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CAPITAL FORMATION IN LATIN AMERICA

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ABSTRACT

This paper studies investment in Latin America and explores the relationships of investment with growth, exchange rates and the terms of trade. It addresses the theoretical issue of the relationship between the real exchange rate and the real price of capital with a model of a small open economy with four assets. It discusses the dynamics of both the real price of capital and the real exchange rate in response to different shocks, including a change in monetary policy, an increase in external interest rates and a deterioration of the terms of trade. In the model (with a nominal exchange rate rule fixed by the central bank) a deterioration of the terms of trade leads to an immediate decline of the real price of capital, followed by a depreciating real exchange rate while the real price of capital slowly recovers.

The paper explores the determinants of investment in Latin America. The regressions use quadrennial panel data for the period 1970-1985 in Argentina, Brazil, Chile, Colombia, Mexico and Venezuela. Together, these six countries account for 86 percent of the total GDP of the region. The decline in private investment shares in Latin America during the 1980s seems to result from the deterioration in the terms of trade, from the decline in growth (resulting from adjustment programs designed to reduce current account deficits), from a reduction in complementary public investment, from increased macroeconomic instability, and from a large stock of foreign debt. The real exchange rate and the real rate of depreciation have no significant role in the determination of private investment.

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I. INTRODUCTION

This paper studies investment in Latin America and explores the relationships of investment with growth, exchange rates and the terms of trade.

Figure 1 shows investment shares in GDP in different developing regions. The economies of East Asia invest some 30 percent of GDP each year, a proportion that was roughly constant through the 1980s. Latin America's investment share in GDP is well below the East Asian levels. It was 24 percent at the end of the 1970s and fell to its debt-stricken plateau of roughly 17 percent of GDP in the mid-1980s. Despite continuing capital flight, Latin America's investment has increased over the past three years to more than 20 percent of GDP. Yet the region still suffered a deep crisis in 1989.

Part of Latin America's misery no doubt originates from an unfavorable external environment involving the suspension of private loans and worsening terms of trade. Although these factors are important, they do not give us a complete picture of what went wrong in Latin America during the 1980s. Many of the problems derive from domestic mistakes.[1] Since 1982, Latin

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[1] See Williamson (1990) for a discussion of the extent to which adjustment has occurred in Latin America.

American countries have faced the choice between adjustment or accommodation as the two roads of sustained resource transfers abroad. Chile and Mexico chose adjustment, suffered a deep recession, and reformed their economies. After 1984, Chile recovered fast, due to an aggressively depreciating real exchange rate and the revival of both public and private investment. Mexico's recovery is still in process.

Argentina and Brazil chose accommodation. By 1990, Argentina and Brazil's lack of adjustment has resulted in both inflation and recession. The effects of financial instability on investment is clear in the Argentinian case but, to this date, much less apparent in Brazil.

BOX : Adjustment and Accommodation in the 1980s

		Inflation	
		Reduced Inflation in 1989	Hyperinflation in 1989
Income Period	$y_{1989} > y_{1980}$	CHILE	BRAZIL
	$y_{1989} < y_{1980}$	MEXICO	ARGENTINA

In the box above, Chile represents the success story of adjustment and Argentina is the basket case. Brazil and Mexico represent less clear cut cases.

In Brazil, where the real exchange rate after the 1982 debt shock depreciated little compared to the preceding period, the investment share in

GDP fell much less than the investment share in GDP in Argentina, Chile and Mexico, where the real depreciation was large. (See table 2 in section III). Serven and Solimano (1990) survey empirical studies showing an adverse impact of real depreciation on investment. This paper proposes to show that, once the relevant variables (for instance, the terms of trade) are taken into account, the effect of a real depreciation on investment is not significant. I first address the theoretical issue of the relationship between the real exchange rate and the real price of capital. Section II uses a model of a small open economy with four assets to discuss the dynamics of both the real price of capital and the real exchange rate in response to different shocks, including a change in monetary policy, an increase in external interest rates and a deterioration of the terms of trade. In the model (with a nominal exchange rate rule fixed by the central bank) a deterioration of the terms of trade leads to an immediate decline of the real price of capital, followed by a depreciating real exchange rate while the the real price of capital slowly recovers.

Section III explores the determinants of investment in Latin America. The regressions use quadrennial panel data for the period 1970-1985 in Argentina, Brazil, Chile, Colombia, Mexico and Venezuela. Together, these six countries account for 86 percent of the total GDP of the region (Table 1). The decline in private investment shares in Latin America during the 1980s seems to result from the deterioration in the terms of trade, from the decline in growth (resulting from adjustment programs designed to reduce current account deficits), from a reduction in complementary public investment, from increased macroeconomic instability, and from a large stock of foreign debt.

The real exchange rate and the real rate of depreciation have no significant role in the determination of private investment in my regressions.

Table 1: Share of Gross Domestic Output in Regional Output and Growth Rates of Latin American Countries[a]
(percent)

	Share in Total GDP (percent) 1980	Growth Rate of GDP per Capita (percent per year) 1950-80	1981-89[d]
Brazil	34.2	4.2	0.0
Mexico	23.1	3.0	-1.0
Argentina	11.8	1.8	-2.6
Colombia	6.3	2.3	1.5
Venezuela	7.1	1.5	-2.8
Peru	3.9	2.1	-2.7
Chile	3.4	1.8	1.1
Uruguay	1.2	1.4	-0.8
Ecuador	1.6	3.1	-0.1
Guatemala	1.2	1.8	-2.0
Dominican Republic	1.1	2.6	0.2
Bolivia	0.8	1.3	-2.9
El Salvador	0.5	1.3	-1.9
Paraguay	0.7	2.4	0.0
Costa Rica	0.6	3.3	-0.7
Panama	0.5	2.9	-1.9
Nicaragua	0.4	2.3	-3.7
Honduras	0.4	1.4	-1.3
Haiti	0.2	0.7	-2.1
Latin America[b]		2.7	-0.8

[a] Countries ordered by average share in regional GDP between 1950 and 1985;
[b] Latin America except Cuba; [d] preliminary;
Sources: Robert Summers and Alan Heston, "Improved International Comparisons of Real Product and its Composition: 1950-1980," Review of Income and Wealth, June 1984; and ECLAC, Preliminary Overview of the Latin American Economy, 1989.

II. EXCHANGE RATE DYNAMICS AND THE STOCK MARKET

This section focuses on a simple model of the real exchange rate and the real price of capital in order to understand the mechanisms which affect these two variables. I will argue that the negative correlation between investment and real exchange rates observed in the 1980s derives from shocks that reduce the real price of capital and at the same time generate a real depreciation rather than from a causal relationship running from real devaluations to desired lower levels of investment. I develop the argument in the context of flexible exchange rates as well as in the context of economies where the nominal exchange rate is chosen by the central bank.

