Fundamentals, financial factors and firm investment in India: A Panel VAR approach

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Fundamentals, Financial Factors and Firm Investment in India

A Panel VAR Approach

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This study analyses the role of fundamentals and financial factors in determining firm investment in India with imperfect capital market in a panel VAR framework. Previous research in this area is based on the test of significance (or some variant of this) of the cash flow variable in the investment equation. In this strand of research, cash flow is considered to be a financial factor. The major theoretical problem of this approach is that in a forward-looking model cash flow might be correlated to fundamental variable(s) of a firm. Because in a forward looking model, current cash flow of a firm also incorporates expectation of fundamentals. There is a problem of disaggregating the fundamental effect of cash flow from the finance effect. Thus, a statistically significant cash flow may not imply that financial market imperfections determine investment. This could be resolved in a VAR framework as it uses a simultaneous equations model. An econometric model is formulated with the joint determination of investment, marginal profit (marginal with respect to capital stock), cash flow and balance sheet variables. The latter captures financial market imperfections while cash flow is modelled to reflect both fundamental factors as well as financial market imperfections while marginal profit is a pure fundamental variable. Using VAR methodology with dynamic panel is a newer approach in the panel regressions. By suitable orthogonal decomposition (such as Choleski decomposition) of the shocks (to cash flow or to fundamental or financial variables) and then looking at the impulse responses one can understand the nature of dynamic adjustments of investment, fundamentals and financial factors.

I. Intruduction

The purpose of this paper has been to explore the dynamic relationships between firm fundamentals and financial factors that are assumed to be crucial in determining firm level investment. It is generally agreed upon among economists that perfect capital market is a far cry from the reality. Thus the central message of the Modigliani–Miller theorem that debt-equity ratio is irrelevant in determining a firm's investment, breaks down. In a perfect capital market a typical firm's investment decision is governed by the expected profitability of the investment project. The latter is identified as the fundamental factor—often called marginal Q. In reality, marginal Q is not observable, hence researchers employ the ratio of

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stock market valuation of firms to its replacement cost as the proxy for marginal Q. The idea is that the stock market valuation of firms reflect its true value in the absence of bubbles in the stock prices.[1]

In an imperfect capital market, on the other hand, unlike in the neo-classical theory of investment, neither the interest rate nor Tobin's Q determines investment. Imperfections in the capital market arise, among other things, because of asymmetric information, leading to moral hazard and adverse selection between the lenders and the borrowers. In this situation, balance sheet variables, such as firm's net worth, total debt etc., or other financial variables such as, cash flow, interest cost as the proportion of interest cost plus cash flow become important determinants of its credit worthiness to debt holders. As a result, investment is determined by one or more of these financial variables than the fundamentals.

In theoretical models of investment that incorporate asymmetric information were formulated by Jaffee and Russell (1976), Myers and Majluf (1984), Stiglitz and Weiss (1981), Williamson (1987)[2] among others. The seminal paper that addresses testing of credit constraints in the loan market and related issues pertaining to informational problems is due to Fazzari, Hubbard and Petersen (1988). Hubbard (1998) is a good survey paper in this area.[3]

The majority of the empirical literature starting with Fazzari, Hubbard and Petersen (1988) employs cash flow[4] to capture the financial frictions in the loan market. Their common strategy is to regress firm level investment on Tobin's Q and cash flow in a reduced form equation for different groups of firms that have different costs of information in the loan market and test the null hypothesis of the coefficient of cash flow. Firms are classified into groups of high cost or low cost of information on the basis of a criterion, such as dividend pay-out ratio, size, credit rating etc. If Tobin's Q is found to be non-significant while cash flow is found to be significant it is concluded that financial market imperfections rule the loan market. An alternative approach is to estimate a structural model of investment as in Whited (1992) that employs the Euler equation approach.

In a latter study, however, Fazzari and Petersen (1993) argued that cash flow—investment correlation might as well arise because of some other reason, *viz.* the demand shock. However, they argued that if firm investment for fixed capital is constrained by the

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1. The last assumption that stock prices reflect fundamental is highly questionable.
2. Jaffee and Russel (1976), and Stiglitz and Weiss (1981) apply the informational problems in the loans market and Williamson (1987) also applies it in the loans market with costly state verification while Myers and Majluf (1984) applies it to the equity market.
3. Chirinko (1993) is a good survey of neoclassical theories of investment.
4. Some of the papers have employed other balance sheet variables as mentioned before.

availability of finance, then the managers divert funds from some other source if the former has a higher cost of adjustment than the former. This 'other source' is typically working capital fund—strictly speaking financial working capital.

