DM/84/8

INTERNATIONAL MONETARY FUND

Fiscal Affairs and Research Departments

Government Policy and Private Investment in Developing Countries*

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February 2, 1984

Summary

The behavior of private investment in developing countries has obvious implications for both long-term development as well as for the design of shorter-term stabilization programs. What determines the rate of private investment, and how it responds to changes in government policies, are questions of considerable importance to policymakers and academics alike. For example, would a tightening of monetary policy result in a fall in real private capital formation, or leave it unchanged? Similarly, would an increase in government capital expenditures have a negative or positive impact on private investment? Clearly any meaningful analysis of growth in developing countries must take into account questions of this nature.

While private investment behavior has been studied extensively in the case of the industrial countries, there is as yet very little systematic evidence on this subject available for developing countries. The purpose of this paper is to formulate a model of private investment in developing countries, with the objective of analyzing the empirical relationship between private investment and some of its main determinants. The focus of the exercise is particularly on the role played by variations in bank credit and government capital formation in the private sector's investment decisions. The concentration on these two factors allows an explicit treatment of the issue of real and financial crowding out, a subject on which there is considerable controversy. Furthermore, the analysis attempts to make an empirical distinction between public investment that is related to the development of infrastructure, which is likely to be complementary with private investment, and other types of government investment which may in fact substitute for private capital formation.

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* An earlier version of this paper was presented at the IV Latin American Congress of the Econometric Society, Santiago, Chile, July 19-22, 1983. The authors are grateful to Edward Buffie, Sebastian Edwards, Peter Heller, Peter Montiel, V. Sundararajan, Vito Tanzi, and George von Furstenberg for helpful comments. Abdel R. Ismael provided valuable research assistance.

The model is estimated for 24 developing countries using a data set on private and public investment that was specially constructed for this exercise. Data on the public sector, properly defined to include the general government, autonomous institutions, and nonfinancial state enterprises, is not readily available and has to be put together from different sources. The empirical results indicate that it is possible to identify a fairly well-behaved private investment function for developing countries. The principal policy-related conclusions of the study are: first, that changes in bank credit to the private sector have a significant impact on private investment, so that if the flow of credit is reduced, for whatever reason, private investment would tend to decline; and second, that an increase in the infrastructural component of government capital formation (represented by various empirical proxies) would raise private investment, but that similar increases in other types of public investment appear to crowd out the private sector to some extent.

I. Introduction

While the subject of private investment behavior has received a great deal of attention in the literature, the focus has been almost exclusively on industrial countries. Clearly it is equally relevant for policymakers in developing countries to be able to assess how private investment responds to changes in government policy. This issue is of importance not only for the design of long-term development strategies, but also for the implementation of shorter-term stabilization programs. Even if it can be assumed that an increase in private investment, ceteris paribus, has an unambiguous positive effect on output, it is still necessary to establish how private investment in developing countries is determined, and in particular what variables systematically affect it, so as to evaluate the influence the government can exercise over private investment decisions that change the current and future growth rate of the economy. The interaction between government policy and private investment is, therefore, crucial for the analysis of the effects on the real sector of a stabilization program that involves elements of demand restraint--a question on which there is still considerable controversy. 1/

Although a broad consensus has emerged in recent years on the form of several key macroeconomic relationships in developing countries, such as the aggregate consumption function, the demand for money, imports and exports, etc., no such convergence of views is apparent in the case of the investment function. The theoretical literature on investment is itself quite rich and has yielded a well-defined class of models of the flexible-accelerator type, of which perhaps the most popular is the neoclassical model of investment associated with the writings of

1/ See, for example, Khan and Knight (1981), (1982), and Gylfason (1982).

Jorgenson (1967), (1971), and Hall (1977), and variants of this model have been applied with a fair degree of success in a number of advanced countries. 1/ There is, however, quite a large gap between the modern theory of investment and the models that have been typically specified for developing countries. This reflects a variety of reasons, both analytical and pragmatic. Due to a number of institutional and structural factors present in most developing countries, such as the absence of well-functioning financial markets, the relatively larger role of the government in capital formation, distortions created by foreign exchange constraints, and other market imperfections, the assumptions underlying the standard optimizing investment models are typically not satisfied in those countries. Furthermore, even if the standard models could be directly adapted to developing countries, severe data constraints arise when attempting to implement them empirically. For example, data on variables such as the stock of capital, the labor force, and wages, simply do not exist for most developing countries, and in the absence of information on real financing rates (debt and equity) it is not possible to easily calculate the service price or user cost of capital. For that matter, there are also serious conceptual problems in defining private investment in economies where autonomous state enterprises play a relatively important role; whether these should be classified as part of the public sector or the private sector is often unclear. It is probably correct to assume that these various problems have in the past tended to seriously inhibit the modelling of private investment in developing countries along standard theoretical lines.

More recently, however, some studies, e.g., Sundararajan and Thakur (1980) and Tun Wai and Wong (1979), have attempted to incorporate features of the neoclassical model into investment models for developing countries, taking into account the relevant data problems and other structural features. In a sense, these studies represent a starting point for this paper. The purpose here is to develop a simple framework for studying private investment in developing countries, which extends the previous work on the subject in two main directions. First, we focus on the role of government policy and derive an explicit relationship between the principal policy instruments--variations in bank credit and government expenditures (specifically government investment)--and private capital formation. Within the framework of this model we are able to directly treat questions relating to the impact of stabilization policies on growth and other real variables in the economy, and at the same time assess the extent of both financial and real "crowding out" that may occur. Since the share of the government in total capital formation can become quite large, real crowding out takes on a special importance in developing countries. 2/ Second, in contrast to previous

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1/ See Jorgenson (1971), Clark (1979), Bischoff (1969), (1971), Hines and Catephoros (1970), and Beenstock and Willcocks (1980).

2/ For a general discussion on the effects of government expenditures on capital formation, see von Furstenberg and Malkiel (1977). Both the studies by Sundararajan and Thakur (1980) and Tun Wai and Wong (1979) also stress the independent role of government investment on private investment.

studies, the model here attempts to make a distinction between public investment related to the development of infrastructure, and other types of government investment, arguing in essence that the effect on private investment will depend on the type of public investment in question. To our knowledge such a distinction has not hitherto been empirically utilized.

The resulting model is estimated on a pooled basis for 24 developing countries over the period 1971-79. Since data on private investment (defined as total fixed capital formation less gross investment of the public sector, including the general government, autonomous institutions, and nonfinancial state enterprises) are not generally available in a convenient form, a special data set had to be constructed from national sources, supplemented by Fund staff estimates where necessary. Considerable effort was made to ensure cross-country consistency in the specific definition of private investment, and the selection of the 24 countries was determined primarily by the availability of data. The results of the exercise are then used to draw some broad inferences about the main determinants of private investment and the effectiveness of government policy.

The paper proceeds as follows: in Section II we discuss the basic patterns of total investment and its private and public components across various countries. The derivation of the model and the resulting estimates are contained in Section III. The concluding section summarizes the principal results and their main policy implications.

II. The Structure and Pattern of Investment in Developing Countries

As a starting point we examine the basic data on investment in developing countries to establish what patterns, if any, are evident. For this purpose the average ratios of total investment to GDP, along with the corresponding ratios for the private and public components, are presented in Table 1 for the 24 developing countries in the sample. The total investment ratio varies considerably across countries--ranging from a low of 12 percent for Haiti to a high of nearly 36 percent for Singapore. 1/ The mean value of the investment-income ratio is about 22 percent for the countries as a group, but the significant deviations from this mean would reject the hypothesis that the investment-income ratio is the same, or even similar, across developing countries. As such one would be in error in any attempt to generalize from the investment patterns in any single country, or a few countries, to the group of developing countries as a whole. There appears to be some relation between the investment-income ratio and the level of development of the

1/ Over the same period, 1971-79, the average ratios of investment to income in the major industrial countries were: Canada (23 percent); France (23 percent); Germany (22 percent); Japan (33 percent); United Kingdom (19 percent); and the United States (18 percent).

