

REFORMS AND INVESTMENT IN INDIA

by

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Abstract: This paper examines the determinants of private corporate investment in India with emphasis on the implications of the policy reforms initiated in 1991. The results suggest that the net impact of the reforms on corporate investment has been salutary. The adverse impact of the decline in public investment has been outweighed by the positive effects of the decline in the cost of capital and favourable changes in investor perception brought about by the reforms. While it is not possible to generalise from a single country case, our results cast doubt on the existing cross-country evidence of a negative impact of structural adjustment reforms on private investment.

JEL Classification: E22, O11, O16.

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1. Introduction

The success of a structural adjustment programme (SAP) in bringing about a sustainable recovery in economic activity in a given economy depends crucially on the behaviour of investment in the aftermath of the reform process. Since the expansion of public investment is usually constrained as part of fiscal austerity measures embodied in a SAP, the required recovery of investment has to come largely from the private sector. The behaviour of private investment has therefore been a major focus of attention in assessing the reform outcome. The existing evidence across a wide spectrum of developing countries generally points to a decline or stagnation of private investment during the immediate post-reform years (World Bank 1988, Harrigan and Mosley 1991 and Greenaway and Morrissey 1992). A growing body of empirical literature has attempted to investigate whether this “stylised fact” is an outcome of the SAP *per se* or whether it can be attributed to non-policy factors such as terms of trade shocks or debt crisis (Greene and Villanueva 1991, Chhibber, Dailami and Shafik 1992, Serven and Solimano 1993, Bleaney and Greenaway 1993 and Bleaney and Fielding 1995). While the results of these studies are far from conclusive, there is some support for the hypothesis that specific elements of a SAP, such as trade liberalisation and a restrictive macroeconomic policy, may adversely impact on private investment.

The existing empirical literature on the impact of SAPs on investment, however, suffer from two main limitations. Firstly, most of the studies have been conducted using cross-country regression analysis¹, a methodology which is based on the implicit assumption of homogeneity in the observed relationship across countries. Such cross-country comparisons are however fraught with danger because there are vast differences among developing countries with respect to various institutional and structural characteristics impinging on the observed relations as well

¹ A notable exception are the various country studies in Chhibber, Dailami and Shafik (1992)

as to the nature and quality of data (Srinivasan 1994). Secondly, given the nature of data availability and the need to include a sufficient number of countries in the sample to derive statistically acceptable results, the authors have often been forced to adopt variable choices which are largely inconsistent with the postulates of the relevant theory. For instance, the real interest rate is often taken as the measure of the cost of capital while ignoring the role of the relative price of capital goods. This is a serious omission because a trade liberalisation program may have a significant impact on the relative price of capital which can counter balance or even swamp the cost implications of interest rate changes triggered by the reform package. Also, the capital stock, which is a crucial explicator of investment dynamics, is usually absent in regression specifications. Moreover, whereas the theory of investment is basically about the investment behaviour of *the firm* (or private business investment), the dependent variable commonly used in the empirical analysis is *total private investment*, which includes both residential investment by households and investment by firms. Total private investment is a poor proxy for business investment because household investment tends to dominate the total private investment series in most developing countries, and there are fundamental differences between household residential investment (which is the key component of household investment) and business investment in terms of the underlying determinants.

The above discussion highlights the need for country studies of investment behaviour based on careful model formulation for informing the debate on the implications of SAPs for investment behaviour in developing countries. In this context, the present study aims to examine the determinants of private corporate investment in India with emphasis on implications of the stabilisation cum structural adjustment policy package implemented in 1991². We chose India as the subject of our study for two reasons. Firstly, investment performance has been a key emphasis in the policy debate in India following the reforms initiated in 1991 (EPWRF 1995; Athukorala and Sen 1995). Secondly, the Indian macroeconomic data base is relatively rich by developing country standards. The availability of disaggregated data on the price of capital goods, capital stock and private corporate investment allows us to follow closely the received theory of investment in the specification of the

² For details on the Indian reforms see Bhagwati (1993) and Cassen and Joshi (1995).

investment function. Perhaps India is the only developing country for which a separate data series on business investment is available for a period of sufficient length for econometric investigation. Also, the Indian data base permits us to construct a cost of capital index incorporating the real interest rate, the relative price of capital goods and the rate of depreciation, and to take into account the possible impact of lagged changes in the capital stock on investment in model formulation.

