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Does Devaluation Hurt Private Investment?

The Indonesian Case

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and
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In the short run, devaluation hurts private investment because higher real import costs for capital and intermediate goods limit private sector profitability. In the long run, the recovery in tradable goods sectors increases profitability and private investment recovers. But how long is the long run?

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This paper — a product of the Office of the Vice President, Development Economics — is part of a larger effort in PRE to understand the response of the private sector to policies, so as to better design adjustment programs. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Maureen Colinet, room S9-021, extension 33490 (43 pages with figures and tables).

Devaluation affects investment because of its effect on the real supply price of capital goods; the real price of imported inputs, which together with capital goods are used to produce output; the real product wage and thereby profitability and investment; real income, which affects the demand for domestically produced goods; and nominal and real interest rates, which in turn affect investment.

Information on the short- and long-term effects of devaluation are critical in designing adjustment programs — particularly in assessing the appropriate amount of external assistance because the short-term effects may be radically different from the long-term effects.

In the short run, the real cost of imported capital and inputs increases, which hurts private sector profits and dampens investment. In the long run, real exchange rate depreciation leads to a restructuring of private industry to meet rising export demand, efficiency improvements increase profitability, and private investment recovers quickly.

But how long are the short and long runs?

Chhibber and Shafik, using an econometric model of the Indonesian economy, found that Indonesia adjusted in about two or three years — which is a relatively quick turnaround compared with other countries undergoing adjustment.

In the opinion of the authors, the credibility of Indonesia's economic policies played a key role in Indonesia's turnaround. By orchestrating comprehensive reforms in taxation, the financial sector, and the exchange rate, the Indonesian government sent a clear signal to the private sector that lent credibility to its adjustment efforts. This was also crucial to the recovery of investment and the restoration of growth.

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1. Introduction

The lack of investment response after the initiation of adjustment programs has raised concern about their long run sustainability.[1] With exchange rate devaluation as the single most important instrument in many adjustment programs[2], questions have arisen about the likely contractionary effects of a devaluation on aggregate demand and on capital formation. These concerns have become widespread especially since the publication of the Krugman-Taylor[3] paper formalising the various channels by which a devaluation may have contractionary effects on output and employment in the economy. Since then a large and growing literature has developed on this issue[4], that has been summarised in a recent paper by Lizondo and Montiel (1989).

A devaluation affects investment through several channels. Firstly, a devaluation alters the real supply price of capital goods. Secondly, it affects the real price of imported inputs which are used in conjunction with capital goods to produce output. Thirdly, a devaluation has an impact on the real product wage and thereby affects profitability and investment . Fourthly, a devaluation produces changes in real income which affects the demand for domestically produced goods. Finally, a

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[1]The World Bank recently carried out a comprehensive review of adjustment programs and is currently conducting a second more updated review. For details see Thomas et. al. (1989).

[2] See Edwards (1989) for a thorough analysis of the theoretical and empirical determinants and effects of exchange rates in developing countries.

[3] See Krugman and Taylor (1978)

[4] See for example Branson (1986), Buffie (1986, 1989), Cavallo (1977), Gylafson and Schmid (1984), Risager (1984), Shea (1976) and van Wijnbergen (1986).

devaluation affects . minal and real interest rates which in turn have an impact on investment. The net effect of a devaluation on investment will therefore be a composite of several factors and is theoretically indeterminate.

The short versus long run effects of a devaluation on private investment can go in opposing directions. Even if the short run effects are negative because of increases in the real cost of imported capital and inputs, the long run effects may still be positive. The increase in exports and growth due to devaluation could result in higher private investment. Therefore, the information on the short versus long run effects of a devaluation is critical in the design of adjustment programs and in particular in assessing the size of external assistance required for their successful implementation. The short run negative effects appear largely due to the contractionary demand effect of a devaluation and to the higher costs of imported inputs into production.[5] However, as the economy responds through higher exports to increased competitiveness, the long run effects on private investment can be significantly favorable.

It is necessary to view the effect of devaluation on private investment in a macroeconomic context. If a devaluation is to achieve its primary objective of improving the trade imbalance then for a given level of output, domestic demand must fall:

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[5]Some ascribe a negative effect of stabilization on private investment can also arise from the increased uncertainty about policy changes once the government embarks on a program. The opposite is also possible if the i..ception of a reform program signals that the government is willing to take action, then uncertainty can be reduced and credibility enhanced.

$$Y = Cp + Ip + Cg + Ig + (X - M).$$

For fixed output levels (Y) an increase in private investment (Ip) is possible only if public expenditures (Cg + Ig) fall by more than the improvement in the trade imbalance (X-M).[6] If aggregate output falls, the short run effect on private investment is likely to be negative. On the other hand, if the effect on output of a devaluation is positive due to a strong and rapid response from the tradeable goods sectors, these negative effects can be avoided. Even if these positive effects are not large enough in the short-run because of a weak supply response, the long-run effects need not be. How quickly would a turn-around take place and under what conditions would this come about? These would naturally vary from one country to another. In this paper, we examine the Indonesian case where the economy has adjusted rapidly to oil shocks and private investment has begun to respond since 1986. The turn-around has come about fairly quickly and provides useful lessons to countries undergoing reform programs. The evolution of a number of macroeconomic indicators in Indonesia is presented in Table 1.

We estimate the channels through which a devaluation affects private investment empirically for Indonesia and attempt to quantify the composite effect of devaluation on private investment. We do this with a model of investment and growth which is formulated to capture the various channels mentioned above. The econometric analysis

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[6] Assuming no effect of a devaluation on private consumption. This is verified later for Indonesia.

TABLE 1

INDONESIA - ECONOMIC INDICATORS

Mid-1987 Population (mils) 171.4
1987 Per Capita GNP in US$: 450

	Shares of Gross Domestic Product (from current price data)						Growth Rates (% per annum) (from constant price data)				
	1965	*1973*	*1980*	*1986*	*1987*	*1988p*	*1965-73*	*1973-80*	*1980-87*	*1987*	*1988p*
Gross Domestic Product m.p.	100.0	100.0	100.0	100.0	100.0	100.0	8.2	7.2	3.6	3.4	4.7
Net Indirect Taxes	2.3	4.6	3.3	..		..	..	..	..	..	..
Agriculture	56.0	38.2	24.0	25.8	26.0	..	4.8	3.8	3.0	2.8	3.8
Industry	12.6	26.5	41.7	31.4	33.5	..	15.2	7.3	2.1	1.6	4.8
(of which Manufacturing)	8.4	10.6	13.0	14.2	14.1	..	9.0	14.7	7.8	7.5	8.6
Services	31.4	35.2	34.3	42.8	40.6	..	5.0	10.1	5.6	5.4	5.1
Resource Balance	-0.1	1.7	12.8	0.3	2.8	2.4	..	..	..	..	..
Exports of GNFS	5.3	20.3	33.0	22.1	26.3	24.6	12.6	5.8	-0.3	16.8	5.5
Imports of GNFS	5.4	18.6	20.2	21.8	23.6	22.2	17.6	12.6	1.1	4.4	3.1
Total Expenditures	100.1	98.3	87.2	99.7	97.2	..	7.5	8.9	4.1	0.6	4.2
Total Consumption	92.3	77.5	62.9	75.1	71.9	..	5.6	7.8	4.9	6.9	3.4
Private Consumption	87.2	67.8	52.3	63.2	61.4	..	5.1	6.9	5.1	8.4	4.3
General Government	5.1	9.7	10.5	11.8	10.4	..	9.8	13.9	4.1	-0.2	-1.5
Gross Domestic Investment	7.8	20.8	24.3	24.6	25.4	..	17.5	11.9	3.1	-11.4	6.0
Fixed Investment	7.8	..	21.6	21.7	21.8	..	..	..	0.6	4.4	7.0
Changes in Stocks	..	..	2.7	2.9	3.6	..	..	..	..	..	..
Gross Domestic Saving	7.7	22.5	37.1	24.9	28.1	..	21.6	15.0	0.0	-4.7	5.0
Net Factor Income	1.2	-1.7	-4.1	-4.2	-5.3	..	..	..	..	..	..
Net Current Transfers	..	0.0	0.0	-0.1	0.1	0.2	..	..	..	..	..
Gross National Saving	..	20.8	33.0	20.6	22.9	..	43.8	15.9	0.4	-6.5	5.2

