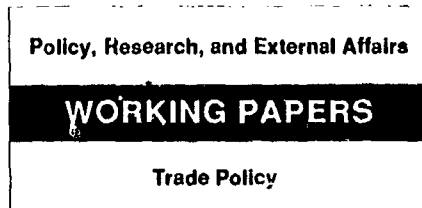


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Adjustment, Investment, and the Real Exchange Rate in Developing Countries

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and
Jaime de Melo

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This review of adjustment experience suggests that sharp devaluation of the exchange rate is probably ineffective in countries exporting primary goods. To encourage investment, adjustment packages must do more to ensure a stable macroeconomic environment and appropriate debt relief.

WORKING PAPERS

Trade Policy

WPS 473

This paper — a product of the Trade Policy Division, Country Economics Department — is part of a PRE research project on the sustainability of trade reform in structural adjustment programs. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Rebecca Sugui, room N10-031, extension 37951 (44 pages including tables).

At the center of the controversy about the effectiveness of “adjustment with growth” loan packages from the IMF and the World Bank has been the heavy emphasis on real exchange rate depreciation as a way to restore external balance and elicit a positive supply response.

Faini and de Melo examined the adjustment record for a large sample of developing countries and found that adjustment has been far more successful for countries exporting manufactured goods than for countries exporting primary goods (mostly low-income African countries).

Devaluation of the exchange rate in countries exporting primary goods appears to be ineffective. Most of their adjustment has taken the form of reduced spending rather than increased supply. As a result, they have not resumed sustainable growth.

The longer-term prospects for exporters of manufactured goods are much brighter. They show more signs of improving efficiency and less decline in investment than do exporters of primary goods.

Faini and de Melo found strong support for the debt overhang argument. That is, after controlling for other factors, they found that the resumption of private investment growth had been hampered in countries with a heavy debt burden and an unstable macroeconomic environment. Investors postpone investment until the uncertainty about a stabilization program is resolved — and low investment, in turn, increases the probability of economic deterioration. This suggests that adjustment packages must do more to ensure a stable macroeconomic environment and appropriate debt relief.

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Adjustment, Investment, and the Real Exchange Rate
in Developing Countries

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1. Introduction

The developing countries have been in crisis since 1982. By then, the combination of deteriorating terms of trade, rising real interest rates on their external debt and the drying up of commercial lending forced them to pursue drastic economic adjustment policies. Faced with a sharp withdrawal of commercial bank funds that was only partly compensated by official lending, and unwilling to default, developing countries had to effect a positive transfer to developed countries. The crisis required a sharp adjustment: developing countries would have to earn foreign exchange by exporting more or save it by importing less. It is now recognized that the brunt of adjustment fell on absorption, in particular on investment. In most developing countries, with the significant exception of Southeast Asian countries, adjustment was achieved by cutting investment rather than by increasing saving. Both public and private investment fell. Admittedly, prior to 1982 many countries had embarked on overly ambitious investment programs, partly because recycled petro-dollars were all too readily available. Yet the fall in investment, particularly private investment, could have adverse implications for a sustained recovery.

In response to the debt crisis, the IMF increased its lending, and the World Bank responded by introducing quick-disbursing adjustment loans to help countries achieve both macroeconomic equilibrium and an efficient structural adjustment. In many quarters, the crisis was viewed as an opportunity to carry out much needed microeconomic reforms that would raise efficiency and allow adjustment to take place without a loss in growth despite the loss in investment.

Whatever the differences in the depth of the crises affecting them, most developing countries have been undergoing structural adjustment for almost a decade now. What can be said overall about the success of adjustment since the crisis? In this paper, we evaluate adjustment packages by focusing on two key issues: did the sharp devaluation of the real exchange rate (advocated by international organizations) generate a supply response, and did microeconomic rationalization sufficiently raise the marginal efficiency of investment to compensate for the adverse effects of adjustment on the volume of investment? In other words, are there signs that the structural reforms are bearing fruit at least in the form of more efficient, if not higher growth, and, if there is recovery, is it sustainable?

Sustainability has assumed particular importance because the sharp drop in living standards that has accompanied adjustment programs in many countries has created tensions that affect investment decisions. Is the uncertainty preventing investment in countries that would otherwise attract investment precisely because of the lower real wages? If credibility is indeed low, that is, if investors are waiting to see whether economic conditions will deteriorate, then their expectations could become self-fulfilling, and could lead to the abandonment of otherwise well-conceived adjustment packages.

To set the tone for our analysis of these issues, we need first to get a general sense of how adjusting countries are doing. Just as the severity of the crises differed widely across countries, so too has the burden of adjustment and its timing, and no classification system for grouping countries can fully capture this diversity. Table 1 summarizes the latest available figures. Here we chose a country grouping based on

Table 1. MACROECONOMIC INDICATORS FOR THREE COUNTRY GROUPINGS:

Period Averages for 1978-81, 1982-85, and 1986-88

Period	GDP growth			Investment/GDP			Real exchange rate <u>1/</u>			Debt/GDP (debt-service ratio in percent in parentheses)		
	1978-81	1982-85	1986-88	1978-81	1982-85	1986-88	1978-81	1982-85	1986-88	1978-81	1982-85	1986-88
	Primary exporters <u>2/</u>	2.8	1.4	2.4	21.4	18.4	17.2	1.03	1.13	1.39	.35 (15)	.53 (20)
Manufacturing exporters <u>3/</u>	4.8	2.4	4.9	26.2	23.5	21.8	1.03	1.12	1.39	.21 (25)	.35 (28)	.40 (29)
Fuel exporters <u>4/</u>	6.6	2.0	0.9	27.9	24.9	19.4	1.0	0.95	1.35	.34 (18)	.44 (25)	.63 (39)

Notes: All data are unweighted period averages.

Sample of 83 countries with population exceeding 1 million in 1980. Classifications are described in appendix.

1/ The real exchange rate index is the ratio (expressed in common currency units) of a weighted sum of trading partners' WPI indexes over the domestic CPI index 1980 = 100. (See appendix).

2/ Residual grouping (45 countries).

3/ Countries with a share of manufacturing exports in total exports \geq 30% or a share of manufacturing in GDP \geq 13% (23 countries).

4/ Countries with a share of fuel exports in total exports \geq 50% (15 countries).

economic structure: fuel exporters, manufacturing exporters, and, as a residual category, non-fuel primary exporters. Period averages are taken for four macro-indicators: GDP growth, the share of investment in GDP, the real exchange rate, and two debt-burden indicators (the debt-to-GDP ratio and the debt-service ratio).

Three facts stand out. One is that only manufacturing exporters have resumed growth at pre-crisis levels (mostly the East Asian countries). Although the debt-service burden of this group is high (partly because of a few Latin American countries in the grouping), it has stabilized.^{1/} Growth among the fuel exporters has deteriorated throughout the three periods. Primary exporters have recuperated most of their loss in growth, but they have not arrested a declining trend in their external debt indicators.