Table 1. Average Ratios of Total, Private, and Public Investment to GDP, 1971-1979

(In percent)

Country	Total Investment	Private Investment	Public Investment
Argentina	27.2	17.3	9.9
Bolivia	18.1	7.2	10.9
Brazil	22.8	18.9	3.9
Chile	13.1	4.3	8.8
Colombia	21.4	16.4	5.0
Costa Rica	23.3	16.4	6.9
Dominican Republic	20.5	12.9	7.6
Ecuador	22.8	16.4	6.4
Guatemala	16.5	12.7	3.8
Haiti	12.0	5.5	6.5
Honduras	20.9	13.4	7.5
Mexico	21.2	12.8	8.4
Panama	27.0	15.6	11.4
Paraguay	21.8	17.0	4.8
Venezuela	29.1	18.1	11.0
Barbados	22.2	17.2	5.0
Trinidad	24.4	19.1	5.3
Indonesia	19.4	13.1	6.3
Thailand	22.8	19.4	3.4
Turkey	19.4	9.7	9.7
Singapore	35.6	26.5	9.1
Korea	27.9	22.6	5.3
Sri Lanka	16.0	8.5	7.5
Malaysia	22.2	13.8	8.4

Source: See Appendix.

country, although this relation is not very rigid (Chart 1). For example, countries with a high average per capita income, 1/ such as Argentina, Singapore and Venezuela, also had among the highest average investment-income ratios. At the other end of the spectrum are the lower-income developing countries--Haiti, Sri Lanka, and Bolivia--with a relatively smaller ratio of investment to income. Of course there are a number of important exceptions so that one would have to be cautious in concluding either that a higher investment-income ratio necessarily leads to an

1/ Defined as nominal GDP (in U.S. dollars) deflated by population.

increased level of economic development, or alternatively that a higher level of per capita income results in more investment. 1/

The relation between investment and growth in developing countries has been documented and discussed by Robinson (1971) and more recently, by Goldstein and Khan (1982). 2/ Using a production function approach these studies have shown that, ceteris paribus, an increase in the ratio of investment to income will lead to an increase in the growth rate. At the same time, however, the accelerator model that is widely used for studying investment in developing countries specifies a positive relationship between investment and the change in output. The association between investment and growth would thus seem on a priori grounds to be of a two-way nature rather than causal. Such an association is apparent from the scatter plot of the average investment-income ratios and the average rates of growth in the 24 countries in the sample shown in Chart 2. The observations do indeed appear to lie along an upward sloping line, indicating that countries with higher investment-income ratios have also experienced higher average levels of growth. The relationship is by no means exact, reflecting undoubtedly the absence of other variables, such as the growth of the labor force, and productivity and technological changes, etc., that are important factors in the growth process. Nevertheless, the simple scatter does provide support for the premise that higher rates of investment are generally associated with higher growth rates.

The variation across countries in the shares of private investment in total investment is even larger than was the case for the total investment ratio. Over the period 1971-79 private investment represented over 75 percent of total gross investment in some countries--Brazil, Colombia, Guatemala, Barbados, Trinidad and Tobago, Thailand, Singapore, and Korea--while it was less than 50 percent in Bolivia, Chile and Haiti. Any generalization here too would obviously be quite hazardous, since the relative proportion of the private sector in total capital formation represents a myriad factors, the most important of which would likely be the political preferences of the country. Nevertheless there seems to be an association, albeit perhaps a loose one, between the total investment-income ratio and the share of private investment in total investment. This leads us to the first of two straightforward empirical propositions relating to public and private investment that be examined on the basis of data presented in Table 1.

1/ For example, Chile has a relatively low investment-income ratio even though its average per capita income of about $1,300 during 1971-79 would put it in the fourth quartile of the countries in the sample. At the same time Korea had an investment-income ratio of nearly 28 percent but an average per capita income of $700.

2/ The paper by Goldstein and Khan (1982) contains a brief survey of a number of empirical studies on the subject and summarizes their main results.

CHART 1

RELATIONSHIP BETWEEN INVESTMENT-INCOME RATIO AND PER CAPITA INCOME: 1971-79

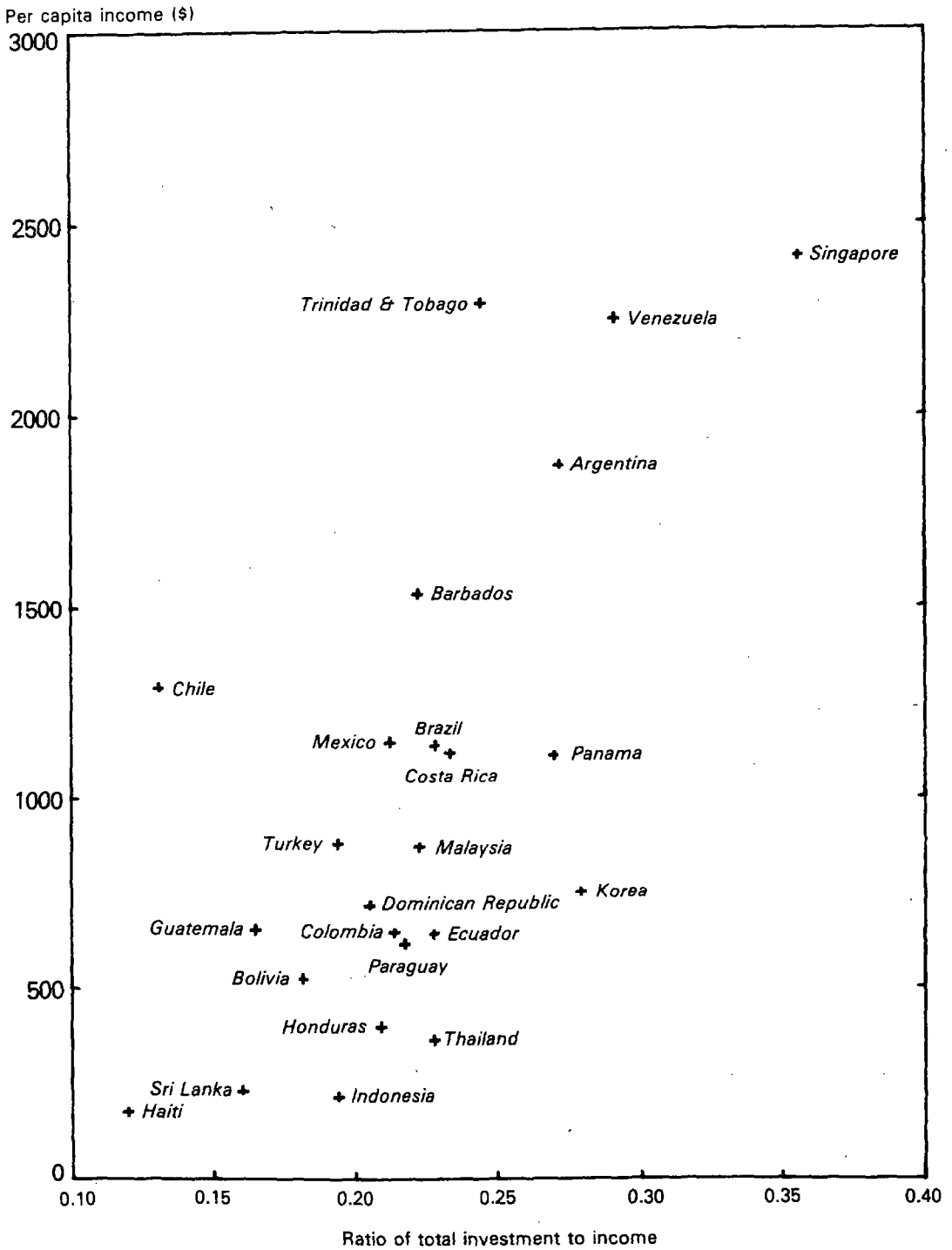
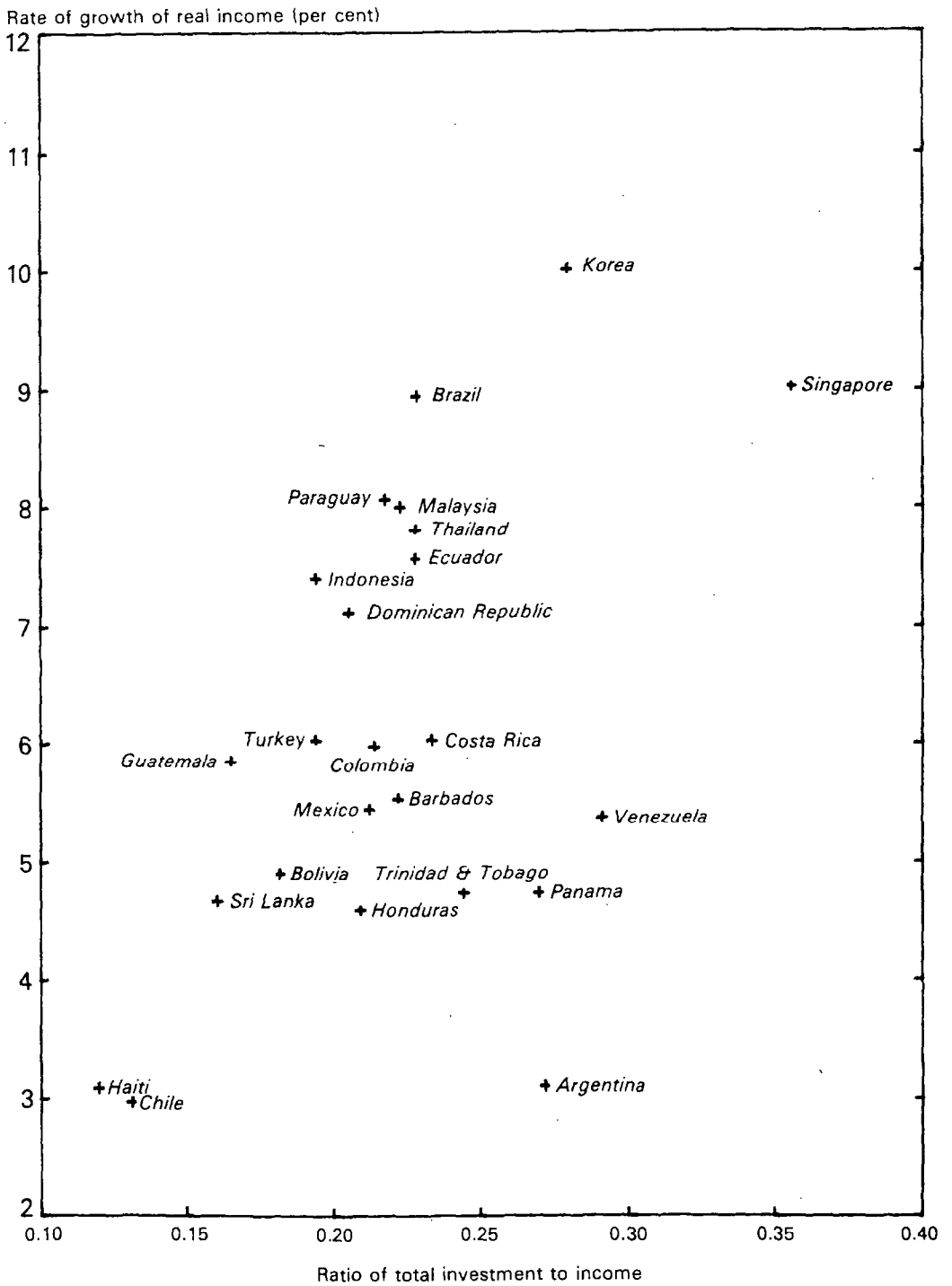


