The Pakistan Development Review
35 : 4 Part I (Winter 1996) pp. 419—439

Government Investment and Economic Growth in the Developing World

MOHSIN S. KHAN

I. INTRODUCTION

There has been a sea change in the views of the economics profession as well as economic policy-makers over the past decade or so regarding the role of the government in the development process. Indeed, it is now becoming conventional wisdom that government can no longer be a dominant player in economic activities, but rather should restrict itself to providing an "enabling" environment within which the private sector can take the lead and flourish. More specifically, government intervention in the economy has to be designed carefully so as to support the private sector and not inhibit its development. The general acceptance of this paradigm is evident in the steadily declining importance of government activities in the economies of most of the developing world.

But does this new paradigm mean that government investment has no role whatsoever in affecting growth in developing countries? Reality is that public investment still represents a large share of total investment in the majority of developing countries, and the question is what role it plays in relation to private investment in stimulating economic growth. The objective of this paper is to ascertain empirically for a large group of developing countries the relative importance of public and private investment in promoting and sustaining growth.

Despite considerable interest in the issue, the empirical evidence on the relative effects of public and private investment on growth in developing countries is quite limited. A number of recent studies examining this issue have shown that private investment has a larger positive impact on growth than public investment [Khan and Reinhart (1990); Coutinho and Gallo (1991); Serven and Solimano (1990) and Khan and Kumar (1997)]. However, many of the existing studies have used small samples of countries over limited time periods, so that the validity and

Mohsin S. Khan is Deputy Director, Research Department, International Monetary Fund, Washington, D. C.

Author's Note: The views expressed in this paper are the sole responsibility of the author and do not necessarily reflect the opinions of the International Monetary Fund. I am grateful to Nadeem Haque, A. R. Kemal, Ashfaque Hasan Khan, and Manmohan Kumar for helpful comments.

robustness of this conclusion is still in doubt. Moreover, to examine the relative effects of public and private investment, a number of other important issues related to differences in the two components of investment across developing country regions or across countries in different income groups need to be investigated. Finally, other determinants of growth, such as macroeconomic instability, which have received considerable attention in the recent literature, have also to be taken into account when assessing this issue.

The empirical analysis in this paper is undertaken for a sample of 95 developing countries for the period 1970–90. The large sample allows for consideration of the hypothesis that there are significant differences in the differential effects of public and private investment on growth for four developing country regions—Africa, Asia, Middle East, and Latin America.[1] Such an examination has merit in view of the marked differences in the performance of developing countries during the last two decades. Asian countries, for instance, have had generally a superior performance than have 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 of real per capital incomes of developing countries.[2]

The rest of the paper is organised as follows: Section II first discusses the extent to which public and private investment may be complementary or substitutes, and then describes the estimation equations to be used in the empirical analysis. Section III contains the main empirical 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. Section IV examines the implications of the differential impact of public and private investment for the speed of convergence to a steady-state. Finally, Section V contains a summary of the main findings.

II. PUBLIC INVESTMENT AND GROWTH

1. Patterns of Public and Private Investment

The magnitude of public and private investment in developing countries over the last two decades is illustrated in Table 1. It is striking that public sector

[1]The diversity in performance among developing country regions has become particularly evident during the 1980s; see, for instance, Ossa (1990) and Kumar (1992).

[2]Existing studies of convergence 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).

Table 1

Public and Private Investment in Developing Countries, 1970–90 [1]

(*As Percent of GDP*)

		Total	Public	Private
Africa	(46)	19.7	10.6	9.1
Asia	(14)	20.5	8.6	11.9
Latin America	(24)	19.3	7.9	11.4
Europe and Middle East	(11)	24.5	14.1	10.4
All Developing Countries	(95)	20.3	10.0	10.3

[1]Data are unweighted averages. Number of countries is given in brackets; for sample of countries, see Appendix.

investment in developing countries accounts for nearly half of total investment. In industrial countries, by contrast, public investment accounts for less than one fifth of total investment.[3] 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 in lower-income countries. Nevertheless, the information in Table 1 raises questions 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.[4] This is most likely to be true in those developing countries where the existing stock of infrastructure capital is generally inadequate. In this regard, it is worth noting in Table 1 that the share of public investment in countries in Africa and the Middle East is higher than that of private investment; in Asian and Latin American countries

[3]This is based on an unweighted average for the OECD countries for the 1980s.