The paper is structured as follows. The investment function used in the empirical analysis is specified in Section 2. We begin with the basic neoclassical model of investment which relates investment to lagged capital stock, change in output and the cost of capital. This is then augmented by introducing credit availability, uncertainty and the complementarity between public and private investment to derive the final estimating equation. Section 3 describes the data base and the econometric procedure. In Section 4, we present the results and relate them to the ongoing policy debate. Section 5 concludes.

2. The Model

The investment function is formulated following the neoclassical approach to business fixed investment (Jorgenson 1967 and 1971). Assuming constant elasticity of substitution (σ) between capital and variable inputs, we observe the following relation between desired capital stock (K^*), the expected level of output (Y) and the expected rental cost of capital (C):

$$K_t^* = \alpha Y_t C_t^{-\sigma} \quad (1)$$

where C_t is,

$$C_t = [PK_t[r_t - \pi_t^e + \delta_t]/P_t, \quad (2)$$

Here, α is the distribution parameter, PK is the price of capital goods, P the output price level, r the nominal bank lending rate, π^e the expected inflation rate of capital goods and δ the geometric rate of capital depreciation³.

If there are costs to adjusting the capital stock and gestation lags in the adjustment process, then firms gradually respond to changes in the desired capital stock. Net investment (I_t^n) can therefore be expressed as a function of lagged changes in the desired capital stock:

$$I_t^n = \sum_{j=0}^J \beta_j \Delta K_{t-j}^* \quad (3)$$

Where β represents the delivery lag distribution extending for J+1 periods. Assuming that capital depreciates geometrically at a constant rate, replacement investment (I_t^r) is taken to be proportional to the capital stock available at the beginning of the period and adjusts instantaneously,

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

Combining (1), (3) and (4) and appending a stochastic error (u_t), we obtain the neoclassical model of investment:

$$I_t = \delta K_{t-1} + \sum_{j=0}^J \alpha \beta_j \Delta Y_{t-j} C_{t-j}^{-\sigma} + u_t \quad (5)$$

where the distributed lag coefficients are an amalgam of the delivery lag, expectational and production parameters.

For the purpose of this study we augment this basic model by adding the following explanatory variables: credit availability (BC), uncertainty in the macroeconomic environment [proxied by the standard deviations of output (SDY) and cost of capital (SDC)], a post-reform intercept dummy (PRD), and public investment (PBI). The rationale behind this augmentation is discussed below focusing on each variable in turn.

³ Investment tax credit, depreciation allowances and corporate income tax are ignored for lack of data.

The basic model is based on the assumption of perfect capital markets which implies that the firm's investment decisions are independent of financial conditions. The applicability of this assumption in the context of developing countries can be questioned on the basis of the neo-liberal literature on financial repression due to McKinnon (1973) and Shaw (1973). McKinnon and Shaw forcefully argue that, in the context of a typical developing country, the availability of loanable funds may exert an independent influence on investment behaviour independent of the cost of capital. This view suggests the inclusion of a credit constraint [proxied by the stock of real bank credit to the private sector (BC)] as an additional explicator in the investment function (Solimano 1992).

The use of BC as an additional variable can be further supported by drawing upon the recent theoretical literature on the implications of the 'finance constraint' for the firm's investment decisions.⁴ According to this literature, external finance, if available at all, may be more costly than internal finance because of transactions costs, contract enforcement (agency cost) problems and asymmetric information. The argument rests on the distinction between "insiders" (the firm's owners /managers) who have full information about a particular firm's investment prospects, and "outsiders" who may correctly perceive the prospects for a population of firms but cannot distinguish the quality of individual firms. An empirical implication of the application of asymmetric information and agency cost issues to financial markets is that the availability of finance (in particular, bank credit) may constrain the investment decisions of certain firms (especially those which are smaller in size or younger in age).⁵ One can reasonably argue that problems of asymmetric information and contract enforcement will be more severe in developing countries given the segmented nature of capital markets and a lack of a well developed system of property rights.

The basic model also assumes that the investment decision is reversible (that is, invested capital can be sold easily to other users) and that each decision is an once and for all

⁴ For a useful survey of this literature see Gertler 1988.

