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Evidence on the dynamics of investment-cash flow sensitivity

Vikash Gautam

Indira Gandhi Institute of Development Resaerch

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Abstract

An important debate in the literature relates to the use of investment-cash flow sensitivity (ICFS) to measure finance constraint faced by firms. This debate is grounded on four prominent issues: a priori sorting of firms, treatment of distressed firms, use of cash flow to represent only internal liquidity of firms and restricting firms to a single regime. In this paper we investigate these issues using a sample of 2676 Indian manufacturing firms over the period 1994 to 2009. We use firm level estimates of ICFS to sort firms into positively cash flow sensitive (PCF-sensitive) group, cash flow insensitive (CF-insensitive) group and, negatively cash flow sensitive (NCF-sensitive) group. We find that all three group of firms start with high levels of investment. But, only the PCF-sensitive firms have high level of cash flows. With age, the investment of all three groups of firms remains stationary. But, for CF-insensitive firms only the cash flow rises with age. Further, we use a multinomial logistic regression to study the determinants of ICFS in the three groups. The results suggest that the interpretation of NCF-sensitive, PCF-sensitive and CF-insensitive as distressed, financially constrained and financially unconstrained, respectively, can be contested by the data.

Keywords: investment-cash flow sensitivity, finance constraint, distress, multinomial logistic regression

JEL Code: D21, D82, G31, G32

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1. Introduction

A recurrent puzzle in the literature is to identify the financially constrained firms from a sample of firms. Since finance constraint is not observable, most researchers use investment-cash flow sensitivity (ICFS), as the metric, to investigate the presence of finance constraint in firms.[1] The argument is– firms operating in imperfect capital markets (i.e., firms facing the problems of asymmetric information) may find external funds either unavailable or very expensive. This is because the suppliers of external funds, who are unsure about a firm's project quality, seek a premium to compensate for the losses that might arise by funding risky projects. This premium precludes some firms from making investments that they would have chosen to make, had funds been available. Such firms are interpreted as financially constrained against the unconstrained firms which pay negligible premium. Investments by constrained firms, as a consequence of high premium on external funds, are likely to be highly correlated with the cash flows where cash flows are taken as a proxy for internal liquidity. The usual practice, for validating this hypothesis, is to sort the sample of firms into groups based on their likelihood of facing financing constraints using some variable like dividend payout, size, group affiliation, age, export sensitivity, commercial paper rating etc. The group of firms for which ICFS is significantly higher is interpreted as financially constrained and the group of firms for which ICFS is insignificant is interpreted as financially unconstrained. This is known as excess sensitivity hypothesis in the literature.

There is significant amount of work which confirms to the excess sensitivity hypothesis. However, there are also some works which argue that ICFS is a noisy measure of financial constraints.[2] The debate on this issue revolves around three major arguments: firstly, cash flow is a noisy variable to measure finance constraint faced by firms since, apart from signaling change in internal liquidity, it also signals growth opportunities of firms. This is because firms which are younger and smaller would possibly react more to an innovation in cash flows since it provides a greater revision of expected profitability [Gilchrist and Himmelberg (1995)]. So, we may find the correlation between investment and cash flows to vary across subsample of firms but for reason

[1] For a comprehensive literature survey see Hubbard (1998); Lensink, Bo and Sterken (2001) and; Calcagnini, and Saltari (2010).

[2] See footnote 1 for references of such works.

that has nothing to do with financing constraints. Secondly, sorting of firms into constrained and unconstrained groups, based on some *a priori* measure, implies an implicit assumption of monotonicity of financing constraint with the sorting variable(s). On contrary, Cleary, Povel and Raith (2007) and Hovakimian (2009) suggest a U-shaped investment-cash flow sensitivity curve with respect to the sorting variables. Therefore the monotonicity assumption may give biased estimates. Thirdly, conditions leading to finance constraint may change with any new shock, positive or negative, affecting the firm over time. Not allowing firms to be financially constrained in one period and unconstrained in other period is too restrictive [Hu and Schiantarelli (1998), Hovakimian and Titman (2006)].