I start by integrating two separate strands of the literature on monetary policy. The closed economy models emphasize the impact of monetary policy on asset yields and asset prices and the resulting link to investment and aggregate demand. By contrast, the open economy literature shows that, under conditions of capital mobility and flexible exchange rates, changes in net exports, not in investment, are the chief result of monetary policy. This paper integrates the two approaches by introducing the real price of capital as an additional key variable in the open economy macroeconomic model.

In the Mundell-Fleming model, the standard open version of the IS/LM model, a monetary expansion leads to an increase in aggregate demand. The income expansion is entirely due to the exchange rate depreciation, induced by incipient capital outflows. As long as foreign interest rates remain fixed, the monetary expansion has no effects on investment spending. Dornbusch (1976) extended the Mundell-Fleming model to exchange rate expectations and long run price flexibility. In this model, given the

differential speeds of adjustment in goods and assets markets, a monetary expansion leads to an initial overshooting of exchange rates. But, just as in the Mundell-Fleming model, the effects of the monetary expansion come entirely from the change in the relative price of domestic goods and investment spending is not emphasized as a channel of transmission of monetary policy.

Those results stand in contrast with models of the closed economy, where the main channel of transmission from monetary expansions to aggregate demand is the stock market and investment as, for example, in Tobin's analysis. In closed economy IS/LM models, a monetary expansion increases aggregate demand because it reduces interest rates, increases the price of capital and thus induces more investment spending.

The model developed in this section reconciles the two views, showing that in the open economy, with flexible exchange rates, a monetary expansion affects exchange rates and the price of stocks, thus expanding both investment and net exports.

The special features of the model are the presence of a stock market, full long-run flexibility of prices and short-run goods-price stickiness. Stock prices and exchange rates can jump at any point in time. In focussing on the stock market as a channel of transmission for policies, the analysis follows Tobin and Blanchard (1981). In emphasizing differential speeds of adjustment in goods and assets markets as a basis of exchange rate dynamics, the analysis follows Dornbush (1976). I first develop the model under the assumption of full employment and a price level that rises when demand for domestic output exceeds its full employment level. Then I discuss the closed form solution of the dynamic system. An extension of the model

covers the case of an economy with less than full employment. Finally I discuss the model under a crawling peg regime.

The Model

Consider a small open economy, with flexible exchange rates and four assets: money, stocks, short-term domestic bonds, and foreign bonds. Nonmoney assets are assumed to be perfect substitutes and arbitrage ensures that they have the same expected short run rate of return. Therefore, the expected real interest rate on domestic bonds, r^*, must equal the given real interest rate on foreign bonds, $\bar{r}$, plus the expected real depreciation rate, $\dot{e}^*/e - \dot{p}^*/p$:

$$r^* = \bar{r} + \dot{e}^*/e - \dot{p}^*/p \tag{1}$$

We assume in (1) that the foreign inflation rate is zero and thus the real interest rate on foreign bonds is equal to its nominal interest rate. A dot indicates a time derivative, and an asterisk indicates an expectation; e is the nominal exchange rate and p is the price level.

Arbitrage also ensures that the expected real interest on bonds equals the real profit rate, ρ/q, plus expected capital gains, $\dot{q}^*/q$:

$$r^* = \rho/q + \dot{q}^*/q \tag{2}$$

Here q is the real price of stocks in terms of domestic goods and ρ are profits per unit of physical capital. Under the assumption of full employment and a constant capital stock, ρ is constant. The analysis of an economy with

less than full employment and a cyclical relationship between output and expected profits per unit of physical capital is considered later.

The expected real interest rate on domestic bonds is defined as the difference between the nominal interest rate, i, and the expected inflation rate:

$$r^* = i - \dot{p}^*/p \tag{3}$$

Equations (1), (2) and (3) describe arbitrage among stocks and bonds. Since money is held for transactions purposes, it is assumed to be an increasing function of income, y, and an inverse function of the common nominal return on nonmoney assets, i. Portfolio balance obtains when the demand for real cash balances equals the real money stock, $m = M/p$:

$$m = y/vi \tag{4}$$

I assume in (4), following Mundell (1965), that velocity is a linear function of the opportunity cost of holding money. The nominal interest rate is assumed positive.

Equations (1)-(4) determine the price of capital, the nominal exchange rate, and domestic interest rates (q, e, i, r^*) as functions of the foreign interest rate, $\bar{r}$, of the policy variable, M, of the price level, p, and of expectations, $\dot{p}^*$, $\dot{q}^*$, $\dot{e}^*$.

I next specify the behavior of the price level. I assume that prices increase whenever aggregate demand for domestic goods exceeds the full employment level of output. The aggregate demand for domestic goods is made up

of investment spending, of consumers' and government expenditures and of net exports. Following Tobin, investment is an increasing function of the real price of stocks. Consumption is assumed to depend on permanent and transitory income. Under the assumption of full employment and a constant tax structure, consumption is constant. Net exports depend on the real exchange rate, defined as $x \equiv e/p$. A real depreciation raises competitiveness of our goods relative to foreign goods, increasing demand for our goods and reducing our demand for foreign goods. I assume that an increase in the real exchange rate expands net exports. From this argument it follows that the demand for domestic goods exceeds its full employment level whenever the real exchange rate or the real price of stocks exceed their steady state levels. The equation for the rate change of the price level can be written as:

$$\dot{p}/p = \theta(x - \bar{x}) + \phi(q - \bar{q}) \tag{5}$$

where, $\bar{x}$ and $\bar{q}$ are respectively the steady state values of the real exchange rate and price of stocks. θ represents the product of the aggregate demand elasticity in relation to the real exchange rate times the speed of adjustment of prices and ϕ represents the product of the aggregate demand elasticity in relation to the real price of stocks times the speed of adjustment of prices.

The model is closed by assuming rational expectations. It reduces to three differential equations describing the behavior of the real price of stocks, the real exchange rate, and the real money stock:

$$\dot{q}/q = y/vm - \rho/q - \theta(x-\bar{x}) - \phi(q-\bar{q}) \tag{6}$$

$$\dot{x}/x = y/vm - \theta(x-\bar{x}) - \phi(q-\bar{q}) - \bar{r} \tag{7}$$

$$\dot{m}/m = - \theta(x-\bar{x}) - \phi(q-\bar{q}) \tag{8}$$

We have assumed in (8) that the nominal money stock is constant. Thus the growth rate of the real money stock equals the rate of deflation.

In a steady state, $\dot{q} = \dot{x} = \dot{m} = \dot{p} = 0$ and the real price of stocks is equal to the ratio between the real profit rate and the real interest rate:

$$\bar{q} = \rho/\bar{r}$$

Dynamics

I linearize the system formed by equations (6)-(8) around its steady state. The system has three characteristic roots:

$$\lambda_1 = \bar{r}$$

$$\lambda_{2,3} = -A \pm (A^2 + r\,\bar{x}\,\bar{\theta})^{1/2}$$

where: $A = (\bar{x}\theta + \bar{q}\phi)/2$.