⁵ Empirical studies that have tested the "finance constraint" using firm-level panel data are Fazzari, Hubbard and Petersen (1988) for the US, Devereux and Schianterelli (1990) for the UK and Hoshi, Kashyap and Scharfstein (1991) for Japan. These studies, however, use the firm's cash flow as a proxy for the "finance constraint".

opportunity. A “new view” of investment has, however, stressed that many real-world investment decisions violate these assumptions and that irreversibility and the possibility of delay are important considerations in the investment decision (Pindyck 1991, Dixit and Pindyck 1994). Plant and equipment investment can be considered “sunk costs” if capital, once installed, is firm- or industry-specific and cannot be put to productive use in a different activity or if secondary markets are not efficient. The decision to undertake an irreversible investment in an uncertain environment can be viewed as involving the exercising of an option - the option to wait for new information that might affect the desirability and timing of the investment. The value of the lost option is a component of the opportunity cost of investment. According to the “new view”, this opportunity cost can be substantial in most circumstances and a higher degree of uncertainty about the future can have a significant negative effect on investment. Here, uncertainty can originate from two independent sources - the macroeconomic environment and policy factors. The second source of uncertainty can be considered to be of more relevance in a reforming economy where entrepreneurs’ willingness to invest in certain sectors (say, export-oriented activities) would depend on whether they perceive certain reforms (such as trade liberalisation) to be credible and sustainable (Rodrik 1991).

Empirical studies of the effect of macroeconomic uncertainty on investment have used a variety of measures of uncertainty⁶. In this study, following Hendry (1995) we use the three-year moving average standard deviations of output (SDY) and the rental cost of capital (SDC) as measures of the degree of macroeconomic uncertainty. Capturing the impact of policy credibility on investment performance poses a more serious problem. There are both conceptual and measurement problems in deciding on the relevant policy variable where credibility is the issue (Rodrik 1991). Rather than focusing on a specific policy variable, we include an intercept dummy variable, PRD, which takes the value 1 for the post-reform years and zero otherwise, to test whether the stabilisation cum structural adjustment policy reforms *per se* has influenced investment behaviour over and above its impact operating through other variables explicitly allowed for in the regression specification.

⁶ See Ferderer (1993), Pindyck and Solimano (1993), Serven and Solimano (1993) and Price (1995).

Finally, guided by the prevalent view in the Indian economic literature that public investment plays an important complementary role in promoting private investment, we include public sector fixed capital formation (PBI) to the set of determinants of investment as discussed above⁷. This complementarity is expected to work on both supply and demand sides⁸. On the supply side, the private sector relies on public investment for most of the infrastructure, because this is either a natural or a legal monopoly of the government. Thus public investment in infrastructure and private investment should be complementary. On the demand side, in theory, the relationship is ambiguous. If there is some slack in the economy one would expect a change in public investment to push private investment in the same direction. Otherwise, some private investment will probably have to be “crowded out”. This ambiguity notwithstanding, given the dominant role played by the government in the provision of infrastructure and in key intermediate- and investment-goods producing industries, it is generally assumed that “the stimulation effect of public investment on private investment tends to dominate any possible negative effect through competing for investible funds” (Bardhan, 1984, p. 25).

With these additional variables and an intercept term, and by approximating K^* linearly for estimation purposes, the investment function can be written as:

$$I_t = c + \delta K_{t-1} + \sum_{j=0}^J \theta_{1j} \Delta Y_{t-j} - \sum_{j=0}^J \theta_{2j} \Delta C_{t-j} + \theta_3 BC_t + \theta_4 PBI_t - \theta_5 SDY_t - \theta_6 SDC_t + u_t \quad (6)$$

Equation (6) provides a useful framework for examining the relationship between macroeconomic stabilisation cum structural adjustment programme and the behaviour of private investment after the initiation of the programme. First absorption reduction measures implemented as part of the stabilisation programme may lead to a decline in output in the

⁷ See Bardhan (1984, Chapter 4).

⁸ Such a complementarity between public and private investment has been found for other developing countries by Blejer and Khan (1984).

short run. If investment is highly responsive to changes in output (via the accelerator), then the stabilisation measures may lead to a decrease in private investment, at least initially. Moreover, since public investment faces the brunt of the cuts in fiscal adjustment, private investment may be further affected if the latter is highly complementary to public investment. Also, a real depreciation of the exchange rate will increase the cost of imported capital and intermediate inputs and consequently depress investment. Finally, rational entrepreneurs may defer investment until they are convinced that the reforms are likely to be permanent (Ibarra 1995). On the positive side, a trade reform that emphasises tariff cuts on capital goods should bring about a fall in the relative price of capital goods (and hence, C) leading to an increase investment. Financial sector reform such as an increase in the real deposit rate or a reduction in directed credit allocation policies) which increases the availability of real bank credit to the private sector may also have a favourable impact on investment, though this may be mitigated by a possible increase in the real lending rate following a deregulation of interest rates. Also, since a stabilisation program is usually implemented in a situation of high economic instability, a credible stabilisation program can reduce the uncertainty in investors' minds about the future state of the economy (by reducing SDY and SDC) and hence increase investment.