The second significant fact is the universal, and pronounced, decline in the investment share in GDP. For the non-fuel groups, the share has fallen by about 20%, while for fuel exporters the decline was even sharper, reaching 30%. To be sure, it can be argued that the overly ambitious investment programs following the oil boom needed to be scaled down. But the declines for the primary and manufacturing exporters are very high and may cause concern about the prospects for sustained recovery.

The finding of a declining investment share in GDP and a slowing down of the rate of growth in spite of a sharp deterioration in the real exchange rate is even more pronounced if we divide our sample of 83 countries into currently (i.e., in 1988) severely indebted countries and others. In doing so, we find that the 36 severely indebted countries had a decline in average growth from 3.1 percent in 1978-81 to 2.5 percent in 1986-88 while the average share of investment in GDP fell from 22.3 percent

in 1978-81 to 15.7 percent in 1986-88. For this severely indebted group of countries, the real exchange rate depreciation was 46 percent.

The third significant finding from Table 1 is the sharp real exchange rate depreciation. Six years into the crisis, the real exchange had depreciated by close to 40 percent, for all three country classifications. The sharp real exchange rate depreciation would have been required by any adjustment program involving an increase in the net transfer from debtor to creditor. Otherwise the required shift towards tradable activities would not have materialized.

But there is more behind this sharp and universal depreciation in the real exchange rate. When the IMF and World Bank stepped in to fill at least some of the financing gap left by the withdrawal of commercial lending, they offered "adjustment with growth" packages that relied heavily on a sharp depreciation of the real exchange rate as a condition for obtaining funds. Of course, the real exchange rate is an endogenous variable that can never be fully under a country's policy control, but it is no exaggeration to say that achieving a sharp real exchange rate depreciation was the centerpiece of these adjustment packages. 2/

The failure of such a large number of countries to resume sustainable growth in spite of obvious efforts to adjust has given ammunition to the advocates of debt relief and to the critics of the adjustment with growth packages advocated by the IMF and the World Bank. The heavy emphasis on real exchange rate depreciation as a way to restore external balance and elicit a significant supply response has been at the centre of this controversy about the effectiveness of these adjustment with growth packages. In the first part of the paper, we take a fresh look at the role of the exchange rate in the context of adjustment by introducing a

crucial distinction between the short-run supply effect of a real exchange rate depreciation (often found to be positive) and its long-run effect on growth in output through its impact on investment.

In addition to the emphasis on a sharp depreciation of the real exchange rate, most adjustment packages introduced a host of productivity-enhancing microeconomic reforms. Typically the reforms included a rationalization of public sector recurrent and investment expenditures; a restructuring of public enterprises; and trade, fiscal, and credit policy reforms to provide more nearly neutral and transparent incentives. While it is too early to see the full effects that are expected from these microeconomic reforms, one could hope to detect some effects in the form of a greater efficiency of investment. In the second part of the paper, we analyze the behaviour of investment during adjustment, looking first into the efficiency and cost of investment. Can one attribute most of the decline in private investment to the rising cost of capital goods, and did the efficiency of investment improve during adjustment? Second, because investment decisions are at least partially irreversible, we look into the influence of the macroeconomic environment, particularly the debt overhang, on investment decisions.

In what follows, we address the evidence for a large sample of developing countries. In Section 2 we state succinctly the controversy surrounding the role of the real exchange rate in achieving external balance and restoring growth. Section 3 gives evidence on adjustment in the external balance and the supply-side effects of real depreciation. Section 4 looks at the effects on investment of real depreciation and other factors. Conclusions and implications for a sustained recovery are discussed in section 5.

2. The Controversy

A standard framework for analyzing the effects of adjustment programs is the two-sector dependent economy model with exogenous terms of trade. Consider the situation prevailing before the crisis. Before 1981, many countries could run a trade deficit and resolve the resulting excess demand for foreign exchange through external borrowing. When foreign borrowing was foreclosed or, at the least, greatly reduced, the absorption-income gap had to be reduced to reduce the current account deficit. (Many countries had to produce a surplus in their non-interest current account to service the increased payments on their external debt caused by higher real interest rates on commercial debt.)

When resources are initially fully and efficiently employed, closing the absorption-income gap by reducing absorption is often referred to as the primary cost, or inevitable cost, of reducing a current account deficit. If closing the gap also entails a reduction in resource use because of relative price (or other) rigidities, there is also a secondary cost of adjustment. Over the medium term, adjustment policies to reduce the external deficit would include both expenditure-reducing and expenditure-switching policies (e.g., a real exchange rate depreciation). In addition, if the adjustment package is introduced at a time of inflation, a cutback in demand is desirable to reduce inflationary pressures. When resources are not fully or not efficiently employed, one can also expect a supply response to a depreciation of the real exchange rate.

The relative effectiveness of expenditure-reducing and expenditure-switching policies depends on the marginal propensity to

consume tradables and on supply responsiveness. The lower the marginal propensity to consume tradables, the less the adjustment that will be obtained from a given demand reduction. And the more difficult it is to shift existing resources from non-tradable to tradable activities, the greater the required relative price shift (i.e., the greater will have to be the real exchange rate depreciation).

To give some idea of the scope for substitution in demand, note that many countries, especially primary exporters, do not consume exports domestically. Also, close substitutes for imports are typically not available in the short to medium run. Data for a group of 40 developing countries indicates that the share of consumer good imports fell from 30% in 1980 to 25% in 1987. Such a shift toward the inelastic component of total imports is likely to reduce the effectiveness of expenditure-switching policies.

The traditional structuralist argument against devaluation is that it has a small impact on the trade balance because of low elasticities. This traditional argument has been buttressed by the contention that the redistributive mechanisms brought into play by devaluation (i.e., the shift from low savers to high savers) are contractionary from the demand side (Krugman and Taylor, 1977). Traditional stabilization packages reach the point of "overkill" (Diaz-Alejandro 1980, Dell 1982) when it is further recognized that restrictive monetary policy may have a contractionary effect on supply through higher interest costs (Cavallo 1977, Bruno 1979).

These shortcomings did not go unnoticed within the international agencies. But it was not until the advent of adjustment lending in the early eighties (\$26 billion from the IMF and \$16 billion from the World Bank during 1980-87) that these agencies made an explicit attempt to

combine short-run stabilization goals with growth-oriented policies. In this new framework (see Corbo et al., 1987, and Thomas et al., 1990), devaluation of the real exchange rate still played an essential role, not only to restore external balance but also to achieve a more efficient resource allocation. From the perspective of this new framework, the advocates of adjustment with growth believed that the positive supply response to a real devaluation would be sufficient to dominate its contractionary effects.