In a recent study Ganesh-Kumar, Sen and Vaidya (2001) studied the investment behaviour of Indian firms in an imperfect capital market. It was found that the firms with more outward orientation, measured by the export intensity of their sales, are less constrained in the financial markets and vice versa. Bagchi, Das and Moitra (2002) employing the methodology of Fazzari and Petersen (1993) found that firms in the medium dividend-paying category are credit constrained while both the low dividend paying and high dividend paying firms are not credit constrained.[5]

Though there is overwhelming evidence in support of sensitivity of financial variables to investment, many researchers have expressed suspicion about the results. The research methodology of employing cash flow and other financial variables to explain firm investment has been questioned by many (see Kaplan and Zingales (1997), Fazzari, Hubbard and Petersen (1996)). It has been argued that sensitivity of cash flow on firm investment can as well be ascribed to another interpretation, viz. that cash flow (or other financial variables) may contain information about future values of the fundamentals. In a forward looking model investment depends upon the present value of the expected future marginal returns to capital (or marginal profitability of capital) which is the relevant fundamental and is called marginal Q. Any variable that helps predict the fundamental should appear as a state variable for the firm's investment decision and so is statistically significant in investment equation. Cash flow (or other financial variable) of a firm is closely related to the return on capital. Hence if other variables do not fully specify the expected marginal value of capital then coefficient of cash flow becomes statistically significant in the reduced form regression.

There is another problem associated with the failure to distinguish properly between marginal Q and average Q. As marginal Q which represents the present value of marginal profitability of capital is not observable researchers have to depend upon a proxy for it. Researchers employ average Q which is a measure of average profits. This is justified by assuming constant returns to scale in production technology, perfect competition in product and factor markets. Then marginal Q equals average Q (see Hayashi, 1982). However, if the assumptions are not satisfied, which are seldom met in reality, marginal Q differs significantly from the average. Average Q becomes an improper proxy for the marginal. Average Q, however also measures the financial health of the firm. Any measure of financial health of the firm will also influence investment in the presence of financial market

5. Banerjee and Duflo (2002) and Banerjee, Cole and Duflo (2003) have shown that small scale firms in India are credit constrained. However, they employ a different methodology which in this context is subject to a number of serious criticisms from the stand point of econometric methodology. See Marjit, Das and Chattopadhyay (2004).

imperfections. Thus, financial variables so selected actually capture fundamentals instead of the financial frictions in the loan market. Gilchrist and Himmelberg (1998) has termed them as "two identification problems". In order to address the first identification problem, Gilchrist and Himmelberg (1995) modelled the forward-looking role of cash flow for predicting future marginal profitability of capital (MPK) in a panel VAR framework. They showed that cash flow could very well explain investment even in a perfect capital market. However, they also found evidence against the model in the sense that cash flow is excessively sensitive to investment—more than what one would expect in a perfect capital market. They concluded that financial market imperfections are likely cause of such excess sensitivity. In the more recent paper, Gilchrist and Himmelberg (1998) tried to solve the second identification problem by estimating present value of future MPK which replaces average Q. They formulate a panel VAR model that is used to predict future stream of MPK. And the marginal Q so defined can be decomposed into two parts—a fundamental Q and a financial Q. In this way they avoid the problems associated with the unrealistic assumptions for substituting marginal Q by average Q. The paper formulates a structural model of investment that incorporates the financial market frictions in the dynamic programming problem of the firm.

In this paper we attempt to understand the underlying dynamic relationships between the fundamental and financial variables that are presumed to govern investment decision of Indian firms. The firms belong to the private manufacturing sector and the set includes both listed and non-listed firms. In this study we replace average Q by a measure of marginal profitability of capital which can be estimated both for listed and non-listed firms. This is an advantage of the methodology of Gilchrist and Himmelberg (1995; 1998) over the other strand of the literature that can only consider listed firms.

The paper is organised as follows. Section II describes the methodology, data and variables, Section III reports the empirical results. The overall conclusions are presented in Section IV.

II. The Methodology

In India, prior to 1991, the financing decisions of firms were regulated since the amount of equity issue was subject to the approval of the Controller of Capital Issues. The banks and the financial institutions were also subject to various regulations in respect of lending. So prior to 1991 it was not possible to test how far the firms were on their desired path of financing or not. Hence we concentrate on the post liberalisation era in India, viz. since 1991-92.