CHART 2

RELATIONSHIP BETWEEN INVESTMENT-INCOME RATIO AND REAL GROWTH: 1971-79



Proposition I: Countries with a high share of private investment in total investment also tend to have a higher ratio of total investment to income.

This proposition reflects the fact that countries where the private sector has been allowed to take on a larger role in the investment process have managed to raise the overall level of savings, and therefore total investment. It further provides some indication of the interaction between private investment and public investment and, therefore, on the issue of crowding out. If there is perfect substitutability between private and public investment there should be no relation between the private investment component and the total investment-income ratio, since any change in private investment would be offset by movements in the opposite direction of public investment, and vice versa. This type of complete crowding out which has been discussed by, among others, David and Scadding (1974) is based on the argument that the private sector perceives any addition to the government capital stock as potentially competing with its own, and thus there is an immediate decline in its desired rate of investment. While the theory has some appeal, this extreme form of crowding out has been found to occur rarely, if ever, in practice, and consequently is equally unlikely to take place in our sample of countries.

Evidence of the relationship between the average ratio of private investment to total investment and the average investment-income ratio for the 24 countries is presented in Chart 3. This scatter diagram does appear to provide some confirmation for Proposition I. Just how strong the relationship is can be assessed more rigorously by running a regression relating the investment-income ratio (I/Y) to the share of private investment in total investment (PRII/I) using the cross section data on the 24 countries. This yielded the following results: 1/

$$(I/Y) = \underset{(2.02)}{0.095} + \underset{(2.73)}{0.190}(PRII/I)$$

$$\bar{R}2 = 0.252$$

This result indicates some quantitative support for the conclusions drawn from the scatter diagram as the slope coefficient turns out to be positive and significantly different from zero at the 5 per cent level. 2/

1/ T-values are shown in parentheses below the estimated coefficients, and $\bar{R}2$ is the adjusted coefficient of determination.

2/ The fit of this equation is quite poor, indicating that there are other factors as well that explain the investment-income ratio. It can be noted that had we regressed I/Y on the share of public investment, the coefficient would be simply the negative of the slope coefficient in the estimated equation. The relationship between government investment and the total investment-income ratio is also discussed by Kelly (1982).

The available evidence on the relationship discussed above between total investment and growth, together with Proposition I, brings us to the second proposition:

Proposition II: Countries with higher shares of private investment in total investment also tend to have higher growth rates.

Chart 4 is a scatter diagram of the average ratio of private investment to total investment against the average rate of growth of real GDP during 1971-79. Here again the observations lie along a positively sloped line, and we find that generally the countries with the highest average ratios of private investment to total investment also experienced the highest average growth rates. There are, of course, certain outliers, such as Trinidad and Tobago and perhaps Argentina, where one would have expected on the basis of the private investment-total investment ratio a much higher average growth rate. By regressing the ratio of private investment to total investment (PRII/I) on the growth of real GDP (DYR) we obtained the following results: 1/

$$(PRII/I) = \underset{(5.17)}{0.383} + \underset{(3.91)}{0.045}DYR$$

$$\bar{R}2 = 0.410$$

This equation also yields support for Proposition II as the coefficient measuring the relationship between growth and the share of private investment in total investment is positive and significant at the one percent level. As in the previous case the fit of this equation reflects, no doubt, the absence of other relevant determinants.

Generally speaking, the cross-section information on the broad patterns of investment yields some "stylized facts" that point to the importance of private investment behavior in developing countries. The initial empirical results in this Section essentially provide the basic motivation of formulating and testing models for private investment--to which we now turn.

III. Specification and Estimation of a Model of Private Investment

1. Theoretical formulation

The model developed here is basically a variant of the flexible-accelerator model adapted to incorporate some of the institutional and

1/ Since we are interested only in the sign of the coefficient relating to the two variables it is immaterial which particular variable is taken as the dependent variable.

