

Liberalization and Business Investment in India

by

Prema-chandra Athukorala* and Kunal Sen**

*Research School of Pacific and Asian Studies
The Australian National University

** School of Development Studies
University of East Anglia
United Kingdom

Abstract: This paper develops a model of business investment in developing countries and illustrates it through an application to India. The model is derived from the standard theory of business investment, with appropriate adoption to reflect structural features specific to developing countries. The estimation results suggest that the level of the capital stock, rental cost of capital, the level of domestic economic activity and public investment are significant determinants of business investment in India. Our results help explain the behaviour of business investment in India following the structural adjustment reforms in 1991.

JEL Classification: E22, O16.

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1. Introduction

There are a sizable number of studies on the determinants of private investment in developing countries.¹ These studies, however, suffer from a number of methodological flaws which need to be redressed in future research. First, whereas the theory of investment is basically about the investment behaviour of *the firm* (business investment), the dependent variable commonly used is *total private investment*.² Total private investment is a poor proxy for business investment because there are fundamental differences in terms of the underlying determinants between household residential investment (which is the key component of household investment in most developing countries) and business investment. Second, many of these studies employ ad hoc investment functions, not derived from a specific model but formulated largely to suit the nature of readily available data. For instance, none of the studies have appropriately captured the effect of the user cost of capital on private capital formation - a key link between financial markets and real economic activity in any industrial-country macroeconomic model. The effect of the level of existing capital stock on investment - another key postulate of the received theory of investment - has also been largely ignored.

Thirdly, given that the available time-series for most countries are often short, the overwhelming majority of studies have been conducted using cross-country data.³ Cross-country regression analysis is based implicitly on the restrictive assumption of 'homogeneity' in the observed relationship across countries. It is common knowledge that there are considerable variations among developing countries in relating to various structural features and institutional aspects that have a direct bearing upon investment behaviour. Moreover, given vast differences among countries with respect to the nature and quality of data, cross-country comparison is fraught with danger. Not only the statistical procedures for

* This paper draws on Athukorala and Sen (2002).

measuring investment, but also the magnitude of errors in data arising from differences in the implementation of these procedures, varies significantly among countries (Srinivasan 1994). Finally, the estimation procedures used in most studies have not appropriately handled simultaneity problems and issues of spurious correlation, which are bound to be significant in applied investment analysis.

The purpose of this paper is to develop a model of business investment in developing countries. The model is derived from the standard (neoclassical) theory of business investment, with appropriate adoption to reflect structural features specific to investment behaviour in developing countries. It is then estimated on Indian annual data over the period 1954-1996 and used in examining investment behaviour in India following the market-oriented structural adjustment policy reforms implemented in 1991. The estimation procedure used in this study places special emphasis on capturing the dynamic lag structure of investment behaviour, while guarding against the problem of spurious correlation and simultaneity bias.

India is chosen as the laboratory to test the model for two reasons. First, the Indian macroeconomic database is relatively rich by developing country standards and meets the data requirement of our exercise. India is perhaps the only developing country for which a separate data series on corporate investment is available for a period of sufficient length for econometric investigation. The availability of disaggregated data on the capital stock and the key variables required for the construction of an index of the relative price of capital allows us to implement an investment function specified in line with the received theory of investment. The second reason stems from the policy focus on investment behaviour in the Indian economic policy debate following the policy reforms initiated in 1991. A large number of studies have consistently reported a significant negative impact of structural adjustment programs (SAPs) on private investment in the immediate post-reform years.⁴ In contrast to this 'stylised fact, there has been a marked increase in private corporate investment in India in the post-reform period. As a policy application of our empirical model, we examine its usefulness in explaining this investment expansion.

The paper is structured as follows. The investment function 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, macroeconomic 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 and interpret the estimation results. Section 5 illustrates the policy application of the estimated model by examining the impact of the 1991 reforms on business investment in India. Section 6 concludes.