[4]See Blejer and Khan (1984). For industrial countries, Aschauer (1989, 1989a) 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 his estimates is considered implausibly high; see, for example, Ford and Poret (1991) and Rubin (1991).

private investment has a higher share. It has become evident over the last few years, however, that public investment in infrastructure may not automatically have a beneficial impact on private investment and growth. In many cases, political-bureaucratic motivations have led to expenditures in infrastructure facilities that were sub-optimal. This occurred in part because the concern was with maximising employment than with creating these facilities at low cost. Also, it occurred because regional or other political considerations resulted in uneconomic location, size, or even sector of the investment projects.

In addition to investment in infrastructure, a large part of public investment is undertaken by state-owned enterprises. In most developing countries, industrial policy and the regulatory framework have linked private sector production directly to public sector activities in both goods and 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 fulfil public investment plans.

The above considerations suggest that while the public sector capital stock may be complementary to private sector activities and have a positive effect on growth, its efficiency may be questionable sometimes. Moreover, in many developing countries public sector enterprises often 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, as well as 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 monetisation of deficits, crowding out occurs through an increase in the inflation rate, which creates uncertainty with regard to the expected returns from investment.

2. Specification of Equations

The differential impact of private and public sector investment on growth can be evaluated via the framework of an extended neoclassical growth model [Solow

(1956)]. In this well-known model, capital accumulation, growth of labour force, and technical change are the key determinants of real per capita income. Thus real per capita income in this model is specified as follows:[5]

$$Ln(\frac{Y}{L}) = a + \gamma\, t + \frac{\alpha}{1-\alpha} Ln(S) - (\frac{\alpha}{1-\alpha}) Ln(n+\gamma+\delta) + \in \quad \ldots \qquad \ldots \qquad (1)$$

where Y and L denote real output and labour respectively; α refers to the share of aggregate capital in income; S is the aggregate saving (and investment) rate; n and γ are respectively the growth rate of labour and technology; δ denotes depreciation of the capital stock; and $\in$ is an error term.

The above model was extended by including separately public and private capital stocks. Assuming that both types of capital stock depreciate at the same rate δ, real output per capita can be specified as follows:

$$Ln(\frac{Y}{L}) = a + \gamma\, t + \frac{\alpha}{1-\alpha-\beta} Ln(Sg) + \frac{\beta}{1-\alpha-\beta}(Sp) - \frac{\alpha+\beta}{(1-\alpha-\beta)} Ln(n+\gamma+\delta) + \in \quad \ldots \qquad \ldots \qquad (2)$$

where in addition to the above variables, Sg and Sp now denote public and private investment respectively; and α and β denote the shares of public and private capital in income.

The specification of Equations (1) and (2) is based on a strong assumption that all countries are at their steady states. However, it is possible to extend Equation (2) to allow estimation of the effect of various explanatory variables on per capita growth.

Following Mankiw, Romer and Weil (1992), it can be shown that Equation (2) can be transformed into an equation for the steady state growth path as follows:

$$Ln(y(t)) - Ln(y(0)) = (1-e^{-\lambda t})[\frac{\alpha}{1-\alpha-\beta} Ln(Sg) + \frac{\beta}{1-\alpha-\beta} Ln(Sp) - \frac{\alpha+\beta}{1-\alpha+\beta} Ln(n+\gamma+\delta) - Ln(y(0))] + \in \quad \ldots \qquad \ldots \qquad (3)$$

where the left-hand side of the equation is the growth of per capita income, $\lambda = (n + \gamma + \delta)/(1- \alpha - \beta)$ is the speed of convergence and $y(0)$ is income per capita at some initial date; the other variables are defined as before.

Equation (3) is the basis for the empirical analysis of the effect of public and private investment on per capita growth. The estimates of variants of Equation (3)

[5]This equation can be derived readily from a Cobb-Douglas production function. For details, see Khan and Kumar (1997).

are all obtained in unrestricted form, that is without imposition of the theoretical restrictions across the parameters of the various explanatory variables.