Before turning to the estimation of the model, one additional methodological issue needs to be addressed. This has to do with the well-known "Lucas Critique" of reduced-form models (Lucas 1976). As we have already noted, the coefficients of equation 6 are a combination of both expectational and structural (technology) parameters and are, therefore, not invariant to changes in policy regimes. Following the Lucas Critique, one can argue that the preferred route to the modeling of dynamic models is the estimation of stochastic first order conditions for optimal choice by rational, forward-looking representative agents (the "Euler Equation" approach). The Lucas Critique seems particularly relevant in our case; with the sharp changes in policy that occurred in the Indian economy in 1991, parameter instability of a reduced form model (such as equation 6) between the pre- and post-reform periods is a distinct possibility. Should this be the case, the use of an empirical model estimated for the the pre-reform period to make post-reform inferences is problematic.

In this study our preferred strategy is to use a data-based approach to guard against the possibility of parameter instability, namely to employ a recursive estimation technique to check for possible structural instability of the empirical model. The choice of this approach is based on two considerations. Firstly, the presence of credit constraints on the firm's investment demand implies that at any point in time, there will be some firms which are credit constrained and some which are not. The Euler equation approach invariably precludes this possibility. The preferred modeling strategy from a time-series perspective is, therefore, to include a proxy for the credit constraint as an additional variable in the investment demand function⁹. Secondly, recent studies by Chirinko (1988) and Oliner, Rudebusch and Sichel (1995, 1996) show that traditional reduced-form investment models exhibit only modest amount of parameter nonconstancy even in the presence of significant policy shifts and that the "empirical Euler equations appear to provide no improvement when judged by the metric of structural stability" (Oliner, Rudebusch and Sichel 1996, p. 311).

3. Data and The Econometric Procedure

Equation 6 is estimated over the sample period 1955 to 1994 using annual data.¹⁰ All variables, except SDY, SDC and C (which are measured in proportional form) and of course PRD, are measured in natural logarithms. Data sources are listed and methods of data transformation adopted and key limitations of the data are discussed in the Appendix. The data series are summarised in Table 1, in order to aid the interpretation of the results.

In line with the standard practice in modern time-series econometrics, we began the estimation process by testing the time series properties of the data. Two tests for unit roots were used: the augmented Dicky-Fuller (ADF) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. The latter tests the null of a unit root against the alternative of stationarity

⁹ The analogue to this in the time-series consumption function literature is the modeling of current consumption as a function of the past period's consumption and current income (popularised by Campbell and Mankiw 1987). Such a formulation is justified on the grounds that the Rational Expectations - Permanent Income Hypothesis (RE-PIH) may apply to some individuals but not to others (who may, for example, be liquidity constrained).

¹⁰ All data series are on the basis of the Indian fiscal year, April 1 in the previous year to March 31 of the given (stated) year.

while the former tests the null of stationarity against the alternative of a unit root. The choice of the KPSS test to supplement the widely used ADF test is based on evidence that tests designed on the basis of the null that a series is $I(1)$ have low power in rejecting the null.

Reversing the null and alternative hypotheses is helpful in overcoming this problem (Kwaitkowski *et al.* 1992). The test results (presented in Table 2) suggests that the variables do not have the same order of integration; I, K and PBI are found to be $I(1)$ variables while C, BC, SDY and SDC belong to the $I(0)$ category. Thus now-fashionable econometric procedures that are appropriate for $I(1)$ variables are not applicable in our case. However, given the presence of non-stationary variables, it is necessary to guard against the possibility of estimating spurious relationships. The time-series econometrician's prescription in this type of situation is to difference the non-stationary variables (to achieve stationarity) and use them in that transformed form together with the other (stationary) variables. This procedure, while statistically acceptable, has the disadvantage of ignoring long-run relations embodied in level variables. We therefore opt to use the general to specific modelling procedure of Hendry, which minimises the possibility of estimating spurious relations while retaining long-run information (Hendry 1995).