Two roots are positive and one is negative. I define the absolute value of the negative root as λ. The steady state is a saddle point equilibrium. Given the value of the real money stock, there is a unique combination of the price of stocks and the exchange rate, such that the economy converges to the steady state. The equations of motion along the stable arm are:

$$m(t) = [m(0) - \bar{m}]e^{-\lambda t} + \bar{m} \tag{9}$$

$$q(t) = (\bar{q}/\bar{m})\, m(t) \tag{10}$$

$$x(t) = (\bar{x}/\bar{m})\, B\, [m(t) - \bar{m}] + \bar{x} \tag{11}$$

where: $B = 1 + \bar{r}/\lambda$. Observe that $B > 1$.

In response to a shock, granted that the price of stocks and the exchange rate jump to place the economy on the stable path to equilibrium, the adjustment process is faster the larger the elasticities of aggregate demand in relation to the real price of stocks and in relation to the exchange rate; the faster prices move in response to excess demand; and the larger the foreign interest rate.

Comparative Dynamics

Consider an unanticipated monetary expansion. Steady state real price of capital, interest, and real exchange rates are invariant to nominal money, which only affects prices proportionately in the long run. To understand the short run effects of a monetary expansion, I assume that the economy is initially in steady state when the unanticipated expansion in nominal money occurs. When it does take place, real balances increase as the price level does not adjust instantaneously. The nominal interest rate fails to maintain portfolio equilibrium and the expected inflation rate further decreases the expected real interest rate on domestic bonds. Arbitrage makes for an immediate depreciation of the exchange rate and an immediate jump of the price of stocks. As the price level increases, real balances fall. Consequently,

interest rates start to increase, the exchange rate slowly appreciates, q falls and the economy returns to steady state equilibrium. The process of adjustment is illustrated in figure 2.

Observe that initially, the exchange rate movement exceeds that of the capital price. At t(0), when the monetary expansion takes place, the exchange rate relative to the value of stocks is:

$$e(0)/p(0)q(0) = B\bar{x}/\bar{q}$$

where $\bar{x}$ and $\bar{q}$ are the values of x and q in the initial steady state and $B > 1$.

The reason why the exchange rate depreciation has to exceed the initial increase in the price of stocks rests on the fact that expected movements in q affects both the real profit rate and the expected capital gains, while movements in the exchange rate only affect expected capital gains, as can be seen in the arbitrage equation below:

$$i - \dot{p}^*/p = \rho/q + \dot{q}^*/q = \bar{r} + \dot{e}^*/e - \dot{p}^*/p$$

The initial jump in the price of stocks increases investment spending. The initial jump of the exchange rate maskes domestic goods more competitive. Both effects contribute to an incrase in aggregate demand and create inflation. As the price level increases the economy returns to the steady state.

An extension For Economies With Less Than Full Employment

I now extend the analysis to the case of economies described by IS/LM type models, where output is assumed to be determined by aggregate demand, yd:

$$y = yd \tag{12}$$

We re-write the equation for the slow adjustment of prices:

$$\dot{p}/p = h(1 - yd/\bar{y}) = \theta(x - \bar{x}) + \phi(q - \bar{q}) \tag{5'}$$

where $\bar{y}$ is the steady state level of output and h is the speed of adjustment of prices. It follows that:

$$yd/\bar{y} - 1 = (z/h)(x - \bar{x}) + (\phi/h)(q - \bar{q}) \tag{13}$$

We next consider the cyclical behaviour of profits. IS/LM models assume mark-up pricing and a constant capital stock. Those assumptions imply that profits per unit of physical capital are an increasing function of output:

$$\rho = ay \tag{14}$$

We substitute (12) and (14) in the system of differential equations formed by (6)-(8). Linearization of this system around its steady state gives:

$$\begin{bmatrix} \dot{q} \\ \dot{x} \\ \dot{m} \end{bmatrix} + \begin{bmatrix} \bar{q}\phi - \bar{r} & \bar{q}\theta & \overline{rq}/\bar{m} \\ \bar{x}\phi\gamma & \bar{x}\theta\gamma & \overline{rx}/\bar{m} \\ m\phi & m\theta & 0 \end{bmatrix} \begin{bmatrix} q - \bar{q} \\ x - \bar{x} \\ m - \bar{m} \end{bmatrix} = 0$$

where $\gamma = 1 - \bar{r}/h$

This system has three characteristic roots: $z_1 = \bar{r}$ and $z_{2,3} = -F \pm (F^2 + \bar{r}\,\bar{x}\,\theta)^{1/2}$, where $F = (\bar{q}\phi + \bar{x}\theta\gamma)/2$. As before, two roots are positive and one is negative. The steady state is a saddle point equilibrium.

We can distinguish two cases. If prices move fast, $h > \bar{r}$ and $1 > \gamma > 0$. I call the absolute value of the negative root in this case $\bar{z}$.

If prices move very slowly, $h < \bar{r}$, $\gamma < 0$ and $\bar{q}\phi < \bar{x}\theta|\gamma|$. We call the absolute value of the negative root under those last assumptions $\underline{z}$.

We can immediately verify that $\dot{\bar{z}} < \bar{z} < \lambda$, where λ is the absolute value of the negative root in the model with full employment. I conclude that the speed of adjustment in response to monetary shocks in an economy with less than full employment is slower than in the case of fully employed economies. During the adjustment process to the steady state, in addition to inflation (or deflation) I also observe levels of activity above (or below) the activity level in steady state.

For economies with less than full employment where prices move relatively fast, the equations of motion along the stable arm are:

$$m(t) = [m(0) - \bar{m}]\, e^{-\bar{z}t} + \bar{m} \tag{15}$$

$$q(t) = (\bar{q}/\bar{m})\, m(t) \tag{16}$$

$$x(t) = (\bar{x}/\bar{m})\, H\, [m(t) - \bar{m}] + \bar{x} \tag{17}$$

where: $H = 1 + \bar{r}[(1/\bar{z}) - (1/h)]$.

If prices move fast, h is large and $H > 0$. In this case, the effects of a monetary expansion are qualitatively the same as in the case of the fully employed economy. It leads to an overshooting of the exchange rate, a jump of the price of stocks, and an increase in aggregate demand. To the inflationary effects obtained in the fully employed economy I must now add an output expansion. The increase in output increases demand for real balances leading to an initial reduction of the interest rate that is smaller than in the case of the fully employed economy. It follows that the overshooting of

the exchange rate in the present case is smaller than in the case of the fully employed economy.[2]

Note that in (10) and (16), q(0) is the same. This result can be readily understood. The expected cyclical profits that did not exist in the full employment case, are now discounted at higher interest rates, arising from the cyclical increase in the demand for real cash balances.