As stated before the objective of this paper is to explore the inherent dynamics of investment, MPK, cash flow and any other financial variable. Thus, we did not attempt to specify an investment equation and estimate it for firms classified *a priori* into groups of high and low cost of information. We instead specify a VAR relationship between investment, MPK, cash flow and working capital. The last variable is chosen as another financial variable in addition to cash flow. Gilchrist and Himmelberg (1998) worked with only the first three variables while we prefer to add another, *viz.* working capital (actually financial working capital), which is expected to exert only financial friction effect. Cash flow is likely to have both a fundamental and a financial effect while working capital has supposedly more financial effect (see Fazzari and Petersen (1993)). As MPK is a newer concept in this field we first define and derive the expression for it. Then we will move into the VAR methodology.

The profit function of the firm is defined as

$$\pi(k, n, w, F) = \max_{x>o} p(y)y - wx - F$$

s.t. $y = A k^{\alpha} n^{\beta} x^{\mu}$ with $\alpha+\beta+\mu = 1+\vartheta$ where ϑ is the returns-to-scale parameter.

$p(y)$ = inverse demand function, x= variable factor(s), w= variable factor price(s), n= quasi factor (R&D workers), F = fixed cost. F may include wage cost to n.

We have assumed here a Cobb-Douglas production function, but it is not necessarily constant returns to scale.

By envelope theorem

$$MPK = \frac{\partial \pi}{\partial k} = \theta\left(\frac{py}{k}\right)$$

where, $\theta = (1+\eta^{-1})\alpha$ and η = firm level price elasticity of demand (< -1) .

Assuming that firms are, on average, at their equilibrium capital stock and the adjustment cost is negligible then

$MPK_{it} = r_{it} + \delta_{it}$

where r_{it} = risk adjusted discount rate and is defined as total interest expenditure on term loans divided by total long term loans and δ_{it} = depreciation rate and is defined as total depreciation divided by capital stock (actually value of plant and machinery).

It is unreasonable to assume that firms in different industries face same η or same α, we estimate θ for each industry, denoted by θ_j. Industry estimate of θ_j is given by

$$\hat{\theta}_j = \left(\frac{1}{N_j} \sum_{i \in I(j)} \sum_{t \in T(i)} \left(\frac{py}{k}\right)_{it}\right)^{-1} \left(\frac{1}{N_j} \sum_{i \in I(j)} \sum_{t \in T(i)} (r_{it} + \delta_{it})\right)$$

where, N_j = number of firm-year observations for industry j.

Therefore, $MPK_{it} = \hat{\theta}_j \left(\frac{(py)_{it}}{k_{it}} \right)$. An alternative estimate of MPK can be constructed using the following relationship.

$$\frac{\partial \pi}{\partial k} = \psi \left(\frac{\pi}{k} + \frac{F}{k} + \eta^{-1} \frac{py}{k} \right) \text{ where } \psi = \frac{\alpha}{\alpha + \beta - \vartheta}$$

But this form is suitable for aggregative data, such as for country panels as in Abel and Blanchard (1986). With firm level accounting data *π/k* and py/k are observable but not F. Also η is either assumed to be same across industries or perfect competition is assumed. Hence we employ the MPK estimated by the previous method.

In a standard VAR methodology first a contemporaneous relationship among the endogenous variables is specified augmented by lagged values of the endogenous variables. The reduced form of this system of equation has only the lagged values and is estimated by some suitable method. The structural parameters are identified by imposing some restrictions on them which is often Choleski type leading to a recursive structure. Identification can also be achieved by some other set of conditions, generally from imposed on the basis of economic theory which gives a non-recursive structure of the contemporaneous relations. This is the structural VAR. We, however, adopted a Choleski decomposition with an ordering of variables investment, MPK, cash flow and working capital. This ordering is purposedly done so that shocks to MPK is orthogonal to investment, shock to cash flow is orthogonal to both investment and MPK and so on. Thus contemporaneous shock in investment affects MPK, cash flow and working capital, but the contemporaneous shock to MPK does not affect investment and similarly for MPK, cash flow and working capital.

Given the coefficient estimates for the contemporaneous relations and also the lagged variables one can now generate impulse response functions which can be interpreted as the dynamic multipliers. For a vector of current endogenous variables, Y_t and a vector of exogenous variables (shocks), V_t , a VAR is given by

$$B\, Y_t = \Gamma(L)\, Y_{t-1} + D\, V_t$$

where B = Matrix of structural parameters on the contemporaneous endogenous variables, $\Gamma(L)=\Gamma_1+\Gamma_2 L + \ldots\ldots\ldots + \Gamma_{k-1} L$, L= lag operator, D = Matrix of contemporaneous response of X_t to V_t . As V_{jt} is structural shock and so is assumed to affect only the jth. equation. Thus D is set at unit matrix.