Under this procedure, the long-run relationship being investigated is embedded within a sufficiently complex dynamic specification, including lagged dependent and independent variables, in order to minimise the possibility of estimating spurious relationships. The estimation procedure starts with an over-parameterised autoregressive distributed lag (ADL) specification of an appropriate lag order:

$$Y_t = \alpha + \sum_{i=1}^m A_i Y_{t-i} + \sum_{i=0}^m B_i X_{t-i} + \mu_t \quad (7)$$

where α is a vector of constants, Y_t is a $(n \times 1)$ vector of endogenous variables, X_t is a $(k \times 1)$ vector of explanatory variables, and A_i and B_i are $(n \times n)$ and $(n \times k)$ matrices of parameters. .

Equation 7 constitutes the “maintained hypothesis” of our specification search. The modelling procedure is first to estimate the unrestricted equation (using OLS) and then progressively simplify it by restricting statistically insignificant coefficients to zero and reformulating the lag patterns where appropriate in terms of levels and differences to achieve orthogonality. To be acceptable, the final equation must satisfy various diagnostic checking procedures. In applying this estimation procedure, we set the initial lag length on all variables in the general ADL equation at two periods. This is the established practice in modeling with annual data.

4. Results

The final parsimonious estimated equation, together with a set of commonly used diagnostic statistics, are reported in Table 3. The equation is statistically significant at the one per cent level (in terms of the standard F test) and it performs well by all diagnostic tests. Apart from these tests, a residual correlogram of up to six years was estimated for each equation, with no evidence of significant serial correlation. To determine whether the parameters of the equation were constant over the post-reform period, the equation was re-estimated using recursive OLS. Plotting the recursive estimates of the coefficients of the key explanatory variables in the equation - ΔC_t , ΔY_t , ΔPBI_t , PBI_{t-1} and ΔBC_{t-1} - we find no evidence of structural instability in the parameter estimates¹¹. Thus, the coefficient estimates can be used with confidence for making inferences about the impact of policy reforms on investment behaviour.

The results point to a significant negative effect of change in the rental cost of capital on the level of investment. One percentage point decrease in cost of capital seems to bring about a five percentage point increase in real corporate investment. There is also evidence of the standard accelerator mechanism being important in explaining private investment; the coefficient on the income variable is positive and statistically significant at the five-percent level. There is also evidence of a significant positive short run effect of lagged bank credit on

¹¹ Graphs are not reported due to space constraints. They are available from the authors on request.

private investment. However, the lagged level term of the variable is found to be statistically insignificant (and therefore omitted in the reported regression) suggesting that its impact is not important in determining the long-run (steady-state) level of investment. On the other hand, the lagged level term for public investment is found to be statistically significant providing support for the proposition that in the Indian economy, public investment has a strong complementarity with private investment.

In the experimental runs, the variables representing uncertainty in the macroeconomic environment (SDY and SDC) consistently had statistically insignificant coefficients with some sign reversal. These variables were, therefore, dropped in the final equation. The absence of a statistically significant impact of SDY and SDC on investment in the Indian case may perhaps reflect the fact that, unlike most other developing countries, India has had a stable macroeconomic environment for most of the time-period under consideration (Joshi and Little 1994).

There has been an impressive increase in corporate fixed investment following the reforms. Annual average investment during 1991-94 was Rs 1308bn as compared to Rs 600bn during 1986-90 (Table 1). The estimated investment function, when analysed in the context of data reported in Table 1 (and Figures 1 and 2), yield the following inferences about the impact of policy reforms on this increase in investment.

The decline in real public sector investment during the post reform years (from an annual average level of Rupees 1841 bn during 1986-90 to 1722 bn during 1991-94) seems to have had an adverse impact on corporate investment¹². However, this adverse impact has been outweighed by a recovery in economic activity by the second year of reforms (real GDP growth averaged 5 per cent in 1993-94 as compared to 0.8 per cent in 1992) and the salutary effects of the decline in real rental cost of capital brought about by the policy reforms. The coefficient attached to the cost of capital index suggests a 24 percent decline in real rental

¹² Real bank credit to the private sector does not show any secular tendency in the post-reform period. While financial sector reform implemented since 1991 (in particular, a reduction in quantitative credit allocation policies) may have had a positive effect on the latter, this may have been neutralised by the contractionary monetary policy followed in the initial years of the reforms.

cost of capital between 1986-90 and 1991-94. An inspection of the composite data series of C (Figure 2) suggest that this decline was largely brought about by decline in the price of investment goods brought about by import liberalisation¹³ which was much larger in magnitude than the combined cost effect of currency depreciation and the increase in bank lending rates.