This new emphasis on growth did not diminish the criticism, however. A "new" structuralist critique pointed out that devaluation could be contractionary, this time from the supply side. The effect would come through the higher cost of imported inputs (Buffie 1984), a lower volume of real credit (because of higher input prices with constant nominal credit) and consequently higher interest costs for firms (Van Wijnbergen 1986), and, in the presence of widespread wage indexation, through higher labor costs. Finally, in the longer run, the negative effect on supply could be compounded if a real depreciation depressed investment because of a higher cost of imported capital equipment (Buffie 1986).

As an example, consider the following back-of-the-envelope calculation of the contractionary effects of a devaluation that increases the costs of intermediate inputs. For the countries in Table 1, the real exchange rate depreciated by approximately 25% between 1980 and 1987. Assuming an economy-wide value-added ratio of 0.5, imported intermediates at 30% of total intermediates, and long-run demand and supply elasticities of 1 and 2 respectively, the contractionary effect would be 5% of GDP. (In addition, the contractionary effects from the demand side could conceivably lead to excess supply among non-traded sectors.) 3/

It should be understood that this "new" critique assumes that a nominal devaluation results in a real devaluation on impact -- as has been the case in the eighties. The amount of the real devaluation will probably be less than the nominal devaluation, but it will be substantial, as the figures in table 1 show. Over the longer term, as various studies have pointed out (e.g. Edwards 1989a), there is a tendency for the real devaluation to erode because of wage indexation and other factors. The critique remains worthy of closer investigation, however, in view of the pronounced depreciation in the real exchange rate apparent from table 1 and the difficulties many countries have had in resuming growth.

Finally, a related critique from the advocates of debt relief is that the resulting overkill from the extreme severity of adjustment programs combined with a deteriorating external debt position has inhibited private investment. According to these critics, the debt overhang has acted as a tax on the proceeds of investment (Sachs, 1989) and uncertainty has created negative incentives for private investment (Rodrik 1989, and Dornbusch 1988). As pointed out earlier, the criticism rests upon the consequences of uncertainty on the decision to invest in a world where the investment decision is at least partly irreversible. The argument here is that uncertainty about the future course of an adjustment package will lead potential investors to adopt a wait and see attitude even if crucial indicators for a decision to invest, like real wages, are favourable. In the typical Latin American case, flight capital will not be repatriated for investment because uncertainty about the outcome of the ongoing adjustment package is high.

3. External Adjustment and the Real Exchange Rate

We have seen that developing countries responded to the shocks of the 1980s by depreciating their real exchange rate. 4/ How effective has real exchange rate depreciation been? First we analyze the evolution of the trade balance to see how much of the improvement in the trade balance was accounted for by real exchange rate depreciation after controlling for time trends and country specific effects. Second, we look for evidence of supply response to the real exchange rate.

Start with the trade balance. For each one of the three country groupings in table 1, we pool countries and correlate the trade balance-to-GDP ratio with absorption, the real exchange rate, country dummies and a time trend. Unfortunately, because of lack of data, we are unable to separate out directly the effect of demand switching and supply response. Results are reported in Table 2. All coefficients for the real exchange rate are significant with the exception of that for fuel-exporters, which is not surprising since natural-resource-based economies usually have price-insensitive supply structures. Generally the lagged value of the real exchange rate is insignificant. The coefficient on absorption is even more significant. For our sample, then we conclude that the real exchange rate depreciation contributed to improving the trade balance.

We also reestimated the same equation adding dummy variables for the post-1981 period on the coefficients of A and RER. For the primary-exporter group a significantly negative value showed up for the real exchange rate dummy variable, suggesting no contribution of real exchange rate depreciation to trade balance improvements. 5/ This is consistent with other studies which have attempted to link the trade balance with the real exchange rate. 6/

Table 2. Determinants of the Trade Balance
(Dependent variable: $(TB/GDP)_t$)

	Manufacturing Exporters	Fuel Exporters	Primary Exporters
$\ln A_t$	-0.16 (.066)	-0.78 (.764)	-0.49 (.123)
$\ln RER_t$	0.18 (.076)	0.10 (.109)	0.20 (.836)
$\ln RER_{t-1}$	0.07 (.065)	0.15 (.117)	0.08 (.090)
NOBS ^a	390 (20)	230 (11)	355 (18)

a/ Number of countries in parenthesis. Maximum time span is 20 years (1965-85). Countries with less than 40 observations excluded t-statistics in parenthesis.

Notes: Standard errors in parenthesis. Estimation method: Instrumental variables (IV). Instruments: real money supply and lagged values of absorption and real exchange rate. Time trend and country intercepts omitted.

$(TB/GDP)_t$ = trade balance over GDP.

A_t = real absorption.

RER_t = real exchange rate (defined as in table 1).

Country intercepts not reported.

It is interesting to measure the relative contribution of changes in absorption and of the real exchange rate on the trade balance. The index $R = a_2/a_1$ (elasticity of the trade balance with respect to price/elasticity of the trade balance with respect to absorption) measures the relative impact on the trade balance of a reduction in absorption and of a real depreciation. For our three country groupings, this index is 1.13 for manufacturing exports, 0.13 for fuel exporters, and 0.41 for primary exporters. The exchange rate contributes to trade balance improvements mostly for manufacturing exporters. This is exactly what the "old" structuralists would argue. For the rest of the developing world, the relative effectiveness of expenditure switching policies is very low indeed. Falling in this category are small low-income countries, which are at a relatively early stage of industrialization with a small and undiversified industrial sector. These countries have few opportunities for expanding exports, which are concentrated in a few primary commodities. The scope for export expansion is typically even more limited for natural-resource-based economies such as fuel exporters, although there may be room for adjustment on the import side if they have a larger share of consumer imports. These are the prototypical "structuralist" economies (see Chenery 1975, Taylor 1982).

One can also use the estimates in table 2 to see how much of the improvement in trade balance was accounted for by real exchange rate depreciation after controlling for country-specific effects and the time trend. For manufacturing exporters (primary exporters), the average trade-balance-to-GDP ratio was 4.9 (2.3) percentage points higher in 1983-85 than in 1979-81. For manufacturing exporters, real exchange depreciation accounted for a 2.1 percentage point improvement in the trade balance while

for primary exporters real exchange rate depreciation only contributed for 0.8 percentage point improvement.

The limited scope for import substitution is also apparent from the evolution of the composition of non-fuel imports during the 1980s. The data (not shown here) indicates some import substitution in consumer goods with a rising share of intermediate goods in imports. But since the share of consumer goods in total imports was already low at the onset of adjustment (about 20%), it is likely that little supply response could be expected from the replacement of imports with domestically produced substitutes for the majority of developing countries.