2. The Model

The investment function is formulated following the neoclassical approach to business fixed investment (Jorgenson 1967 and 1971). The basic model is altered to reflect structural features that are specific to the developing world. 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,

$$C_t = [PK_t[r_t - \pi^e_t + \delta]/P_t, \quad (2)$$

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 rate of capital depreciation.⁵ 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:

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

Where β represents the delivery lag distribution extending for $J+1$ periods. 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:

$$I_t = \delta K_{t-1} + \sum_{j=0}^J \mathbf{a} \mathbf{b}_j \Delta (Y_{t-j} - C_{t-j}^s) + u_t \quad (5)$$

For estimation purposes, we approximate K^* linearly on the assumption that expectations of the output and rental cost terms are based on extrapolations of past values. This gives the following modified model:

$$I_t = \delta K_{t-1} + \sum_{j=0}^{J_1} \mathbf{q}_{1j} \Delta Y_{t-j} - \sum_{j=0}^{J_2} \mathbf{q}_{2j} \Delta C_{t-j} + u_t \quad (6)$$

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.

The basic model is based on the assumption of perfect capital markets which implies that the firm's can borrow freely in order to implement their investment plans.

The validity 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). These authors have forcefully argued that, in the typical developing country, the availability of loanable funds may influence investment behaviour independent of the cost of capital. This view suggests the inclusion of a credit constraint (proxied by real bank credit to the private sector (BC)) as an additional explicator in the investment function (Solimano 1992).

The use of BC as an explicator of investment can be further supported by drawing upon the recent theoretical literature on the implications of the 'finance constraint' for the firm's investment decisions.⁶ 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).⁷ 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 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, Ibarra 1995).

Empirical studies of the effect of macroeconomic conditions on investment have used a variety of measures of macroeconomic uncertainty (Ferderer 1993, Pindyck and Solimano 1993 and Price 1995). In this study, we use the three-year moving average standard deviations of the change in output (SDY) and the change in rental cost of capital (SDC) as measures of the degree of uncertainty.⁸ Capturing the impact of policy credibility on investment performance poses a more serious problem (Rodrik 1991). As we have noted in the Introduction, the Indian government embarked in 1991 on a structural adjustment programme that was comprehensive in its coverage and far-reaching in its nature. In such a context, there are both conceptual and measurement problems in deciding on the relevant policy variable where credibility is the issue. 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 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.

Finally, we chose public sector fixed capital formation (PBI) as an explanatory variable for the following reasons. Public investment may affect private investment both *via* supply and demand sides. 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 (Blejer and Khan 1984). 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, the investment function can be written as:

$$I_t = c + d K_{t-1} + \sum_{j=0}^J q_{1j} \Delta Y_{t-j} - \sum_{j=0}^J q_{2j} \Delta C_{t-j} + q_3 BC_t + q_4 PBI_t - q_5 SDY_t - q_6 SDC_t + u_t \quad (7)$$

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 7 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 7) 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 function.⁹ Secondly, Oliner, Rudebusch and Sichel (1995 and 1996) have found 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 7 is estimated over the sample period 1955 to 1995 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 are discussed in the Appendix.

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 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 1) suggests that the variables do not have the same order of integration; I, K and PBI are found to be $I(1)$ variables while ΔC , ΔY , 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 opted to use the general to specific modelling procedure of Hendry, which minimises the possibility of estimating spurious relations while retaining long-run information.¹¹

Insert Table 1 about here

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:

$$Y_t = \mathbf{a} + \sum_{i=1}^m A_i Y_{t-i} + \sum_{i=0}^m B_i X_{t-i} + \mathbf{m}_t \quad (8)$$

where \mathbf{a} 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 8 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.

The use of the ordinary least squares (OLS) method to estimate equation (7) can yield biased coefficient estimates because autonomous shocks to the error term (such as a shock to technology or to demand) may be correlated with the change in output (ΔY), as a profit-maximising firm decides on the combination of capital, other factors of production and output simultaneously. To guard against the potential simultaneity bias, the equation was using two-stage least squares (2SLS). The growth rates of real agricultural output and real government consumption and the lagged dependent variable were used as instruments for ΔY .

4. Results

The final parsimonious estimated equation, together with a set of commonly used diagnostic statistics, are reported in Table 2. 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 2SLS. By 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 found no evidence of structural instability in the parameter estimates.¹² Thus, the coefficient estimates can be used with confidence for making inferences about the impact of policy reforms on investment behaviour.