Finally, the positive and significant coefficient attached to the post-reform dummy (PRD) can be interpreted to imply a favourable perception on the part of entrepreneurs on the credibility and sustainability of the reform process which has led to an increase in corporate investment. The reforms may have been considered to be credible for three reasons; firstly, the key elements of the reform (such as the cuts in tariffs of capital goods, the convertibility of the exchange rate and the deregulation of interest rates) were implemented following a clear pre-announced agenda.; secondly, the initial stabilisation measures brought about a remarkable improvement in the macroeconomic environment¹⁴; finally, and perhaps more importantly, the outward oriented policy stance quickly received bipartisan support.

5. Concluding Remarks

In this paper we have examined the determinants of private corporate investment in India with emphasis on the implications of the recent structural adjustment policy reforms for investment behaviour. The results of our econometric analysis suggest that the net impact of the reforms on corporate investment has been salutary. The decline in real public sector investment brought about by the fiscal squeeze carried out as part of the reforms seems to have had a significant adverse impact on corporate investment. However, this adverse impact was outweighed by the salutary effects of the reform process on investment operating through the decline in real rental cost of capital and favourable changes in investor perception in the aftermaths of the reforms.

¹³ The average nominal tariff rate on capital goods declining from 85 percent in 1991 to 25 percent in 1994.

¹⁴ For a description of the macroeconomic crisis and its aftermath, see Agrawal *et al.* 1995.

Our findings stand in contrast to the existing cross-country evidence on the response of the latter to stabilisation cum structural adjustment reforms. We consider our results to be robust as they come from a systematic estimation of an investment function which is well rooted in the received theory of investment. Of course it is not possible to generalise from a single country case. It could well be that, quite apart from the improved methodology, the results are dictated by “peculiarities” of the Indian experience. For instance, during the pre-reform period, India was a clear outlier among other developing countries in terms of the extremely high level of the relative price of capital goods (Jones 1993). Given this initial condition, the significant reduction in tariffs on capital goods could have emerged as a *key policy factor* in the impressive performance of private corporate investment in the post-reform Indian economy. Be that as it may, our results do cast doubt on the reliability of existing cross-country evidence and point to the need for many more systematic country studies before valid generalisations about the impact of structural adjustment programmes on investment behaviour can be made.

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DATA APPENDIX

The data series used in this study have been directly obtained or compiled from the following publications:

- (1) Central Statistical Organisation (CSO), *National Accounts Statistics*, Delhi (various issues).
- (2) Reserve Bank of India, *Report on Currency and Banking*, Delhi (various issues).

In the selection and transformation of most of the data series, we have simply followed established practice in this field of research. However, the choice of data series for the compilation of the C index and the construction of the real capital stock series (K) need some explanation.

The bank lending rate used in constructing the C series is the one year lending rate of the State Bank of India (the premier commercial bank in India). Ideally, the lending series should have been constructed as weighted averages of rates relating to loans of different term structures using relative shares of respective deposits/loans. Unfortunately, information on the maturity structure of loans is not readily available. There is, however, evidence that, as most of the key series move in tandem, the choice of a particular series over the preferred weighted average does not make significant difference in empirical analysis (Laumas 1990). The measure of the general price level is the GDP deflator (1980 = 1.00). Capital good prices are measured in terms of the implicit deflator for gross domestic fixed capital formation (1980 = 1.00). The expected rate of change in capital goods price is measured as the rate of change of capital goods price (measured by the implicit deflator for gross domestic fixed capital formation) with a one-year lag. The static inflationary expectations hypothesis that undergirds this variable choice is considered appropriate, for a low-inflation country like India, especially when working with annual data.

Data on real capital stock are readily available from Source (2) for the years since 1981. This series was extended back to 1955 applying the following formula,

$$K_{t-1} = K_t - DEP_t - I_t$$

where K is real capital stock at the end of year 1981, and DEP and I denote real depreciation and real private corporate fixed investment during each year.

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Table 1. Summary Data on Variables Used in Econometric Analysis*

Variables	1955-60	1961-70	1971-80	1981-85	1986-90	1991-94
Dependent Variable						
I	112	186	213	521	599	1308
Explanatory Variables						
K	4621	5780	10765	14253	16144	17107
BC	10	34	213	707	1301	1755
Y	5722	7828	11264	15159	19709	24603
PBI	241	634	879	1437	1841	1722
SDY(%)	2.9	4.0	3.8	4.8	5.8	3.8
SDC(%)	3.2	2.5	3.1	1.2	2.1	1.6
ΔC	3.6	3.9	6.4	8.9	13.4	10.2

Notes: * Value series are in billions of Indian rupees at constant (1981) prices. Figures reported are annual averages for the given sub-period.