Price Indices	(1980 = 100) *1980*	*1984*	*1985*	*1986*	*1987*	*1988p*	Inflation Rates (% p.a.) *1965-73*	*1973-80*	*1980-87*	*1987*	*1988p*
Consumer Prices (IFS 64)	100.0	151.7	158.9	168.2	183.8	198.6	56.3	17.0	8.9	9.3	8.1
Wholesale Prices (IFS 63)	100.0	156.2	163.9	167.5	198.4	..	..	18.8	9.9	18.4	..
Implicit GDP Deflator	100.0	151.8	161.1	156.7	178.8	206.6	62.9	19.8	8.4	14.1	15.5
Implicit Expenditures Defl.	100.0	148.6	159.0	158.5	181.1	..	62.7	16.8	8.9	14.3	..

Central Government Budget	Share of GDP (%) *1980*	*1984*	*1985*	*1986*	*1987*	*1988p*	Growth Rates *1980-84*	*1986*	*1987*	*1988p*
Current Receipts	21.1	21.2	19.6	16.1	18.0	16.9	16.4	-11.8	30.5	7.5
Current Expenditures	14.1	12.1	13.4	13.2	13.0	12.3	11.9	5.5	15.7	8.4
Current Budget Balance	7.0	9.1	6.2	2.9	5.0	4.6	..	..	..	..
Capital Receipts							..	..	..	..
Capital Expenditures	9.8	8.4	9.2	7.2	7.7	7.7	12.2	-16.1	26.0	14.1
Adjustments							..	..	..	..
Overall Deficit	-2.8	0.7	-2.9	-4.2	-2.8	-3.2	..	..	..	..
Official Capital Grants		0.2	0.2	0.3	0.3	0.4	..	..	..	..
External Borrowing (net)	2.7	2.6	1.9	3.6	2.4	3.1	16.6	105.6	-24.3	50.0
Domestic Non-Bank Financing							..	..	..	..
Domestic Bank Financing	0.2	-3.5	0.8	0.3	0.1	-0.3	..	..	..	..

Official X-Rate (Rupiah/US$)	626.99	1025.90	1110.60	1282.60	1643.80	1696.00
Index Real Eff. X-R Base 1980	100.00	92.38	89.75	69.12	50.77	48.99

uses the recent literature on cointegration and error correction models to highlight the relationship between devaluation and private investment.

The results, while interesting in terms of their implications for Indonesia, are also meant to be illustrative of the application of cointegration techniques. The approach allows for an analysis of the nature of the long run equilibrium relationship between investment and its determinants as well as the short run dynamics, without generating the types of spurious correlations often found in time series econometrics. In addition, the error correction model provides a realistic framework for describing how rational, but fallible, agents make optimizing decisions.

The paper is divided into five sections. Section 1 discusses the channels between devaluation and private investment. In Section 2 we set out the error correction growth-investment model. In Section 3 we describe the trends in Indonesia's key macroeconomic variables and policy changes that have driven investment behavior. The estimates of the model are presented in Section 4 with a set of simulations that look at the short versus long run implications of devaluation on private investment. The final section presents our conclusions.

2. Devaluation and Investment: The Model

2.1. The Channels

There are several possible channels through which a devaluation affects private investment. In general, a devaluation raises profitability in the traded goods sector and lowers it in the non-traded sector. If capital is sector-specific then total investment demand for non-traded goods must rise since the higher capital demand of the traded goods sector cannot be met by negative gross investment in the non-traded goods sector. In the more general case when capital is not entirely immobile between sectors the impact of devaluation on investment is indeterminate in theory because disinvestment in non-tradeable sectors may be larger than the increase in investment in the tradeable goods sector. The net outcome will depend on the strengths of the various channels, which we discuss individually:

Cost of Imported Inputs: In recent years there has been a substantial literature on the effects of devaluation on investment through the cost of imported inputs . A devaluation raises the cost of imported inputs relative to non-traded goods prices but not in terms of traded goods prices. Its effect therefore is unambiguously negative on investment as profits in the non-traded goods sector will fall. This will not be offset by a rise in profitability in the traded goods sector through this channel.

Supply Price of Capital: The effects of devaluation on the supply price of capital are indeterminate. In sectors that depend heavily on traded capital goods, a

real devaluation lowers the overall supply price of capital. Where nontraded goods constitute a larger share of investment costs, a devaluation raises the supply price of capital. Consequently, the net effect of devaluation on the supply price of capital depends on the relative shares of traded and nontraded goods in total investment costs.

Real Wages: The effect of devaluation on the real product wage is dependent on how nominal wages are allowed to respond to higher prices.[7] If nominal wages remain fixed, then obviously a devaluation will lead to a fall in real wages, an increase in profitability and a rise in investment demand. If wage indexation is allowed then real wages could rise or fall depending on the degree of indexation. In the more general case where wages adjust with a lag to overall inflation in the economy, real wages would fall in the short run. This should lead to a rise in profitability and a positive effect on investment. The net effect, however, is ambiguous and requires empirical verification.

Real Interest Rate: In an economy with an open capital account the domestic real interest rate is approximately equal to the real foreign interest rate plus the rate of expected real depreciation.

$$ri = rf + ne$$

[7] These effects have been discussed by van Wijnbergen (1986) and Branson (1986).

where ri is the real interest rate in the domestic market, rf is the real foreign interest rate and ne is the expected real depreciation.

It is important therefore to distinguish between the effect of an anticipated future devaluation and the effect of a previously unanticipated devaluation. Given financial arbitrage between domestic and foreign assests, an unanticipated devaluation therefore should have no effect on real interest rates. In the case of an anticipated devaluation, real interest rates would rise in response to the expected devaluation. Once the devaluation took place, real interest rates would subsequently fall to the level of foreign interest rates if domestic and foreign assets are perfect substitutes.[8]

2.2. The Investment Model

We now turn to a model which can be empirically estimated and which captures these theoretical linkages. The process by which firms move from actual to desired levels of capital stock is hypothesized to follow an error correction mechanism. The rationale for such a hypothesis is, firstly, that error correction models have proven to be empirically useful at explaining a number of long run macroeconomic relationships.[9] Secondly, unlike the more common partial adjustment model, the error correction approach implies that agents incur no costs for changes that are

[8] See Ahmed and Chhibber (1989) for a theoretical exposition of this issue.

[9] For empirical examples, see Davidson et al, 1978; Currie, 1981; Salmon, 1982; Henry and Minford, 1988; and Shafik (1989).

planned.[10] In addition, the recent literature on cointegration provides a theoretical justification for the empirical success of error correction models. By including variables in both levels and differences, error correction models capture both the long run equilibrium and the short run dynamics between macroeconomic time series. Granger (1983) has shown that error correction models produce cointegrating sets of variables and that all cointegrating series can be represented by an error correction mechanism.