In estimating Equation (3), allowance is made for cross-country differences in γ, reflecting technical change, as well as differences in human capital and macroeconomic stability. Concerning 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. This link allows for not only a one-time shift in production possibilities, but also for sustained increases in growth rates due to dynamic scale economies and learning by doing [Grossman and Helpman (1990); Edwards (1992)]. Instead of assuming γ to be constant across countries, in the empirical specification 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.

Following the recent literature on growth, human capital—which has received considerable emphasis in explaining cross-country differences in long-run growth—was incorporated as an explanatory variable.[6] Finally, macroeconomic instability, which has been shown to adversely affect growth, was also considered.[7] One of the key measures of such instability—budgetary deficits—was introduced into the equation as an additional explanatory variable.

III. EMPIRICAL RESULTS

1. Effects on Growth

Consider first the empirical results for the model in Equation (3) with aggregate investment as the main explanatory variable and technological change invariant across countries. Columns (1) to (3) in Table 2 provide these results for three different periods—1970–90, 1970–80, and 1980–90.[8] 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 real GDP growth over the past two decades is explained by the variation in the investment ratio, initial per capita

[6]For a discussion of the importance of human capital in the growth process, see Lucas (1988); Barro (1991) and Levine and Renelt (1992).

[7]For an analysis of the relationship between macroeconomic stability and growth, see Frenkel and Khan (1990) and Fischer (1993).

[8]For the sample of developing countries and data definitions and sources, see Appendix.

Table 2

Determinants of Per Capita Growth: Single Equation Estimates[1]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average Per Capita Growth during	1970–90	1970–80	1980–90	1970–90	1970–80	1980–90	1970–90
Constant	3.06[a]	−1.55[a]	−1.61[a]	−2.76[a]	−1.23[a]	−1.45[a]	−1.72[a]
	(0.78)	(0.52)	(0.48)	(0.77)	(0.51)	(0.47)	(0.83)
Initial Per Capita GDP	−0.18[a]	−0.04	−0.14[a]	−0.20[a]	−0.03	−0.15[a]	−0.23[a]
	(0.06)	(0.04)	(0.03)	(0.06)	(0.05)	(0.04)	(0.06)
Implied Rate of Convergence	0.010	0.004	0.015	0.011	0.003	0.016	0.012
Investment (Total)	0.75[a]	0.44[a]	0.35[a]				
	(0.12)	(0.09)	(0.08)				
Investment (Public)				0.28[a]	0.21[a]	0.13[a]	0.29[a]
				(0.08)	(0.06)	(0.05)	(0.98)
Investment (Private)				0.43[a]	0.21[a]	0.21[a]	0.40[a]
				(0.07)	(0.05)	(0.05)	(0.07)
Population and Technical Change	−0.90[a]	−0.30	−0.61[a]	−1.08[a]	−0.29	−0.70[a]	−0.79[a]
	(0.30)	(0.19)	(0.19)	(0.31)	(0.19)	(0.19)	(0.32)
Human Capital							0.02[a]
							(0.01)
Fiscal Balance							0.03[a]
							(0.01)
R^2	0.33	0.24	0.27	0.34	0.23	0.28	0.44
S.E.E.	(0.34)	(0.25)	(0.23)	(0.34)	(0.25)	(0.23)	(0.29)

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

income, and population growth. All the variables have the expected signs and are statistically significant. The variable of special interest is the investment ratio. The estimated coefficient suggests that a one percentage point increase in the investment ratio across developing countries is associated with an increase in per capita real GDP of three-quarters of a percentage point.[9] For the sub-periods the patterns are similar, although the coefficients of the investment ratio, as well as the fits of the equation, are somewhat lower than for the full period.

Now one can proceed to consider the separate roles played by public and private sector investment in determining per capita growth. As indicated in Column (4) of Table 2, while both types of investment had a positive impact in the estimates for the full period 1970–90, their *magnitude* differed considerably, with private investment having a much stronger impact than public sector investment. However, the results for 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. Put this way, it can be argued that there was much more complementarity between private and public investment than was the case during the last decade.