CHART 3

RELATIONSHIP BETWEEN RATIO OF PRIVATE INVESTMENT TO TOTAL INVESTMENT AND INVESTMENT-INCOME RATIO 1971-79

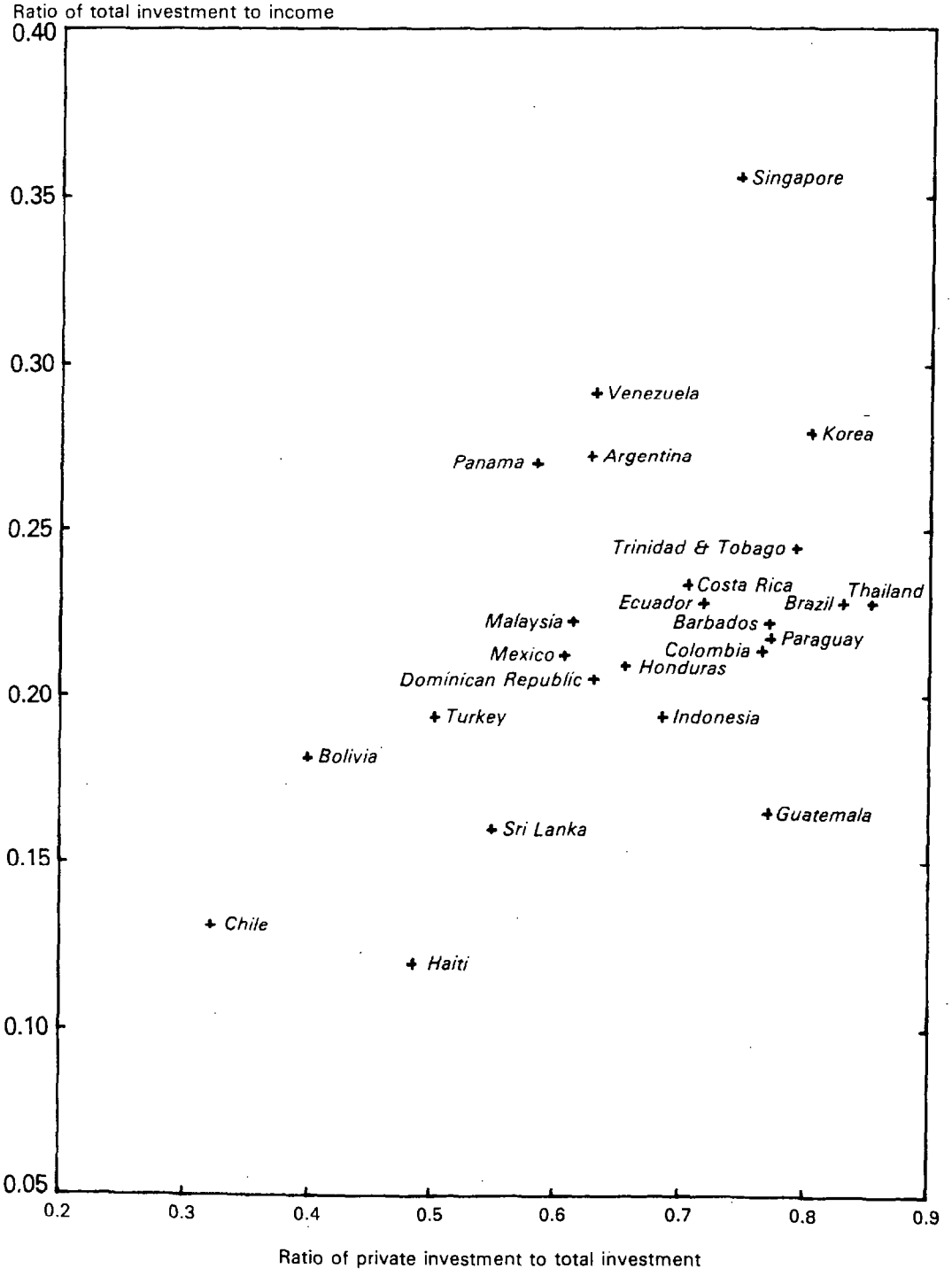
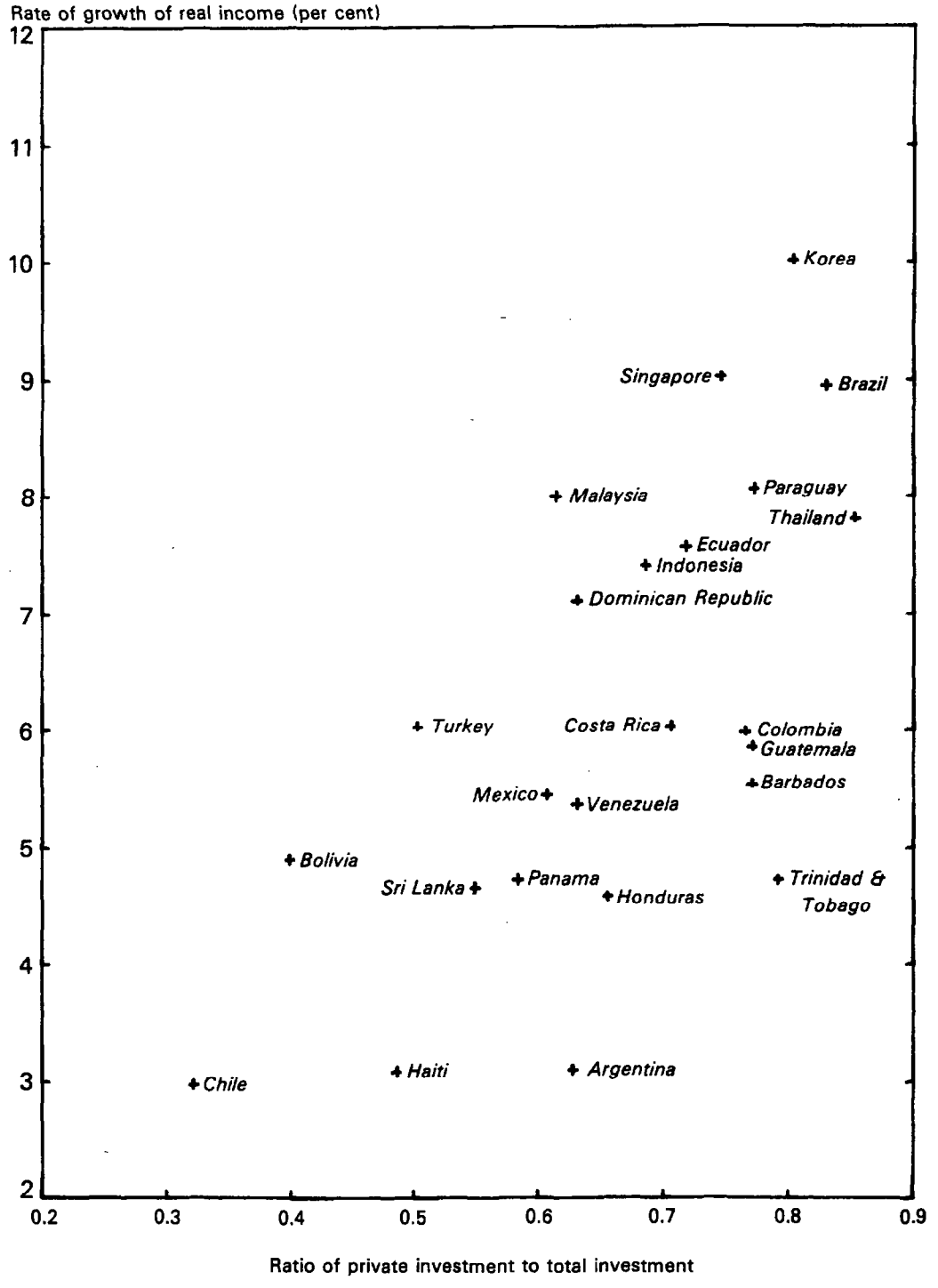


CHART 4

RELATIONSHIP BETWEEN RATIO OF PRIVATE INVESTMENT TO TOTAL INVESTMENT AND REAL GROWTH: 1971-79



structural characteristics of a developing economy. A number of problems tend to limit the applicability of a strict version of the neoclassical investment model, as set forth by Jorgenson (1967), (1971), Hall (1977), and others, to developing countries, although there have been some notable attempts in this direction. 1/ By and large, the difficulties associated with the concept and measurement of the capital stock, 2/ the calculation of the rental price of capital, the definition and estimation of production functions, and general financial and labor market imperfections, make it necessary to modify the basic model to place greater emphasis on the effects of resource constraints, both financial and physical, faced by private investors in developing countries. 3/ The basic aim in this paper is to derive a theoretically-consistent model within the flexible accelerator framework that stresses such resource constraints, and at the same time incorporates an explicit role for monetary and fiscal policies in the process of private capital formation.

In the long-run representation of the accelerator model the desired stock of capital can be assumed to be proportional to expected output:

$$(1) \quad KP_t^* = aYR_t^e$$

where KP* is the capital stock that the private sector wishes to have in place in future periods, and YR^e is the corresponding expected level of output. 4/ This is a very standard formulation and can be rationalized by assuming that the underlying production function has (technologically) fixed proportions among factors inputs, so that factor prices do not enter into the specification. 5/ While the parameter "a" is assumed constant, we do allow KP_t^* to be affected by changing economic conditions so that the model does fit into the flexible accelerator mode.

1/ The study of Sundararajan and Thakur (1980) comes closest to directly implementing the neoclassical model to two developing countries--India and Korea.

2/ See Ward (1976) for a comprehensive discussion of this issue.

3/ See, for example, Galbis (1975), Tun Wai and Wong (1979), Leff and Sato (1980), and Fry (1980).

4/ Strictly speaking, since we are dealing with private sector investment the output variable should be the expected private sector output. For simplicity, we assume that private sector output is proportional to total output and therefore work throughout with the latter.

5/ See Klein (1974). Using an alternative production function, say for example, a Cobb-Douglas function, would directly introduce the rental price of capital to wages ratio, or the price of investment goods to the price of capital services, into equation (1). As we mentioned above, none of these such variables are easy to calculate in developing countries and for this reason we have to assume a somewhat restrictive model that does not admit the possibility of factor substitution. Clearly if the elasticity of substitution is non-zero empirically, the present model would involve a degree of misspecification.

Lags in the adjustment of actual investment that arise because of the time it takes to plan, build, and install new capital, can be introduced via a partial-adjustment mechanism for the capital stock, whereby the actual stock of capital is assumed to adjust to the difference between the desired stock in period t and the actual stock in the previous period: 1/

$$(2) \quad \Delta KP_t = \beta[KP_t^* - KP_{t-1}]$$

or,

$$(2a) \quad KP_t = \beta KP_t^* + (1-\beta)KP_{t-1}$$

where KP is the actual private capital stock so that ΔKP is net private investment, and β is the coefficient of adjustment, $0 \leq \beta \leq 1$.

