PRIVATE INVESTMENT AND MACROECONOMIC ADJUSTMENT
A Survey

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This article reviews theories of investment behavior and examines empirical studies of investment in developing countries. The emphasis is on understanding the interactions among macroeconomic policies, structural adjustment, and private investment. The article deals with the effect of exchange rate policy on investment, the relationship between public and private investment, the importance of market imperfections and financial constraints on capital formation, and the effect of economic instability on irreversible investment decisions.

The correction of external imbalances in many developing countries during the 1980s took the form of large cuts in investment rather than increases in domestic savings. This decline in investment, which mirrored the decline in the transfer of external resources after 1982, was especially sharp in the highly indebted countries and was accompanied by slowed growth in these and other developing countries. In addition, both public and private rates of investment fell, although the decline in private investment was more drastic. If this trend continues, it will slow potential growth in these economies and will reduce long-run levels of per capita consumption and income, endangering the sustainability of the adjustment effort.

This reduction in investment seems to reflect several factors. First, the decline in the availability of foreign savings has not been matched by a

corresponding increase in domestic savings. Second, the deterioration of fiscal conditions due to cuts in foreign lending, higher domestic interest rates, and the acceleration of inflation in several countries forced a fiscal adjustment that in many cases took the form of a contraction in public investment. Third, the macroeconomic instability associated with external shocks has hampered private investment. And fourth, the debt overhang has discouraged investors through its implied tax on future output and the ensuing credit constraints in international capital markets.

In many countries, macroeconomic adjustment has not improved the response of private investment. Even when substantial progress has been made in correcting imbalances and restoring profitability—often through drastic cuts in real wages—the effect on private investment has been weak and slow to appear. Many of these issues are difficult to explain in the context of conventional investment theories. We review here recent developments in investment theory and empirical studies on investment in developing countries to explain some features of investment behavior that were important in the 1980s:

- The relation between public and private investment that results from the traditional financial crowding-out effect and the physical complementarity between public and private capital.
- The importance of imperfections in financial markets and financial constraints in a world of imperfect and asymmetric information.
- The effects of changes in the real exchange rate on the volume, timing, and composition of investment. These effects are especially important in developing countries because of the typically high import content of investment.
- The irreversible nature of most investments, which makes private investors particularly sensitive to risk and dampens their response to changes in economic incentives.
- The complex relationship between the foreign debt overhang and the volume of private investment.
- The dependence between the returns to individual investors and the level of aggregate investment, which makes possible a failure in coordination. Such a failure can leave the economy trapped in a low-investment, low-growth equilibrium after adjustment.

In this article we first review theories of investment. Then we examine the effect of monetary, fiscal, and exchange rate policies on private investment, emphasizing economic or institutional features that are specific to developing countries (for instance, pervasive rationing in financial markets, complementarities between public and private investment, considerable reliance on imported capital goods, and shifts in income distribution). Such features may determine how macroeconomic policies influence private investment. Finally we examine recent literature on credibility, uncertainty, and irreversibility in investment decisions, and look at how such factors influence the investment response.

Investment Theory

Keynes (1936), who first called attention to the existence of an independent investment function in the economy, observed that investment depends on the prospective marginal efficiency of capital relative to some interest rate reflecting the opportunity cost of the invested funds. He pointed out that private investment was intrinsically volatile since any rational assessment of the return on investment was bound to be highly uncertain. The "animal spirits" of private investors would be the main driving force in investment decisions.

After Keynes, the evolution of investment theory was linked to simple growth models. These models gave rise to the accelerator theory, popular in the 1950s and early 1960s and widely used even today in practical growth exercises. The accelerator theory makes investment a linear proportion of changes in output. Its extreme simplicity explains its popularity: given an incremental capital-output ratio, it is easy to compute the investment requirements associated with a given target for output growth. In this model, expectations, profitability, and capital costs play no role.

The restrictive assumptions behind the accelerator theory led Jorgenson (1967) and Hall and Jorgenson (1971) to formulate the neoclassical approach. In this approach the desired (or optimal) capital stock depends on the level of output and on the user cost of capital (which in turn depends on the price of capital goods, the real interest rate, and the depreciation rate). Lags in decisionmaking and delivery create a gap between the current and desired capital stocks, giving rise to an investment equation, that is, an equation for the change in the capital stock.