The model developed here is also useful in the analysis of external shocks. Consider, for instance, an increase in the steady state foreign interest rate. It raises expected domestic interest rates by the same amount, reducing demand for real cash balances: the exchange rate immediately depreciates and the price of stocks immediately falls. As a consequence the composition of aggregate demand changes, as net exports substitute for investment spending.

The Model with a Crawling Peg

Consider once again the system described by equations (1)-(4). Under a managed exchange rate, money becomes endogenous and I can drop equation (4).

Assume that the central bank avoids overvaluation by following a crawling peg and devaluing the exchange rate in response to increases in

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[2] Observe that $H < B$. In economies where prices move very slowly, the possibility of undershooting arises. For this perverse case to obtain, the elasticity of aggregate demand in relation to the real price of capital has to be large enough to generate an income expansion and thus an increase in the demand for money that would exceed the initial expansion in real balances.

domestic prices in excess of increases in foreign prices. The central bank also looks at the current account and devalues faster if the exchange rate is overvalued. The central bank adopts the following devaluation rule:

$$\dot{e}/e = \dot{p}/p - \alpha(x - \bar{x}) \tag{18}$$

Our system is now formed by equations (1), (2) and (18). In steady state, the real price of capital and the real exchange rate are constant:

$$\dot{q}/q = 0 = \bar{r} - \alpha(x - \bar{x}) - \rho/q \tag{19}$$

$$\dot{x}/x = 0 = -\alpha(x - \bar{x}), \quad \text{i.e.,} \quad x = \bar{x} \tag{20}$$

This system is represented in figure 3. The upward sloping schedule, $\dot{q}/q = 0$, represents the combinations between the real exchange rate, x, and the real price of capital, q, for which the real price of capital is constant. To the left of the schedule $\dot{q}/q = 0$, the real price of capital is increasing and it is rising to its right.

The vertical schedule $\dot{x}/x = 0$ cuts the x axis at the equilibirum real exchange rate, $\bar{x}$. If $x > \bar{x}$, the real exchange rate is falling; it is rising if $x < \bar{x}$.

Figure 3 also shows the unique path to equilibrium. The real price of capital can jump at any point in time, but the real exchange slowly follows the central bank rule.

An Adverse Terms of Trade Shock

A permanent decline in the terms of trade requires a higher real exchange rate in the new equilibrium and shifts both schedules to the right, as shown in figure 4. In response to the shock, the real price of capital immediately falls because the expected real depreciation increases the domestic real interest rate above the foreign interest rate. From then on, as the real exchange rate depreciates, the real price of capital slowly recovers. During the adjustment process, the real price of capital and investment are below their equilibrium levels.

One might expect that a permanent deterioration of the terms of trade would also reduce the real profit rate, ρ. In that case, the schedule $\dot{q}/q=0$ would shift further to the right, moving the new equilibrium to a point below the one represented in figure 4. In this case, the real price of capital would instantaneously fall more than before. Although it would increase during the adjustment process, it would be permanently lower than under the hypothesis represented in figure 4.

IV. THE EMPIRICAL EVIDENCE

This section discusses the empirical evidence from regressions of the private investment share in GDP on a group of variables including the log of the terms of trade. The regressions use quadrennial panel data for the period 1970-1985 in Argentina, Brazil, Chile, Colombia, Mexico and Venezuela. These countries account for 86 percent of the total GDP of Latin America. The data is reported in Appendix 3.

Real Exchange Rates and Investment

The positive correlation between the decline in investment shares in GDP in the 1980s and the real depreciation observed after the debt shock (table 2) can mislead us to believe that the real depreciation caused the decline in investment.

Serven and Solimano (1990) survey mechanisms linking devaluations to investment as well as empirical studies that find a negative impact of devaluations on investment.[3] The rationale for these findings include the following. First, the adverse real income effect of real depreciation (following the line of the "contractionary devaluation" literature) could

TABLE 2
Real Depreciation and Changes in Real Investment Shares

	Percent Change in Effective Real Exchange Rates 1982-88 relative to 1980-81[a]	Percent Change in Investment Share in GDP 1982-88 relative to 1980-81
Argentina	-39.3	-29.5
Brazil	- 8.4	-14.0
Chile	-22.2	-36.6
Colombia	-13.3	-2.6
Mexico	-26.5	-24.9
Venezuela	- 4.4	-23.2

[a] Morgan Guaranty defines the real exchange rate as domestic prices divided by foreign prices. A minus sign thus indicates a depreciation.
Sources: Morgan Guaranty and World Bank

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[3] See for instance Faini and Melo (1990).

reduce firms' desired capacity. Second, without monetary accommodation, exchange depreciation may result in higher interest rates and depress investment. If these are the channels of transmission, one would not expect to find a significant negative coefficient of real depreciation in an investment regression where both income and interest rates are included. A third argument is also used. Because a devaluation might raise the cost of imported capital, it might lead to a decline in investment. This would be true in the non-traded goods sector, but not for investment in the traded goods sector. Thus, there is an uncertain effect of real devaluations on aggregate investment. One should also observe that the higher cost of imported capital could encourage investment with a high domestic component in preference to investment with high foreign exchange content without affecting the level of investment.

Serven (1990) assumes an exogenous real exchange rate. He shows that the long run effect of a real devaluation is ambiguous while an anticipated real exchange rate depreciation provides an incentive for a speculative reallocation of investment over time. When a real depreciation is expected, an investment boom is likely to develop if the import content of capital goods is high relative to the degree of capital mobility (the expected depreciation promotes flight into foreign goods). The boom will be followed by a slump when the depreciation takes place because such devaluation amounts to a removal of a subsidy to investment. With high capital mobility the anticipated depreciation promotes flight into foreign assets and the opposite investment pattern described above.

In the previous section I used a model with a crawling peg where the real exchange rate is determined jointly with the real price of capital.

In that model, an expected real depreciation rate (in response to an adverse terms of trade shock) and temporarily raises the domestic real interest and reduces the real price of capital below its equilibrium level. The deterioration in the terms of trade causes both the real depreciation and the reduction in the real price of capital and investment. Our results, obtained in a model with perfect capital mobility, are consistent with Serven's results for his case of high capital mobility.

The first regression in table 3 shows a strong positive effect of an improvement in the terms of trade on investment. Table 3 also reports the

TABLE 3: REGRESSION ANALYSIS
Quadriennial Panel Data
Periods: 1970-73, 1974-77, 1978-81, 1982-85
Countries: Argentina, Brazil, Chile, Colombia, Mexico, Venezuela
Number of Observations: 24
Constant term not reported, t-statistics in parentheses.