Insert Table 2 about here

Insert Table 3 about here

The results support the hypothesis that business investment in a given year is negatively affected by the size of the initial capital stock; the coefficient on K is statistically significant at the one per cent level and suggests a long-run investment elasticity of -1.5 with respect to K . The coefficient on change in rental cost of capital (ΔC) is statistically significant with the postulated (negative) sign. A one percentage point rise in the rate of increase in real rental cost of capital is associated with a 4.4 per cent decline in corporate investment.¹³ The standard accelerator mechanism is important in explaining corporate investment behaviour; the coefficient on the income variable (ΔY) is positive and statistically significant at the five-percent level. It suggests that one per cent increase in income is associated with a 3.1 per cent increase in business investment.

There is evidence of a significant positive short run effect of bank credit (BC) on private investment. An increase in real bank credit by one per cent is associated with 0.16 per cent increase in annual increase in corporate investment. However, the coefficient on the lagged level term of BC turned out to be statistically insignificant with erratic sign changes in various experimental runs (and therefore was omitted in the reported regression). This implies that the availability of bank credit is not important in determining the long-run (steady-state) level of investment.

The results for the public investment variable provide support for the proposition that, in the Indian economy, public investment has a strong complementarity relationship with corporate investment. The impact (short-run) and steady-state elasticities of corporate investment with respect to public investment are 0.76 and 2.78 respectively.

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).

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. We defer further discussion of the post-reform dummy to the next section where we discuss the effect of the SAP on investment in more detail.

5. The 1991 SAP and Its Effect on Private Corporate Investment

The reform package introduced by the Indian government in 1991 had all the standard ingredients of a stabilisation *cum* structural adjustment programme. On the stabilisation front, the government implemented a contractionary aggregate demand policy with a cut in the fiscal deficit as a ratio of GDP from 8.4 per cent in 1991 to 5.9 per cent in 1992 and a decrease in the growth of money supply from 17.2 per cent per annum in 1991 to 7.3 per cent per annum in 1993 (Agrawal *et al.* 1995). A large proportion of the adjustment in government expenditures as a part of the fiscal austerity measures was borne by public investment which fell as a ratio of GDP from 9.4 per cent in 1991 to 8.8 per cent in 1992. Along with the reduction in domestic absorption was a devaluation of the Indian rupee against the US dollar of about 18 per cent. On the structural adjustment front, there were significant cuts in tariffs, especially on capital goods, and a domestic deregulation programme that consisted of the elimination of virtually all entry barriers to most industries as well as the associated constraints on scale and technology. In the

financial sector, controls on interest rates were relaxed, leading to an increase in the bank lending rate from 16.5 per cent in 1991 to 19 per cent in 1993.¹⁴

There has been an impressive increase in corporate fixed investment following the reforms (Figure 1). Annual average investment more than doubled during 1992-95 as compared to 1986-91 (Table 3). The estimated investment function, when analysed in the context of data reported in Table 3, yield the following inferences about the impact of policy reforms on this increase in investment.

Insert Figures 1 and 2 here

Insert Table 3 about here

The slowdown in the growth of real public sector investment (the average annual rate of growth in real public investment decreased from 6 per cent in 1981-1991 to 3.8 per cent in 1992-1995) and the decline in real bank credit (from an annual average level of Rupees 687 billion during 1986-91 to 651 billion during 1992-95)¹⁵ during the post reform years seem to have had an adverse impact on corporate investment. However, these negative effects were more than offset by the positive effect of a recovery in economic activity (real GDP growth averaged 5 per cent in 1993-95 as compared to 0.4 per cent in 1992) and the decline in real rental cost of capital brought about by the policy reforms. The cost of capital index fell by 12 per cent between 1986-91 and 1992-95. An inspection of the composite data series of C (Figure 2) suggests that the dominant force behind this decline was a decline in the price of investment goods brought about by import liberalisation.¹⁶ Interestingly, the decline in the investment goods price was much larger in magnitude than the combined cost raising effects of currency depreciation and the increase in bank lending rates.

Added to these positive effects has been the general investment-enhancing impact of the new investment climate in the post reform era. The statistically significant positive coefficient on the post-reform dummy (PRD) in the estimated regression is consistent with the view that the reforms have had a positive impact on investment over and above their impact operating through the explanatory variables. It can be argued that

the corporate sector may have considered the reforms to be credible for two reasons; firstly, the reforms measures were “forceful and explicit”, and secondly, the reform process “moved over a number of areas, in rapid succession” (Bhagwati 1993 pp. 84 and 85).