The foundations of this approach have been criticized on the grounds that the assumptions of perfect competition and exogenously given output are inconsistent; that the assumption of static expectations about future prices, output, and interest rates is inappropriate, since investment is essentially a forward-looking process; and that the lags in delivery are introduced in an ad hoc manner.

An alternative view, associated with Tobin (1969), is that what matters is the relation between the increase in the value of the firm due to the installation of an additional unit of capital and its replacement cost. When the increase in the market value of the additional unit exceeds (or is less than) the replacement cost, firms will want to increase (or decrease) their existing capital stock. This ratio, known in the literature as marginal Q, may differ from unity because of delivery lags and adjustment or installation costs. However, marginal Q is not easily measured, so what is used instead is the ratio of the market value of the entire existing capital stock to its replacement cost (the average Q ratio).

Abel (1980), Hayashi (1982), and Precious (1985), however, pointed to problems in using average Q. If firms enjoy economies of scale or market power, or if they cannot sell all they want, marginal and average Q will systematically differ. Moreover, the assumption of increasing installation costs is dubious. The

cost of additions to an individual firm's capital stock is likely to be proportional—or even less than proportional—to the volume of investment, because of the lumpy nature of many investment projects. More important, disinvestment, if feasible, is more costly than positive investment: capital goods often are firm-specific and have a low resale value. An extreme but useful view of this asymmetry is to consider investment completely irreversible.

This notion, introduced by Arrow (1968), suggests that under conditions of certainty, irreversibility creates a wedge between the cost of capital and its marginal contribution to profits. However, it is under conditions of uncertainty that irreversibility can have important implications for investment decisions. Recent literature (Bernanke 1983; McDonald and Siegel 1986; Pindyck 1991; Bertola 1989; Bertola and Caballero 1990) has emphasized that irreversible investment can be very negatively affected by risk factors. The intuitive reason is that if the future is uncertain, any addition to productive capacity today risks the chance that the firm may find itself stuck tomorrow with excess capital that cannot be (costlessly) eliminated. This implies that uncertainty may be as relevant for investment decisions as are such conventional variables as interest rates or taxes.

In the Keynesian tradition, the disequilibrium approach (Malinvaud 1980, 1982; Sneessens 1987) views investment as a function of both profitability and demand for output. In Malinvaud (1982), investment decisions have two stages: first, the decision to expand the level of productive capacity, and second, the decision about the capital intensity of the additional capacity. The former decision depends on the expected degree of capacity utilization in the economy, which provides an indicator of demand conditions; the latter decision depends on relative prices such as the cost of capital and labor. The distinction between the decisions is meaningful because factor proportions are assumed variable before the investment but fixed after it. The investment decision, in turn, takes place in a setting in which firms may be facing current and expected future sales constraints, an important departure from the continuous market-clearing assumed by both neoclassical (Jorgenson's) and Tobin's Q models. Therefore, investment depends both on profitability and on the prevailing sales constraints, which determine the rate of capacity utilization (see Sneesens 1987).

Disequilibrium models have often been criticized on the grounds that their assumptions regarding expectations are too simple and that they do not explain why prices are rigid. However, market disequilibrium and rational expectations are not necessarily inconsistent hypotheses. Neary and Stiglitz (1983) have developed rational expectations models in which the markets for goods and labor do not clear, in a context of forward-looking agents that anticipate future sales constraints and wage and price rigidities (see also Precious 1985). This is particularly relevant since investors are concerned with whether investment decisions made today will be justified by events in the future. From the policy viewpoint, important problems of macroeconomic adjustment, such as a persistent decline in output, are associated with (transitory) disequilibrium in the

goods and labor markets. In such conditions, investment behavior may involve a combination of expectations and market disequilibrium.