Dependent Variable: Share of Private Investment in GDP

Independent Variables:

Growth Rate of GDP	Share of Public Investment in GDP	Log of Terms of Trade	Index of the Real Exchange Rate	Rate of Appreciation of the Real Exchange Rate	R^2
.81	.89	-6.77			
(6.72)	(4.39)	(-2.62)			.74
.81	.75		.003		
(5.04)	(3.24)		(.07)		.65
.81	.75			.002	
(5.67)	(3.20)			(.02)	.65

reaction of the private investment share in GDP in response to growth, to movements of the share of public investment in GDP, to the index of the real exchange rate, and to the rate of real appreciation. I cannot reject the hypothesis that the coefficients of the real exchange rate and of real apreciation are zero. Growth, the share of public investment in GDP, and the terms of trade explain 74 percent of the variation of the private investment share in output.

Private and Public Investment

In Latin America, a high proportion of investment is accounted for by the public sector. Between 1985 and 1988, public investment accounted for more than half of total investment in Bolivia, for approximately half of total investment in Argentina, Chile, and Colombia and for more than one third of investment in Brazil, Uruguay, and Venezuela. Public enterprises dominate a wide range of economic activities including banking, transport, and mining industries. In many countries the explanation for the large participation of government in production lies in considerations such as the absence of a private sector able to undertake major projects. Even though the performance of the public sector has been strongly criticized, the empirical evidence shows that there is an important complementarity between public and private investment. Government investment in fixed capital crowds in private investment, possibly because it increases productivity by providing infrastructure and services. In our regressions a one percentage point increase in the share of public investment in GDP raises the share of private investment in GDP by more then half a percentage point.

Complementarity between private and public investment does not rule out the possibility that an increase in total government spending, rather than

just on investment outlays, could crowd out private investment. An increase in total spending not financed by an increase in taxes provokes a deficit which is in part financed by borrowing from the local credit market. This form of financing can have a detrimental effect on private investment. High fiscal deficits push up interest rates and reduce the availability of credit to the private sector.

TABLE 4: REGRESSION ANALYSIS
Quadriennial Panel Data
Periods: 1970-73, 1974-77, 1978-81, 1982-85
Countries: Argentina, Brazil, Chile, Colombia, Mexico, Venezuela
Number of Observations: 24
Constant term not reported, t-statistics in parentheses.

Dependent Variable: Share of Private Investment in GDP

Independent Variables:					
Growth Rate of GDP	Share of Public Investment in GDP	Log of Terms of Trade	Stock Share of Claims on Government in Total Domestic Credit	Flow Share of Claims on Government in Total Domestic Credit	R^2
.74	.62		-1.06		
(5.26)	(2.64)		(-1.48)		.68
.76	.78	-6.21	-.78		
(5.98)	(3.52)	(-2.39)	(-1.18)		.76
.74	.75			-1.38	
(5.17)	(3.47)			(-1.42)	.68
.76	.88	-6.25		-1.00	
(5.89)	(4.35)	(-2.39)		(-1.13)	.76

Departing from the hypothesis of perfect capital markets, I test for crowding out, introducing the share of claims on government in total domestic credit as a variable in our regressions. I use in one equation the share of the stock of claims on government in the stock of domestic credit and in the other the share of the flow of claims on government in the total domestic credit flow. In all equations, the coefficients are negative as expected, but the t-statistics are small.

Instability and Investment

Bernanke (1983) shows that irreversible investment invites delay, as entrepreneurs wait for the resolution of uncertainty. Firms are cautious in their decisions to expand capacity because under uncertainty, investment today can lead to excessive capacity tomorrow if circumstances change.

Substantial budget deficits have created financial instability in many Latin American countries such as Argentina and Peru. In these countries, volatility of output, interest rates, relative prices, and inflation increase uncertainty and, thus, reduce investment.

The need to carry out an external transfer to creditors represents another source of uncertainty in the investment climate because carrying out the transfer in the future may require tax increases and changes in relative prices.

The regressions in table 5 test the hypothesis that uncertainty affects the private investment share in Latin America by bringing into the picture two additional variables, one at a time. One of the new variables is the log of the ratio of the total external debt to exports. The coefficient of

TABLE 5: REGRESSION ANALYSIS
Quadriennial Panel Data
Periods: 1970-73, 1974-77, 1978-81, 1982-85
Countries: Argentina, Brazil, Chile, Colombia, Mexico, Venezuela
Number of Observations: 24
Constant term not reported, t-statistics in parentheses.

Dependent Variable: Share of Private Investment in GDP

Independent Variables:

Growth Rate of GDP	Share of Public Investment in GDP	Log of Terms of Trade	Index of Economic Instability	Log of the Ratio of External Debt to Exports	R^2
.81	.89	-6.77			
(6.72)	(4.39)	(-2.62)			.74
.66	.69		-1.55		
(4.23)	(3.25)		(-1.79)		.70
.71	.83	-5.86	-1.07		
(4.90)	(4.06)	(-2.22)	(-1.29)		.76
.70	.63			-3.55	
(4.98)	(2.93)			(-2.01)	.71
.74	.79	-5.49		-2.23	
(5.59)	(3.65)	(-2.00)		(-1.26)	.76

the variable standing for the debt overhang has the expected negative sign. Its t-statistic is larger than 2 in the equation that does not include the terms of trade but in the equation that includes the terms of trade, the coefficient for the debt overhang is not significant.

The other variable used to test the effect of macroeconomic instability on private investment is an index of instability built by adding the log of the debt ratio, the log of (1+the inflation rate) and the log of the coefficient of the variation of the real exchange rate (calculated from monthly data during each of the four-year periods). Once again, the coefficient has the expected negative sign but is not significant in the equation which includes the log of the terms of trade.

Concluding Remarks

The regressions in tables 3, 4 and 5 show that growth, the share of public investment in GDP, and the log of the terms of trade explain 74 percent of the variation of the private investment share in output. The coefficients of these variables are significant and stable across specifications. One percentage point increase in the growth rate increases the private investment share in output by less than one percentage point. This result is consistent with other empirical studies that find a strong response of investment to changes in output.[4] Our regressions dampen the scope for any "excessive"[5] output-related variability of investment in the cycle by using four-year averages for the variables.

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[4] See regressions for 24 developing countries in Blejer and Khan (1984). They find an important positive effect on private investment from the degree of capacity utilization and availability of credit. They also find evidence of public investment in infra-structure crowding in private investment.

[5] High coefficients of the variable standing for change in output in investment regressions are considered excessive because part of output fluctuations are transitory.

In our regressions a one percentage point increase in the share of public investment in GDP raises the share of private investment in GDP by more than half percentage point, confirming the hypothesis of complementarity between private and public investment. This complementarity does not rule out the possibility that an increase in the budget deficit crowds out private investment. I tested the hypothesis that government borrowing from the local credit market crowds out private investment. In all equations, I found the expected negative coefficients, but small t-statistics.

The coefficients of the variables standing for the debt overhang and macroeconomic volatility had the expected negative signs but small t-statistics in the regressions including the terms of trade.