Turn now to supply response. We assume that output supply at each point of time is a function of the capital stock, the cost of variable inputs, and possibly of lagged supply. Because of lack of data for our large sample, we approximate the cost of variable inputs by the real exchange rate. This variable is also intended to proxy the costs of labor and, more importantly, the presumed supply-augmenting effects of adjustment programs based on real exchange rate depreciation. As before, dummy variables capture country specific effects. The country-classification is unchanged. After taking a quasi first difference of the supply equation, one obtains the reduced form of table 3.

Interestingly, when it comes to the coefficient on the real exchange rate, one finds consistently a negative and significant contribution to supply (the lagged effects appear insignificant). It must, of course, be recognized that our simple reduced-form is certainly a short-cut way of trying to capture the supply-enhancing effects of a real depreciation. In terms of the framework developed earlier, the results in table 3, suggest that the presumed resource switching towards tradables

Table 3. The Impact of the Real Exchange Rate on Supply(Dependent variable: $\ln Y_t$.)

	Fuel Exporters	Primary Exporters	Manufacturing Exporters
$\ln Y_{t-1}$	0.439 (0.151)	0.313 (0.065)	0.207 (0.113)
$\ln Y_{t-2}$	-0.042 (0.069)	0.073 (0.030)	0.127 (0.053)
$\ln RER_t$	-0.098 (0.036)	-0.168 (0.061)	-0.083 (0.032)
$\ln RER_{t-1}$	0.069 (0.077)	0.152 (0.061)	-0.006 (0.054)
$\ln I_t$	0.120 (0.026)	0.105 (0.009)	0.157 (0.015)
Wald Test	477.6 (5) ⁺	853.8 (5) ⁺	81.8 (5) ⁺
Sargan Test	5.44 (5) ⁺	4.56 (5) ⁺	0.91 (5) ⁺
Test for 2nd order serial correlation N(0,1)	-0.813	0.839	-0.345

Maximum time-span is 20 years (1965-85). Countries with less than 4 observations excluded.

Notes: Standard errors in parenthesis. Estimation method. Instrumental variables. Instruments: world demand, real money supply, real GDP, and real investment. The Wald test measures joint significance. The Sargan test measures the accuracy of the instrument set. First-order serial correlation is introduced by taking first-differences in the original equation.

Variables: Y: real GDP
 RER: real exchange rate (as defined in table 1)
 I: real gross fixed investment
 +: degrees of freedom

elicited by the massive real exchange rate depreciation involved at least a temporary output loss. In a world where factor specificity plays an important role, switching policies would be expected to lead some resource idleness. It may well be that non-tradable activities used factors not easily transferable to tradable activities. Probably the real exchange rate variable also captures other adjustment effects associated with terms of trade loss like lack of foreign exchange. Nonetheless, taken together, the results in tables 2 and 3 give support, though perhaps only suggestive, to the concerns raised by the structuralist critique.

4. Investment, the Real Exchange Rate, and the Debt Overhang

The sharp fall in the share of investment in GDP in developing countries (Table 1) does not bode well for a consolidation of adjustment achievements to date in the absence of a significant increase in the efficiency of investment. ^{7/} Lower investment not only reduces future productive capacity, it also engenders lowered expectations for future growth. These expectations may be socially destabilizing. In addition, lower investment limits the scope for resource reallocation in response to reforms throughout the economy. Yet it is resource reallocation to the new set of incentives created by the reforms that is expected to play a crucial role in most adjustment-with-growth programs.

The disappointing investment rate in developing countries may be attributable to the extreme economic and financial distress of the most recent period, or it may be attributable to the design of adjustment policies. Two components of the adjustment-with-growth programs may have been responsible for the investment slump. The first has to do with the

effects of a real depreciation; the second with the microeconomic reforms that were part of the conditionality provisions of the adjustment packages supported by the World Bank. Consider again the impact of a real depreciation. It has been argued (e.g., Blejer and Khan 1984), that the availability of foreign exchange exerts a powerful influence on investment both because it is needed to purchase mostly foreign-produced capital goods and because it may permit a less restrictive monetary policy. A real exchange rate depreciation is expected to promote investment by increasing the availability of foreign exchange. This may not happen, however, since a real exchange rate devaluation may substantially raise the real cost of capital goods (Buffie 1984).

The second way in which adjustment programs may have contributed to the slump in investment comes from the cut in public expenditures required by IMF stabilization programs and by the strong public sector management reform component in World Bank structural adjustment programs. Structural adjustment programs aimed at restoring growth not only by rationalizing fiscal and financial incentives through economy-wide market and financial sector reforms, but also by strengthening public sector management. Many structural adjustment packages required a combination of divestiture of some public enterprises and a freeze on the creation of new ones and on employment levels in existing ones -- in other words, a reduction in public sector's expenditure. It was hoped that private sector investment would move in to replace public sector investment and that, as a result of the policies aimed at rationalizing price incentives and reforming public sector management, the overall marginal efficiency of investment would rise.

To evaluate the proximate causes of the fall in the investment share in GDP, we collected time-series data on public sector investment for a sample of 32 countries. The data can be used to provide a rough breakdown of total investment by public and private sector components. The remainder of the paper is based on analysis of these data.

4.1 Efficiency of Investment and Cost of Investment

The longer term trends (1970-86) of public and private investment rates are displayed by subperiod for the manufacturing and primary exporter groups in table 4. Comparable trends for the G-7 countries are also provided as a reference. Broadly similar trends apply to developed and to developing countries. For all country groupings, private and public investment falls in the post-1982 period, and the cost-of-capital index rises. Fluctuations, however, are more pronounced for developing than for developed countries.

For developing countries, four stylized facts emerge. First is an increase in the share of public investment during the period of "easy" credit, when there was ample liquidity in the world capital markets following the first oil price rise. Second is a sharp downward shift in the share of private investment in GDP after the crisis, especially for primary exporters. Third is a steady increase in the real cost of capital along with a rise in the relative price of investment goods. Fourth is a sharp swing in the ICOR for manufacturing exporters, with an improvement during 1983-86, whereas the ICOR for primary exporters remains stable.