Another view is provided by macroeconomic models of coordination failure, which emphasize the inability of individual agents to successfully coordinate their decisions in a decentralized economic system. Although there are many potential sources for such failure (see Cooper and John 1988), the most common one is the existence of monopolistic competition and increasing returns to scale. In this context, the returns on investment depend on the overall level of economic activity, which in turn is positively affected by the volume of aggregate investment. Since each individual firm is likely to view its own contribution to aggregate investment as negligible, the social and private returns to investment diverge, with the former exceeding the latter. Under certain conditions, the economy may get stuck in an "insufficient investment" equilibrium, in which individual firms invest too little—lowering aggregate investment— precisely because each firm expects aggregate investment to be low (Kiyotaki 1988, Shleifer and Vishny 1989). As we emphasize later, this mechanism may play an important role in adjustment programs.

There is a growing literature on the effects of financial constraints on investment. At the micro level, firms may face binding financial constraints in domestic capital markets because interest rates are controlled or because of endogenous credit rationing (Stiglitz and Weiss 1981). Asymmetric information, adverse selection, and incentive effects may make interest rate changes an inefficient device to sort out good borrowers from bad borrowers. Under those conditions, credit rationing and quantitative constraints may be preferred by creditors.

The recent literature on the financial determinants of investment (see Fazzari, Hubbard, and Petersen 1988a, 1988b; Calomiris and Hubbard 1989; Mayer 1989; MacKie-Mason 1989; and Hubbard 1990) has emphasized that internal finance (retained profits) and external finance (bonds, equity, or bank credit) are not perfect substitutes. The discrepancy in the cost of financing is due to asymmetric information: lenders in capital markets cannot evaluate the quality of investment opportunities. This raises the cost of new debt and equity above the opportunity cost of internal funds. In this view, investment is sensitive to such financial factors—a departure from the idea of the perfect capital market.

Fazzari, Hubbard, and Petersen (1988a) and Hubbard (1990) report empirical research along these lines for industrial countries. They test the role of the financial structure of the firm in the Q, neoclassical, and accelerator models of investment by firm size. They find that financial effects are important for investment but also that there are differences in the sensitivity of investment to liquidity, depending on firms' policies regarding retained earnings. An important macroeconomic dimension of these findings is that, provided fluctuations in cash flow and liquidity are correlated with movements in aggregate economic activity and the business cycle, macroeconomic instability may affect investment mainly for firms that rely heavily on internal finance.

Chenery and Bruno (1962) raise an important point: in developing economies where domestic and foreign capital goods are highly complementary, the lack of foreign exchange to import machinery and equipment can constrain growth, although in the medium run, substitution between domestic and foreign capital goods, as well as export promotion, could ease the foreign exchange constraint (see Bacha 1984, 1990). Finally, income distribution may affect private investment through (a) the rate of profit, (b) the level of aggregate demand, and (c) the degree of social and political stability.

Macroeconomic Policy and Private Investment

Monetary, fiscal, and exchange rate policies aimed at correcting unsustainable macroeconomic imbalances are bound to affect private investment. The standard macroeconomic package oriented toward improving the balance of payments and reducing inflation includes restrictive fiscal and monetary policies supplemented by a real devaluation. Here we review the relevant empirical literature on the macroeconomic determinants of investment in developing countries, and highlight the transmission mechanisms through which such policies affect capital formation.

Monetary Policy

The restrictive monetary and credit policies included in stabilization packages affect investment in two ways: they raise the real cost of bank credit; and, by raising interest rates, they increase the opportunity cost of retained earnings. Both mechanisms raise the user cost of capital and lead to a reduction in investment. This effect has been confirmed in studies by de Melo and Tybout (1986), Greene and Villanueva (1991), and Solimano (1989). Other economists disagree, however. Van Wijnbergen (1982), Blejer and Khan (1984), Lim (1987), and Dailami (1990), for example, find that in the repressed financial markets typical of many developing countries, credit policy affects investment directly, because credit is allocated to firms with access to preferential interest rates rather than through the indirect interest rate channel—although interest rates also affect firms that borrow in the unofficial money market (van Wijnbergen 1983a, 1983b). Thus the institutional structure of financial markets in developing countries is important in determining the effect of monetary and credit policy on investment, and how such policy is transmitted.