An error correction model can be derived from the minimization of a quadratic cost or loss function.[11] Consider the case where the firm's intertemporal optimization problem is to minimize the expected costs associated with adjusting to the desired capital stock over an infinite horizon defined as:

$$(1) \quad \text{Min } E\sum_{t=0}^{\infty}[c(K_t - K_t^*)^2 + (K_t - K_{t-1})^2].$$

Differentiating and rearranging the above, an equation of the error correction form is obtained:

$$(2) \quad \Delta K_t = a_0 K_t^* + a_1(K_{t-1} - K_{t-1}^*) + a_2 \Delta K_{t-1}.$$

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[10]The partial adjustment model results in consistent undershooting if the economy is growing since agents incur a cost for any change, even a desirable one. See Nickell, 1985 for an analysis.

[11] For a more detailed discussion of the derivation of error correction models, see Nickell, (1985); Hendry and von Ungern Sternberg, (1981).

This formulation implies that capital stock responds to both changes last period as in the partial adjustment model as well as to changes in the target, K^*. The levels term, $(K_{t-1} - K_{t-1}^*)$, captures the divergence from the long run equilibrium as agents respond to new information.

The relationship between investment and the stock of capital is defined conventionally as:

$$(3) \quad I_t = K_t - (1-\delta)K_{t-1}$$

where δ = depreciation rate.

The long run equilibrium relationship between desired investment and the capital stock is:

$$(4) \quad I_t^* = K_t^* - (1-\delta)K_{t-1}^*.$$

Applying the lag operator, $LK=K_{t-1}$

$$(5) \quad I_t^* = [1-(1-\delta)L]_1 K_t^*$$

and in differenced form,

$$(6) \quad \Delta I^* = [1-(1-\delta)L]\Delta K^*.$$

Substituting equations (5) and (6) into equation (2) :

$$(7)\quad \Delta I_t^* = \alpha_o[1-(1-\delta)L]\Delta K_t^* + a_1\{I_{t-1} - [1-(1-\delta)L]\Delta K_{t-1}^*\} + a_2\Delta I_{t-1}$$

The determinants of the equilibrium capital stock are hypothesized to be expected profits which are a function of demand and costs:

$$(8)\quad K^* = f(PF^e) = f(Y, C)$$

where PF^e = expected profits,

Y = aggregate demand
C = costs.

The importance of both demand and costs is a reflection of the nature of technology which is hypothesized to be putty-clay. Costs are a function of domestic and world prices which are proxied by the real domestic interest rate (r), real import prices (m), and the real exchange rate (n). We enter the real exchange rate because it has an effect on the supply price of capital and the real wage rate as discussed in Section 2.1. Its net effect on investment, as we discussed earlier, is indeterminate.

$$(9)\quad C = f(r, m, n).$$

Substituting equation (9) and (8) into (7) and rearranging, one obtains a dynamic model of investment which is of the error correction form:

$$(10)\quad \Delta I_t = b_0\Delta Y_t + b_1\Delta r_t + b_2\Delta m_t + b_3\Delta n_t + b_4[I_{t-1} - b_5Y_{t-1} - b_6r_{t-1} - b_7m_{t-1} - b_8n_{t-1}].$$

An equivalent model derived in terms of the capital stock would take the form:

$$(11)\quad \Delta K_t = b_0\Delta Y_t + b_1\Delta r_t + b_2\Delta m_t + b_3\Delta n_t + b_4[K_{t-1} - b_5Y_{t-1} - b_6r_{t-1} - b_7m_{t-1} - b_8n_{t-1}].$$

These relationships will be tested econometrically below.

2.3. Stationarity Testing

The problems associated with econometric analysis of non-stationary time series were first identified by Granger and Newbold (1974) in their discussion of "spurious regressions." They recommended differencing as a strategy for "de-trending" data when spurious correlations were suspected. However, simple differencing of time series is both ad hoc and results in the loss of information about the equilibrium relationship between the levels.

The recent literature on cointegration, combined with advances in testing properties of time series, addresses both the spurious regressions critique while

retaining long run information about the relationship in equilibrium.[12] The intuition is that if the econometric interaction of a set of stationary variables results in a "white noise" error, a non-spurious statistical relationship exists and the model is "sufficient" since there is nothing left to explain econometrically.

The first step in the process is to explore the time series properties of the variables involved to determine what order of differencing is required to achieve stationarity. Many macroeconomic time series, such as output or investment, tend to have unit roots (I(1)) implying that differencing once results in a stationary series. Variables such as real interest rates or stock prices are often stationary without any differencing, i.e., are I(0). Series that need to be differenced twice to achieve stationarity are called I(2). Once the order of the series is determined, it is possible to assess in what form they should enter in the equation so as to obtain unbiased coefficients

Given that stationarity testing is relatively new, there is still some controversy about the power of alternative tests. Hence, two different techniques for evaluating the time series' properties were used. The first, the Cointegrating Regression Durbin-Watson (CRDW) test is the standard Durbin-Watson statistic that results from

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[12] For a survey of the literature, see a special August 1986 issue of the Oxford Bulletin of Economics and Statistics, volume 48, number 3, with articles by Hendry, Granger, Hall, Jenkinson, Banerjee et al, and Molinas. For a further discussion, see Dolado and Jenkinson, 1987 and Engle and Granger, 1987.

regressing the difference of the variable on a constant when the null is I(1) and the second difference on a constant when the null is I(2).[13]

The results for the CRDW test on data for Indonesia are reported in table 2. The variables are defined as:

I	=	real private investment
GDP	=	real gross domestic product
KP	=	private sector capital stock
r	=	real interest rate
m	=	real import prices
n	=	real exchange rate

The CRDW test results indicate clearly that all of the relevant variables have unit roots, i.e. that first differencing results in stationary series. The test statistics for the null of I(2) are considerably over the critical value of approximately unity for the CRDW test.

The alternatives to the CRDW statistics are Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests.[14] The Dickey-Fuller test where the null hypothesis is a unit root (I(1)) takes the form:

$$(12) \quad \Delta X_t = \Delta X_{t-1} + \sum_{j=1} \alpha_j \Delta X_{t-j} + e_t$$

[13] See Sargan and Bhargava, 1983 for the derivation of the Cointegrating Regression Durbin-Watson test statistic.

[14] For a derivation, see Dickey and Fuller, 1979 and Dickey and Fuller, 1981.

