) have emphasized, other techniques are much more sensitive to model misspecification; in that sense OLS is robust. Nevertheless, in order to examine whether using alternative estimation procedures alters the results in any marked manner, estimates using Two-Stage Least Squares (TSLS) were also obtained.

A second criticism could be that by using cross-sectional data, information on the dynamics of the growth process is not taken into account. It should be noted, however, that the main issues examined in the paper are more appropriately examined in a cross-sectional context; for instance, the issue of convergence is by definition concerned with differences in the long-run growth rates across countries. Nevertheless, the relationship between public and private investment and growth was examined using pooled time-series cross-section data to assess the robustness of the results reported above. 1/

Consider first results of TSLS shown in Table 6. These results suggest conclusions that are broadly similar to those obtained using the OLS. There is clear evidence of convergence, but the speed of convergence is somewhat lower. Private investment has a decidedly higher productivity compared to public investment, and the human capital variable has a positive coefficient that is not statistically significant.

With regard to the use of panel data, there are two additional issues that should be noted. The first is the period over which the time series data are averaged, since the use of annual data would be clearly inappropriate for analyzing the growth process and in any case would exhibit excessive noise. The procedure adopted was to average growth over a period ranging from 3 to 6 years. 2/ This is a more general procedure than that used in the literature where growth has been arbitrarily averaged over five-year periods. The second issue concerns the use of specific model estimation procedures for panel data; the results presented use OLS on full sample. 3/

1/ See Knight, Loayza, and Villanueva (1993) for a detailed discussion of estimates of the basic Solow model using panel data.

2/ When the average is for 3 years, there are 6 observations per country, giving a pooled sample for the 95 countries of 570 observations. With a 6-year average, there are 3 observations per country giving a sample of 285 observations.

3/ See Cheng (1986) for a discussion of the different procedures that could be used to estimate the model.

Table 6. Determinants of Growth: TSLS and Panel Data Results 1/

	Two-Stage least squares		Panel data 3 years	Panel data 5 years
	(1)	(2)	(3)	(4)
Constant	-9.08[a]	-8.01[a]	-0.38	-0.53[a]
	(2.62)	(0.61)	(0.14)	(0.20)
Initial per capita GDP	-0.13	-0.16	-0.003	-0.001
	(0.13)	(0.12)	(0.01)	(0.10)
Population and technical change	-3.21[a]	-2.10[a]	-0.11[a]	-0.15[a]
	(0.89)	(0.10)	(0.04)	(0.07)
Human capital 2/		0.02	0.003	0.001
		(0.006)	(0.01)	(0.01)
Trade orientation		0.32		0.02
		(0.36)		(0.04)
Foreign direct investment		0.03	0.01	
		(0.05)	(0.02)	
Private investment	0.57[a]	0.54[a]	0.05[a]	0.06[a]
	(0.28)	(0.18)	(0.01)	(0.01)
Public investment	0.36[a]			
	(0.13)			
Public investment dummies				
Africa		0.19[b]	0.02[a]	0.02[b]
		(0.12)	(0.01)	(0.01)
Asia		0.13	0.05[a]	0.06[a]
		(0.20)	(0.01)	(0.02)
Latin America		0.08	0.01	0.01
		(0.14)	(0.01)	(0.01)
Europe and Middle East		0.12	0.04[a]	0.04[a]
		(0.19)	(0.01)	(0.01)
$\bar{R}^2$	0.25	0.37	0.12	0.12
S.E.E.	(0.27)	(0.33)	(0.13)	(0.16)

1/ Columns 1 and 2 report results for equation (7) using TSLS. The Panel data results, in Columns 3 and 4, use respectively data averaged over 3 years (6 observations per country) and 5 years (4 observations per country); a and b denote statistically significant at the 5 and 10 percent level.

2/ Secondary school enrollment ratio.

Since the panel procedures assume common slope coefficients for all observations, they are rather restrictive. Nevertheless, even with this restriction, the results presented for the three- and five-year horizons reenforce the earlier findings using cross-sectional data (Table 6, columns (3-4)). A number of additional interesting results also emerge. For instance, given the shorter time horizon, there is now virtually no relationship between initial GDP and subsequent growth. The human capital variable, while positive, still has a statistically insignificant effect. The result that stands out is the relatively similar effect private and public investment have on growth in Asia, and the Europe and Middle East region. In these regions, it would appear that in the short run public investment can provide a boost to growth, much as does private investment, but this effect is not sustained over time.