The reduced form is

$$Y_t = B^{-1}\, \Gamma(L)\, Y_{t-1} + B^{-1}\, V_t$$

$$= A(L)\, Y_{t-1} + U_t$$

Consider the vector MA representation of a VAR

$Y_t = A(L)\ Y_{t-1} + Ut$

$Y_t = [I - A(L)\ L]^{-1}\ B^{-1} V_t = \theta(L) V_t$

where $\theta(L) = \Sigma_0^{\infty} \theta_i L^i$,

$\theta_i =$ nXn matrix of parameters from the structural model

$= [\theta_i^{jk}]$.

Thus

$\frac{\partial Y_{t+i}}{\partial V_t} = \theta_i$, where for i =0, gives θ_0 - the impact multipliers.

The effects of U_{kt} on the value of $Y_{j,\ t+i}$ is θ_i^{jk}. Plotting θ_i^{jk} against i gives impulse response functions. After n periods the cumulated sum of the effects of ε_{kt} on $\{X_{j,\ t}\}$ is $\Sigma_0^n\ \theta_i^{jk}$. As n tends to infinity $\Sigma_0^n\ \theta_i^{jk}$ gives long run multiplier.

A related concept is variance decomposition function. Variance decompositions allocate each variable's forecast error variance to the individual shocks. At (t-j) forecast error is

$$Y_t - E_{t-j}\ Y_t = \sum_{i=0}^{j-1} \theta_i V_{t-i} \qquad [E_{t-j}\ V_t = 0]$$

The matrix of forecast error variance is

$$E(Y_t - E_{t-j} Y_t)(Y_t - E_{t-j}\ Y_t)' = \sum_{i=0}^{j-1} \theta_i\ \theta_i'$$

The diagonal elements of the above are the forecast error variances for the individual series.

$\theta_i = [\theta_{ivs}]$: (v,s) element of θ_i

σ_s = sd for s th. shock

j-steps ahead forecast error variance of k th' residual is

$$E(Y_{kt} - E_{t-j} Y_{kt})(Y_{kt} - E_{t-j} Y_{kt})^2 = \sum_{i=0}^{j-1} \sum_{s=1}^{n} \theta_{iks}^2\ \sigma_s^2 \qquad \text{for } k = 1,....n$$

Variance decomposition function is the j-steps ahead forecast error variance (in %) for variable v attributable to k th shock

$$VDF(v,k,j)=\frac{\sum_{i=0}^{j-1}\theta_{ivk}^{2}\,\sigma_{k}^{2}}{\sum_{i=0}^{j-1}\sum_{s=1}^{n}\theta_{ivk}^{2}\,\sigma_{s}^{2}}$$

Impulse response function is calculated using Runkle's Monte Carlo simulation (Runkle 1987). Actual residuals are randomly sampled, and the sampled residuals are used as shocks to the estimated VAR. After the artificial series are generated, they are used to perform the same SVAR analysis. After, say 200 replications of the model, s.e.'s are calculated for the parameter estimates, the impulse response function and variance decomposition function.

Use of VAR for panel data has been developed by Chamberlin (1985), Holtz-Eakin, Newey and Rosen (1988) and others. Often economists, particularly macroeconometricians raise an objection against using VAR methodology for panel data as panels, particularly for firm level data typically have very small time series component. So objection is raised against using them to estimate a VAR, the associated impulse response function and the variance decomposition function which all have time dimension. But they fail to understand that the asymptotic properties do not depend upon the number of years of observations, rather on the number of observations. So once the parameters estimates are obtained, there is no difficulty in calculating impulse response function and the variance decomposition function because they are actually simulated with artificial shock. In principle one can estimate a panel VAR model for AR(1) with as low as three years of observations, though it is preferable to work with five or more years that gives the better options for the choice of instruments.

Denoting by Y_{it} a 4X1 vector for the observations for the i th. firm in t th. period on investment, MPK, cash flow and working capital the reduced form for the specified VAR is given by

$Y_{it}=AY_{i,\,t-1}+f_i+d_t+u_{it},$ $\quad$ $i=1, \ldots, N$ and $t=1,\ldots,T.$

where, A =hxh matrix of slope coefficients

f_i = hx1 vector of (unobserved) firm effects

d_t = hx1 vector of year effects (to be estimated).