On the basis of these broad trends, one would be tempted to conclude that adjustment programs were largely successful, at least for manufacturing exporters. For this group, the fall in public and

Table 4: EFFICIENCY OF INVESTMENT AND COST OF INVESTMENT, 1970-88
(unweighted period averages)

Period Average	Private <u>a/</u> Investment	Public <u>a/</u> Investment	Total <u>a/</u> Investment	Ind. Deflator (q) GDP Deflator (p)	Private ICOR <u>b/</u>	Total ICOR <u>b/</u>	Cost of Capital Index <u>c/</u>
Manufacturing Exporters <u>d/</u>							
1970-74	12.8	6.2	19.0	1.00	1.08	1.64	54
1975-82	14.7	7.9	22.8	1.01	2.14	3.41	100
1983-88	12.3	6.5	18.8	1.03	1.88	2.67	233
Primary Exporters <u>d/</u>							
1970-74	14.6	5.6	20.2	.98	1.29	1.80	38
1975-82	14.7	7.3	22.0	1.05	1.51	2.32	100
1983-88	10.9	6.0	17.0	1.07	1.50	2.31	158
Developed Countries <u>e/</u>							
1970-74	20.7	4.1	24.9	.98	2.07	2.50	76
1975-82	19.0	3.7	22.7	1.00	2.20	2.63	100
1983-88	18.5	3.1	21.6	1.00	1.91	2.23	152

Note: δ = depreciation rate ($\delta = 0.07$);
 IP = real private investment;
 q(p) = investment (GDP) deflator;
 GDP = real GDP;
 i = nominal interest rate.

a/ Ratios to GDP expressed in real terms.

b/ $IC(t) = IP(t) / (GDP(t) - (1 - \delta) GDP(t-1))$.

c/ $r = (i + \delta - \hat{q}) (q/p)$.

d/ See appendix for definition of country groupings.

e/ Data for US, UK, France, Germany, Japan, Italy, Canada. Government bond yield taken as proxy for interest rate.

private sector investment was accompanied by an increase in the efficiency of total investment. It could also be argued that the reduction in the size of the public sector's capital expenditures weeded out the most inefficient investments and that the rationalization of public sector investments raised the marginal efficiency of public investment.

However, by emphasizing the need for a real exchange rate depreciation, adjustment programs compounded the increase in the cost of capital. It was hoped that the higher cost of capital would increase the efficiency use of capital. And, helped by financial sector reforms, distortions in factor prices favouring capital-intensive production techniques would be eliminated. In the final analysis, this means that the same growth rates can now be achieved with a smaller investment effort if the efficiency-augmenting effects are sufficiently strong.

These findings and interpretations are at best suggestive, but certainly not conclusive. The fall in the ICOR may reflect a higher rate of capacity utilization of a slowly increasing (or perhaps even shrinking) volume of capacity. It may also reflect a cutback of projects with long gestation lags (particularly public investment projects). In both cases the decline in the ICOR may not be sustainable and is likely to be reversed. Better information (like a breakdown of GDP into public and private sector components) would be needed for a sounder verdict. 8/ We can, however, go a bit further and verify whether the real exchange rate depreciation was a cause of the increase in the real cost of investment. We can also verify whether the major cause of the decline in private

investment was the increase in the cost of investment or other factors such as depressed demand.

We start with the cost of capital goods. Table 5 displays estimates of the elasticity of the relative price of capital goods in terms of the real exchange rate. The results show that a real exchange rate devaluation significantly increases the relative price of investment. The effect is stronger for manufacturing exporters than for primary exporters. At first sight this appears paradoxical. However, the result is less surprising when we consider that the share of construction in total investment is usually higher in lower-income countries (see Chenery, Syrquin, and Robinson 1986). In sum, the results in tables 4 and 5 suggest that our data are at least consistent with the "new" structuralist critique, namely, that depreciation of the real exchange rate will have some contractionary effects on supply in the medium to long term. Of course, the undesirable effects of these contractionary pressures must be balanced against any efficiency-enhancing effects resulting from less distortion in the cost of capital.

We turn next to the causes of the decline in private investment. A contributing factor must have been the income loss that resulted from the combination of worsening terms of trade and higher debt-service payments. For the same group of countries as those in table 1, Faini et al. (1990) estimate a loss in income of 2.5 percent of the average GDP between 1978-81 and 1982-86 (period averages). To sort out further the effects on private investment of demand side shocks and of the cost of capital, we estimate a standard accelerator model in which the growth of absorption and the expected cost of capital are the main determinants of investment demand. The simplicity of the accelerator model makes it attractive for separating

Table 5: The Real Exchange Rate and the Relative Price
of Investment Goods
(dependent variable $\ln(q/p)$)

	Manufacturing exporters	Primary exporters
$\ln RER$	0.46 (0.07)	0.26 (0.07)
Wald test (X^2)	99.2 (15) ⁺	147.9 (9) ⁺

Notes: Data and country classification are the same as table 4. Estimation method: instrumental variables. Instruments: lagged RER, country intercepts, real money supply, public investment. Standard errors in parenthesis. Country intercepts not reported. The Wald test measures joint significance.

Variables: q: investment deflator
p: GDP deflator
RER: real exchange rate
+: degrees of freedom

the effects on investment due to the combined effects of changes in the level of aggregate demand and changes in the expected cost of capital. We also examine whether the different components of the cost of capital (the real interest rate and the real price of investment goods) affect investment differently. ^{9/} Finally, we look for any significant impact on private investment of foreign exchange availability (measured as the sum of export receipts and non-monetary capital flows) and of public investment.

As expected, private investment is positively related to real GDP growth and negatively related to the cost of capital (table 6). The long-run elasticity of the investment rate with respect to the cost of capital is 0.16 for manufacturing exporters and .12 for primary exporters. Foreign exchange availability exerts a positive, but statistically weak, impact for primary exporters and no effect at all for manufacturing exporters. Public sector investment never proved to be statistically significant in any of the equations. Our data were unable to detect any significant complementarity (or substitutability) between public and private investment. This may be because our data did not distinguish between investment in infrastructure and investment by public enterprises.

It is instructive to apply the estimates in table 6 to the investment and cost of capital figures of table 4 to calculate the portion of the decline in investment between 1975-82 and 1983-85 accounted for by variations in the cost of capital. This estimate is obtained by multiplying the long-run elasticity of investment with respect to the various components of the cost of capital by the change in the average value of these components between the two periods. The calculation indicates that only a fraction of the fall in private investment is attributable to increases in the cost of capital, even for manufacturing

Table 6. Output and Substitution Effects in Investment
(Dependent variable: I/Y)

	Manufacturing Exporters	Primary Exporters
$(I/Y)_{t-1}$	0.61 (.11)	0.39 (.11)
$Costk_{t-1}$	-0.06 (.026)	-0.07 (.026)
GY	0.12 (.06)	0.17 (.06)
GY_{t-1}	--	0.15 (.08)
FXGDP	--	0.01 (.007)
δ q/p	-1.43 (.46)	-1.03 (.46)
δ (q/p) $_{t-1}$	--	-1.11 (.53)
Wald test (X^2)	83.8 (4) ⁺	84.3 (7) ⁺
Sargan test (X^2)	56.4 (43) ⁺	33.7 (39) ⁺
Test for 2nd order serial correlation (N(0,1)).	0.305	0.565

Notes: Standard errors in parenthesis. Estimation Method: instrumental variables. The Wald test measures joint significance. The Sargan test evaluates the accuracy of the instrument set. First-order serial correlation is introduced by taking first-differences in the original equation. Country intercepts not reported.