An attempt was made next to see whether allowing technical change to vary across countries alters these basic results. Assuming a given *average* rate of technical change, it was postulated that technical 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 (3) did this proxy appear significant, or lead to any change in the relative effect of public and private investment, compared to the original assumption of no cross-country variation. This result could be due to the fact that in the original specification of Equation (3) there is an implicit restriction that the coefficient on technical change (in conjunction with population growth) is equal 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 weak effect that did not alter the earlier results.

The extent to which taking into account human capital and budgetary position changes the basic conclusion was also examined. The stock of human capital was

[9]Note that from the initial income variable, one can obtain the rate of convergence among developing countries, which turns out to be 0.01. This implies that once the cross-country variation in investment and population growth is taken into account, the poorer developing countries (measured by their per capita income in 1970) narrowed the gap between them and the richer developing countries at a rate of roughly 1 percent a year. For further details, see Khan and Kumar (1997) and International Monetary Fund (1993).

proxied by the average of the proportion of population with school enrolment at the primary and secondary school level. The budgetary variable was the balance of the general government as a proportion of GDP averaged over the entire period or the two sub-periods. As shown in Column (7) of Table 3 both these variables enter the regression with the expected sign, are statistically significant, and generally improve the explanatory power of the equation.[10]

2. Regional Variation

An analysis was also undertaken to assess the impact of regional differences by re-estimating Equation (3) with slope dummies for both private and public investment for each of the four regions. The results in Table 3 show that for the 1979–90 period, the regional slope dummies increase considerably the explanatory power of the Equation, which now accounts for over half the cross-country variation in per capita growth of real GDP. The standard "F" test of no differences in the impact of public and private sector investment was strongly rejected. The regional differences were quite marked and accorded with standard priors. For Africa, and to some extent for the Middle East, both types of investment exercised a similar impact, while in Latin America public investment appeared to have had, on average, very limited impact and private investment a pronounced positive effect. In Asia, public investment was statistically significant, but had an effect on growth only about half that of private investment.

A somewhat different picture emerged 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 size of the coefficient exceeded that on private investment, as well as in the Middle East grouping. During the 1980s, for both Africa and the Middle East the size and significance of the coefficients of public investment declined, while for the other two regions there is no noticeable change. This result implies 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 Middle Eastern regions.

It is also interesting to consider whether the above regional differences were associated with differences in income and the level of development across developing countries. It could be argued that in low-income countries, regardless of the region, the need for infrastructure public investment is likely to be greater than in the high-

[10]The average rate of consumer price inflation was also considered as a proxy for macroeconomic instability. It had the correct sign and was statistically significant when it was included by itself; however, when it was included together with budgetary balances, it became insignificant. Since the fiscal position and inflation are generally closely related, particularly in developing countries, this result is not altogether surprising.

Table 3

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)
Human Capital Enrolment Ratio (Secondary)		0.32[a] (0.15)	
Average Years of Schooling (Secondary)	0.016[b] (0.009)		0.02[a] (0.01)
Fiscal Balance	0.007[a] (0.004)	0.02[a] (0.01)	0.03[a] (0.01)

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[a]	0.51[a]	0.14	0.31[a]	0.12[a]	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)
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	0.55		0.41		0.46	
S.E.E.	(0.30)		(0.24)		(0.22)	

[1]For detailed description of data see the Appendix. Standard errors are in brackets; [a] and [b] denote statistically significant at the 5 and 10 percent levels, respectively. For the human capital variable, various measures identified earlier were included in the initial estimation. However, only the ones which were significant were included in the final estimates reported here.

income countries. Furthermore, in the high-income countries, the private sector is likely to be sufficiently developed to provide many of the goods and services which otherwise would have to be provided by the public sector. Hence, in the low-income countries the impact of public investment may be greater than in the high-income countries. This hypothesis was tested by reestimating Equation (3) by including two slope-dummies for public investment: one for countries in the low-income group (defined as the bottom one-third of all countries ranked by per capita GDP in 1970) and the other for countries in the high-income group. The results showed that the impact of public investment in the low-income group was noticeably greater than in the high-income group—the slope coefficients had values of 0.33 and 0.25, respectively—but it still remained less than the effect of private investment.