Source and methods: Data sources and methods of data compilation are explained in the Appendix .

Table 2. Tests for Unit Roots¹

Data series	DF test of $H_0:I(1)$ versus $H_1:(0)$ ²	KPSS test of $H_0:I(1)$ versus $H_1:(0)$ ³
I	-2.49	0.101(9)
K	-0.67	0.139(4)
ΔY	-10.26	0.033(3)
ΔC	-9.84	0.031(3)
BC	-4.77	0.012 (1)
PBI	-2.34	0.179(1)
SDY	-10.69	0.018(1)
SDC	-1.23E+8	0.101(2)

Notes:

- (1) Except in the cases of ΔC , SDY and SDC, all the tests were conducted 'with trend' to allow for the possibility that, for most economic time-series, the usual competing alternative to the presence of a unit root is a deterministic linear trend. The critical values at the 5% level are: DF test = 3.52 and KPSS test = 0.146.
- (2) In all cases, the auxiliary regressions achieved residual whiteness without augmentation.
- (3) Value of the lag truncation parameter used in nonparametric variance correction to account for serial correlation is given in parentheses. After examining the 'lag window' for up to 10 lags, this parameter was set at a level where the test statistic tends to settle down (Kwiatkowski *at al.*, p. 174).

Table 3: Determinants of Private Corporate Investment in India: Regression results[#]

$$\Delta I_t = -0.38 + 0.31\Delta BC_{t-1} + 2.61\Delta Y_t - 2.42\Delta C_t + 1.18\Delta PBI_t + 0.94PBI_{t-1}$$

(0.49) (3.63)^{***} (2.21)^{**} (3.47)^{***} (2.91)^{***} (2.87)^{***}

$$-0.41K_{t-t} + 0.75PRD - 0.54I_{t-1} + 0.29\Delta I_{t-1}$$

(1.31)^{*} (3.37)^{***} (4.13)^{***} (2.18)^{**}

$R^2 = 0.62$ $F(9,28) = 5.07^{***}$ $SE = 0.22$ $DW = 2.15$

$LM1 - F(1,27) = 0.26$ $LM2 - F(2,26) = 0.17$ $RESET - F(1,27) = 0.14$ $JBN - \chi^2(2) = 1.87$

$ARCH1 - F(1,27) = 0.07$ $ARCH2 - F(2,26) = 0.09$

$R^2 = 0.62$ $F(9,28) = 5.07^{***}$ $SE = 0.22$ $DW = 2.15$

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$ARCH1 - F(1,27) = 0.07$ $ARCH2 - F(2,26) = 0.09$

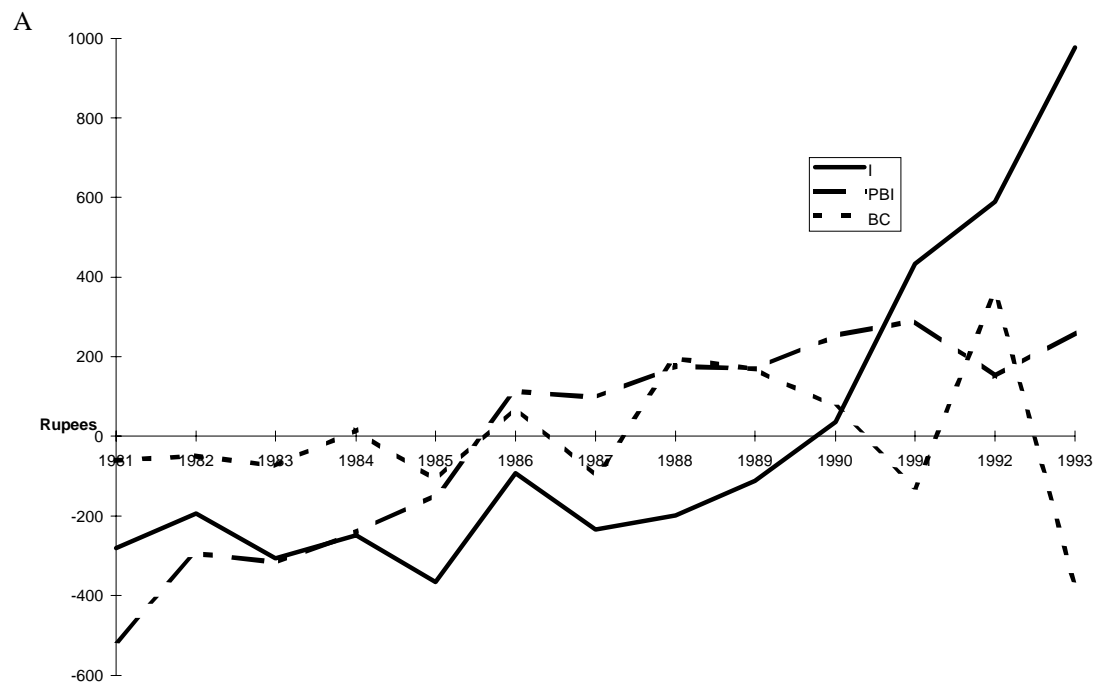
Estimates of Long Run Elasticities:^{##}