V. Conclusions

The issue of convergence in real per capita incomes is at the forefront of modern empirical growth analysis. This paper has examined the extent to which there was convergence across developing countries during the last two decades, paying particular attention to the differential effect of private and public investment on growth. The framework developed also allowed for the role of human capital, trade orientation, and foreign direct investment in determining long-term growth.

Utilizing a large sample of 95 developing countries over the period 1970-90, a variety of empirical tests were undertaken. The main results can be summed-up as follows:

a. There is clear evidence that during the last two decades there was no relationship between initial per capita income and the subsequent growth of per capita GDP. That is, there was no "unconditional" convergence of real per capita incomes among the developing countries.

b. Once the aggregate investment rate and population growth are taken into account, there is evidence of convergence. However, the rate of convergence has differed considerably during the two decades; during the 1970s, the convergence process was slower than during the 1980s, reflecting perhaps the fact that poorer developing countries are catching up at a faster rate over time with the wealthier ones.

c. There is a substantial difference in the efficiency of private and public sector investment, with private investment being more productive than public investment, especially during the 1980s. There are, however, significant regional variations, with the difference most apparent for Latin America and Asia, but much less pronounced for Africa and Europe and Middle East. One important implication of dividing investment into its public and private components is that the rate of convergence is found to be somewhat faster than in the case when total investment is considered.

d. The stock of human capital, trade orientation, and foreign direct investment have had a positive but generally weak direct effect on per capita GDP growth in the sample considered here.

e. The above findings are robust to the use of alternative estimation techniques, as well as the use of panel data with growth measured over different time horizons.

There are several important implications of these results for economic theory and policy. Concerning theory, the results support the basic neoclassical framework, with emphasis on savings and population growth, for analyzing long-term growth performance of developing countries. Furthermore, it is important to make a distinction between the respective roles played by public and private investment. The results also offer some weak support to the emerging literature suggesting that outward-oriented policies, by increasing competition and exposure to foreign technology, have dynamic effects on growth, rather than just static efficiency gains.

The key policy implication concerns the role of public and private investment in the growth process. The evidence suggests a clear need to improve the productivity of public sector investment by identifying much more rigorously the types of investment that have positive net returns and are likely to be complementary to the private sector. At the same time, measures should be undertaken to stimulate private investment. This can be done in part by structural reforms which facilitate the mobilization of savings and help allocate resources to productive private sector investment. At the same time, an increased emphasis on education, and the adoption or maintenance of outward-oriented policies, could play an important role both in stimulating private investment and in spurring sustainable long-term economic growth.

APPENDIX

Sample and Data Definitions

1. Sample of developing countries

The sample consists of 95 developing countries. The countries included are:

a. Africa

Algeria, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Djibouti, Equatorial Guinea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mauritania, Morocco, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra, Leone, Somalia, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zaire, Zambia, and Zimbabwe.

b. Asia

Bangladesh, China, Fiji, India, Indonesia, Korea, Malaysia, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Sri Lanka, and Thailand.

c. Latin America

Argentina, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Surinam, Trinidad and Tobago, and Venezuela.

d. Europe and Middle East

Cyprus, Egypt, Hungary, Jordan, Malta, Oman, Poland, Syria, Turkey, Yemen, and Yugoslavia.

2. Data definitions and sources

y : real GDP per capita (in 1985 international prices).

n : population growth

I : ratio of total fixed investment to GDP.

Ig : ratio of public sector fixed investment to GDP (public sector includes general government, nonfinancial state enterprises, and principal autonomous agencies).

Ip : ratio of private sector fixed investment to GDP.

H^P : gross enrollment ratio at primary level.

H^S : gross enrollment ratio at secondary level.

FDI : ratio of foreign direct investment to GDP.

T : trade orientation defined as the ratio of the average of exports and imports to GDP.

For Tables 1 to 5, all ratios and growth rates are averages for the periods 1970-80, 1980-90, and 1970-90; H^P and H^S are for the beginning of each period. In Table 6, the ratios are averages for 3 and 5 years, and H^P and H^S are again for the beginning of each period.

Data on y were obtained largely from Summers and Heston ((1988) and (1991)) for the period up to 1985 and were extended to 1990 using per capita growth rates from the IMF's World Economic Outlook (WEO) database; for some low-income countries data were obtained from Ahmad (1992). Data on n, FDI, and T were from the WEO database. Data on I, Ig, and Ip were obtained from the World Bank's "DEC Analytical Database," supplemented by data from the International Finance Corporation database on private investment and from the WEO database. Data for H^P and H^S for the period up to 1980 are from the UNESCO publication "Trends and Projections of Enrollment by Level of Education and by Age" (March 1983), and from UNESCO Statistical Yearbooks thereafter.

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