3. Two-stage Least Squares Estimates and Panel Data

There are two types of extensions which can be made to the empirical analysis. The first is econometric, namely to explicitly take into account the correlation between the right-hand-side variables such as private investment and the error term. In order to examine whether using alternative estimation procedures alters the basic results in any marked manner, estimates using Two-Stage Least Squares (TSLS) were also obtained. A second extension would be to use pooled rather than cross-sectional data, so that information on the dynamics of the growth process can be taken into account. Although long-run growth is more appropriately examined in a cross-sectional framework, the relationship between public and private investment and growth was also examined using pooled time-series cross-section data to assess the robustness of the results reported above.

The results of TSLS shown in Table 4 suggest conclusions that are broadly similar to those obtained using the OLS. Private investment has a decidedly higher effect on growth 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 inappropriate for analysing the growth process and in any case would exhibit excessive noise. The procedure adopted was to average growth over a period ranging from three to five years.[11] This is a more general procedure than that 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 the full sample.[12]

[11]When the average is for three years, there are six observations per country, giving a pooled sample for the 95 countries of 570 observations. With a five-year average, there are four observations per country giving a sample of 380 observations.

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

Table 4

Public and Private Investment: 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[a]	–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	–3.21[a]	–2.10[a]	–0.11[a]	–0.15[a]
Technical Change	(0.89)	(0.10)	(0.04)	(0.07)
Human Capital[2]		0.02	0.003	0.001
		(0.01)	(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]			
Dummies	(0.13)			
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)
Middle East		0.12	0.04[a]	0.04[a]
		(0.19)	(0.01)	(0.01)
R^2	0.25	0.37	0.12	0.12
S.E.E.	(0.27)	(0.33)	(0.13)	(0.16)

[1]The Panel data results, in Columns 3 and 4 use data averaged over 3 years (6 observations per country) and 5 years (4 observations per country). [a] and [b] denote statiscally significant at the 5 and 10 percent level.

[2]Secondary school enrolment 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 reinforce the earlier findings using cross-sectional data (Table 4, 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, has a statistically weak effect. An interesting result is the relatively similar effect of private and public investment on growth in Asia. For this region, it could be argued that in the short run public investment provided an equal boost to growth as did private investment, but this effect was not sustained over time.

IV. IMPLICATIONS FOR THE SPEED OF CONVERGENCE

This section looks at the implications of the above empirical findings for the speed of convergence of real per capital incomes among developing countries. Since private investment appears to have had a considerably larger impact on per capita growth than public investment, the steady-state growth rate of an economy would increase in proportion to the share of private investment. However, this result says very little about the speed with which the steady-state path is attained, or equivalently, the speed of convergence among countries. For instance, even if the steady-state growth is significantly higher because of private investment, the speed of transition towards this steady state, or the rate of convergence, may remain unaffected.

From a policy-maker's perspective, whether or not the speed can be affected by policy changes may perhaps be as important as the effect of policy changes on the growth path itself. This is so since the transition to an optimal growth path, in the framework utilised above, is likely to last a considerable length of time, and any measures which can speed up that process would be regarded as highly desirable. Hence, in the literature on the determinants of long-run growth and convergence, while the emphasis has been mainly on factors determining the steady-state growth path, the issue of the speed of transition has also received significant attention. [See, for example, Lucas (1988); Romer (1989); Barro (1991); Barro and Sala-i-Martin (1992) and Mankiw, Romer and Weil (1992)].

The methodology for examining this issue is to introduce an additional regressor in Equation (3), which is an interactive term consisting of the product of the log of initial income and public investment ratio. The specific form of this equation is

$$Ln(y(t)) - Ln(y(0)) = (1 - e^{-\lambda t}) \left[\left(\frac{\alpha + \beta}{1 - \alpha - \beta} (Ln(S) - Ln(n + \gamma + \delta)) \right] \right.$$
$$\left. - [Ln(Sg) \bullet Ln(y(0))] - Ln(y(0)) \right] + \in \quad \ldots \quad \ldots \qquad (4)$$

If the coefficient on the interactive term in Equation (4), plus the coefficient on the initial income term, is smaller than that on initial income term alone (without the additional regressor), it would mean that countries with more public investment have a higher speed of convergence. If the combined coefficient is unchanged, it would mean that the share of public investment does not affect the speed of convergence. If, however, it is larger, then public investment slows down the rate of convergence. This procedure is then repeated with private investment and a comparison is made of the speed of convergence.