Table 2: TESTING FOR UNIT ROOTS: COINTEGRATING REGRESSION DURBAN-WATSON STATICS (CRDW), DICKEY-FULLER (DF) AND AUGMENTED DICKEY-FULLER (ADF) TESTS [NULL HYPOTHESIS IS A UNIT ROOT, I.E., i(1)]

Variable	DF	DF W/C	DF W/C&T	CRDW (I(1))
I	0.79	-2.60	-1.04	0.15
GDP	1.50	-1.40	-1.66	0.05
KP	-0.31	1.95	-1.75	0.05
r	0.35	-1.67	-2.37	0.78
m	1.52	0.50	-0.87	0.48
n	1.92	1.22	-0.69	0.40
	ADF	ADF W/C	ADF W/C&T	CRDW(I(2))
I	0.09	-2.67	-2.14	3.33
GDP	0.55	-1.19	-1.77	2.42
KP	1.63	-0.46	-2.54	1.86
r	0.63	-1.23	-2.29	2.64
m	1.36	0.67	-0.70	2.53
n	1.39	0.90	-0.78	2.08

Where the null hypothesis is I(2), the test is:

$$(13) \quad \Delta\Delta X_t = b\Delta X_{t-1} + \sum_{j=1} \alpha_j \Delta\Delta X_{t-j} + e_t$$

The test statistic is the standard "t" test on the lagged dependent variable "b" Because the test is sensitive to whether a drift (C) or time trend (T) are included, it was repeated in different forms for each variable. The Augmented Dickey-Fulller test includes second and third lags of the left hand side variable to capture any additional

dynamics. The critical values for the ADF test are the same as those for the DF test.[15]

The DF and ADF test results are ambiguous. The critical values for the DF and ADF tests are somewhat debatable and therefore the results must be considered tentative, especially given the relatively small sample size. The critical values are between -2.61 and -3.20, which are above most of the test statistics reported in Table 2. The test results are much better when a constant and time trend are included.

Stationarity testing is still at an early stage and in general there is greater confidence in the power of the CRDW test over the DF and ADF tests. In addition, visual inspection of the relevant variables indicates that they appear stationary after differencing once.[16] Consequently, it seems plausible to conclude that the variables have unit roots, i.e. that they are I(1).

2.4. The Engle-Granger Technique

A technique proposed by Engle and Granger for modelling cointegrated time series will be used.[17] Engle and Granger suggest a two stage modelling procedure

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[15] Engle and Granger, 1987, p. 269.

[16] The fact that the variables are trended in the levels can also be seen in Figures 1, 2, and 3 in the text.

[17] Engle and Granger, 1987.

in which the equilibrium levels relationship is explored prior to estimating a dynamic equation. The alternative procedure of estimating an unrestricted dynamic equation and then reparamaterizing may be more attractive, but is not well suited to modelling under limited degrees of freedom.[18]

The first stage of the Engle-Granger procedure consists of econometric analysis of the hypothesized long run relationship in the levels to determine whether the variables cointegrate. Evidence of cointegration includes an R2 that is close to unity, significant coefficients,[19] a significantly non-zero Cointegrating Regression Durbin-Watson statistic, and significant Dickey-Fuller and/or Augmented Dickey-Fuller test results on the residuals from the levels regression. The coefficient estimates at this levels stage can be interpreted as the long run multipliers.

The second stage of the Engle-Granger procedure consists of using the lagged residuals from the levels regression to capture the process by which agents correct for expectational errors in previous periods. These lagged residuals, along with differenced terms, reflect the short run dynamics as rational, but fallible, agents respond to changing economic signals.

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[18] For a discussion of the advantages and disadvantages of the Engle-Granger procedure versus general dynamic modelling, see Jenkinson, 1987 and Banerjee et al, 1987.

[19] Note that because of autocorrelation of the residuals, the "t" statistics from the levels regression are biased upwards and therefore it is not possible to evaluate the true significance of the coefficients. However, it is possible to accept the insignificance of coefficients at the levels stage since if a variable is insignificant when the "t" statistics are upwardly biased, it will certainly be insignificant for the true value of the coefficient.

3. Empirical Estimation for Indonesia

We estimate the investment model described in Section 2 with Indonesian data.

The model described in Section 2.2 hypothesizes that the interaction of these variables determines the equilbrium level of investment or capital stock in the economy. The model was tested using both private investment and the private sector capital stock as the dependent variables.[20] The investment equation is linear whereas the capital stock equation is in logarithms, with the exception of the interest rate and the import price index which are linear. All variables are in real terms. The first stage levels results for the 1974-87 period are presented in Table 3. All the variables are significant, with the exception of the real interest rate which has a slightly low "t" statistic.[21] This may reflect the time series properties of the real interest rate since it is the only variable that may be stationary without differencing. Otherwise the interest rate, like all the other variables, is appropriately signed.

The cointegration statistics that have been constructed from these levels regressions appear promising. The Cointegrating Regression Durbin Watson test, which resulted from regressin~ the first difference of the residuals on a constant and

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[20] The private investment equation was run as a linear relationship whereas the capital stock equation was run in logs (except for the interest rate and the import price series which were not in logs).

[21] Note that the "t" statistics from the cointegrating levels regression are upwardly biased owing to autocorrelation of the residuals. The statistics are reported here, however, in order to assess whether certain variables should be dropped since if they are insignificant when the "t" statistics are are biased upward, they are likely to be irrelevant to the long run equilibrium relationship.

Table 3: PRIVATE INVESTMENT EQUATION IN LEVELS

	Private Investment	Private Capital Stock
	(1)	(2)
Regressor		
Constant	-1.59 (2.30)	-0.05 (0.64)
GDP_{t-1}	0.60 (8.87)	0.55 (5.31)
r_t	-2.30 (4.66)	-0.18 (5.02)
m_{t-1}	-0.02 (4.33)	-0.001 (3.36)
n_{t-1}	0.01 (2.12)	0.0004 (1.16)
KP_{t-1}	-0.29 5.85)	0.62 (8.12)
R2	0.98	0.99
CRDW	3.11	3.08
F	78.26	6638.09
DF	-3.79	-4.96
ADF(2)	-0.85	-2.54

GDP = real gross domestic product
r = real interest rate
m = real import price
n = real exchange rate
KP = private sector capital stock

evaluating the Durbin-Watson statistic, is significantly non-zero. Both the Dickey-Fuller and Augmented Dickey-Fuller tests are sufficiently high to indicate that the residuals are "white noise." These results imply that some equilibrium relationship exists between private investment, output, interest rates, and import prices.

Using the lagged residuals from the above levels regression, an unrestricted equation using differences was estimated for both the level and stock of private capital and are presented in Table 4. Ideally, it would be possible to include several lags of each differenced variable and to reparamaterize according to significance until the most parsimonious model was obtained. However, in order to preserve degrees of freedom and given that the data are annual, only one lagged difference for output, interest rates, and import prices was included in Table 4. The reparameterizations in equations (4) and (6) in Table 4 have highly significant coefficients for all of the independent variables. Output affects investment in lagged form implying that it is serving as an indicator of expected demand. The effect of the interest rate is highly significant reflecting the negative effects of the cost of capital on private investment. The coefficient of the real import price index is significantly negative and is larger than the positive coefficient on the real exchange rate. This implies that the first round effect of a devaluation on private investment will be negative. This issue will be explored further in the next section with a complete macroeconomic model. The above results provide strong support for the use of an error correction model to describe private investment behaviour in Indonesia. The lagged residuals term (Res(-1)), which reflects the equilibrium error term, is always significant and correctly negatively signed. This implies that there is a long run equilibrium relationship