The formulation given by equation (2), or (2a), is in terms of net private investment, whereas the data on investment is available only in in gross terms, including depreciation. As such one has to transform equation (2) into gross investment terms to be able to derive an equation that can be empirically estimated. Furthermore, it turns out that such a transformation also permits one to eliminate the private capital stock variable from the specification and thus get around this particular data constraint as well. Gross private investment (IP_t) is defined as equal to net investment plus depreciation of the previous period's capital stock:

$$(3) \quad IP_t = \Delta KP_t + \delta KP_{t-1}$$

where δ is the rate of depreciation. Using standard lag-operator notation equation (3) can be conveniently written as:

$$(4) \quad IP_t = (1-(1-\delta)L)KP_t$$

where L is a lag operator, $LKP_t = KP_{t-1}$. By simply inverting equation (4) we can relate the private stock of capital to gross private investment as follows:

$$(5) \quad KP_t = \frac{IP_t}{(1-(1-\delta)L)}$$

1/ Dynamics can also be introduced through specifying a distributed-lag function for expected output; see Hall (1977).

Substituting for KP_t and KP_{t-1} in equation (2a) using equation (5) we obtain: 1/

$$(6) \quad \frac{IP_t}{(1-(1-\delta)L)} = \beta K_t^* + (1-\beta)\frac{IP_{t-1}}{(1-(1-\delta)L)}$$

which has the solution:

$$(7) \quad IP_t = (1-(1-\delta)L)\beta K_t^* + (1-\beta)IP_{t-1}$$

If we then proceed to substitute for K_t^* from equation (1) into equation (7), we can derive a basic dynamic-accelerator model for gross private investment:

$$(8) \quad IP_t = \beta a(1-(1-\delta)L)YR_t^e + (1-\beta)IP_{t-1}$$

Equation (8) has the important advantage that while it is completely consistent with the original capital stock model given by equations (1) and (2), it does not require information, as mentioned above, on net investment or on the stock of capital, and can therefore be readily applied to available gross investment data in developing countries.

An alternative way of deriving equations (7) or (8) would be to start by directly specifying a partial-adjustment function for gross investment as follows:

$$(9) \quad \Delta IP_t = \beta[IP_t^* - IP_{t-1}]$$

where IP* is the desired level of investment. In the steady state desired private investment is given by: 2/

$$(10) \quad IP^*_t = (1-(1-\delta)L)KP_t^*$$

Combining equations (9) and (10), and solving for IP_t yields an equation that is exactly the same as equation (7). 3/

1/ Given equation (5) the previous period's stock of capital is:

$$KP_{t-1} = \frac{IP_{t-1}}{(1-(1-\delta)L)}$$

2/ It should be noted that this equation requires that $KP^*_{t-1} = KP_{t-1}$. This equality would generally hold, for example, in the steady state.

3/ In addition as $KP_t^* = aYR_t^e$ we can derive an equation identical to equation (8) from equations (9) and (10).

Following the approach suggested by Coen (1971) the response of private investment to the gap between desired and actual investment as measured by the coefficient β, can be assumed to vary systematically with economic factors that influence the ability of private investors to achieve the desired level of investment. 1/ We hypothesize that the response of private investors depends on three main factors: first, the stage of the cycle; second, the availability of financing; and third, the level of public sector investment. The phenomenon of crowding out is, therefore, captured through affecting the speed of adjustment rather than directly changing the desired level of real private investment. 2/

During the expansionary phase of the cycle when demand conditions are bouyant, private investors can be expected to respond more rapidly to changes in desired investment. 3/ On the other hand, however, if the trend or potential level of output is taken as an indicator of full capacity, then the reaction of investment to the discrepancy between the desired and actual rates of investment would tend to be smaller in situations when actual output was above capacity as more strain was put on available resources, leading to an increase in input prices; alternatively in situations of excess capacity investment could respond more rapidly. It is, therefore, not entirely clear as to what type of effect, on average, one would expect cyclical factors to have on the change in private investment. 4/

The effect of the availability of financing on the coefficient of adjustment is less ambiguous. Generally speaking, a clear consensus has emerged in recent years that, in contrast to the case in developed countries, the principal constraint on investment in developing countries is the quantity of financial resources rather than their cost. 5/ The rates of return on investment in these countries tend to be typically quite high while real interest rates on loanable funds are kept low by governments for a variety of reasons. In such circumstances one would not expect to find the investor equating the current marginal product of capital to its service cost. Indeed, as the total amount of financing

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1/ This approach does allow private investment to vary with underlying economic conditions and makes the model consistent with the flexible-accelerator framework.

2/ The latter method, discussed later, turns out to yield an estimation equation that is similar to the one obtained by the method adopted here.

3/ See von Furstenberg (1980). As noted in that paper, the cyclical response may itself involve lags arising from the difficulties of terminating on-going investment projects as demand declines, and initiating investment rapidly as demand picks up.

4/ The situation is further complicated if one introduces expectations into the analysis. For example, if output is abnormally high one may expect it to grow at below-average rates in the future stages of the cycle and thus current investment may decline.

5/ This view, associated with McKinnon (1973), has gained considerable currency in the literature on financial development.

is limited and the price mechanism is not allowed to operate smoothly, it would seem legitimate to hypothesize that the private investor in a developing country is restricted by the level of available bank financing. 1/ Any effect exerted by the rate of interest on private investment is not direct within this rationing framework, but occurs via the channel of financial savings. 2/

The rudimentary nature of capital markets in developing countries limits the financing of private investment to the use of retained profits, bank credit, and foreign borrowing; of these the flow of bank credit to the private sector is quantitatively perhaps the most important. An increase in real credit to the private sector will generally encourage real private investment, and by rolling over bank loans the maturity of the debt can be lengthened sufficiently. The role of foreign capital flows, whether in the form of direct investment or portfolio investment, in the domestic investment process has also been documented in a number of studies. 3/ The effects of foreign financing are broadly similar to the effects of variations in bank credit--both tend to increase investment since they expand the pool of financial savings. 4/ As control of total bank credit generally represents the main instrument of monetary policy in developing countries, 5/ through varying the composition of credit between the public and private sectors, the government can affect the speed and ability of private investors to respond to achieve their desired level of investment. Monetary policy can thus have a direct and potent influence on the rate of private investment. In a similar vein, private investment can be influenced by interest rate and exchange rate policies that cause changes in private capital flows.

Finally, it is a well-accepted proposition that in developing countries private and public investment are related, 6/ although there is considerable uncertainty as to whether on balance public sector invest-

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1/ This may be somewhat restrictive for those developing countries where firms can issue shares and obtain equity financing. However, in most developing countries this is only a limited possibility.

2/ For a discussion of the effects of interest rates on investment, see Galbis (1975), and Fry (1980), (1981). It is interesting to note that in the currently popular financial development models an increase in interest rates, by increasing financial savings, raises rather than lowers private investment.

3/ See Weisskopf (1972), Stillson (1976), and Tun Wai and Wong (1979).

4/ A theoretical discussion of how an increase in foreign capital flows can increase total financial savings is contained in Khan and Knight (1982)

5/ Other tools of monetary policy, such as open-market operations, have a limited scope in economies where capital and bond markets remain relatively underdeveloped.

6/ See Galbis (1975), Heller (1975), Tun Wai and Wong (1979), and Sundararajan and Thakur (1980).

ment raises or lowers private investment. 1/ Our cross-section estimates in Section II, for example, indicated that the investment-income ratio was inversely related to the share of public sector investment in total investment, and positively to the corresponding share of private sector investment. However, as those weak tests of substitutability do not allow firm conclusions to be drawn, the issue has to be carefully examined.

In broad terms, public sector investment can result in crowding out if it utilizes scarce physical and financial resources that would otherwise be available to the private sector, or if it produces marketable output that competes with private output. Furthermore, the financing of public sector investment, whether through taxes, issuance of debt, or inflation, will lower the resources available for the private sector and thus depress private investment activity. On the other hand, public investment that is related to infrastructure and the provision of public goods can also clearly be complementary to private investment. Public investment of this type can enhance the possibilities for private investment and raise the productivity of capital, increase the demand for private output through increased demand for inputs and ancillary services, and augment overall resource availability by expanding aggregate output and savings. The overall effect of public investment on private investment will, therefore, depend on the relative strength of these various effects and there is no a priori reason to believe that they are necessarily substitutes or complements. Assuming that the possibility of financial crowding out is taken into account by the composite variable incorporating the change in bank credit to the private sector and private capital flows, our specific concern here is with real aspects of public sector investment. If on average public and private investment are substitutes we would expect that the coefficient of adjustment of private investment would be smaller the higher the rate of public investment; complementarity would imply a faster response. 2/ Again this allows us to relate private investment behavior to government policy, which in this case would be given by changes in government capital expenditures.