Fiscal Policy

High fiscal deficits push up interest rates or reduce the availability of credit to the private sector, or both, thus crowding out private investment. Hence the reduction of the public deficit during macroeconomic adjustment should allow

private investment to expand (as confirmed by van Wijnbergen 1982 in the case of the Republic of Korea). However, the way a fiscal deficit is corrected also matters. The mix of tax increases and spending reductions will affect aggregate private investment. Efforts to reduce the public deficit often involve cutting back on public investment. Some of these expenditures (especially on such components of infrastructure as roads, ports, and communication networks) may be complementary with private investment and will cause private investment to fall. This underscores the need to protect public expenditure on infrastructure during the adjustment process to encourage the recovery of investment and growth.

Several empirical studies have attempted to shed light on this issue. A study by Blejer and Khan (1984) based on cross-country data found that government investment in infrastructure is complementary with private investment (and other types of government investment are not). More recently, Greene and Villanueva (1991) and Serven and Solimano (1991) arrived at similar conclusions based on multicountry panel data. Musalem (1989) reported that private and public investment were complementary in a time-series study of investment in Mexico. Balassa (1988), however, reported cross-section estimates showing that an increase in public investment led to a decline in private investment. Furthermore, he found a negative correlation between the share of public investment in total investment and the size of incremental capital-output ratios, which indicates that public investment is less efficient than private investment. Khan and Reinhart (1990) reexamined the differences in productivity between private and public investment for a sample of twenty-four developing countries and found that the marginal productivity of public sector capital is negative (although not significantly so), whereas that of private investment is significantly positive.

Changes in Output

Empirical studies of investment in developing countries show that changes in output are the most important determinant of private investment (see Blejer and Khan 1984; Faini and de Melo 1990; Greene and Villanueva 1991; Serven and Solimano 1991). To a certain extent this is puzzling, since a substantial amount of fluctuation in output appears to be transitory and therefore should not affect investment. And it is costly to install capital, so adjusting to transitory shocks is sub-optimal. Thus the puzzle remains largely unexplained (see Shapiro 1986), although it might be due to investors' myopic expectations or short planning horizons.

Whatever the cause, the implication is that the contraction in demand induced by adjustment measures is likely to have an adverse short-run effect on investment because of its negative effect on output growth. This is apparent in the context of the Q theory of investment. Solimano (1989) shows that in Chile, aggregate investment profitability is procyclical—Tobin's Q increases in

upturns and falls in downturns—so we should expect the market value of capital, and hence investment, to fall in the short run in response to a slowdown in economic activity.

The downturn may also affect investment through its effect on expectations. A recession, for instance, could lead investors to postpone investing until the economy recovers. This response may, in turn, delay the recovery. To avoid such an outcome, it is important that governments design demand adjustment policies that minimize the potentially adverse effects on investment and growth.

Exchange Rate Policy

To reduce the external imbalance, adjustment programs rely on a combination of policies that cut back on expenditures and switch spending toward domestic goods. Such expenditure-switching policies generally include a real devaluation, with significant consequences for investment.

PROFITABILITY. Devaluation has important effects on profitability through its impact on the relative price of capital goods. Because investment goods combine domestic components (that is, construction or infrastructure) and foreign components (machinery and equipment), a real depreciation raises the real cost of imported components and acts like an adverse supply shock in the "production" of investment goods. Buffie (1986) and Branson (1986) note that a real depreciation increases the real cost of new capital goods relative to domestic goods, depressing investment in nontradable activities. In the tradable goods sector, however, the cost of new capital goods—relative to the price of output—falls, and investment rises. The result for aggregate investment is therefore uncertain.

The empirical studies reflect this theoretical ambiguity. In the short run real depreciation adversely affects investment (although its long-run effect may be positive). For example, Musalem (1989) finds that devaluation had an adverse effect on investment in Mexico. Faini and de Melo (1990) arrive at similar results using data for twenty-four developing countries. Branson (1986) explicitly calculates the impact of a devaluation on Tobin's Q in the home goods sector, concluding that profits fall (along with the market value of capital), while the real cost of new capital goods rises. Solimano (1989), using an empirical simultaneous equation model for Chile, also concludes that a real depreciation reduces investment in the short run, although it recovers in the medium term. Moreover, this study finds that a real appreciation produces an unsustainable expansion in investment. Empirical analysis of panel data on private investment for a number of developing countries (Serven and Solimano 1991; Cardoso 1991; and Larrain and Vergara 1991) shows that the real exchange rate has an insignificant effect, in the statistical

sense, on aggregate investment; its coefficient of variation does have a significantly adverse effect.