$E(u_{it},u_{js}) = \sigma^2$ $\quad$ for $i=j$ and $t=s$,

$\qquad = 0$ $\quad$ for $i \neq j$ or $t \neq s$,

$E(f_j,u_{it}) = 0$ for all j, i, t

It may be noted that exogenous variables can also be added to regressors' list and $Y_{i,t-1}$ can also be written in a VAR(p) form. d_t represents time dummies that accommodates the year specific shocks which is same across all such as common movements in interest rates or other macroeconomic conditions that are not captured by $Y_{i,t-1}$. The least squares dummy variable method or the within effects estimator cannot be applied because of the presence of lagged endogenous variable. The estimates are biased; Nickell (1981) has derived an expression for the bias. The appropriate method of estimation is instrumental variable estimator as proposed Anderson and Hsiao (1982) or the generalised methods of moments (GMM) estimator as proposed by Arellano and Bond (1991).

To take care of year effect, i.e. d_t, we take all the variables in deviation from the relevant yearly average. Henceforth our Y_{it} will denote the adjusted value of Y_{it} from its yearly average. To take care of fixed firm effect, we take the model in deviation form as

$$Y_{it} - Y_{i,t-1} = A\left(Y_{i,t-1} - Y_{i,t-2}\right) + \left(u_{it} - u_{i,t-1}\right)$$

It may be noted that $\left(Y_{i,t-1} - Y_{i,t-2}\right)$ is correlated with $\left(u_{it} - u_{i,t-1}\right)$. However,

$\left(u_{it} - u_{i,t-1}\right)$ is uncorrelated with $\left(Y_{i,t-2} - Y_{i,t-3}\right)$ and $Y_{i,t-2}$.

Arellano and Bond (1991) and Kiviet (1995) confirm using $Y_{i,t-2}$ as instrument (on the basis of their simulation results). We also used $Y_{i,t-2}$ (and $Y_{i,t-3}$ for the variables corresponding to the second lag) for our estimation.

The Anderson-Hsiao estimator is given by

$\beta_{AH} = (Z' X)^{-1} Z' Y$ where for i = 1,....,N

$Z_i = [Y_{i,1},......, Y_{i,T-2}]'$, $X_i = [\Delta Y_{i2},......,\Delta Y_{i,T1}]'$,

$Y_i = [\Delta Y_{i3},.....,\Delta Y_{iT}]'$, $X = [X_i]'$, $Y = [Y_i]'$ and $Z = [Z_i]'$

For the GMM estimators of Arellano and Bond (1991) we use the following moment restrictions for the original unadjusted Y_{it}

$E(Y_{it}' \; u_{it}^j) = 0$

This implies $E[\, Y_{t-2}' \; (u_{it} - u_{i,t-1})] = 0$ for the adjusted Y_{it}.

Arellano and Bond (1991) in fact discussed two GMM estimators—One Step and Two Step. They differ in respect of the weighting matrix, A_N below. The One Step GMM Estimator is given by

$$\beta_{GMMI} = \left(X'Z^* A_N Z^{*\prime} X\right)^{-1} X'Z^* A_N \; Z^{*\prime} \; Y$$

where Z_i^* is a block diagonal matrix whose s th block is given by

$[y_{i,1},......, y_{i,s}]$, for s = 1,.......,T-2

$$Z = [Z_1^{*\prime},......., Z_N^{*\prime}]' \text{ and } A_N = \left(\frac{1}{N}\sum_1^N Z_i^{*\prime} H Z_i^*\right)^{-1}$$

where H is a T – 2 square matrix with twos in the principal diagonal, minus ones in the principal sub-diagonals and zeros elsewhere.

The Two Step GMM Estimator is given by

$$\beta_{GMM2} = \left(X' Z^* A_N Z^{*\prime} X\right)^{-1} X' Z^* A_N Z^{*\prime} Y$$

where

$$A_N = \left(\frac{1}{N}\sum_1^N Z_i^{*\prime} \Delta\hat{e}i \Delta\hat{e}i' Z_i^*\right)$$

and $\Delta\hat{e}i = (\Delta\hat{e}i3,......., \Delta\hat{e}iT)$ are the residuals from a consistent one-step estimator of ΔY_i. Generally GMM1 is used for this purpose. Though we defined GMM2 for the sake of completeness of estimation method of the dynamic panels, we actually employed Anderson-Hsiao estimator and GMM1 estimator.