On the basis of the arguments above we can express the coefficient of adjustment in equation (9) as a function of cyclical factors, and monetary and fiscal policy variables. A linear representation of this relationship would be:

$$(11) \quad \beta_t = b_0 + \frac{1}{(I_t^* - I_{t-1})} [b_1 GAP_t + b_2 \Delta DCR_t + b_3 GIR_t]$$

1/ See von Furstenberg and Malkiel (1977).

2/ Note that we have explicitly assumed that causation runs from public sector investment to private investment. It can be argued that causation also runs the other way if the government has a reaction function for public investment. See Heller (1975).

where,

GAP = cyclical factors, given by the difference between actual and trend output; 1/

ΔDCR = change in real bank credit to the private sector plus real net private capital flows; and,

GIR = real public sector investment.

Equation (11) states that the response of private investment depends on the magnitude of these three factors, measured in relative terms with respect to the size of the discrepancy between desired and actual investment. 2/ The signs of the parameters in this equation are expected to be:

$$b_1 \gtrless 0;\ b_2 > 0;\ b_3 \gtrless 0.$$

Substituting equation (11) into equation (9) yields:

$$(12)\quad \Delta IP_t = b_0[IP_t^* - IP_{t-1}] + b_1 GAP_t + b_2 \Delta DCR_t + b_3 GIR_t$$

Since from equations (10) and (1) we have

$$IP_t^* = (1-(1-\delta)L)KP_t^* = (1-(1-\delta)L)aYR_t^e$$

we can obtain a dynamic reduced-form equation for gross private investment which incluces cyclical factors, the change in real bank credit, and real public sector investment as the explanatory variables:

$$(13)\quad IP_t = b_0 a(1-(1-\delta)L)YR_t^e + b_1 GAP_t + b_2 \Delta DCR_t + b_3 GIR_t + (1-b_0)IP_{t-1}$$

Representing crowding out through allowing the parameter β to be variable, as is done here, is certainly not the only way to arrive at an equation such as (13). For example, one could easily specify desired private investment as a function of the output gap, changes in credit, and government investment, in addition to expected real output, as follows:

1/ The trend level of output (TYR) is calculated as:

$$TYR = YR_0 e^{g_1 t}$$

where YR_0 is the initial value of output, g_1 is the average growth rate of YR, and t is a linear time trend.

2/ See Sundararajan and Thakur (1980) for a similar formulation.

$$(14)\quad IP_t^* = a(1-(1-\delta)L)YR_t^e + c_1GAP_t + c_2\Delta DCR_t + c_3GIR_t$$

Substituting (14) into equation (9) and solving for IP_t we obtain:

$$(15)\quad IP_t = \beta a(1-(1-\delta)L)YR_t^e + \beta c_1GAP_t + \beta c_2\Delta DCR_t + \beta c_3GIR_t + (1-\beta)IP_{t-1}$$

which as an unrestricted reduced-form is exactly the same as equation (13). The only difference would be the interpretation of the behavioral parameters.

A simple extension of equation (13) is to postulate the coefficient of adjustment, β, depends on both the level (GIR) and the change in public sector investment (ΔGIR). 1/ This would yield the following equation:

$$(16)\quad IP_t = b_0a(1-(1-\delta)L)YR_t^e + b_1GAP_t + b_2\Delta DCR_t + b_3GIR_t + b_4\Delta GIR_t + (1-b_0)IP_{t-1}$$

In estimating equations (13) and (16) we would expect the coefficient measuring the strict accelerator, b_0a, to be positive, and the long-run coefficient, a, to be close to unity. This would ensure that in the steady state the capital-output ratio would be constant. The effects of government policy on private investment can be directly obtained from the estimates of b_2 and b_3 (and b_4). While there is some empirical support for the hypothesis that an increase in the flow of credit to the private sector will benefit private investment, the results for the effect of public sector investment have been somewhat indeterminate. 2/ Given the widespread belief that public sector investment plays a relatively important role in private capital formation in developing countries, the lack of empirical support for the relationship is quite surprising. Our basic contention is that this is not so much an indication of the absence of any statistical relation, but rather a reflection of the fact that different types of public investment--infrastructural and other--tend to have offsetting effects. Ideally it would be more meaningful to separate out the infrastructure component of public investment, and then estimate the independent effects of the different categories. Unfortunately, as there is a great deal of overlap between the categories of public investment, it is not possible to make such functional distinctions in the data.

1/ The effect of the change in public investment is also considered to be ambiguous.

2/ For example, Sundararajan and Thakur (1980) found the coefficient of the public sector capital stock in the private investment equation to be statistically insignificant in both the countries in their sample. Furthermore, the coefficient corresponding to b_3 was only significantly different from zero at the 5 per cent level in one country (Greece) out of the five studied by Tun Wai and Wong (1979). Similar insignificant results are also reported by Galbis (1975).

Recognizing that such distinctions are in fact crucial in understanding the role of public sector investment we experimented with various proxies for the infrastructural and non-infrastructural components of public sector investment. The basic assumption underlying these proxies is that infrastructure investment is an on-going process that moves in line with the pace of economic development. As it generally has a long gestation period and reflects decisions made in the past, such investment cannot be adjusted very rapidly. By contrast, it is assumed that other types of investment can be altered by the government more easily and with relatively greater speed. The first of the two approaches we adopt here takes the trend level of real public sector investment (TGIR) as representing the the long-term or infrastructural component, and argues that this should have a positive effect on gross real private investment; 1/ deviations of real public sector investment from the trend are assumed to correspond to non-infrastructural investment. 2/ Using this distinction we can specify the investment equation as:

$$(17)\quad IP_t = b_0 a(1-(1-\delta)L)YR_t^e + b_1 GAP_t + b_2 \Delta DCR_t + b_3 TGIR_t + b_4(GIR_t - TGIR_t) + (1-b_0)IP_{t-1}$$

The coefficient b_3 in equation (17) would be expected to be positive, whereas the sign of b_4 would depend on the existence of real crowding out or crowding in. In the former case it would be negative, and vice versa.

An alternative approach is to make the distinction between types of public investment on the basis of whether the investment is "expected" or not. Again we argue that expected public investment is closer to the long-term component and would therefore exert a positive influence on private investment, while the effect of the unexpected or surprise component is uncertain. 3/ To calculate expected real public investment we used an essentially empirical method, namely fitting a first-order

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1/ The trend level of real public sector investment is calculated as

$$TGIR = GIR_0\ e^{g_2 t}$$

where GIR_0 is the initial value of real public sector investment, g_2 is the average growth rate of GIR, and t is a linear time trend.

2/ To the extent that public investments of the infrastructure kind are lumpy, and there are replacement cycles following periods of high public investment, this type of trend approximation would possibly be in error. For this reason, and others, we use different measures for public infrastructure investment.

3/ It could also be argued in a rational-expectations framework that if there is a high degree of substitutability the effect of expected public investment on the rate of private investment would be negative. Correspondingly, since private investors could not respond quickly to surprises, the latter may turn out not to have any impact. Ultimately the issue is, however, an empirical one.

autoregressive process of the following form:

$$(18) \quad GIR_t = \rho_0 + \rho_1 GIR_{t-1}$$

where ρ_0 is the average level of GIR and ρ_1 is the autogressive parameter. 1/ The predicted values from equation (18) were defined as expected real public sector investment (EGIR), and the residuals as the unexpected component. Using these two variables the basic investment equation then becomes:

$$(19) \quad IP_t = b_0 a(1-(1-\delta)L)YR_t^e + b_1 GAP_t + b_2 \Delta DCR_t + b_3 EGIR_t + b_4(GIR_t - EGIR_t) + (1-b_0)IP_{t-1}$$

and we expect the following signs:

$$b_0 a > 0; \; b_1 \gtrless 0; \; b_2 > 0; \; b_3 > 0; \; b_4 \gtrless 0.$$

Using the alternative approaches outlined above to make a distinction between infrastructural and noninfrastructural public investment should prevent the results from being dependent on the specific approximation employed. Even so, it should be recognized that these measures do not cover the many possible ways that public and private investment may be related. For example, it could be argued that this relationship may be a lagged one, and while the lagged effect has not been modeled explicitly, both the trend and expected government investment variables should capture the delayed response of private investment indirectly. The basic point to stress is that in the absence of actual information on the functional components of public investment one should use different approximations, such as we have done here.