Table 4: PRIVATE INVESTMENT EQUATION IN FIRST DIFFERENCES WITH ERROR CORRECTION TERM

	Difference of Private Investment		Difference of Private Capital Stock	
	(3)	(4)	(5)	(6)
Regressor				
$DGDP_t$	0.518 (0.55)		0.2461 (1.86)	
$DGDP_{t-1}$	0.5517 (4.77)	0.6014 (11.68)	0.3365 (1.93)	0.5742 (4.44)
Dr_t	-1.9338 (7.29)	-1.9228 (9.26)	-0.1349 (3.36)	-0.1691 (4.98)
Dm_t	-0.0007 (0.55)			
Dm_{t-1}	-0.0257 (6.87)	-0.0267 (13.75)	-0.0012 (3.49)	-0.0016 (5.54)
Dn_t			0.0001 (0.46)	
Dn_{t-1}	-0.0128 (3.52)	-0.0136 (8.04)	0.0002 (0.76)	-0.0007 (2.69)
DKP_{t-1}	-0.2908 (7.40)	-0.2929 (8.36)	0.5978 (7.26)	0.6017 (6.42)
RES_{t-1}	-1.6725 (4.07)	-1.8350 (8.69)	-0.7362 (1.55)	-1.3841 (3.35)
R2	0.98	0.98	0.99	0.99
CRDW	2.95	3.11	2.41	2.99
F	28.78	47.51	346.59	341.34
DF	-4.56	-3.79	-3.02	-3.04
ADF(2)	-1.42	-0.85	-2.17	-1.48

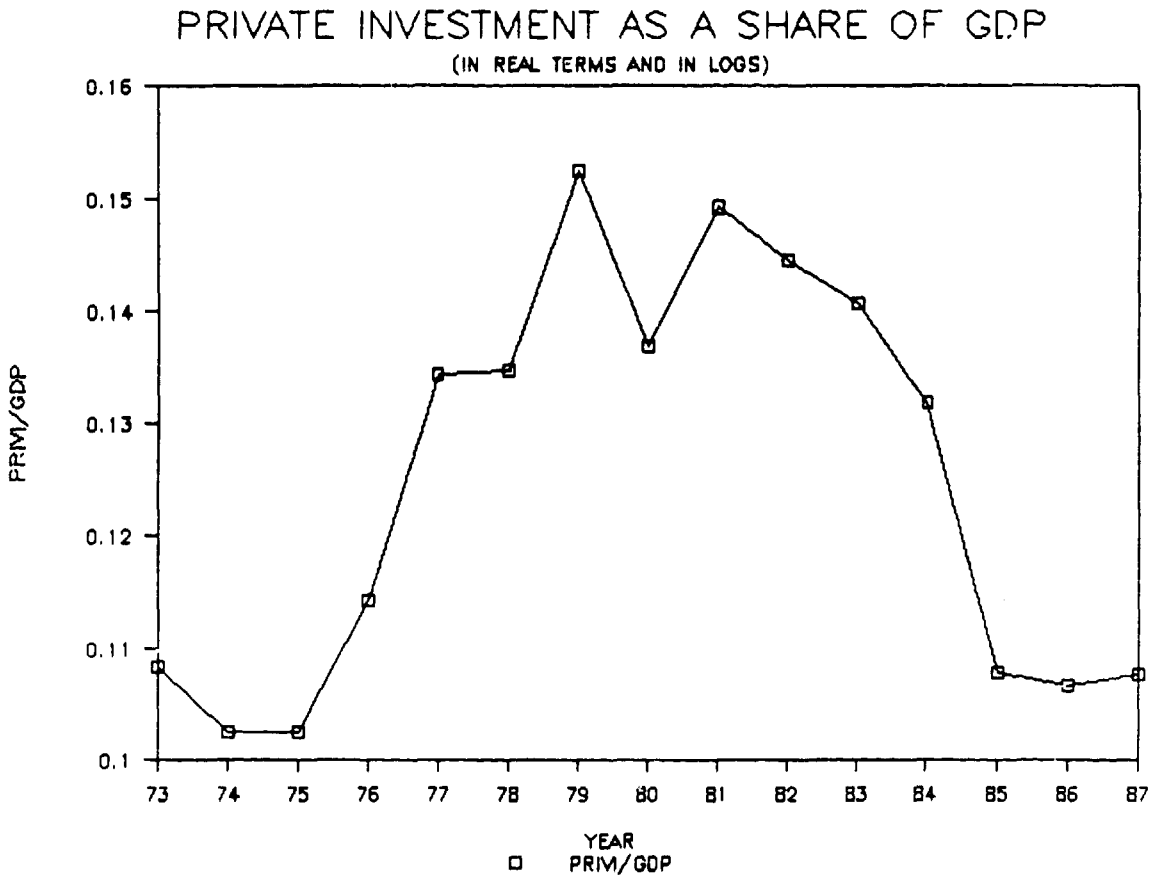
between private capital formation, output, real interest rates, and import prices and that agents learn from past expectational errors about the target capital stock over time.

The cointegration statistics are very high for the unrestricted versions of the equations (3 and 5). In the reparamaterizations (equations 4 and 6), the regression with the capital stock has better cointegration statistics than that with investment. The cointegration statistics for equation 6 indicate that the residuals from the model are white noise and therefore the equation explains of the time series dynamics. Recursive estimation with one step Chow tests also showed that the parameters were stable.

The model provides an interesting explanation of the evolution of private investment in Indonesia over the period. Figure 1 depicts the rise in the private investment ratio. Non-oil private investment peaked at almost 11 percent of GDP in 1979 and then fell to a low of between 6-7 percent of GDP in the late 1980s. The aggregate private investment series with oil included follows roughly the same pattern, although the decline after 1979 is more gradual. The graph indicates the degree to which investment has borne the brunt of adjustment to both favorable and unfavorable external shocks.[22]

[22]In contrast, consumption growth has been steady, implying that Indonesia successfully smoothed consumption.

Figure 1


PRIVATE INVESTMENT AS A SHARE OF GDP
(IN REAL TERMS AND IN LOGS)
PRIV/GDP
0.16
0.15
0.14
0.13
0.12
0.11
0.1
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
YEAR
PRIV/GDP

The movement of the real interest rate in Indonesia is depicted in figure 2. The definition of the interest rate variable is somewhat complicated by the existence of a dual financial market up to 1983 with the state banks providing subsidized credit to certain borrowers coexisting with private banks that lend at more market rates.[23] The existence of subsidized interest rates in the state banks was not motivated by a need for cheap public borrowing since the balanced budget law constrained the government's ability to borrow domestically.[24] Instead, the subsidized credit was a mechanism whereby the state transferred some of its oil rents to the private sector in certain targeted areas, such as export-oriented projects or those undertaken by native investors. This policy of heavily subsidised credit could not be maintained after the oil prices declined. The 1983 financial liberalization reflected the passing of the government's terms of trade losses due to falling oil prices to the private sector. Real interest rates were positive after 1983, in response to the financial reform and their subsequent movement reflected expectations about inflation, the exchange rate and risk.

Changes in real import prices depicted in figure 3 reflect the substantial devaluations associated with the adjustments of the 1980s. After a decline in the real import price index during the 1970s, the trend thereafter is steadily upward, with the

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[23] For a summary of the evolution of the Indonesian financial system, see Erquiga, 1987, pp. 42-79. The very negative interest rates in 1979 and 1980 are due to the high growth in the GDP deflator of over 25 percent per annum in those years.

[24] Chamley and Hussain, 1988, p. 19.