In general, a high dependence on imported capital and intermediate goods, along with a relatively low share of traded goods in total investment, would result in a contraction of investment after a real devaluation. Lizondo and Montiel (1989) distinguish between investment in traded and nontraded goods in a model in which capital is sector-specific. They decompose the effect of devaluation on the cost of capital, the product wage in both sectors (also examined by van Wijnbergen 1985 and Risager 1988), and the cost of imported intermediate inputs. The results show that the net effect of a real depreciation is ambiguous; investment in tradable goods increases while investment in domestic goods declines.

Anticipated and unanticipated devaluation may affect the profitability of investment through the real interest rate. In the case of an unanticipated devaluation, we assume that interest rates are market-determined. Devaluation will raise the price of imported intermediate inputs, and wages under indexation will rise. If monetary policy does not fully accommodate the increase in prices, real money balances will fall, pushing up the real interest rate for a given rate of (expected) inflation. In this way, devaluation depresses the market value of existing capital and exerts an adverse effect on investment. By contrast, if devaluation were anticipated and if it eliminates expectations that the currency will be devalued, investment may expand, since the required return on capital would tend to fall, mirroring the reduction in the anticipated rate of depreciation. This result depends on the degree of capital mobility and on the import content of investment.

FINANCIAL EFFECTS OF DEVALUATION. The debt crisis of the 1980s has attracted attention to the effect of devaluation on the real value of foreign currency liabilities. In the case of firms with foreign debts, devaluation automatically raises the burden of debt, reducing the net worth of firms producing home goods. If domestic credit markets are imperfect (as is often the case in developing countries), these firms may face credit constraints or higher financing costs as creditors raise interest rates to compensate for the increased risk of default. These financial pressures will lead directly to reduced investment for indebted firms at risk of bankruptcy. The increase in the real value of the firms' foreign debt also affects investment indirectly. As the net worth of these firms falls, so does the quality of the portfolios of their domestic creditors. Banks and financial intermediaries may be forced to reduce their exposure by cutting their loans— or they may simply go bankrupt. The ensuing tightening of credit markets may reduce the supply of credit (or raise interest rates), even for firms that had no foreign currency liabilities. The implications for investment are obvious as financing becomes scarce and expensive.

The financial effects of an unanticipated devaluation may require the government to bail out firms or financial intermediaries to avoid an epidemic of

bankruptcies that could jeopardize the adjustment effort. Financing the bailout, however, may lead either to inflation or to a domestic debt overhang, if the government or the central bank issues bonds to cover the foreign exchange losses of commercial banks or firms. The ensuing rise in the public debt puts upward pressure on interest rates, crowding out private investment. It is important to note the implicit tradeoff between supporting investment today (by subsidizing indebted firms) and supporting investment tomorrow, when previously issued public debt may crowd out investment.

Empirical studies of the financial effects of devaluation and its impact on investment are scarce; the exceptions are Easterly (1990) and Rosensweig and Taylor (1990). In Easterly's model, devaluation results in a drop in gross domestic product (GDP) and in private investment, but the decline in investment is greater than the reduction in GDP. The main cut in investment comes from corporations and is due to a sharp increase in real foreign indebtedness. Easterly reports that the cash flow of corporations declines substantially as a result of capital losses on dollar debt, while the replacement cost of capital rises sharply. Rosensweig and Taylor also underscore the importance of foreign currency liabilities. In their model for Thailand, GDP increases following a real depreciation, under the assumption of a strong export response to relative price incentives (ignoring capital losses on foreign debt). Higher net worth results in more deposits to banks, credit supply rises, and interest rates fall. The result is an increase in investment. But when the capital losses on foreign liabilities associated with a devaluation are taken into consideration, the expansionary net effect on exports may be offset, and domestic capital formation may fall.

DEVALUATION, OUTPUT, AND INVESTMENT. Devaluation may also reduce investment by depressing aggregate demand. Moreover, if investment has a significant import content, the expansion of output is likely to be a necessary (but not sufficient) condition to expand investment (Serven 1990).