The only remaining unobservable variable in equations (13), (16), (17), and (19) is expected output and there are a variety of ways of generating it. Hall (1977) and Bischoff (1971), for example, use a general distributed-lag formulation relating the current level of output to its past values. An alternative approach would be to utilize the adaptive-expectations model of Cagan (1956), where expected output is assumed to respond to the error between actual output and the output that was expected in the previous period:

$$(20) \quad \Delta YR_t^e = \lambda[YR_{t-1} - (1+g)YR_{t-1}^e]$$

where λ is the coefficient of expectations, $0 \leq \lambda \leq 1$, and g is the growth rate of output. Using lag-operator notation we can write equation (20) in terms of YR_t^e:

1/ This process was chosen arbitrarily and no attempt was made to test for alternative more-complicated types of autoregressive schemes. With annual data and limited number of observations for each country, the simplest process given by equation (18) seemed to be appropriate.

$$(20a)\quad YR^e_t = \frac{\lambda YR_{t-1}}{(1-(1-\lambda)(1+g)L)}$$

Substituting for YR^e_t from (20a) in equations (13), (16), (17), and (19) we obtain the following:

$$(21)\quad IP_t(1-(1-\lambda)(1+g)L) = \lambda b_0 a(YR_{t-1} - (1-\delta)YR_{t-2}) + (1-(1-\lambda)(1+g)L)[b_1 GAP_t + b_2 \Delta DCR_t + b_3 GIR_t + (1-b_0)IP_{t-1}]$$

$$(22)\quad IP_t(1-(1-\lambda)(1+g)L) = \lambda b_0 a(YR_{t-1} - (1-\delta)YR_{t-2}) + (1-(1-\lambda)(1+g)L)[b_1 GAP_t + b_2 \Delta DCR_t + b_3 GIR_t + b_4 \Delta GIR_t + (1-b_0)IP_{t-1}]$$

$$(23)\quad IP_t(1-(1-\lambda)(1+g)L) = \lambda b_0 a(YR_{t-1} - (1-\delta)YR_{t-2}) + (1-(1-\lambda)(1+g)L)[b_1 GAP_t + b_2 \Delta DCR_t + b_3 TGIR_t + b_4(GIR_t - TGIR_t) + (1-b_0)IP_{t-1}]$$

$$(24)\quad IP_t(1-(1-\lambda)(1+g)L) = \lambda b_0 a(YR_{t-1} - (1-\delta)YR_{t-2}) + (1-(1-\lambda)(1+g)L)[b_1 GAP_t + b_2 \Delta DCR_t + b_3 EGIR_t + b_4(GIR_t - EGIR_t) + (1-b_0)IP_{t-1}]$$

2. Results

Equations (21)-(24) were estimated using pooled annual data for the 24 countries in the sample over the period 1971-79. 1/ Allowance was made for cross-country differences in the average level of private investment during the period by introducing country-specific dummy variables into the specification. It was assumed, however, that the basic economic parameters were the same in all the countries, so that the results can be treated as applying to an "average" developing coun-

1/ This yielded 216 observations for each of the variables. The basic data are described in the Appendix.

try, rather than to any specific individual country. 1/ The models are, of course, nonlinear in parameters, and as such have to be estimated by a restricted least-squares method that permits identification of the individual parameters. Specifically these nonlinearities are created by the parameters λ, g, and δ. For the coefficient of expectations, λ, a grid search was performed by varying it over the interval (0, 1) in increments of 0.1, and then choosing the one that maximized the log-likelihood function. The parameter g was set equal to the average growth rate for each country over the period 1971-79. Finally, since we do not have any direct estimate available for the rate of depreciation, δ, we used an arbitrary value of 5 per cent per year to transform the output variable. 2/ For given values of λ, g, and δ the equations are linear and can be estimated by standard methods, although it should be remembered that the results will be conditional on the chosen values of the parameters.

The results for the four equations are presented in Table 2. Generally speaking the models seem quite well-specified and, judging by the values obtained for the coefficients of determination, appear to fit the the data satisfactorily. In each of the specifications the log-likelihood function was maximized when $\lambda = 1$, so that from equation (20) expected real output effectively equals the lagged value of real output--$YR^e_t = YR_{t-1}$. It can be seen from the results that the change in output enters with the expected positive sign and the estimated coefficient, $b_0 a$, is significantly different from zero at the 1 per cent level. Furthermore, it is interesting to note that the short-run accelerator coefficient tends to be quite similar across specifications. The long-run response of private investment to a change in output, as measured by the value of the parameter a, turns out to be very close to unity in all cases. The estimated models appear to satisfy the theoretical property that the capital-output ratio should be constant in the steady state. The coefficients of the lagged values of private investment, namely $(1-b_0)$, are also significantly different from zero at the 1 per cent level, and the average time lags in the adjustment of private investment to variations in output are generally around two years. 3/

1/ Preliminary tests with an error-components model yielded very similar results, so that for the sake of simplicity we stayed with the least squares with dummy variables procedure. From a computational point of view using the latter has a decided advantage in models involving the adaptive-expectations scheme, which introduces nonlinearities into the system.

2/ In other words the lagged change in real GDP variable is defined as:

$$\Delta YR_{t-1} = YR_{t-1} - 0.95YR_{t-2}$$

This 5 percent value is close to the estimates obtained by Sundararajan and Thakur (1980). Some sensitivity analysis was performed through varying δ, but the results remained broadly the same as those discussed here in the paper.

3/ The average lag is calculated as $(1-b_0)/b_0$.

Table 2. Results: Real Private Investment*

Equation Number	ΔYR_{t-1} 1/	GAP_t	ΔDCR_t	$PRIR_{t-1}$	GIR_t	ΔGIR_t	$TGIR_t$	$GIR_t - TGIR_t$	$EGIR_t$	$GIR_t - EGIR_t$	λ	$\bar{R}^2$	S.E.E.
(21)	0.349	-0.144	0.197	0.661	-0.024						1.0	0.930	360.5
	(6.32)	(2.23)	(3.31)	(10.80)	(0.46)								
(22)	0.356	-0.113	0.225	0.636	0.079	-0.271					1.0	0.936	344.9
	(6.71)	(1.81)	(3.94)	(10.80)	(1.41)	(4.27)							
(23)	0.319	-0.091	0.257	0.574			0.158	-0.191			1.0	0.934	351.4
	(5.82)	(1.41)	(4.23)	(8.80)			(2.09)	(2.64)					
(24)	0.336	-0.083	0.213	0.634					0.244	-0.284	1.0	0.941	332.9
	(6.56)	(1.36)	(3.88)	(11.19)					(3.62)	(4.28)			

* T-values are shown in parenthesis below the estimated coefficients; $\bar{R}^2$ is the adjusted coefficient of determination; and S.E.E. is the standard error of the estimated equation.

1/ $\Delta YR_{t-1} = YR_{t-1} - 0.95\ YR_{t-2}$.

The estimates of the cyclical response of private investment are fairly weak--the estimated coefficient for the GAP variable is significantly different from zero at the 5 per cent level in the simplest formulation (21). The parameters are also consistently negative, implying support for the hypothesis that private investment is positively related to the degree of capacity in the economy. When output is above its trend level, the economy can be viewed as operating above capacity and investment is constrained by resource availability. However, as the estimates are clearly not very robust we should not place too much weight on this explanation. The results in Table 2 could arise simply from multicollinearity, or for that matter may be due to the fact that the GAP variable, as we have defined it, is not an appropriate measure of cyclical conditions in the economy.

Insofar as the role of financial flows on private investment is concerned, we can observe that the change in bank credit to the private sector and net private capital flows, ΔDCR, has a positive effect in all four equations and the estimated coefficients are significantly different from zero at the 5 per cent level. If the overall quantity of financial resources is given, then any attempt by the government to increase its share of either domestic or foreign financing at the expense of the private sector would lead to crowding out and a decline in the level of private investment. In the light of the cross-section results discussed in Section II, such a decline would most likely result in a fall in total investment as well. As in most developing countries the control over domestic credit of the banking system remains the principal tool of monetary policy, these results carry some importance for the broader issue of the real responses to changes in monetary policy. The estimates indicate that about one-quarter of a change in real credit to the private sector will show up in changes in real private investment in the short run. Similarly, interest rate and exchange rate policy can presumably also have a significant influence on private investment through their effect on private capital flows.

The estimate of the effect of aggregate public sector investment on private investment obtained from equation (21) is in general conformity with the estimates obtained in previous studies--the coefficient b_3 is very small and not significantly different from zero. However, as one proceeds to the expanded versions of the basic equation a pattern does begin to emerge. The results for equation (22) show that the level of public sector investment has a positive effect on private investment, while the change has a negative one. On the basis of these particular results it could be argued that it is not the level of public investment that crowds out the private sector since the coefficient, though carrying a positive sign, is not statistically significant; the change in public investment, however, appears to have a strong crowding-out effect.