Variables: I/Y: private investment/GDP
 δ : depreciation rate (equal by assumption to .07)
 Costk: cost of capital (real interest rate + δ) q/p
 q: investment deflator
 p: GDP deflator
 GY: growth rate of GDP
 FXGDP: foreign exchange availability/GDP
 +: degrees of freedom

exporters, where investment is more sensitive to changes in the cost of capital. We find that 34.6 percent of the decline in private investment is attributable to increases in the cost of capital. Comparable figures for primary exporters are 24.2 percent of private investment. We therefore conclude that the output (and other) effects were a more important contributing factor to the decline in investment than the substitution effect.

4.2 Investment and the Debt Overhang

While the accelerator model is useful for sorting out the contribution of demand shocks and of changes in the cost of capital, the calculations presented above suggest that other factors must have played an important role in explaining the recent dramatic decline in investment among developing countries. To explore these other factors, we now turn to a forward-looking approach to the investment decision. Clearly, entrepreneurs consider the future before committing long-term resources to production, basing their decision on their expectations about the future path of the main determinants of the investment's return.

In a context where investment is at least partially irreversible once capital is installed, the decision to invest is intrinsically tied to the level of uncertainty about the future evolution of the economy. A high level of uncertainty will reduce the propensity to invest of even risk-neutral entrepreneurs insofar as it increases the possibility that highly productive capacity installed today will be of no use tomorrow if economic conditions deteriorate sharply. Under these circumstances, entrepreneurs would prefer to wait for the uncertainty to dissipate rather than make the decision to invest today. In turn, low investment today increases the

probability of economic deterioration tomorrow, making the initial prophecy self-fulfilling (Rodrik 1989). The economy becomes trapped in an inefficient, low-investment equilibrium.

This outcome is not simply a theoretical quibble. The scenario we have just sketched matches the situation in many developing countries, where the debt overhang and widespread symptoms of adjustment fatigue provide a gloomy outlook for the recovery of private investment. A recent World Bank report (1988) concludes that the long-run sustainability of the adjustment effort is threatened by low investment rates, persistent debt overhang, worsening income distribution, and burgeoning fiscal deficits. ^{10/} Under these circumstances, it is no wonder that forward-looking entrepreneurs are quite reluctant to sink resources into nearly irreversible activities.

To model the forward-looking nature of the investment decision, we assume that the representative firm is constrained by a putty-clay technology and operates in an imperfectly competitive output market. (The model is derived in the appendix.) The hypothesis of a putty-clay technology means that production techniques are flexible ex ante but that once chosen, they cannot be changed in response to variations in factor prices. Capital market imperfections are summarized by an agency cost function in which a high leverage is associated with higher costs for the firm. Only debt and retained earnings are available as sources of investment finance. Finally, we dispense with the assumption that the interest rate and the entrepreneur's discount rate are identical. Market imperfections prevent such equalization. The risk premium (i.e., the difference between the discount rate and the interest rate) is assumed to be a function of the macroeconomic environment. The resulting first-order

condition (see the appendix) relates the quasi-forward difference in the marginal capital-output ratio (multiplied by the ratio of the investment to the output deflators) to the determinants of the risk premium. 11/

This framework is convenient for investigating whether variables such as debt ratio, foreign exchange availability, the real exchange rate and public investment have a significant bearing on the investment decision through their impact on the macroeconomic environment. Estimation of the optimality condition helps isolate the effect of the macroeconomic environment on investment by controlling for the more direct impact that these variables have on investment through other channels such as the cost of capital.

We estimate this model for a smaller sample that combines manufacturing and primary exporters. 12/ Table 7 indicates several important results. First, an increase in the debt-export ratio is associated with a lower propensity to invest, possibly because of a higher risk premium. Second a depreciated real exchange rate and a greater availability of foreign exchange both promote investment. Finally, because the impact of the real exchange rate on total investment is not very significant and its inclusion in the equation worsens statistical performance, we also report an equation for total investment without the real exchange rate.

We also investigated whether the debt-export ratio became more significant during the crisis period. Tests for in-sample stability show that the debt-export ratio has a significantly higher coefficient after 1982 ($X^2(2) = 7.5$ and $X^2(2) = 20$ for total and private investment).

The picture that emerges from these estimates is that the macroeconomic environment is likely to have had a significant impact on

Table 7. Effects of the Macroeconomic Environment on Investment
(Dependent variable is y_t)a/

	Private investment	Total investment	Total investment
D/X	1.01 (.21)	1.34 (.62)	1.28 (.43)
D/X (q IC/p) _t	-.74 (.15)	-.40 (.28)	-.42 (.13)
(q IC/p) _t	2.74 (.35)	2.17 (.60)	1.86 (.27)
RER _{t-1}	-2.56 (1.07)	-2.66 (1.91)	--
RER _{t-1} (q IC/p) _t	3.0 (.90)	2.60 (.87)	--
FX _t	-1.11 (.69)	-2.76 (.84)	-3.06 (.34)
FX _t (q IC/p) _t	-.10 (.38)	.11 (.34)	.19 (.11)
Wald test (X ²)	2444 (7) ⁺	2463 (7) ⁺	2214 (5) ⁺
Sargan test (X ²)	9.1 (9) ⁺	11.2 (8) ⁺	13.1 (8) ⁺
Test for 2nd order serial correlation (N(0,1))	.914	-1.74	-.92

Notes: Sample is all countries (manufacturing and primary exporters). Standard errors are in parenthesis. Country intercepts not reported. The Wald test measures joint significance. The Sargan test evaluates the accuracy of the instrument set. First-order serial correlation is introduced by taking first-differences in the original equation.

$$\underline{a/} \quad y_t = (q \text{ IC}/p)_t - (1-\delta) / (1+r)^t (q \text{ IC}/p)_{t+1}$$

Variables: q: investment deflator; p: GDP deflator; r: real interest rate.
 IC: incremental capital-output ratio (= $1/(Q_t - (1-\delta) Q_{t-1})$), where Q: output, δ : depreciation rate)
 D: external debt; X: export
 FX: foreign exchange availability/GDP
 RER: Real exchange rate (defined as in table 1).
 +: degrees of freedom

investment. The sample of 20 countries is smaller than one would wish ideally, and the assumption of continuous optimization by agents is a strong one. Yet the results support the often-heard contention that a credible macroeconomic environment is a prerequisite for a sustainable recovery.

Further support for this hypothesis is given in table 8, which reports the results of regressing the fixed country effects of table 7 on the standard deviation of the real exchange rate, σ . If fluctuations in the real exchange are a good proxy for macroeconomic instability, then the results in table 8 confirm the view that investment responds positively to a stable macroeconomic environment. ^{13/} Taken together, the results in tables 7 and 8 suggest that the state of the macroeconomic environment explains much of the cross-country differences in investment.