The literature on contractionary devaluation (Krugman and Taylor 1978; van Wijnbergen 1982; Edwards 1988; Solimano 1986; Lizondo and Montiel 1989) emphasizes the slow working of substitution effects arising from devaluation. In the short run its adverse effects on income are dominant. These effects operate through two channels on the demand side: one is the likely trade imbalance, which results in a real income transfer to the rest of the world (even at given terms of trade); the other is the negative effect on consumption as real income is redistributed from wages to profits. On the supply side, three mechanisms of transmission may contribute to the contraction of output: the increased real price of imported inputs for domestic goods, the rise in the price of working capital (due to increased interest rates), and real wage resistance. If the currency devaluation leads to a drop in GDP, the slump in economic activity will prompt a cut in investment (unless the slump is perceived to be transitory). Given strong substitution effects, however, such as a large rise in net exports, GDP will expand, raising real income and stimulating

investment spending as the degree of capacity utilization increases. This outcome is more likely as time passes and substitution effects gradually come into play.

THE TIMING OF INVESTMENT. An anticipated devaluation can have a substantial effect on the timing of investment through its effect on interest rates and the future price of imported capital goods (for a detailed exposition, see Serven 1990). Its effect on interest rates depends on the degree of capital mobility, that is, the costs of portfolio adjustment. In the case of imperfect capital mobility, the domestic real interest rate is an increasing function of the foreign real interest rate plus the expected rate of depreciation of the real exchange rate (it may also depend on the relative or absolute stocks of financial assets). The perception that a real depreciation is imminent will be reflected in higher real interest rates—according to the degree of capital mobility. In this way expectations of a devaluation represent a transitory disincentive to invest; pending the depreciation, the real interest rate is high and investment is low. Once devaluation has taken place, the disincentive is eliminated and investment rises.

The import content of capital goods operates in the opposite direction. When a real depreciation is anticipated, the real price of imported capital goods is expected to rise. Before the depreciation, imports of capital goods are cheap and investment high (the mechanism is similar to an anticipated increase in tariffs on investment goods). Dornbusch (1985) notes that this represents a transitory investment incentive that disappears once the depreciation is implemented. The net effect on investment depends on the degree of capital mobility relative to the import content of investment. When capital is highly mobile, the effect on the interest rate dominates, and expectations of a devaluation lead to an investment slump that will persist until the depreciation is actually undertaken. When capital is relatively immobile and investment requires a high proportion of imported capital goods, an anticipated depreciation may result in a transitory investment boom that subsides when the depreciation occurs.

The Incentive Structure

A key ingredient of most adjustment packages is a change in economic incentives that switches spending to domestic goods and raises profitability in the tradable sector. This change in incentives is expected to lead to a burst of investment in tradables, increasing production and economic growth, and thus ensuring the sustainability of the adjustment effort.

In practice, however, the investment response often is unexpectedly slow and weak. In the meantime, the short-run deflationary consequences of expenditure cuts may be magnified, leading to a reduction in growth. In the face of high

costs of adjustment in terms of employment and growth, the stabilization effort may fail.

Conventional investment theories do not explain this slow response except by resorting to the (unconvincing) argument that firms face rapidly increasing costs of adjustment (which does not seem to be the case), or that investors adapt very slowly to economic changes. A more satisfactory explanation takes into account the importance of uncertainty.

Irreversibility, Uncertainty, and Investment

Uncertainty plays a key role in investment decisions because they are irreversible (see Pindyck 1991). These investments represent sunk costs, because capital, once installed, cannot be used in a different activity (without incurring a substantial cost). The decision to invest in an uncertain environment involves exercising an option—the option to wait for new information. The loss of this option, which must be considered part of the opportunity cost of investment, is overlooked in conventional calculations of net present value. As recent studies have shown, this opportunity cost can be substantial and is also sensitive to the prevailing degree of uncertainty about returns to the investment. Thus changes in uncertainty can have a strong effect on aggregate investment. From a policy perspective, a stable incentive structure and macroeconomic policy environment may be as important for investment as the level of the tax incentives or the interest rate. In other words, if uncertainty is high, incentives may have to be prohibitively large to have any significant effect on investment.