Now we turn to data and definitions of the variables. We used the firm level panel data compiled by the Centre for Monitoring Indian Economy (CMIE) and distributed through its software **ProwesS**. The CMIE provides firm level data for several variables from the annual audited financial results of the respective firms. From **ProwesS** database we have taken the firms, incorporated prior to 1991 and the accounting year is (or at least for our period of coverage) April to March. Given these criteria we found 753 firms in the database for which 12 years of data are available, *viz.* 1992-93 to 2003-04. The sample firms are not necessarily listed. There are 108 firms that are not listed. However, there are several variables in a form of annual changes. Hence for actual estimation, total number of years covered is 11. Thus we have a panel of 753 firms with 11 years of observations, 1993-94 to 2003-04. These 753 firms belong to 48 broad industry groups. The industry groupings are based on the criteria of size of sales—if 50 per cent or more of sales for a firm come from a particular product then the firm is classified into that industry group and if a firm does not satisfy this criterion for any product, then it is classified into the category of diversified firms.

For empirical study, we need data on the following variables or some variables computed from them, *viz.* investment, MPK, cash flow, capital stock at replacement cost, working capital, change in working capital. Many of these variables are required to be taken at constant prices. This was achieved by deflating the current price values with appropriate price indices. The value of capital stock at constant price is taken to be the value of plant and machinery deflated by the price index of gross domestic fixed capital formation. Instead of gross (or net) fixed capital formation, we consider only change in the value of plant and machinery because of the fact that the former also includes land. Following precedence, we also define cash flow as income plus amortisation plus depreciation that is deflated by the wholesale price index for the industry group to which it belongs. Working capital is defined as current assets less current liabilities. The former comprises accounts receivables, inventories and cash while the latter comprises accounts payable and short term debt (debts of less than one year maturity). Working capital is deflated by the price index for stocks (of inventories). MPK is calculated by the method described above using **ProwesS** data. To get rid of the size effect (as we are working with heterogeneous firms) we divide all the level variables by the plant and machinery of previous period. We estimated the model for the full sample and also for small sized as well as large sized firms. The firms are classified into groups of small and large on the basis of their net fixed assets in 1992-93. The size classification is fixed on the basis of some off-sample year. The firm size is distributed in the interval [0.01 4107.25] with the median value at 11.83. We split the firms into groups by median value which is Rs. 11.83 crore because the distribution is highly skewed and hence average cannot be used. By this criterion there are 379 small firms distributed in the interval [0.01 11.83] and 374 large firms distributed in the interval (11.84 4107.25].

It may or may not be the case that same ranking remains valid. Looking at the data we find that the ranks of the net fixed assets between any two consecutive years does not change appreciably (correlation is around 0.99), but when comparing the ranks between far off years it changes quite substantially (the correlation being 0.70 to 0.84). However, in the absence of any appropriate criteria to split the sample we had to depend on it. Sales and net fixed assets or plant and machinery are pair wise highly correlated with the correlation coefficient being over 0.95, the same problem arises. As is done in the literature, credit rating and how it changes is a well recognised and widely used criterion. But in India credit, rating for majority of the firms were not available prior to 1997. Hence we had to drop it.

III. Empirical Results

Before going into the econometric results we report the descriptive statistics in Table 1 for the full sample. The table gives the mean and standard deviation of the variables used in our econometric estimation and some other variables of interest. As is revealed from the table, average investment for all firms for all the years is negative, though it is positive for the period 1993-94 to 1997-98 and falls appreciably to become negative in 1999-2000, 2001-02 and 2002-03 though it is positive and quite low compared to that for the earlier years. Again it becomes negative in the last year of our sample. Average MPK shows