In all equations, the effect of an improvement in the terms of trade on investment was large and significant.

Both the real exchange rate and the real rate of depreciation had no effect on investment behavior.

APPENDIX 1: EMPIRICAL STUDIES OF INVESTMENT IN LATIN AMERICA

Investment regressions for Latin America use models that combine elements of different theories.

Behrman (1972) explores the validity of putty-putty versus putty-clay assumptions across a number of different economic sectors in Chile and finds that investment functions differ across sectors.

Billsborrow (1977) shows that the availability of foreign exchange to implement planned capital formation and the internal flow of funds were the most important determinants of investment in Colombia.

Dailami (1987) found a negative relation between cyclical behavior of private investment in Brazil and stock market volatility.

Musalem (1989) shows that investment in Mexico is responsive to the real interest rate, the relative price of investment, and the rate of capital utilization and that there are complementary links between public and private investment.

Ocampo (1990) surveys the literature on determinants of investment in Colombia. The evidence suggests that domestic demand is the major determinant of investment in Colombia. Simple accelerator models explain a large proportion of the variance of manufacturing investment. Investment is also sensitive to the relative price of capital goods, to direct import controls, to internal funds of the manufacturing firms, and to long-term credit availability.

Pinheiro and Matesco (1988, 1989) calculate historical series for the incremental capital/output ratio in Brazil since 1948.

Solimano (1989) studies the impact of cycles of economic activity, relative prices, and policy inconsistencies on investment in Chile.

APPENDIX 2: LOOKING AT INVESTMENT SHARES IN GDP

The data for Latin American investment shares in GDP from different sources present many discrepancies. This section compares statistics from a number of sources and tries to explain the differences. It compares the data for 18 Latin American countries[6] from Summers and Heston (1988) and the data for 13 Latin American countries from the World Bank (Faini and de Melo (1990)). Both represent the share in GDP of total gross investment including variations in stocks. Summers' data represents real gross investment divided by real GDP while the World Bank data represents nominal gross investment divided by nominal GDP. Much of the difference between the two series derives from the use of investment and GDP deflators used by Summers and Heston.

We explore these differences a bit further by looking at the data for Chile and Brazil. The World Bank data for total nominal investment shares in the case of Chile are exactly the same as the data published by the Banco Central de Chile. Figure 5 plots total gross investment shares in GDP as well as the share in GDP of the gross fixed capital formation. The shares of total investment (which includes variation in stocks) moves more widely than the shares of fixed capital formation. Strangely, the variation of stock in a given year can appear as positive when expressed in nominal terms and negative when expressed in real terms. The explanation is that variations in stocks in Chile are calculated as a residual.

The Banco Central de Chile also provides information on real investment shares. Figure 6 shows the shares of total nominal investment in

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[6] Latin America includes 20 countries. Our table excludes Cuba and Haiti.

nominal GDP and the shares of total real investment on real GDP. After 1974, when Chilean major inflation episodes come to an end, the two series are very similar. Of course, because the relative price of capital can move, there is no reason to expect that the real and nominal shares should coincide. But, in general, very high inflation seems to introduce uncertainty about the accuracy of deflators in many Latin American countries.

Figure 7 shows the data for real gross investment divided by real GDP from Summers and Heston and the data from the Banco Central. They follow broadly the same pattern, but the shares reported by Summers and Heston are almost twice as large as the data reported by the Banco Central. This large discrepancy comes from the very different deflators used in the two sources. Data from Summers and Heston also show much larger shares than one would tend to believe for the case of Argentina as well, but not for all other countries.

I now look at the investment shares in Brazil between 1970 and 1988. The national accounts methodology has changed recently and the data for years before 1970 has not been revised. The Instituto Brasileiro de Geografia e Estatistica responsible for the Contas Nacionais published in Conjuntura Economica recommends one not to link the new data with different series. Also, there is no information on variation of stocks from 1985 on. Thus, the only available data after 1985 is for fixed capital formation, not for total investment. The World Bank links data for total investment between 1970 and 1979 with data for fixed capital formation between 1980 and 1986.

Figure 8 compares the shares of real total investment in real GDP reported by Summers and Heston and by Conjuntura Economica, Contas Nacionais. After 1978, the two sources report almost the same numbers. Summers' shares

are larger in the 1970s and thus show a much bigger decline in real investment share in the 1980s relative to the 1970s than the data from Conjuntura Economica.

Figure 9 shows real and nominal shares from Conjuntura Economica. They follow broadly the same pattern until 1986. Inflation accelerated after 1986 and relative prices moved significantly. The price of investment goods increased less than the price of other GDP components in 1987.

APPENDIX 3: DATA USED IN THE REGRESSIONS

- Share of private investment in GDP and Share of public investment in GDP Average of the annual shares during each of the four-year period. Source: World Bank, except for Brazil because of the discontinuity in the World Bank data discussed in the previous appendix. For Brazil I used the shares of private and public total fixed capital formation, reported in the Contas Nacionais.
- Growth rate of real GDP: Average of the annual rates during the four-year period. Source: Economic Commission for Latin America and the Caribbean.
- Log of the Terms of Trade: Log of the average of the yearly indices relative to the country average in the whole period. I also used the log of the average of the yearly indices with almost the same results. Source: World Bank, World Tables, 1989-90 edition.
- Index of the Real Effective Exchange Rate: Average of the monthly indices during the four-year period. Also used deviations from the country average

for the whole period with basically the same results. Source: Morgan Guaranty.

- Average Real Appreciation Rate during the period: Average of the yearly real appreciation during the four year period, calculated from the index above.
- Log of the Coefficient of Variation of the Real Exchange Rate: The coefficient of variation was calculated from the Morgan Guaranty monthly data during each of the four-year periods.
- Log of (1+Inflation Rate): The inflation rate is the four-year period average inflation rate per year of consumer prices. Source: IMF, IFS.
- Log of the ratio: (Total External Debt outstanding at the end of the year/Exports of Goods and Services). Both the total external debt and exports are from World Bank, World Tables, 1989-90 edition.
- Log of the ratio: (Stock of Claims on Government/Stock of Domestic Credit) The ratio is (1 - (line 32d/line32), where line 32d represents claims on the private sector. Data for Chile is reported only until 1984. The 1985 numbers were obtained by telephone. Source: IMF, IFS.

REFERENCES

Behrman, J. (1972) "Sectoral Investment Determination in Developing Economy," American economic Review.

Bernanke, B. (1983) "Irreversibility, Uncertainty and Cyclical Investment," Quartely Journal of Economics.

Bilsborrow, R. (1977) "The Determinants of Fixed Investment by Manufacturing Firms in a Developing Country," International Economic Review.

Blanchard, O. (1981) "Output, the Stock Market and Interest Rates," American Economic Review.