Figure 2

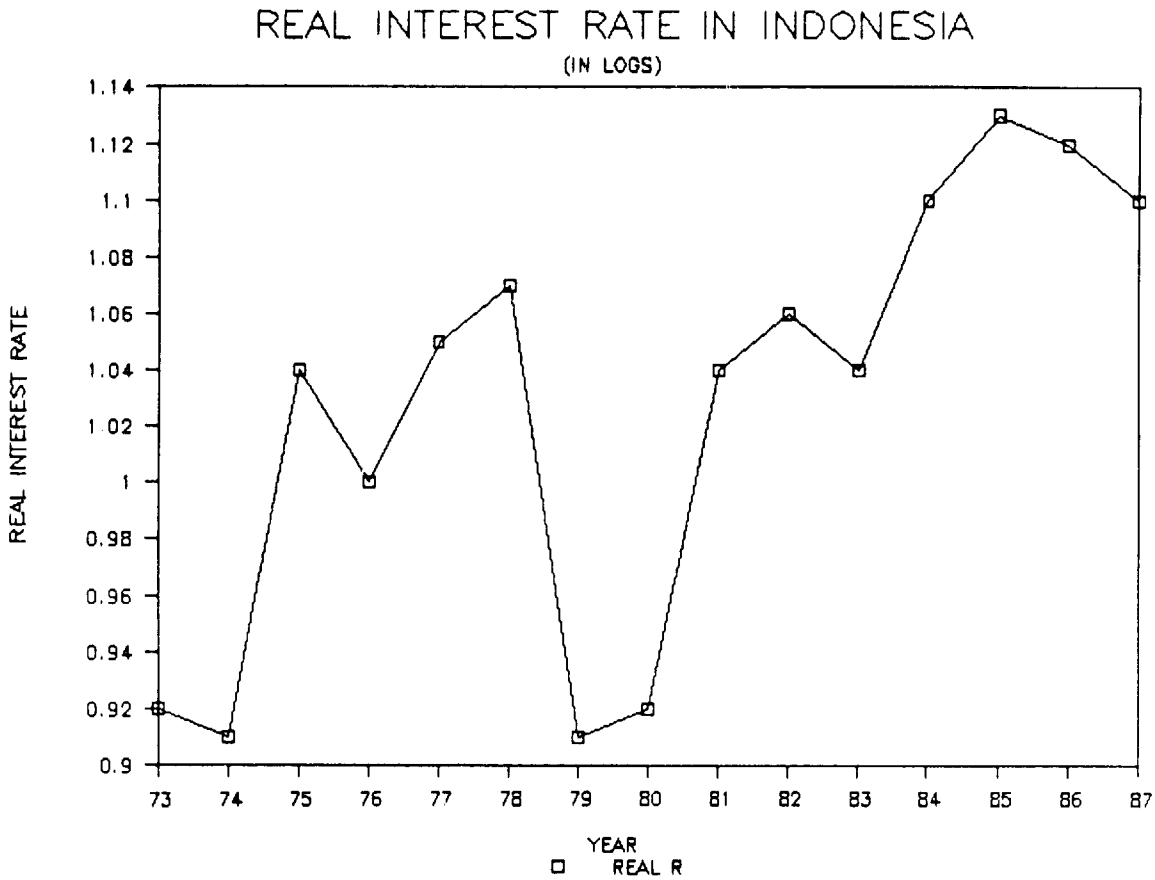
REAL INTEREST RATE IN INDONESIA
(IN LOGS)
REAL INTEREST RATE
1.14
1.12
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0.9
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
YEAR
REAL R

Figure 3


REAL IMPORT PRICES IN INDONESIA
REAL IMPORT PRICES
180
170
160
150
140
130
120
110
100
90
80
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
YEAR
REAL IMPORT PRICES

exception of the 1979-83 period when import prices declined slightly. This effect was reinforced by the fact that costs were exceptionally low during the windfall period. Interest rates were negative in real terms and the exchange rate was overvalued, thus lowering the costs of borrowing and of importing. These policies, which were sustainable as long as the government had access to rents from oil, encouraged a greater investment rate.

The decline in the investment rate during the first half of the 1980s was a reversal of the circumstances that spawned the earlier boom. The fall in the world price of oil had direct effects on output, and therefore aggregate demand, as well as indirect effects on the sustainability of government subsidies of interest rates and the exchange rate. The devaluations of 1979 and 1983 and the financial liberalization of 1983 were symptomatic of growing pressure on the government budget. The rise in the cost of borrowing and of imports further exacerbated the decline in private investment as is confirmed by our econometric results in Table 4.

By the middle of the 1980s, there was a recovery in private investment which has been sustained despite higher import costs due to the large devaluations starting in 1986 and high real lending rates in the economy. Why has private investment recovered in Indonesia despite rising import and credit costs? Why is Indonesia unique among countries that have undertaken a sweeping adjustment program in that private investment has recovered and led to a restoration of growth in the economy? To answer this question, we embed the investment model estimated in this section into a larger macroeconomic model of the Indonesian economy reported in Ahmed and

Chhibber (1989), which is briefly described in the next section. This is necessary to capture the general equilibrium effects of devaluation on variables such as interest rates, the real exchange rate and output that ultimately affect private investment.

4. The Macro-Economic Model

The simulation model used in this section is presented in Table 5. The model consists of five sections - growth, private sector demand, fiscal, external and inflation and interest rates. In the first section, a non-oil growth equation (3.1) is derived from a Cobb-Douglas production function:

$$(14) \qquad Q = f(B, K, L)$$

where Q is non-oil output, B is technical change , K is the non-oil capital stock and L is labour supply.

We use two alternate formulations for B, technical change. In the first, technical change follows a linear trend.

$$(15) \qquad B = f\ (\text{time})$$

In the second, we postulate that export orientation and less import protection will impart greater efficiency to domestic industry and increase the rate of technical

change. We use the real exchange rate as an indicator of changes in outward orientation.[25]

(16) $B = f(n)$

TABLE 5: THE MACROECONOMIC MODEL

A. GROWTH

3.1. $gy = b_1\, gk + b_2 gPOP + b_3 n + b_4\, DY$

3.2. $gk = \ln K - \ln K(-1)$

3.3. $gy = \ln Y - \ln Y(-1)$

3.4. $K = Kp + Kg$

3.5. $Kp = Kp(-1)(1-Sp) + Ip$

3.6. $Kg = Kg(-1)(1-Sg) + Ig$

B. PRIVATE SECTOR DEMAND

3.7. $Ip = a_o + a_1\, Y(-1) + a_2 n + a_3 rL + a_4 m + a_5 K_p(-1)$

3.8. $Cp/p = c_o + c_1\, r_f + c_2\, Y_d + C_3\, Y_d(-1)$

3.9. $Yd = GNP - \text{Net Revenue}$

3.10. $Sp = Yd - Cp$

[25]The trade regime has not undergone major changes in Indonesia during the period under consideration.

C. FISCAL

3.11. $DEF = I_g + C_g + IN_f - CUDT - EXPT - OREV$

3.12. $CUDT = e \cdot tm \cdot M$

3.13. $EXPT = e \cdot tx \cdot X$

3.14. $IN_f = e \cdot i_f \cdot DEBT$

D. EXTERNAL

3.15. $CA = Sp - Ip - [DEF]$

3.16. $n = e \cdot P/P_f$

3.17. $n_{ref} = d_o + d_1 TOT + d_2 Y + d_3 Y_w + d_4 CA/GNP$

3.18. $DEBT = DEBT_{-1} - CA/e$

E. INFLATION AND INTEREST RATES

3.19. $P = f_o + f_1 \cdot M_2 + f_2(P_f + e) + f_3 DEF/GNP + f_4(P_{r-1}) + f_5 K/Y$

3.20. $r = r_f + (n\ ref - n)$

3.21. $rL = r + SPRD$

where:

CA	=	Current Account Surplus in Rupiah
Cg	=	Government Non-interest Current Expenditure
Cp	=	Private Consumtpion
CUDT	=	Revenues from Customs Duties
DEBT	=	Foreign debt in US$
DEF	=	Fiscal Deficit
DY	=	Dummy equal to 1 after 1981
Sg	=	Depreciation rate for public capital
Sp	=	Depreciation rate for private capital
e	=	Nominal Exchange Rate Rupiah/US$

EXPT	=	Revenue from export taxes.
gy	=	Growth of Non-oil output
gk	=	Growth of Capital Stock
gPOP	=	Growth of population
GNP	=	Gross National Product
Ig	=	Government Investment
Ip	=	Private Investment
IN_f	=	Interest payments on foreign Debt in Rupiah
if	=	Average interest rate on foreign debt
K	=	Total Capital Stock
Kp	=	Private Capital Stock
Kg	=	Government Capital Stock
M_2	=	Broad money supply
M	=	Imports in US $
mc	=	Import Cost Index
n	=	Real Exchange Rate Rupiah/US$
n_{ref}	=	Equilibrium Real Exchange Rate
OREV	=	Government Revenue Other
P	=	Consumer Price Index
P_f	=	Foreign Price Index
P_r	=	Rice Price Index
rL	=	Domestic real deposit rate
rf	=	Foreign real Deposit rate
rL	=	Domestic real lending rate
SPRD	=	Spread between domestic lending and deposit rates
Sp	=	Private Savings
tm	=	Import tax rate
tx	=	Export tax rate
TOT	=	terms of trade index
X	=	Exports in US$
Y	=	Non-oil GDP
Y_w	=	World Income

As there are no reliable labor statistics for Indonesia we use population growth (gPOP) as a proxy for labor force growth. In an economy with a flexible labor market such as Indonesia there are unlikely to be major shifts in the unemployment rate. In agriculture-based economies like Indonesia the problem is not unemployment but underemployment with the rural sector and the informal sector absorbing and releasing surplus labour in response to economic cycles.

The model is estimated in growth rates (gy) with a dummy variable (DY) after 1981 to represent the permanent downward shift in the resource base of the economy. The two alternative formulations of the model give the following results:

$$gy = \underset{(2.77)}{0.3263}\ gK + \underset{(2.76)}{0.8561}\ gPoP + \underset{(3.20)}{0.0037}\ t - \underset{(4.84)}{0.0588}\ DY$$

TSLS, $R^2 = 0.77$, DW = 1.56

Instruments: time,lagged capital stock, population growth, lagged real exchange rate, world income, dummy.

$$gy = \underset{(2.92)}{0.2783}\ gK + \underset{(2.57)}{0.6592}\ gPoP - \underset{(0.38)}{0.0007}\ t - \underset{(4.44)}{0.0468}\ DY + \underset{(2.89)}{0.00053}\ n$$

TSLS, $R^2 = 0.86$, DW = 1.76

Instruments : time, lagged capital stock, population growth, lagged real exchange rate, world income, dummy.

The second equation in which technical change and efficiency changes are represented by the real exchange rate performs much better. The share of capital in output is 0.28, and the share of labor is 0.66, the sum is 0.94. The remaining share 0.06 is explained by technical change. The inclusion of the real exchange rate to represent technical change is not very conventional. Others such as Balassa (1985) have used the share of exports in growth equations to represent outward orientation. This is also the approach used in recent work on growth by Roemer (1989). We use the real exchange to get a direct handle on the impact of exchange rate policy on growth. Equation 3.2 through 3.6 are self-explanatory.

The next block (Block B) describes private sector demand. Equation 3.7 on the determinants of private sector investment is taken from Section 2. Private sector consumption in Equation 3.8 is based on permanent and transitory income and real interst rates. The relevant interest rate for consumption is the Singapore interest rate as Indonesia has an open capital account and there is interest rate abitrage.[26] In the fiscal block (Block C) Equations 3.11-3.14 we single out customs duty, export taxes and interest payments on foreign debt as these items change in response to changes in the exchange rate.

Block D describes the determinants of the external accounts and the real exchange rate. Equation 3.15 is the transformed national income identity . The current account surplus equals the difference between net private savings (private savings minus private investment) and the fiscal deficit. Equation 3.16 defines the real exchange rate. Equation 17 defines the real exchange rate in equilibrium. Its arguments are the terms of trade (defined as the price of exports relative to the price of imports), domestic output, world output and the current account deficit as a share of GNP. The equation is derived from a more detailed external trade model. In this model, non-oil exports are a function of the real exchange rate, world income and domestic income. Non-oil imports are a function of the real exchange rate and domestic income. This model is described in Ahmed and Chhibber (1989).The estimated equation gave the following results :

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[26]For detailed tests on this see Ahmed and Chhibber (1989).

$$n = 423.1108 - 0.9086\ TOT + 31.6469\ Y - 6.4465\ Yw + 7.3784\ CA/GNP$$
$$(2.10) \quad (3.50) \quad (2.52) \quad (1.86) \quad (3.07)$$

TSLS, $R^2 = 0.80$, DW = 1.27,

Instruments : terms of trade, world income, lagged real exchange rate, fiscal deficit as a share of GNP, lagged GDP.

The important point to note about this equation for the purpose of the simulations is that the reference or equilibrium exchange rate is determined in terms of basic fundamentals such as the terms of trade, and domestic and world income growth. Note that a 1 point increase in the terms of trade index lowers the equilibrium real exchange rate by about 1 point (-0.90), as predicted by theory. It is also defined in relation to inflows from abroad. A larger current account deficit represented by a lowering of the CA/GNP ratio lowers "n" thereby resulting a real exchange rate appreciation.

Block E determines the rate of inflation and is described more fully in Chhibber (1989). Inflation (Equation 3.19) is determined by wage push (represented by lagged rice price inflation), underutilised capacity (represented by the capital-output ratio)[27] and the fiscal deficit. Import costs in local currency also affect the rate of inflation. Monetary growth determines expectations about inflation and also enters the equation.[28] Equation 3.20 represents interest rate arbitrage. The domestic real

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[27]This is derived as follows: Underutilized capacity (U) equals capacity output divided by actual output (y). Capacity output is equal to the average output capital ratio (a) multiplied by the capital stock (K). Therefore: U = a.K/y.

[28]See Dornbusch and Fischer (1988) for a theoretical exposition of this model.

deposit rate is equal to the foreign real deposit rate plus expectations on depreciation of the real exchange rate, which are defined as the difference between the equilibrium and the actual exchange rate. Equation 3.21 defines the spread between domestic lending and deposit rates.

5. The Effect of Private Investment of Slower Devaluation

The model is used to examine the effects of a slower devaluation on private investment and growth. The rate of devaluation is slowed from 1983-1987 such that the real exchange rate depreciation that Indonesia experienced did not take place (See Figure 4). The outcome of the slower devaluation is that the real exchange rate index remains at about the levels prevailing from 1980 to 1982. According to our model this has implications for the fiscal deficit, the current account deficit, and private investment and growth. Here we focus on presenting the implications for private capital formation so as to assess why investment recovered in Indonesia despite a very sizeable depreciation.

We refer to Sections 1 and 2 where we had outlined the various channels through which devaluation might affect private investment. First, domestic interest rates rise because the real exchange rate becomes overvalued in relation to the reference or equilibrium real exchange rate. This is an inevitable outcome of the open capital account. Note of course that the equilibrium rate also changes (Equation 3.17, Table 3). This is because the current account deficit and domestic growth change. The net outcome is a more appreciated equilibrium exchange rate as is depicted in Figure 4.