Table 1

Descriptive Statistics: Full Sample for all the Years

Year	*I*	*MPK*	*CF*	*ΔINV*	*PAT*	*OP*	*CA*	*ΔWK*	*WK*	*NW*	*DE*
All Years	-0.18	0.04	4.82	0.05	0.19	0.15	3.17	1.03	0.51	2.00	1.40
	(16.73)	(1.23)	(13.83)	(1.55)	(2.20)	(8.50)	(17.31)	(12.69)	(36.36)	(14.69)	(31.43)
1993-94	0.134	0.017	6.31	0.106	0.441	0.546	4.08	1.69	0.479	2.40	1.76
	(0.699)	(0.079)	(20.63)	(1.87)	(3.52)	(3.71)	(20.36)	(13.10)	(4.14)	(16.14)	(14.61)
1994-95	0.183	0.014	5.28	0.115	0.396	0.516	3.83	1.51	0.336	2.33	0.514
	(0.224)	(0.042)	(15.17)	(1.35)	(2.50)	(3.12)	(17.47)	(10.78)	(2.01)	(13.94)	(13.74)
1995-96	0.179	0.013	5.12	0.037	0.299	0.389	3.35	1.29	0.123	2.01	1.19
	(0.190)	(0.033)	(14.42)	(2.32)	(1.00)	(1.76)	(14.46)	(10.16)	(1.32)	(11.09)	(16.49)
1996-97	0.087	0.029	4.81	0.088	0.216	0.281	2.94	1.14	0.042	1.92	0.286
	(0.684)	(0.330)	(9.74)	(1.51)	(0.49)	(0.64)	(12.11)	(9.60)	(1.24)	(10.70)	(20.67)
1997-98	0.088	0.030	5.19	0.088	0.176	0.209	3.06	1.26	0.090	1.92	3.08
	(0.593)	(0.334)	(17.84)	(1.67)	(0.47)	(0.56)	(13.78)	(10.43)	(0.99)	(10.65)	(44.43)
1998-99	-1.87	0.041	4.70	0.023	0.010	-0.830	3.85	0.358	4.23	1.84	0.151
	(53.21)	(0.690)	(15.74)	(0.52)	(3.62)	(27.57)	(35.80)	(20.32)	(117.59)	(10.47)	(24.98)
1999-2000	-0.424	0.166	4.33	-0.019	0.094	0.089	3.10	0.981	0.148	1.88	2.77
	(12.97)	(3.97)	(9.67)	(1.36)	(1.01)	(1.94)	(17.40)	(14.20)	(6.74)	(11.71)	(46.08)
2000-01	-0.291	0.020	4.34	0.117	0.076	0.104	2.99	0.444	-0.554	1.70	1.78
	(7.47)	(0.112)	(10.22)	(1.97)	(4.12)	(1.03)	(13.77)	(20.71)	(18.06)	(14.81)	(52.73)
2001-02	0.056	0.025	4.09	0.047	0.083	0.092	2.53	0.786	0.606	1.98	0.74
	(0.145)	(0.216)	(9.76)	(1.28)	(0.581)	(0.771)	(9.17)	(7.01)	(16.45)	(20.00)	(10.44)
2002-03	0.039	0.036	4.02	-0.057	0.089	0.091	2.44	0.971	-0.039	1.80	2.78
	(0.199)	(0.426)	(10.09)	(1.51)	(0.723)	(0.826)	(9.40)	(7.69)	(7.01)	(19.72)	(38.20)
2003-04	-0.173	0.016	4.87	0.016	0.176	0.198	2.70	0.848	0.141	2.21	0.311
	(4.64)	(0.102)	(13.47)	(0.90)	(0.89)	(1.37)	(9.19)	(5.41)	(1.60)	(17.80)	(26.34)

Note: (a) The figures in the parentheses are the corresponding standard deviations.

(b) MPK = Marginal profitability of capital, I = Investment, CF = Cash Flow, ΔINV = Change in inventories, PAT = Profit after tax, OP = Operating profit, CA = Current asset, WK = Working capital, ΔWK = Change in working capital, NW = Net worth, DE = Debt equity ratio.

(c) All the variables except MPK and debt-equity ratio are divided by previous year's plant and machinery to take care of size effect.

fluctuating trend with the average for all the years being 0.04. The average cash flow by and large remains same. Profit after tax has a decreasing trend with sign of recovery in 2003-04. The same is true about operating profit. The average change in working capital shows a declining trend, so is level of working capital, though the latter jumps to a very high value in 1998-99. Net worth shows slight declining trend though reverts to initial year value. The debt-equity ratio fluctuates within a very high band and shows no pattern over the years.

Now we discuss the results from our VAR analysis. As mentioned before we formulated a 2-lag VAR with Cholesky identification scheme for the ordering investment, MPK, cash flow and working capital. The contemporaneous relations have a reasonably good fit as measured by R^2 or adjusted R^2, the t-values for the coefficient estimates and other measures of regression diagnostics. Adjusted R^2 for all the equations are over 0.42. We report the impulse response functions for unit impulses in MPK, cash flow and working capital on the other variables in Table 2. Impulse response functions are calculated for the next 6 years. Tables 3 and 4 gives the similar impulse response functions for small and large firms respectively. As is evident from Table 2, that both MPK and cash flow affect investment. However, a shock to MPK has smaller effect on investment than for a shock to cash flow though it persists for a larger period for the latter than for the former. The MPK shock has larger effect than cash flow shock on working capital though working capital adjusts more quickly over time than other variables.