6. Conclusion

This paper has attempted to enrich the empirical literature on the determinants of investment in developing countries by developing a fully specified investment function rooted in the received theory of business investment, and implementing it to examine the determinants of business investment in India over the period 1955-1995. The results suggest that the level of capital stock and rental cost of capital are important determinants of business investment along with changes in output and public investment.

The estimated investment function proved to be useful in explaining the remarkable increase in increase in business investment in India following the market-oriented structural adjustment reforms initiated in 1991. It is evident that that the net impact of the reforms on corporate investment has been salutary. The decline in the rate of growth of real public sector investment brought about by the reform-related fiscal squeeze seems to have had a significant adverse impact on corporate investment. However, this adverse impact was outweighed by the salutary effects of the decline in real rental cost of capital brought about by the reform process, and favourable changes in investor perception in the aftermath of the reforms.

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) and (2) Reserve Bank of India, *Report on Currency and Banking*, Delhi (various issues). In the selection and compilation 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). 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 private corporate fixed capital formation (1980 = 1.00). The expected rate of change in capital goods price is measured as the three year moving average of the rate of change of capital goods price (measured by the implicit deflator for private corporate fixed capital formation) with a one-year lag. The adaptive expectation 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 (1) 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.

Notes

- 1 See Rama (1993) and Agenor and Montiel (1996), pp. 84-88 for surveys and references.
- 2 Modeling of business investment has a rich and well-established tradition in developed countries. For a comprehensive survey, see Chirinko 1993).
- 3 Two notable exceptions are the country case-studies in Chibber, Dailami and Shafik (1992) and Fielding (1997).
- 4 See the World Bank (1988), Harrigan and Mosley (1988), and Greenaway and Morrissey (1992) and the works cited therein.
- 5 Investment tax credit, depreciation allowances and corporate income tax are ignored for lack of data.
- 6 For a useful survey of this literature, see Gertler (1988).
- 7 Empirical studies that have tested the “finance constraint” using firm-level panel data include Fazzari, Hubbard and Petersen (1988); Devereux and Schianterelli (1990); and Hoshi, Kashyap and Scharfstein (1991).
- 8 For a variable x , the 3 year moving average is $y(t) = \sum x(t-j)/3$, where $j = 1$ to 3. The standard deviation of x as time t [$sdx(t)$], then, is

$$sdx(t) = \sqrt{\frac{\{\sum [x(t-j) - y(t)]^2\}}{4}}$$
 where $j=0,3$.
- 9 The analogue to this in the time-series consumption function literature is the modeling of current consumption as a function of 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 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.
- 11 For a detailed exposition of this methodology, see Banerjee *et al.* (1993) and Hendry (1996).
- 12 Graphs are not reported due to space constraints. They are available from the authors on request.

- 13 This apparently large elasticity coefficient does not seem unrealistic given the fact that the value of ΔC has varied with a narrow margin (between -2.5% to 3.2%) during the study period.
- 14 For further details on the Indian reforms, see Bhagwati (1993) and Joshi and Little (1996).
- 15 This was due to tight monetary policy that accompanied the reform package.
- 16 The average nominal tariff rate on capital goods declining from 85 percent in 1991 to 25 percent in 1994.

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Table 1. Tests for Unit Roots¹

Data series	ADF test of $H_0:I(1)$ versus $H_1:(0)^2$	KPSS test of $H_0:I(1)$ versus $H_1:(0)^3$
I	-1.85 (0)	0.110(8)
K	-0.67 (1)	0.127 (4)
ΔY	-7.19 (0) ⁴	0.028(3)
ΔC	-6.34 (0) ⁴	0.030(3)
BC	-5.48 (0) ⁴	0.014 (2)
PBI	-2.92 (1)	0.158(2)
SDY	-6.14 (0) ⁴	0.015(2)
SDC	-6.93 (0) ⁴	0.092(2)

Notes:

- (1) Except in the cases of ΔY , 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: ADF test = 3.52 and KPSS test = 0.146.
- (2) Figures in parenthesis indicate the number of lags on the difference variable used in the auxiliary regression to achieve residual whiteness.
- (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).
- (4) Rejection of null hypothesis.