5. Looking Ahead

Six years into the crisis that hit developing countries, three facts stand out. First, only manufacturing exporters have resumed growth to pre-crisis levels and stabilized their debt-service burden. Second, the investment share in GDP has declined substantially. Third, the real exchange rate has depreciated sharply, by about 40 percent compared with its level around 1980. Arguably, a sharp real exchange rate depreciation was called for by the need to service higher interest payments. However, a substantial depreciation was also clearly at the heart of the adjustment with growth packages supported by the IMF and World Bank.

Complemented by microeconomic reforms for rationalizing incentives and by other measures aimed at mobilizing resources, depreciation of the

Table 8: Investment and Macroeconomic Stability a/

	total investment	Private investment
constant	1.69 (.29)	1.45 (.21)
σ <u>b/</u>	-0.30 (.12)	-0.15 (.09)
R ²	0.26	0.13

Note: Estimation method: OLS for 20 observations
Standard errors are in parenthesis

a/ Dependent variable: fixed-effect from table 7

b/ σ : Standard deviation of the real exchange rate (RER)

real exchange rate was expected to help remove long-standing distortions in factor markets that favoured capital-intensive projects and distortions in goods markets that penalized the production of tradables, notably exports. The evidence shows that for most countries, adjustment occurred mainly through a reduction in expenditures. To say the least, the econometric evidence is certainly consistent with structuralist arguments that real depreciation elicits little supply response in the short-run.

A sustainable recovery requires that income growth exceed population growth. For low income countries, population growth is around 2 percent a year. Per capita income growth was still negative during 1986-88 for fuel exporters and positive but less than half a percent for primary exporters. These countries have not yet achieved sustainable recovery in the narrow sense of a growth in per capita income of one percent or more a year. Since adjustment also worsened income distribution in many countries because of the combination of capital flight and plummeting real wages, a sustainable recovery has not yet been achieved.

Yet there is evidence that sustainable growth may be within reach if productivity-raising microeconomic reforms can be sustained long enough. This has been clearly demonstrated by the successful adjustment experience of the East Asian countries during the recent crisis and the spectacular increases in total factor productivity growth they achieved during a 20-year period of outward-orientation. The calculations presented in this paper show signs, in the form of a higher efficiency of investment, that productivity is rising. However, up to now, this effect has been quantitatively small. We also show that only a small part of the decline in investment can be accounted for by the substitution effect arising from the higher cost of investment associated with the sharp real exchange rate

depreciation. Therefore we conclude that, in spite of some investment efficiency improvements, especially among manufacturing exporters, much of the decline in private investment must be accounted for by factors other than the cost of capital. The impact of lower investment on growth was significant. Indeed, if one applies end-of-period ICORs to the estimated elasticities of investment with respect to the real cost of capital, one finds a yearly loss in growth of 1.8 percent for primary exporters and 1.1 percent for manufacturing exporters from the lower investment levels that is not caused by a higher cost of capital.

The decline in real income caused by the unfavourable external environment also contributed to the decline in private investment. However, the evidence also supports the contention that in a world where capital is at least partially irreversible once installed, uncertainty about the future course of the economy will lead investors to wait. Econometric evidence from a forward-looking model of investment behavior shows that investment was negatively related to debt and foreign exchange availability indicators. Therefore, contrary to what has often been asserted, debt relief would raise investment rather than consumption. Evidence was also found that investment was negatively affected by real exchange variability, a proxy for macroeconomic instability.

Two lessons emerge for the design of adjustment programs. In low-income, primary-exporting countries the large real exchange rate devaluation that is central to the adjustment-with-growth strategy may not be effective for a number of reasons. These include the attendant rise in the cost of (mostly) imported capital inputs and the general lack of supply responsiveness to the real exchange rate depreciation. Second, the microeconomic reforms that have been at the heart of many recent adjustment

packages may not bear fruit if there is uncertainty about the sustainability of the stabilization effort. Investors will wait for the uncertainty surrounding a stabilization program to be resolved, and low investment, in turn, will increase the probability of future economic deterioration. Under these circumstances, there is a high payoff for achieving macroeconomic stability by taking appropriate measures for partial debt relief and postponing microeconomic reforms if successful implementation is jeopardized by the uncertainty investors feel about the economy. At the same time, the use of funds available from debt relief should be monitored so as to improve the position of both the creditors and the debtors. As argued by Sachs (1989) and by Claessens and Diwan (1990), debt relief should come with enhanced conditionality to provide the country with the incentive to adjust and, perhaps more crucially, to avoid the resumption of unsustainable macroeconomic policies.

Footnotes

- 1/ The growth rate of the debt-export ratio, d , is related to the nominal interest rate, i , and the growth rate of the nominal export revenue (in dollars), x , by the expression $d = i - x + V/D$ where V is the non-interest current account deficit and D is debt in dollars.
- 2/ See Edwards (1989b), and World Bank (1988) for a description of IMF-World Bank supported adjustment packages.
- 3/ Lizondo and Montiel (1989) give an exhaustive discussion of the various factors contributing to the contractionary effects of devaluation. Also see Edwards (1989a, chapter 8).
- 4/ Real exchange rate depreciation was even stronger for recipients of World Bank-IMF adjustment loans. Thirty countries that did not receive adjustment loans with a major trade reform component depreciated in real terms by less than 2 percent between 1980-2 and 1985-7, whereas 40 countries that received structural adjustment loans depreciated by 22 percent in real terms. (See World Bank, 1988).
- 5/ In the augmented model, the coefficients for RER for the two periods are (t-values in parentheses): 0.32 (3.19); -0.33 (-2.53). We also obtained a statistically significant value for the absorption dummy for the manufacturing-exporter category. That result, -0.07 (-0.99); 0.006 (3.22), is consistent with a regime switch, in which these countries passed to a binding external constraint starting in 1982.
- 6/ For example, Pritchett (1990) finds a weak relationship between the merchandise trade balance and the real exchange rate, after controlling for terms-of-trade improvements. His rationalization,

likely to apply for the 1980s, is that even though exports may respond to variation in the real exchange rate, imports are determined by foreign exchange availability (i.e. by exports) and hence may move perversely.

- 7/ For a sample of 14 countries, the loss of productive capacity attributable to this fall in investment has been estimated to approach, on average, 1% of their GDP each year during 82-86 (Faini et al. 88).
- 8/ Because of the impossibility of distinguishing between the public and private sector components of GDP in our sample, the ICOR calculations in table 4 are at best suggestive of trends in the efficiency of investment. Also, these rough calculations do not account for changes in capacity utilization. For alternative calculations that indicate an increase in the efficiency of investment during the 1980s see Easterly and Wetzel (1989).
- 9/ We also tested for a separate and/or different effect of the real exchange rate but found none.
- 10/ See V. Thomas et al. (1990) for a more complete appraisal of the sustainability of adjustment programs based on a case-by-case approach.
- 11/ The main shortcoming of this approach is that it assumes continuous optimization. Alternative approaches that stress the importance of financial variables on investment (e.g., Fazzari et al. (1988), Dailami (1990) would require data that preclude their application to a large sample of countries.
- 12/ The sample is the same as that in tables 4-6 except that countries with negative ICORs have been eliminated.