The results of estimating Equation (4) are given in Table 5. Column (1) of this

Table 5

Public and Private Investment and Speed of Convergence[1]

	(1)	(2)	(3)
Constant	–2.59[a]	–3.34[a]	–2.31[a]
	(0.89)	(0.84)	(0.85)
Initial Per Capita GDP	–0.23[a]	–0.18[a]	–0.31[a]
	(0.07)	(0.07)	(0.07)
Investment Ratio (Total)	0.76[a]	1.01[a]	0.61[a]
	(0.12)	(0.16)	(0.14)
Initial GDP and Public Investment		–0.03[a]	
		(0.01)	
Initial GDP and Private Investment			0.03[a]
			(0.01)
Population and Technical Change	–0.79[a]	–0.89[a]	–0.92[a]
	(0.32)	(0.31)	(0.32)
Human Capital	0.18[b]	0.17[b]	0.18
	(0.10)	(0.09)	(0.11)
Implied Rate of Convergence	0.013	0.010	0.017
R^2	0.35	0.39	0.39
S.E.E.	(0.33)	(0.41)	(0.41)

[1]The dependent variable is per capita GDP growth during 1970–90. For other notes, see Table 2.

table indicates that without separating the impact of public and private investment, the implied rate of convergence among the developing countries was 0.013. However, as Column (2) indicates, when the interactive term is introduced, although the coefficient on this term is negative, the combined effect (in terms of the coefficient on the initial income) is now smaller. This yields a speed of convergence which is somewhat slower than the speed of convergence without the interactive term. However, as Column (3) shows, when a similar procedure is undertaken with private investment, although the coefficient on private investment is positive, the net effect is greater. Thus an increase in private investment increases the speed of convergence by around a third compared to an increase in public investment.

V. CONCLUSIONS

This paper has considered a number of issues relating to the extent to which public and private investment exert a differential effect on long-run growth of developing countries. The empirical analysis took account of other determinants of per capita growth, including population growth, human capital formation, trade orientation, and measures of macroeconomic instability.

Utilising a large sample of 95 developing countries over the period 1970–90, a variety of empirical tests were undertaken. The main results can be summarised as follows.

First, there is a substantial difference in the impact of private and public sector investment on growth, with private investment having a much larger impact than public investment, especially during the 1980s. This finding holds up even when other determinants of per capita growth are taken into account, alternative estimation techniques are used, and with data averaged over different periods.

Second, there are significant regional variations in both the effect of public and private investment on growth. The difference between the effects is most apparent for Latin America and Asia, but much less pronounced for Africa and the Middle East country groupings. There is also a significant difference across different income groups.

Finally, the relative shares of public and private investment appear to have altered not only the steady-state growth path, but also the speed of convergence of real per capita incomes among developing countries. A higher share of private investment in the total appears to be associated with an increase in the speed of convergence.

In conclusion, it is evident from the analysis in this paper that studies of the growth process in developing countries should make a distinction between the respective roles of public and private capital formation. Furthermore, the empirical evidence supports the proposition that private investment has a stronger effect on growth than does public investment. This result is consistent with the now widely

accepted paradigm that the private sector holds the key to sustained growth and economic development. Yet at the same time, the government can play a critical part in the process by identifying much more rigorously the types of investment that have positive net returns and are likely to be complementary to the private sector. Public investments that do not meet these criteria would appear to affect growth and factor productivity adversely, and thus should be cut or not undertaken. Governments in developing countries would be well-advised to be guided by this principle.

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, Mayanmar, 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*) *Middle East and Europe*

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 enrolment ratio at primary level.
- H^s : gross enrolment 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.
- D : ratio of the stock of external debt to GDP.
- GBG : public sector balances as a percent of GDP.