There is nevertheless considerable overvaluation between the actual and the equilibrium exchange rate resulting in expectations of a depreciation and higher interest rates.

Second, the slower depreciation results in a smaller increase in lagged real import costs. This has a positive effect on private investment in year 2, i.e., 1984 according to the estimated equation in section 2. Third, with an overvalued exchange rate, export growth suffers. As a result, the efficiency benefits from the more depreciated exchange rate do not materialise as export orientation declines and growth suffers. This is captured in our model by the direct positive effect of the real exchange rate in the growth equation. Fourth, the real exchange rate overvaluation also hurts private investment directly as described in Section 2.2. This effect comes from the fact that real wages are higher with a more appreciated real exchange rate which reduces profitability. It could also be due to the negative effect of reduced demand for investment goods in the traded goods sector which is larger than the higher demand in the non-traded goods sector.

Figure 5 shows the combined effect of all these changes through the simulation model on private investment. With a slower devaluation private investment is higher in the second year 1984 primarily due to lower real import costs. However, the positive export and output performance eventually outweigh the benefits of lower real import costs. Private investment declines thereafter and is substantially lower by 1987 than it would have been with a faster devaluation. The recovery in private

Figure 4: REAL EXCHANGE RATE INDEX

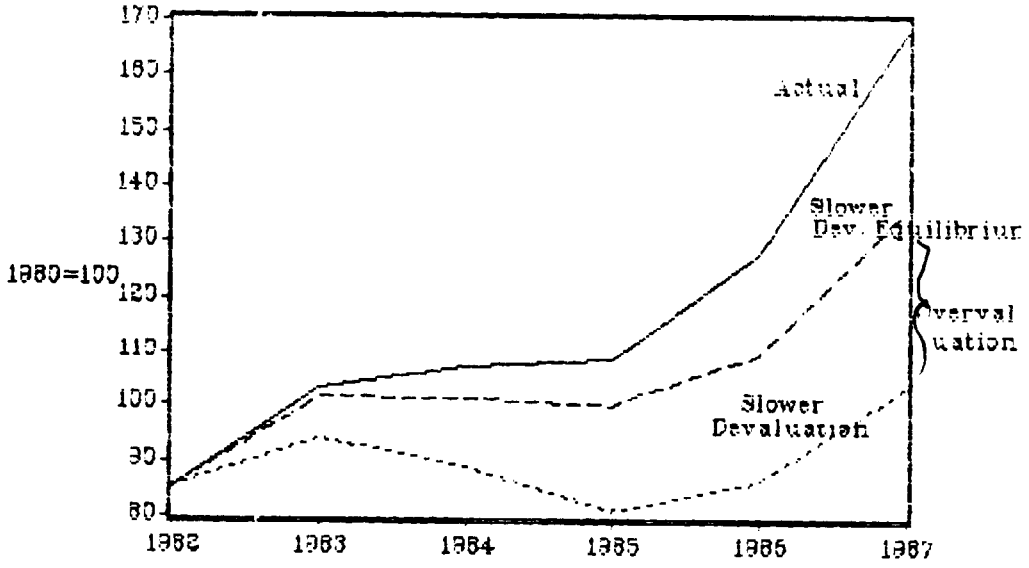
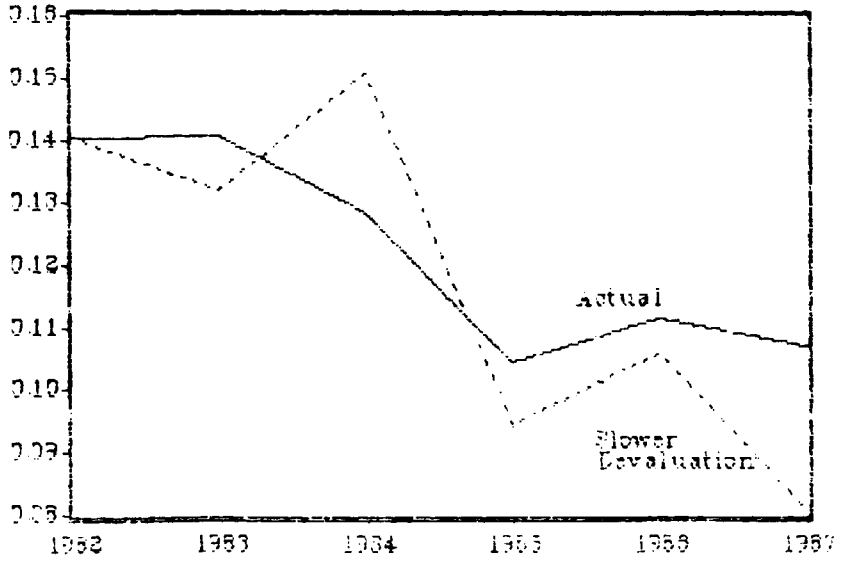


Figure 5: PRIVATE INVESTMENT/GNP



investment which has occurred since 1986 does not materialize. The downward trend is cumulative as lower private investment leads to lower growth which in turn lowers future private investment. It is interesting to note that the medium-term effect of a devaluation is different from the short-run effect. The switch-over comes by the third year of the simulation.

How does the higher private investment get financed? According to the model simulations, partly through higher private savings but primarily through larger foreign borrowing. The higher private savings is an outcome of higher growth in the economy. We have assumed that the improvements in revenue are passed on to the private sector in the form of transfers and subsidies so that there is no direct improvement in public savings from the devaluation. Since the government is a net seller of foreign exchange in the economy (due to oil) the devaluation should lead to higher revenue. But this is compensated by larger transfers to the private sector. As a result, all of the remaining increase in private investment (i.e., the difference between the increase in private investment and private savings) is financed by borrowing from abroad.

The availability of foreign financing was therefore a key aspect of the recovery in private investment. This allowed Indonesia to maintain social spending and private consumption while financing increases in private investment by borrowing abroad. The availability of commercial financing (despite a high debt/GNP ratio) was an outcome of stable and correct macroeconomic policies followed by the government and

the growth in non-oil exports which reduced Indonesia's debt-service ratio (as distinct from the debt/GNP ratio).

6. Conclusions

Does a devaluation hurt private investment? The answer is yes in the short-run according to the simulation results presented in this paper. It does so because of the higher import costs for capital goods which hurt private sector profitability and thus dampen investment. This conforms with the arithmetic of the national income identity. There must be a cut in domestic demand if the devaluation is to succeed in its objectives of improving the balance of payments position. If exports rise and imports fall and if supply response is weak in the short-run, then private investment must be squeezed unless all of the burden is put on private consumption or government expenditure.

In the longer run these effects get reversed. The real exchange rate depreciation leads to restructuring of domestic industry to meet the rising export demand and to efficiency improvements which improve profitability. As growth is revived, private investment recovers quickly. How short is the short-run and how long is the long-run? This paper shows that Indonesia has adjusted in a relatively short amount of time, i.e., in about two to three years. This has been a relatively quick turn around in comparison with other countries undergoing adjustment programs.[29] Clearly other factors that are not included in our model also matter.

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[29] For examples of adjustment experiences, see Thomas et al (1990).

One of these which is difficult to quantify is uncertainty and the credibility of government policies. By orchestrating a comprehensive set of reforms in areas including taxation, the financial sector, and the exchange rate, the government sent a clear signal to the private sector which imparted credibility to its adjustment efforts. This was a crucial element in the recovery of private investment, in the emergence of an array of non-traditional exports, and in the restoration of growth in Indonesia.

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