13/ Alesina and Tabellini (1989) analyze the effects of macroeconomic instability in terms of political decisions.

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Appendix

This appendix describes the data used for the investment equations and the model used in the results reported in table 7.

The Investment Equations

Data. The data for the investment equations were collected from internal World Bank reports on individual countries. The sample was determined by the availability of a time series of about 10 years or more in which total gross investment was broken down into its private and public sector components. Often, investment in public sector enterprises was either unavailable separately or was included with private sector investment. Consistency of treatment was ensured within each country and, whenever possible, investment by public sector enterprises was included with public sector investment. Private investment was obtained as the difference between total gross domestic fixed investment and the collected public sector investment series. The resulting sample of 33 countries is described in table A1.

The Model. The representative firm is assumed to be constrained by a putty-clay technology and to operate in an imperfectly competitive output market. Imperfections in capital markets constrain the financing choice of the firm. There is no well-functioning stock market. There are, as a result, only two sources of finance: (short-term) debt and retained earnings. Entrepreneurs discount future returns at a rate, i , which is assumed to be larger than the risk-free interest rate, r (otherwise firms would accumulate financial assets). Therefore, debt is the privileged

source of finance (perhaps also because of its favored tax status). However, an internal solution to the optimal debt decision is obtained by assuming that higher outstanding debt relative to the firm's capital is associated with increasing agency costs.

The firm's problems can be written as:

$$(A4) \quad \max \sum \left(\frac{1}{1+i} \right)^t [p_t(Q_t) Q_t - w_t N_t - q_t I_t + B_t - B_{t-1} \\ - r_t B_{t-1} - A(B_t, p_t(\cdot) Q_t)]$$

s.t.

$$(A5) \quad Q_t = \sum_{v=t-L}^t (1-\delta)^{v-t} I_v f(k_v)/k_v$$

$$(A6) \quad N_t = \sum_{v=t-L}^t (1-\delta)^{v-t} I_v/k_v,$$

where Q_t , N_t , and I_t represent output, employment and investment, respectively, $p_t(Q_t)$ is the inverse demand function, and w_t and q_t are labor and investment costs, respectively. On the financial side, r_t is the risk-free interest rate and $A(B_t, p(\cdot) Q_t)$ with $A_1 > 0$, $A_2 < 0$ and $A_{11} > 0$ is the agency cost function. Equations (A5) and (A6) define the production and the labor demand function for a putty-clay technology, where L is the average life of capital goods, δ denotes their depreciation rate, and $f(k_v)$ and k_v represent the ex ante production function (in intensive form) and the capital labour ratio.

The first-order conditions for output and debt are:

$$(A7) \quad g(q_t, \bar{w}_t) - \frac{1-\delta}{1+i} g(q_{t+1}, \bar{w}_{t+1}) = MR_t - MR_t A_2$$

$$(A8) \quad (1+i)(1-A_1) - (1+r) = 0,$$

where MR_t denotes marginal revenue and $g(\)$ is an increasing function of factor prices (Nickell 1979). The function g represents the present discounted value over a lifetime of marginal costs of installed capacity for a machine after allowing for depreciation. At an optimum, the cost of an extra unit of capacity today is equated to marginal revenue plus the discounted saving of not having to install more capacity tomorrow. The variable \bar{w} represents the present discounted value of labor costs over the lifetime of a machine. Even after parameterizing the agency cost function and the ex ante production function, one cannot estimate (A7) since \bar{w} is not observable. We can, however, substitute out for \bar{w} by using the first-order condition for k_v (not reported in the text), which relates the marginal rate of substitution between labor and capital in the ex ante production function to q_t/w_t . We find that $g(\) = q_t/f'(k_t)$.

For the purpose of estimation, we assume that $f(k_t)$ is Cobb-Douglas and $A(\)$ is quadratic, i.e.:

$$(A9) \quad A(B_t, p(\) Q_t) = a/2 \left[\frac{B_t^2}{(p_t Q_t)^2} - C \right] p_t Q_t.$$

Substitution and manipulations yield:

$$(A10) \quad \frac{q_t IC_t}{P_t} - \frac{1-\delta}{1+i^r} \frac{q_{t+1} IC_{t+1}}{P_{t+1}} = \frac{(\epsilon-1) \alpha}{\epsilon} [1/2a (i-r)^2 / (1+i)^2 + 1 + ac/2],$$

where IC_t denotes the incremental capital-output ratio, i^r is the real interest rate, $[1+i^r = (1+i)p_t/p_{t+1}]$ and ϵ and α represent the price elasticity of demand and the capital elasticity of output, respectively. The right-hand side of (A.7) is equal to $MR_t (1-A_2)$ after substituting from (A.5) and (A.6) and multiplying by α/p_t . To interpret the left-hand side of eq. (A10) notice that a large value of IC indicates a relatively more capital-intensive technique on the latest vintage which in turn must be attributed, for a given q , to a relatively high level of w , i.e. of the present discounted value of labour costs over the lifetime of machine. As a result the present value of marginal costs associated with a machine (i.e. the function $g(\cdot)$) will be also large and lead, as indicated by eq. (A7), to a lower capacity output. For a given value of δ , (A10) can be estimated if we assume that $i=r$. Suppose though that $1+i = (1+r)(1+\rho)$, where ρ is a multiplicative risk premium that depends on the macroeconomic environment. Multiply (A10) by $1+\rho$ and bring the unobservable terms from the left side to the right side of (A10). We then assume that ρ can be expressed as a function proxy of the state of the macroeconomic environment.

Equation (A10) provides the basis for estimation. We apply (A10) to the panel described above. In estimating equation (A10), we experiment over different values of δ . Notice that if ρ is not equal to zero, then

the lagged value of $q(IC/p)$ should belong on the right side of the equation. Fixed-effect estimation under these circumstances would be problematic, insofar as in dynamic panel data models the speed of convergence is a function of the number of observations per country. To circumvent this problem, we rely on a modified Anderson-Hsiao (1982) procedure. To eliminate the fixed effect, we take first differences of the original equation. By doing so, however, the error term, if it was white noise to begin with, is transformed into a first-order unit-root moving average process which is correlated with the first difference of $q(IC/p)$. Therefore, we use an (efficient) instrumental variable procedure by exploiting all the orthogonality restrictions between the error term and $(q(IC/p))_{t-i}$ where $i > 1$. This generalized method of moment estimator was implemented in the DPD program developed by Arellano and Bond (1988).

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