For Tables 2 and 3, all ratios and growth rates are averages for the period 1970–80, 1980–90, and 1970–90; H^p and H^s are for the beginning of each period. In Table 5, 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, Ip, K_g and K_p 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 Enrolment by Level of Education and by Age" (March 1983), and from UNESCO *Statistical Yearbooks* thereafter.

Estimates of public and private capital stock were obtained using the perpetual inventory method, data on public and private gross investment, and estimates of initial capital stocks in 1960. The depreciation rate for the two types of capital stock was assumed to be similar and varied between 4 and 5 percent per annum.

REFERENCES

Ahmad, Sultan (1992) Regression Estimates of Per Capita GDP Based on Purchasing Power Parities. International Economics Department, World Bank, April. (Unpublished.)

Aschauer, David A. (1989) Does Public Capital Crowd Out Private Capital. *Journal of Monetary Economics* September.

Aschauer, David A. (1989a) Public Investment and Productivity Growth in the Group of Seven. *Economic Perspectives: A Review from the Federal Reserve Bank of Chicago* September/October.

Barro, Robert J. (1991) Economic Growth in a Cross-section of Countries. *Quarterly Journal of Economics* May.

Barro, Robert J., and Xavier Sala-i-Martin (1992) Convergence. *Journal of Political Economy* April.

Blejer, Mario I., and Mohsin S. Khan (1984) Government Policy and Private Investment in Developing Countries. IMF *Staff Papers* June.

Cheng, Hsiao (1986) *Analysis of Panel Data* Cambridge: Cambridge University Press.)

Coutinho Rui, and Giampiero Gallo (1991) Do Public and Private Investment Stand in Each Other's Way. 1991 WDR Background Paper, World Bank, October.

Edwards, Sebastian (1992) Trade Orientation, Distortions and Growth in Developing Countries. *Journal of Development Economics* 39.

Fischer, Stanley (1993) The Role of Macroeconomic Factors in Growth. *Journal of Monetary Economics* 32.

Ford, Robert, and P. Poret (1991) Infrastructure and Private-sector Productivity. *OECD Economic Studies* 17: Autumn.

Frenkel, Jacob A., and Mohsin S. Khan (1990) Adjustment Policies and Economic Development. *American Journal of Agricultural Economics, Proceedings of the ASSA Winter Meeting* (August).

Grossman, A., and E. Helpman (1990) Trade, Knowledge Spillovers and Growth. (NBER Working Paper No. 3485.) October.

International Monetary Fund (1993) Convergence and Divergence in Developing Countries. Chapter IV in *World Economic Outlook* May.

Khan, Mohsin S., and Carmen M. Reinhart (1990) Private Investment and Economic Growth in Developing Countries. *World Development* January.

Khan, Mohsin S., and Manmohan S. Kumar (1997) Public and Private Investment and the Convergence of Per Capita Incomes in Developing Countries. *Oxford Bulletin of Economics and Statistics* February.

Kumar, Manmohan S. (1992) Fiscal Adjustment in Developing Countries. Annex V. *World Economic Outlook* May.

Levine, Ross, and David Renelt (1992) A Sensitivity Analysis of Cross-country Growth Regressions. *American Economic Review* September.

Lucas, R. E. Jr. (1988) On the Mechanics of Economic Development. *Journal of Monetary Economics* 42.

Mankiw, N. A., D. Romer, and D.N. Weil (1992) A Contribution to the Empirics of Economic Growth. *Quarterly Journal of Economics* May.

Ossa, Gistian (1990) The Diversity of Growth Rates Among Developing Countries. *Development Policy Review* 8.

Romer, Paul M. (1989) Capital Accumulation in the Theory of Long-run Growth. In R. Barro (ed) *Modern Business Cycle Theory*. Cambridge: Harvard University Press.

Rubin, L. S. (1991) Productivity and the Public Capital Stock: Another Look. Board of Governors of the Federal Reserve System. (Working Paper No. 118.)

Solow, Robert (1956) A Contribution to the Theory of Economic Growth. *Quarterly Journal of Economics* February.