The effect of uncertainty is independent of investors' risk preferences or the extent to which risks may be diversifiable. Investors may be risk-neutral (as assumed by most of the literature on irreversibility) and their risks diversifiable, but investment would still be hostage to the perceived degree of uncertainty.

From a macroeconomic perspective, different forms of uncertainty may be relevant for investment decisions. For example, in the face of uncertain demand (see Pindyck 1988 and Bertola 1989), firms will opt for lower capacity if investment is irreversible than they would under conditions of reversibility. However, the ex-post capacity level may actually be higher under irreversibility, because if demand is unexpectedly low, an irreversible investment cannot be undone. Pindyck and Bertola also show that increased volatility in demand will generally lead to reduced investment.

Dixit (1987), Krugman (1988), and Krugman and Baldwin (1987) found that when sunk costs of entry are combined with uncertain future real exchange rates, firms are discouraged from entering the export market even though favorable current exchange rates would seem to make entry profitable. Similarly, Caballero and Corbo (1988) show that uncertainty over future real exchange rates can depress exports. Dornbusch (1988) examines the related issue of reversing capital flight following a real depreciation. He argues that if a country

wants to attract capital to irreversible fixed investment, an overdepreciation of the exchange rate may be needed to compensate for the uncertainty faced by investors.

Ingersoll and Ross (1988) and Tornell (1989) examine interest rate uncertainty in the context of irreversible investment where future returns are known with certainty. They conclude that the effect of changes in interest rate uncertainty on the optimal timing of investment may be sizable. Moreover, an expected decline in future interest rates may not lead to increased investment because the change lowers the cost of waiting, and thus the effect on investment is ambiguous. In other words, the volatility of interest rates may have a more important effect on investment than do the actual levels of interest rates.

The relevance of these results for macroeconomic policy in developing countries cannot be overemphasized. Many developing countries suffer from high, unpredictable inflation and price variability. The findings on irreversible investment suggest that changes in prices that affect sectoral incentives may be ineffective in stimulating investment. It may take some time before investors are convinced that the changes are permanent. The decision to implement an adjustment program may well increase uncertainty in the short run, as private agents get mixed signals about which incentives apply to previous policies, which to stabilization, and which to structural reforms. Van Wijnbergen (1985) shows that a trade reform that is suspected to be only temporary can reduce investment in both tradable and nontradable sectors as economic agents postpone decisions in order to receive additional information.

The foreign debt burden faced by highly indebted countries and the associated income transfers to foreign creditors represent another source of instability (Sachs 1988). In a context of uncertainty, the real exchange rate and the demand management policies consistent with the required income transfer are also uncertain. Even the amount of the income transfer is unknown, since it depends on future interest rates and terms of trade. The transfer may require changes in the real exchange rate or fiscal contraction, or both. Thus investors face the risk of large swings in relative prices, taxes, or aggregate demand, each of which leads to reduced investment.

This effect may be hard to identify because foreign debt may affect investment adversely through two additional channels (Borensztein 1990): the debt overhang, which acts as an anticipated foreign tax on current and future income (as part of the returns on investment accrue to foreign creditors in the form of debt service payments); and credit rationing, because a highly indebted country is likely to face credit constraints in international capital markets. Empirical studies (see Faini and de Melo 1990; Greene and Villanueva 1991; and Serven and Solimano 1991) have confirmed that the debt burden has an adverse effect on investment.

The Role of Credibility

From a policy perspective, the incomplete credibility of policy reforms is an important source of uncertainty. Unless investors view the adjustment program as internally consistent and are convinced that the government will carry it out despite the implied social costs, the possibility of reversal will become a key determinant of the investment response. Governments can reverse adjustment policies, but investors cannot undo decisions about fixed capital. In such conditions, the value of waiting arises from the losses that investors would incur if policies were reversed in the future.

Any given set of policies will affect investment depending on the prevailing degree of confidence of the public. Stabilization may entail marked social and economic costs if the government's credibility is low, because the investment response will be too low to offset the deflationary bias of demand restraint. Thus a deep recession may develop before investors are persuaded that adjustment measures will be maintained. This skepticism is particularly relevant in economies with a history of frequent policy swings or failed stabilization attempts—two features shared by many developing countries.