The results for equations (23) and (24) are the most interesting from the point of view of the empirical relationship between public and private investment in developing countries. The estimates for equation (23) indicate that the trend component of real public investment exerts a

positive influence on the level of real private investment, while deviations from the trend have the opposite effect. Both estimated coefficients, namely b_3 and b_4, are significantly different from zero at the 5 per cent level. These results are consistent with the maintained hypothesis that infrastructural investment (as proxied by the longer-term trend level of real public investment) would be complementary to private investment, while other types of investment would tend to be substitutes. Provided that its trend level were not affected, an increase in real public investment would lead to a fall in real private investment in the short run, but the degree of substitutability is by no means perfect as the coefficient is significantly less than unity. 1/

The same pattern is apparent in the estimates for equation (24) where the distinction is made between the expected and unexpected components of public sector investment. Here an expected increase in public sector investment would raise the rate of private investment, but a surprise increase would have adverse effects on private capital formation. Since the coefficients of these variables are of similar order of magnitude and have opposite signs, it is not surprising to find an insignificant coefficient for the aggregate level of public sector investment (equation (21)). Also worth mentioning is the fact that equation (24) had the best fit of the four equations, in the sense that it yielded the lowest value for the log-likelihood function.

As the units of measurement differ somewhat for the variables in the equations reported in Table 2, an alternative way of determining the relative influence of the explanatory variables is to calculate the relevant Beta coefficients. These Beta coefficients, as is well known, measure the change in real private investment, ceteris paribus, for a unit change in each of the exogenous variables. As all the variables are expressed in standard deviation units, the Beta coefficients are independent of units of measurement and can thus be compared directly both within and across equations. 2/ The calculated values for the Beta coefficients corresponding to the four equations are presented in Table 3.

Abstracting from the case of the lagged dependent variable, we can observe from Table 3 that the change in real income is the most important explanatory variable in the first three equations. In equation (24) expected government investment shows up as having the strongest effect relative to the other variables. The financing variable has about one half the effect of the change in output, and turns out to be very similar

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1/ It should be noted that the negative sign for the nontrend public investment could also reflect countercyclical public investment policy rather than crowding out per se. Typically, however, countercyclical fiscal policy tends to involve variations in current rather than capital expenditures.

2/ The one drawback associated with Beta coefficients is that their statistical distribution is not known. As such one cannot perform formal tests of significance and any inferences have to necessarily be casual.

across the estimated equations; the influence of the cyclical variable is marginal at best. Finally, an interesting result to emerge in equations (22)-(24) is that variables approximating noninfrastructural investment have a substantially smaller effect than the infrastructural component. This would indicate that for the period under consideration the complementarity between public and private investment has outweighed the substitution effect.

Table 3. Values of Beta Coefficients

Variable	Equation Number: (21)	(22)	(23)	(24)
ΔYR_{t-1}	0.225	0.229	0.205	0.216
GAP_t	-0.054	-0.042	-0.034	-0.031
ΔDCR_t	0.088	0.100	0.114	0.095
$PRIR_{t-1}$	0.594	0.572	0.516	0.510
GIR_t	-0.026	0.083		
ΔGIR_t		-0.087		
$TGIR_t$			0.162	
$GIR_t - TGIR_t$			-0.049	
$EGIR_t$				0.248
$GIR_t - EGIR_t$				-0.076

IV. Conclusions

There are two principal conclusions that this study reaches. First, we have shown that it is possible to identify a well-behaved empirical function for private investment in developing countries. The traditional view that standard investment theory is not relevant for such countries has come under increasing challenge in recent years, and the analysis here lends support to that trend. By combining elements of the modern theory of investment and certain special features of developing economies we were able to derive a simple yet theoretically-consistent model of investment for a developing country. Econometric tests with variants of this model on a pooled time-series cross-section basis for a group of 24 developing countries also demonstrated its empirical validity.

The generally robust nature of the results that were obtained indicate that there may be a significant payoff to investigating the investment relationship for individual countries further, and particularly to expanding the data base so as to remove some of the restrictions on specification that are forced on the researcher by the lack, or weakness, of data in developing countries. For the time being, however, our results can be treated as indicative of the private investment relationship in an average developing country, and can perhaps be utilized in lieu of actual estimates for any specific country.

Second, we were able to establish a direct empirical link between government policy variables and private capital formation. Our results provide further evidence that private investment in developing countries is constrained by the availability of financing, and monetary policy, by varying the flow of credit to the private sector, can thus directly change private investment decisions. Furthermore, in contrast to previous studies undertaken on developing countries, we were also able to establish a quantitatively important role for public sector investment in the process of private capital formation. The effect appears to depend on the way in which public investment is introduced into the model, and meaningful results are obtained only when a distinction is made between long-term, or infrastructural, and short-term public investment. In either case the government of a developing country does appear to be in a position to alter the pattern of private investment by changing its own investment strategy.

The policy implications of the exercise turn out to be quite straightforward. The tightening of monetary policy, which is a typical element of a stabilization program, would be expected to have adverse effects on the level of private investment and lead to a reduction in growth, unless the authorities were careful to ensure that the flow of real credit to the private sector was not curtailed. In general, attempts by the public sector to absorb a larger share of domestic financial resources would tend to crowd out private investors to some degree. By the same token, if the total supply of foreign financing to an individual developing country is limited, then the larger the public sector borrowing the smaller would be the amount available for the private sector. While in quantitative terms this latter type of crowding out may not be too large in relation to domestic financial crowding out, nevertheless the government has to be conscious of this possibility. The flow of foreign capital may also be affected by inappropriate exchange rate and interest rate policies, and these may also have equally harmful effects on private investment.

The effects of a contractionary fiscal stance are, on the other hand, not that obvious. If the policy takes the form of a cut in real public sector investment that is not related to infrastructure, then one may well observe an increase in private investment as the physical resources, such as capital and labor, released by the government begin to be utilized by the private sector. This beneficial effect, however, can be offset if there is a reduction in infrastructural investment

which impacts negatively on private capital formation. As a general principle, the authorities should, if at all possible, restrict the cuts to investment that is not directly related to the development of infrastructure. This is, of course, difficult to do because of the problems associated with properly identifying infrastructure investment, and the government may not have the necessary leeway to be able to be selective in its choice of the components of public investment to reduce. Even so, it is useful for the government authorities to at least be aware of the private investment, and possibly long-term growth consequences, of across-the-board reductions in capital expenditures.

APPENDIX

Data Definitions and Sources

The basic source for the data used in this study is IMF, International Financial Statistics (IFS). Gross private and public investment data are based essentially on national sources. The data are all deflated by the GDP deflator (1975 = 1.00) to express them in real terms. For current values of the variables the period covered is 1971-79; lagged values of the variables, therefore, are defined over the period 1970-78.

The countries in the sample are: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Haiti, Honduras, Mexico, Panama, Paraguay, Venezuela, Barbados, Trinidad and Tobago, Turkey, Singapore, Korea, Sri Lanka, Malaysia, Indonesia, and Thailand.

The precise definitions of the variables (along with the IFS line numbers where relevant) are as follows:

IP = gross private fixed capital formation (in real terms).

GIR = gross public sector fixed capital formation (in real terms). The public sector is defined to include general government, autonomous agencies, and nonfinancial state enterprises.

YR = GDP in constant 1975 prices (line 99bp).

TYR = trend value of real GDP, calculated as

$$TYR_t = YR_{1970}\, e^{g_1 t}$$

where YR_{1970} is the 1970 value of real GDP and g_1 is its trend growth rate over the period 1970-79.

GAP = deviation of real GDP from its trend value, i.e., GAP = YR - TYR

ΔDCR = change in credit to the private sector (line 32d) in real terms, plus real net private capital inflows. This last variable is taken from IMF, Balance of Payments Statistics Yearbook, 1982.

TGIR = trend value of real gross public sector investment, calculated as:

$$TGIR_t = GIR_{1970}\, e^{g_2 t}$$

where GIR_{1970} is the 1970 value of real public sector investment and g_2 is the average growth rate of GIR over the period 1970-79.

EGIR = expected real gross public sector investment, calculated as:

$$EGIR = \rho_0 + \rho_1 GIR_{t-1}$$

where ρ_0 and ρ_1 are the autoregressive parameters estimated for each country over the period 1970-79.

The 26-country dummy variables, which take on a value of unity for the nine observations corresponding to a particular country and zero elsewhere, are entered into the equations in the same order as the list of countries given above.

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