Table 2: Determinants of Private Corporate Investment in India: Regression results[#]

$\Delta I_t = -1.06$	$+ 0.16\Delta BC_{t-1}$	$+ 3.08\Delta Y_t$	$- 4.36\Delta C_t$	$+ 0.71\Delta PBI_t$	$+ 1.11PBI_{t-1}$
(1.50) [*]	(2.35) ^{**}	(2.39) ^{**}	(3.20) ^{***}	(1.57) [*]	(3.65) ^{***}
$- 0.60K_{t-t}$	$+ 0.77PRD$	$- 0.40I_{t-1}$			
(2.52) ^{***}	(3.98) ^{***}	(3.42) ^{***}			
$R^2 = 0.55$			$F(8,30) = 4.60$ ^{***}	$SE = 0.22$	
$DW = 1.85$			$LM1 - c^2(1) = 0.24$	$LM2 - c^2(2) = 0.17$	
$RESET - c^2 = 0.82$			$JBN - c^2(2) = 2.99$	$SPEC - c^2(2) = 2.25$	
Log-run (steady-state) investment elasticity with respect to:					
Public investment (PBI)			2.8 ^{***}		
Capital Stock (K)			-1.5 ^{***}		

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; *SPEC* = Sargan's test for the correct specification of instruments,

Table 3. Summary Data on Variables Used in Econometric Analysis*

Variables	1955-60	1961-70	1971-80	1981-85	1986-91	1992-95
Dependent Variable						
I	121	187	191	540	764	1884
Explanatory Variables						
K	612	1426	1964	3077	5246	9221
BC	61	122	329	563	687	651
Y	5918	8089	11445	15207	20616	25590
PBI	352	635	879	1442	1913	2124
C(%)	8.6	6.4	9.9	13.9	15.7	13.8
SDY(%)	1.4**	1.5	1.7	1.3	0.6	1.4
SDC(%)	2.7**	0.1	1.6	1.9	2.0	0.8

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

** For the period 1958 - 1960 only.

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

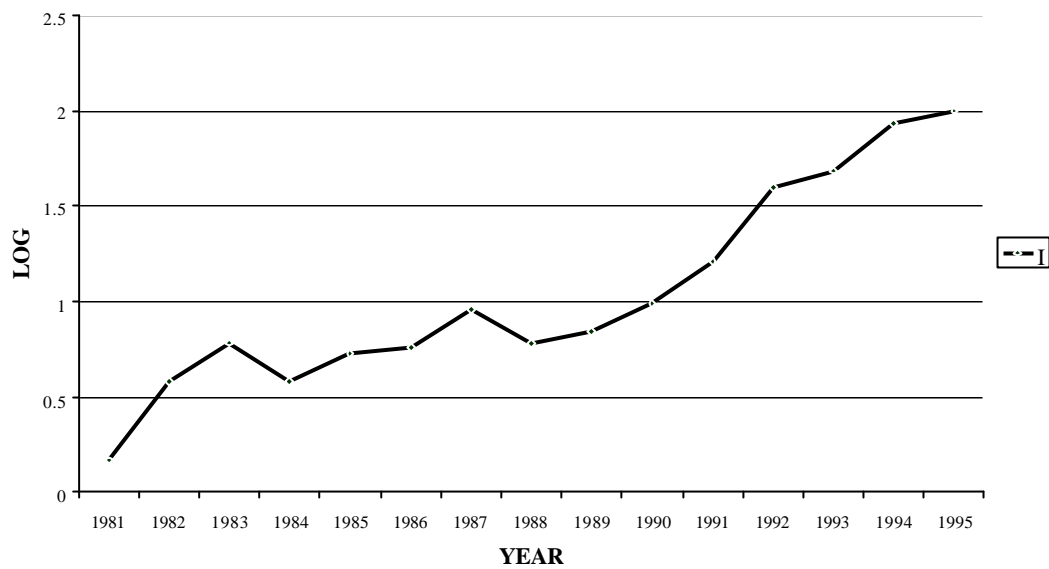


Figure 1: Behaviour of Private Corporate Investment (I) ^{*}, 1981-1995

Note: * mean-adjusted.

Figure 2: Behaviour of Cost of Capital (C) and the Relative Price of Capital Goods (PK/P), 1981-1995



Note: All variables are mean-adjusted.