The right economic incentives are a precondition for investment and growth but not a guarantee. Obviously, credibility would help speed the investment response and reduce the costs of adjustment, but how can governments improve their credibility? In this context, the choice between gradual and abrupt stabilization is an important one. Gradual adjustment involves modest objectives that can be achieved and that are intended to strengthen the government's reputation. In contrast, an abrupt adjustment involves drastic measures—an overdepreciation of the exchange rate, for instance—to stimulate the prompt reallocation of resources (although it could also increase the social costs). The choice will largely depend on the social distribution of adjustment costs.

It is important to emphasize that a reversal of policy is an endogenous outcome, since the private sector ultimately determines whether the adjustment program can be sustained. For example, when a large real depreciation does not attract investment to the tradable sector because confidence is low, its only visible effects will be a decline in real income and a redistribution of income from labor to capital, especially in the tradable sector. However, because the depreciation does not compensate for the lack of credibility, the increased profits will be reflected in increased capital flight. Social pressure and balance of payments problems may eventually force a reversal of policy, thus confirming the initial skepticism of investors.

But the same policy, in a situation of high confidence, can lead to an investment boom that validates the adjustment program. This indeterminacy is due to the difference between the social and private returns to investment: higher aggregate investment helps sustain the adjustment effort and therefore results in higher returns to investment—a mechanism ignored by individual investors.

If left to its own resources, the economy may get stuck in the "low confidence–low investment–adjustment failure" cycle.

How can such a cycle be avoided? The answer is not simple. While transitory investment incentives would appear to be the most appropriate tool to spur investment, in practice they run the risk of destabilizing public finances. By contrast, sufficient external support may raise investors' confidence in the sustainability of the adjustment (Dornbusch 1991).

Uncertainty and Investment: Empirical Applications

The empirical literature on uncertainty and irreversibility is sparse. Pindyck (1986) tests for the effects of uncertainty by introducing the volatility of stock returns as an explanatory variable in an investment equation; his results (with U.S. data) show a negative relation between the volatility of stock returns and investment growth. Solimano (1989) also investigates the effects of economic instability in an empirical model applied to Chile. He finds that the volatility of the real exchange rate and output have a significant negative effect on private investment, and he argues that the large swings in both variables in the 1980s may have reduced private investment as compared to a scenario of lower relative price and output variability. Dailami (1987) reports similar results for Brazil. Dailami and Walton (1989) argue that macroeconomic instability may be a major cause of low investment in Zimbabwe. Recent multicountry panel data studies of investment (Serven and Solimano 1991; Cardoso 1991; Larrain and Vergara 1991) also found that measures of macroeconomic instability, such as the variability of the real exchange rate or of the inflation rate, have an adverse effect on investment.

Empirical applications of structural models of irreversible investment have so far been very limited. Bizer and Sichel (1988) have developed a model of capital accumulation with asymmetric costs of adjustment. In this framework, irreversibility implies higher costs to downward than to upward adjustment. Their preliminary results using industrial sector data for the manufacturing sector are somewhat mixed, perhaps because of problems with aggregation. The role of irreversibility may be masked in aggregate data; as Bertola (1989) points out, irreversibility is probably more relevant at the level of the individual firm. Bertola and Caballero (1990) present a formal model based on the aggregation of individual firms' irreversible investments. The resulting aggregate investment rule gives satisfactory results when applied to U.S. data, although more work is still needed. Caballero (1991) has applied a similar approach to data on some developing countries (Brazil, Korea, Mexico, and Turkey), with highly promising results.

Simulation models provide another way of assessing the practical importance of uncertainty and irreversibility. The development of a structural simulation model suitable for studying the effects of uncertainty on irreversible investment should be a research priority.

Issues for Further Research

This paper has reviewed the theoretical and empirical literature on macro-economic adjustment and private capital formation. Further research should be a priority in the following areas:

- The specific mechanisms through which the level and composition of public investment affect private investment
- The relationships between different types of investment, for instance between investment in human capital and investment in physical capital, or between foreign and domestic investment
- The effects of macroeconomic adjustment policies on the composition and quality of investment
- The consequences of income distribution and redistributive policies for private investment
- The relationship between social and political stability and private capital accumulation.

Note

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