	Elasticity	t-ratio
Income	5.67	2.12 [*]
Cost of Capital	-5.22	2.57 [*]
Public Investment	2.04	2.77 ^{**}

Notes:

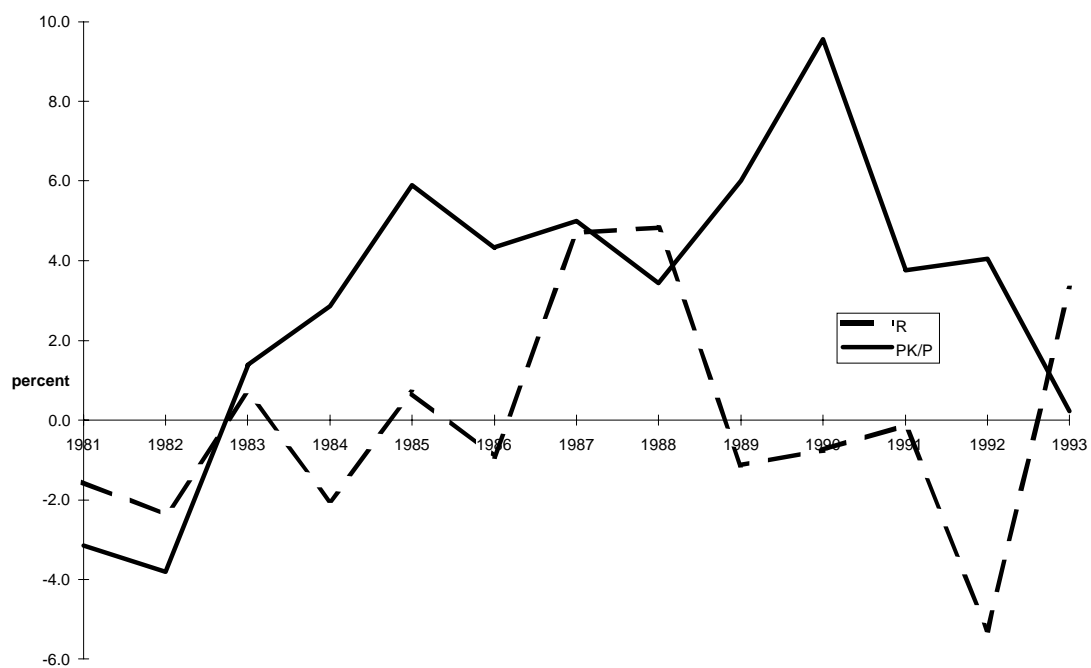
t-ratios of regression coefficients are given in brackets. Approximate critical values for the t-ratios are as follows: 10 percent = 1.31 (*), 5 percent = 1.69 (**), and 1 percent = 2.47 (***). The test statistics are : *LM* = Lagrange multiplier test of residual serial correlation; *RESET* = Ramsey test for functional form mis-specification; *JBN* = Jarque-Bera test for the normality of residuals; *ARCH* = Engle's autoregressive conditional heteroscedasticity test.

Computed from the long-run solutions to the estimated model.

Figure 1: Behaviour of I, PBI and BC, 1982-94

Note: All variables are mean-adjusted.

Figure 2: Behaviour of the Relative Price of Capital (PK/P) and Real Lending Rate (R), 1982-94



Note: All variables are mean-adjusted.