There is also a debate on the treatment of distressed firms in the analysis of ICFS in investigating financial constraint faced by firms.[3] This stems from the contradictory findings of Fazzari, Hubbard and Petersen (1998) and Kaplan and Zingales (1997) in their investigations of financing constraint using ICFS as the metric. Fazzari, Hubbard and Petersen, using dividend payout to sort firms, show significantly greater ICFS for firms that pay low dividends than the firms that pay high dividends. They argue that since dividends and investment are competing uses of funds, firms facing higher premium should choose low dividend payout ratios. On the other hand, Kaplan and Zingales, show that firms that have greater ICFS are less likely to be constrained than firms which have smaller ICFS. They argue that high ICFS is driven by managers' choice to rely primarily on internal cash flow to invest despite the availability of additional low cost external funds. In the resolution of this debate, Fazzari, Hubbard and Petersen (2000) point out that the firms which are identified by Kaplan and Zingales (1997) as financially constrained are actually distressed, whereas they did not consider distressed firms for their exercise. So, an analysis of financial constraint faced by firms must leave out distressed firms because, at margin, a dollar from cash flows is less likely to be invested if a firm is in financial distress.

In this paper, our attempt is to investigate the determinants of ICFS of Indian firms without relying on ex ante classification of firms into constrained, unconstrained and distressed groups. The Indian economy provides a relevant case study for this analysis because since the onset of market-oriented reforms of 1991 banks and other financial institutions were given considerable freedom in deciding whom to lend and how much to lend. Specially, there has been a strong tendency on the

[3] A firm is defined as distressed in a period if the claims of its creditors are broken or honored with difficulty.

part of the Government to move away from state control on the manufacturing sector by allowing greater flexibility with respect to investment decisions and choice of capital structure. More importantly, to the best of our knowledge, most works on India are open to the criticisms noted above.[4] Specifically, they use cash flows to measure internal liquidity of firms without accounting for the information contained in it about growth opportunities of firms. Also, their framework assumes a monotonic pattern of ICFS with the sorting variable(s) and they do not allow firms to change regime in the sample period. Therefore, this exercise, by directly investing the ICFS of firms, is likely to fill a potentially significant gap in the literature. The analysis uses a sample of 2676 Indian manufacturing firms over the period 1994 to 2009.

We use firm level estimates of ICFS to sort firms into positively cash flow sensitive (PCF-sensitive) group, cash flow insensitive (CF-insensitive) group and, negatively cash flow sensitive (NCF-sensitive) group. This grouping of firms is important because these groups are interpreted differently in the literature. The interpretation of PCF-sensitive firms and CF-insensitive firms is in line with the arguments made above, i.e., the PCF-sensitive firms are considered financially constrained whereas the CF-insensitive firms are considered to be operating in a perfect capital market. NCF-sensitive firms are much less researched compared to the other two groups.[5] It is argued that such firms have high growth opportunities but small internal funds at start-up. So, they rely mainly on external sources for their investment needs. Lenders (or investors), to leverage such needs, require their investments to be large enough to generate revenue for the repayment of loans. As such firms mature, their cash flows rise but their growth opportunities fall. On account of rising debt obligations and falling growth opportunities, such firms are likely to be distressed since their probability of default in response to a negative shock is high. However, since we directly investigate the ICFS of firms in the three groups, we keep an open mind to evaluate these arguments in our analysis.

We find that at start-up the NCF-sensitive firms have positively significant investment but negatively significant cash flows implying they are mainly financed by external sources. Moreover, this negative relationship forms a pattern since both the variables remain stationary with age. The

[4] For works on India see Athey and Laumas (1994); Ganesh-Kumar, Sen and Vaidya (2001); Lensink, van der Molen, and Gangopadhyay (2003); Bhaduri (2005) and George, Kabir, and Qian (2011).

[5] We are aware of four such works discussing NCF-sensitive firms in some detail. These are Allayannis and Mozumdar (2004); Bhagat, Moyen and Suh (2005); Cleary, Povel and Raith (2007); Hovakimian (2009).

CF-insensitive firms start with high level of investment and an insignificant level of cash flows. But, their investments remain stationary and the cash flows rise with age. The PCF-sensitive firms start with higher level of investment than the other two groups and their cash flow level is also higher. But, their investments and cash flows both remain stationary with age. Further, we use a multinomial logistic regression model to study the determinants of ICFS in the three groups. The results suggest that the interpretation of NCF-sensitive, PCF-sensitive and CF-insensitive as distressed, financially constrained and financially unconstrained, respectively, can be contested by the data. We suspect that the possible reasons for this could be, as argued before, the use of cash flows to measure internal liquidity of firms without accounting for the information contained in it about growth opportunities of firms; and restricting firms in a single regime over the sample period. Moreover, the results also suggest evidence contrary to the assumption of monotonic pattern of investment-cash flow sensitivity with some of the sorting variable(s).