Blejer, M. and M. Khan (1984) "Government Policy and Private Investment in Developing Countries," IMF Staff Papers.

Dailami, Mansoor (1987) "Expectation, Stock Market Volatility and Private Investment Behavior: Theory and Empirical evidence for Brazil," Washington D.C., World Bank, mimeo.

Dornbusch, R. (1976) "Expectations and Exchange Rate Dynamics," Journal of Political Economy.

Faini, R. and J. de Melo (1990) "Adjustment, Investment and the Real Exchange Rate in Developing Countries," Washington D.C., World Bank: mimeo.

Greene, J. and D. Villanueva (1990) "Private Investment in Developing Countries: An Empirical Analysis," IMF: mimeo, Washington D.C.

Mundell, R. (1965) "Growth, Stability and Inflationary Finance," Journal of Political Economy.

Musalem, A. (1989) "Private Investment in Mexico: An Empirical Analysis," Washington D.C.: The World Bank, Working Paper 183.

Occampo, J. A. (1990) "Investment Determinants and Financing in Colombia," World Bank Conference on "Latin America: Facing the Challenges of Adjustment and Growth," Caracas, mimeo.

Pinheiro, A. Castelar and V. Matesco (1988) "Investimento em Capital Fixo na Economia Brasileira: estimativas trimestrais para o Periodo 1975-87," Rio de Janeiro: IPEA, Texto Para Discussao no. 135.

Pinheiro, A. Castelar and V. Matesco (1989) "Relacao Capital/Produto Incremental: Estimativas Para o Periodo 1948-87," Rio de Janeiro: IPEA, mimeo.

Sachs, J. (1981), "The Current Account and Macroeconomic Adjustment in the 1970's", Brookings Papers on Economic Activity, pp. 201-269.

Serven, L. and A. Solimano (1990) "Private Investment and Macroeconomic Investment: A Survey," Washington D.C.: The World Bank, mimeo, August.

Serven L. and A. Solimano (1990) "Private Investment and Macroeconomic Adjustment in LDCs: Theory, Country Experiences and Policy Implications," Washington D.C.: The World Bank, mimeo, August.

Solimano, A. (1989) "How Private investment Reacts to Changing Macroeconomic Conditions: The Case of Chile in the 1980s," ashingotn D.C.: World Bank, Working Paper 212.

Williamson, J. (1990) Latin American Adjustment: How Much Has Happened? Washington D.C.: Institute for International Economics.

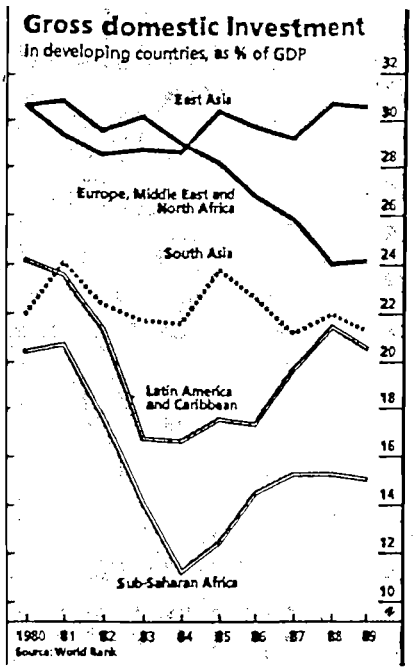
Gross domestic Investment
In developing countries, as % of GDP
East Asia
Europe, Middle East and North Africa
South Asia
Latin America and Caribbean
Sub-Saharan Africa
32
30
28
26
24
22
20
18
16
14
12
10
1980 81 82 83 84 85 86 87 88 89
Source: World Bank

FIGURE 1

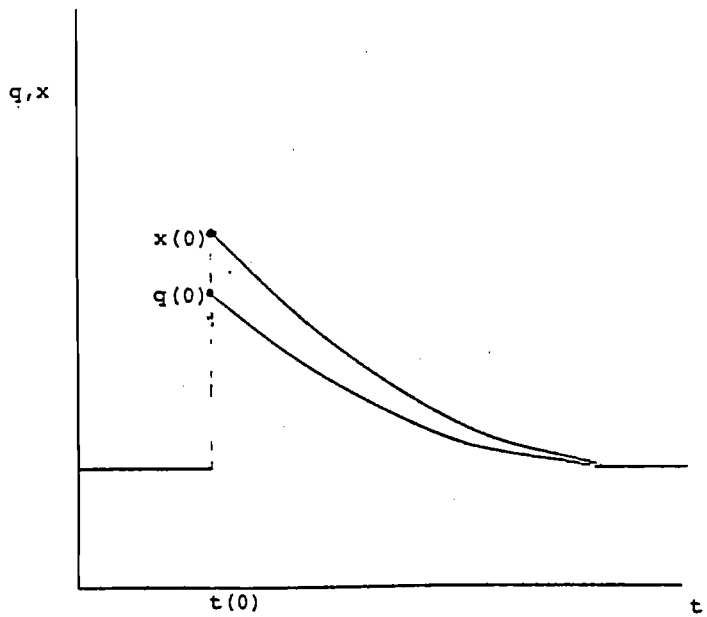

FIGURE 2

Note: In the model I define the real exchange rate as foreign prices/domestic prices. An increase in the real exchange rate indicates a real depreciation.

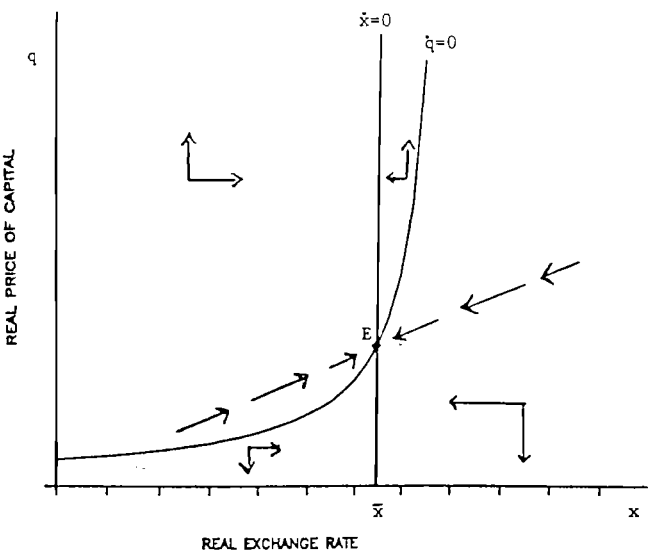
q
REAL PRICE OF CAPITAL
$\dot{x}=0$
$\dot{q}=0$
E
$\bar{x}$
x
REAL EXCHANGE RATE