Serven, L., and A. Solimano (1990) Private Investment and Macroeconomic Adjustment: Theory, Country Experience, and Policy Implications. Macroeconomic Adjustment and Growth Division, World Bank. (Unpublished.)

Summers, Robert, and Alan W. Heston (1988) A New Set of International Comparisons of Real Product and Price Levels: Estimates for 130 Countries 1950–1985. *Review of Income and Wealth* March.

Summers, Robert, and Alan W. Heston (1991) The Penn World Tables (Mark V): An Expanded Set of International Comparisons, 1950-88. *Quarterly Journal of Economics* 48.

Comments

This is an interesting paper in an area of vital importance to policy-makers. The basic objective of the study is to ascertain the relative importance of public and private investment in promoting and sustaining growth in the developing countries. To what extent the study has realised this objective, or the appropriateness of the selection of the sample of countries, and the methodology used, is examined in the following.

The paper points out that private investment tends to promote the GDP more than public investment. However, this result alone can hardly help in policy formulation especially because of the following results reported in the study:

(i) The paper suggests quite rightly that public and private investments are complementary. Seen in that context, would it not mean that a reduction in public investment implies a fall in the effectiveness of private sector investment as well?

(ii) The result that growth elasticity of public sector is relatively smaller may indicate that either public sector is relatively less efficient or that it has over-expanded. Interestingly enough, the effectiveness of private and public sector was the same in the earlier period, indicating that public investment is not inherently inefficient.

(iii) The fall in the growth of elasticity of public investment in the later periods has been ascribed by the author to relative abundance of infrastructure in the latter period but no evidence of that has been presented.

(iv) Has the public investment gone beyond the optimal level? The paper hardly contains any discussion on that issue. Moreover, this can only be done by disaggregating the public investment and looking at the availability of infrastructure compared to requirement. No such analysis has been done either.

(v) If public investment is less efficient, should the private sector be inducted in infrastructure development? Would privatisation of infrastructure result in lower or higher level of industrial growth because private motive on the part of private sector may result in higher cost of infrastructures?

Table 2 shows rather interesting results. The growth elasticity with respect to investment is significantly higher in the earlier period, i.e., 1970–90, than in either of the two sub-periods. Such a result is not expected and one wonders if it is the result of some specification error or some other error. It needs to be looked into.

The elasticity of both public and private investment is very similar during 1970–80 period, but in the 1980–90 period the elasticity with respect to public investment falls. Dr Khan has explained this by referring to inadequacy of infrastructure in 1970–80

which supposedly was quite adequate in the 1980–90 period. This needs verification especially because public investment fell in the latter period and in some cases net investment may have even turned negative. Pakistan probably provides a clear example of that.

The methodology employed in the paper to determine the impact of private and public investment on the growth consists of a regression of growth in a country against the private and public investment. The problems associated with such a cross-country analysis are quite well-known.

The analysis assumes that depreciation of the capital stock in private and public sectors is the same. Such an assumption is not tenable because public sector investments being in infrastructures have a longer life. What impact it will have on the analysis needs to be looked into.

With a view to examining the impact of technical change arising from the openness of the economy, the deviation from 2 percent technical change has been used as an explanatory variable. Why the variable had to be defined in such a way is not very clear.

On page 12 [of the original conference paper] the author suggests restrictions on the original specification that the magnitude of the coefficient of technical change would be equal to sum of the coefficient of public and private investment. This specification may be causing problems and an equation free from such restrictions may be tried.

How was the sample of the countries chosen? Was it purposive? Why were just 14 countries from Asia chosen against the 46 from Africa? Does it not bias the results? If the sample from Asia is enhanced, what would be the impact on the result? This needs to be examined.

Although an interesting study, it does not succeed much in realising the objective which it had laid out for itself. It also fails to take note of the studies already done on Pakistan on this subject. While earlier studies in Pakistan do show that the private and public sector investments are complementary, they have not examined their contribution to growth. Accordingly, disaggregated analysis is required across the countries, and similar analysis may be done for each of the countries.

A. R. Kemal

Planning and Development Division,
Islamabad.