When we consider split samples, the impulse response functions for small firms and large firms differ slightly in their properties. The response of investment to MPK shock is

Table 2

Impulse Response Functions (Full Sample)

	T	*t+1*	*t+2*	*t+3*	*t+4*	*t+5*	*t+6*
Response to MPK Shock:							
Investment	0.00	0.037	0.012	0.000	0.000	0.000	0.000
MPK	1.00	0.115	0.101	0.007	0.002	0.001	0.000
Cash Flow	0.043	0.012	0.008	0.002	0.000	0.000	0.000
Working Capital	0.002	0.0017	0.00012	0.0001	0.000	0.000	0.00
Response to Cash Flow Shock:							
Investment	0.00	0.016	0.011	0.009	0.003	0.000	0.000
MPK	0.00	0.001	0.0003	0.000	0.000	0.000	0.000
Cash Flow	1.00	0.0451	0.0327	0.0121	0.007	0.002	0.001
Working Capital	0.002	0.001	0.000	0.000	0.000	0.000	0.000

marginally higher for small firms to start with but persists for a larger period for the larger firms. The cash flow shock has larger effect on investment of the larger firms, but immediately dies down after three periods while it persists for small firms. Though we also included working capital as another variable to capture financial market frictions it actually added little to the model. The effect of cash flow shock on investment persists for the full sample as well as the split samples even when the effect on MPK dies down. This shows that investment rises even when the most important fundamental, i.e. MPK is not rising. This indicates that cash flow might have a role to play as a fundamental variable in the sense that it contains information about future profitability.

Table 3

Impulse Response Functions (Small Firms)

	T	*t+1*	*t+2*	*t+3*	*t+4*	*t+5*	*t+6*
Response to MPK Shock:							
Investment	0.000	0.039	0.005	0.001	0.000	0.000	0.000
MPK	1.00	0.211	0.142	0.007	0.000	0.000	0.000
Cash Flow	0.045	0.013	0.007	0.001	0.000	0.000	0.000
Working Capital	0.035	0.021	0.011	0.000	0.000	0.000	0.000
Response to Cash Flow Shock:							
Investment	0.000	0.0079	0.0053	0.0021	0.0017	0.000	0.000
MPK	0.000	0.00001	0.0000	0.0000	0.0000	0.000	0.000
Cash Flow	1.00	0.042	0.027	0.015	0.009	0.002	0.000
Working Capital	0.0024	0.0012	0.0007	0.000	0.000	0.000	0.000

Table 4

Impulse Response Functions (Large Firms)

	T	*t+1*	*t+2*	*t+3*	*t+4*	*t+5*	*t+6*
Response to MPK Shock:							
Investment	0.000	0.034	0.024	0.011	0.009	0.003	0.001
MPK	1.00	0.112	0.092	0.023	0.012	0.000	0.000
Cash Flow	0.002	0.001	0.0007	0.000	0.000	0.000	0.000
Working Capital	0.0032	0.0021	0.000	0.000	0.000	0.000	0.000
Response to Cash Flow Shock:							
Investment	0.00	0.0521	0.023	0.0000	0.0000	0.000	0.000
MPK	0.00	0.003	0.001	0.0009	0.0000	0.000	0.000
Cash Flow	1.00	0.102	0.008	0.002	0.001	0.000	0.000
Working Capital	0.001	0.0009	0.000	0.000	0.000	0.000	0.000

IV. Conclusions

We formulated a dynamic model of investment, marginal profitability of capital, cash flow and working capital for a sample of private manufacturing firms for India and estimated the model with panel data by GMM method. Then we calculated the impulse response functions for six years. The descriptive statistics suggest that though average investment was positive in the early nineties, it shows a downward trend and becomes negative in 2003-04. The marginal profitability of capital shows up no regular pattern while average cash flow remains stable over the years. Profit after tax and operating profit show a declining trend while working capital though has declining trend shoots up in 1998-99. Average net worth shows a slight declining trend. The debt equity ratio has no particular trend, actually it fluctuates within a large interval.

The dynamics of the model as revealed by the impulse response functions of investment to marginal profitability of capital and cash flow leads one to make some very interesting conclusions. The effect of MPK shock on investment is slightly larger for smaller firms but it adjusts very quickly than for the larger firms. On the other hand, cash flow has also a role to play as a fundamental variable in the sense it contains information about future values of the fundamental variables. The role of cash flow as a fundamental variable is more for larger firms than for the smaller firms.

However, one needs to check many other things, such a sample split based on listed and non-listed firms, or the firms that have grown more than the others as well as other kinds of ordering of variables for identification. All these will reveal the investment decisions of different kinds of firms as well as inherent dynamics among the fundamental and financial variables. These are the future research agenda for a better understanding of the investment pattern of Indian firms.

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