FIGURE 3

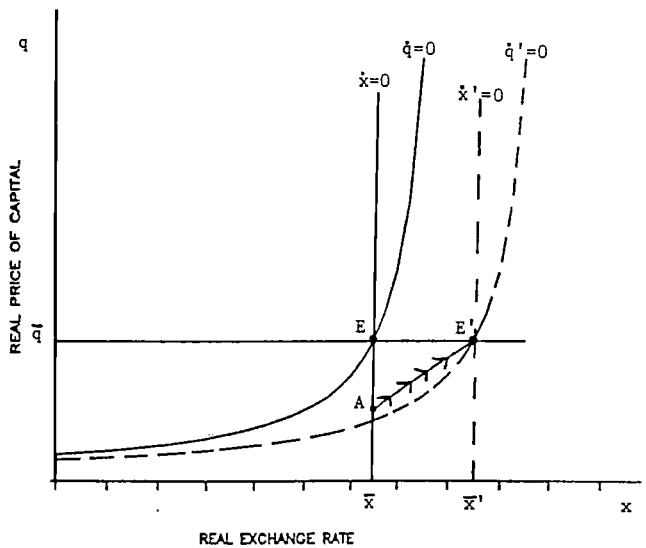
q
REAL PRICE OF CAPITAL
q_1
$\dot{q}=0$
$\dot{x}=0$
$\dot{x}'=0$
$\dot{q}'=0$
E
E'
A
$\bar{x}$
$\bar{x}'$
x
REAL EXCHANGE RATE

FIGURE 4

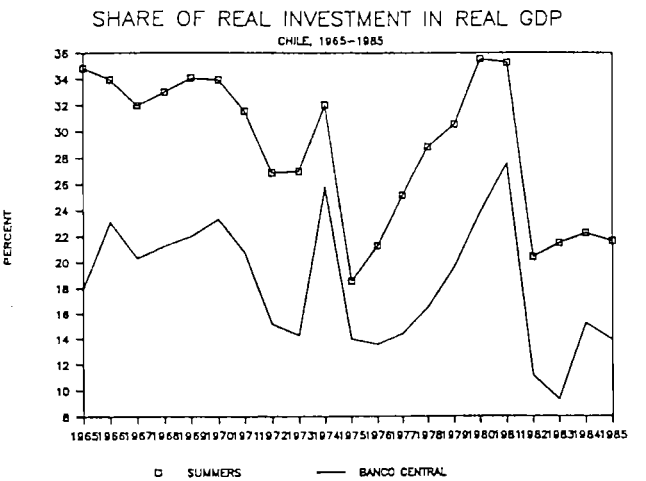
SHARE OF REAL INVESTMENT IN REAL GDP
CHILE, 1965-1985
PERCENT
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985
SUMMERS
BANCO CENTRAL

Figure 5

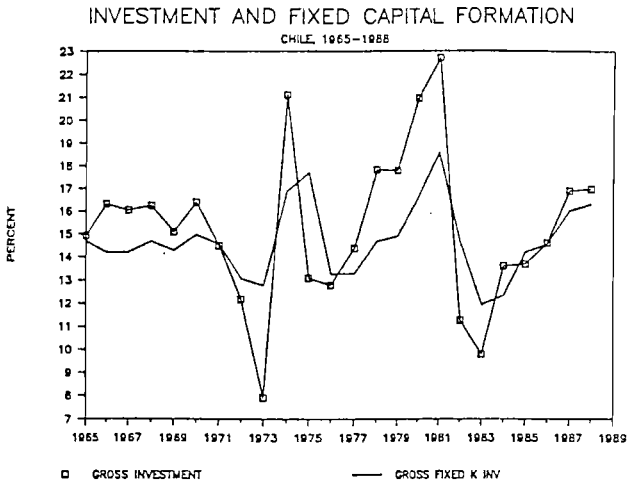

Figure 6

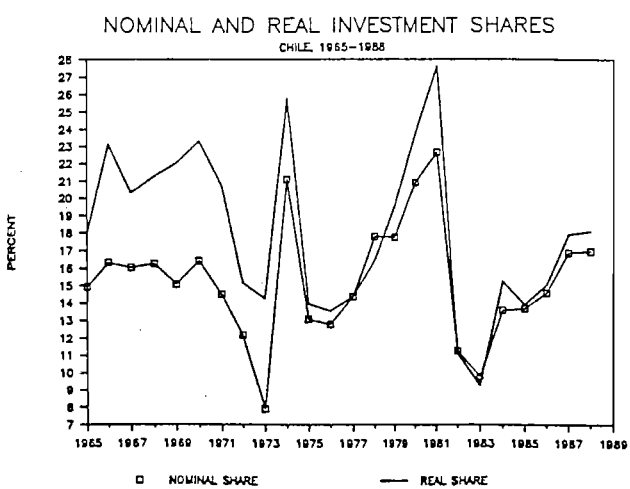

Figure 7

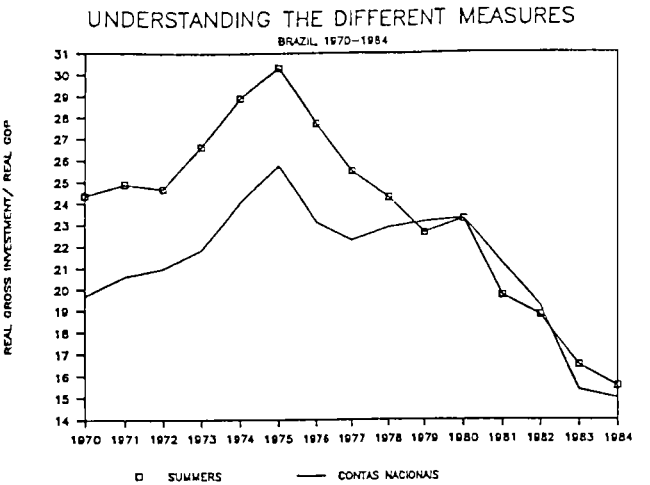

Figure 8

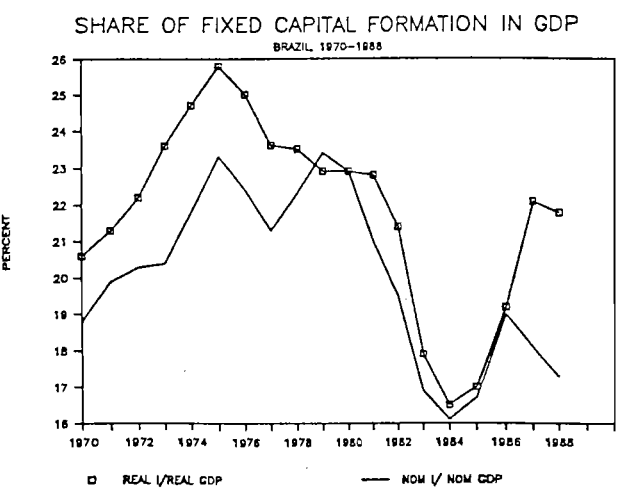

Figure 9