This work is closest in spirit to Hovakimian (2009). She also uses firm level estimates of investment-cash flow sensitivity to sort firms into PCF-sensitive, CF-insensitive and NCF-sensitive group. However, this paper differs from Hovakimian (2009) in the following two ways: First, she uses error term from the homogeneous slope regression model of investment on variables other than cash flows after controlling for fixed firm and time effects to construct ICFS of firms. We, on the other hand, use a variable slope regression model, which allows the firms to have heterogeneous slopes for the variables in the model, to find the estimates of ICFS. We show that a variable slope regression model fits data better than the homogeneous slope model. Second, she uses Tobin's q to represent the growth opportunities of the firms. However, since there are many unlisted firms in our sample, it has not been possible to get an estimate of the Tobin's q for all the firms. Therefore, we use sales accelerator to represent growth opportunities of firms. For a smaller sub-sample of firms that are listed we conduct the entire empirical exercise using the Tobin's q.

The rest of the paper is organized as follows: Section two discusses the methods of measuring firm-level ICFS. Section three discusses the dataset and the variables. Section four outlines descriptive statistics and preliminary analysis. Section five examines how the relationship between investment and cash flows change with age for the three ICFS group of firms. Section six presents the estimation exercise. Section seven concludes the paper.

2. Firm level estimates of ICFS

For the measurement of ICFS there are two approaches that we can follow. First, we can control for the factors other than cash flows in a homogeneous slope regression model and use the error term to construct the measure as suggested by Hovakimian (2009). Second, we can use a variable slope regression model, which allows the firms to have heterogeneous slopes for the variables in the model, to get estimates of ICFS from the model itself. These methods are outlined below:

2.1. Firm level ICFS using homogeneous slope regression model

Cash flow is not the only factor that may affect firms' investment. So, we can estimate the following regression to control for the other factors:

$$\left(I/_{K}\right)_{it} = \beta X_{it} + \varepsilon_{it} \qquad (1)$$

In equation (1) I_{it} is investment by firm i at time t. The list of control variables represented by the matrix X_{it} is the matrix of control variables, β is the matrix of slope coefficients and ε_{it} is the error term which is assumed to be white noise.

The error term from this regression, ε_{it}, can be used to construct ICFS metric:

$$S = \frac{\sum_{t=1}^{n}[(CF/K)_{it}\ x\ (\varepsilon_{it})]}{\sum_{t=1}^{n}(CF/K)_{it}} - \frac{1}{n}\sum_{t=1}^{n}\varepsilon_{it} \qquad (2)$$

here, S is the sensitivity metric, CF represents cash flows and K is beginning-of-period capital stock. i denotes firm, t denotes year and n is the total number of firms. By construction, S takes high values for firms that invest more when their cash flows are high and less when their cash flows are low, after controlling for the other factors. The intuition for equation (2) is as follows: if a firm's investment is not influenced by its cash flows then its average ε_{it} in the periods when cash flows are high should not be significantly different from its average ε_{it} in the periods when cash flows are low. Consequently, average ε_{it} weighted by cash flows should not be significantly different from the simple average ε_{it}. However, if a firm's investment is positively (negatively) correlated with its cash flows then average ε_{it} weighted by cash flows should be higher (lower) than the simple average ε_{it}.

2.2. Firm level ICFS using variable slope regression model

The variable slope model, compared to the homogeneous slope model, allows the construction of the ICFS metric from the model itself. The specification of the variable slope regression model is:

$$\left(I/_{k}\right)_{it} = \alpha CF_{it} + \beta X_{it} + \gamma_i CF_{it} + \varepsilon_{it} \quad (3)$$

This specification augments the specification in the equation (1) by including cash flow variable (CF_{it}) in the equation. The ICFS metric can be computed as the sum of α and γ_i.

The advantage with the homogeneous slope model is that it requires less number of parameters to be estimated since structuring all variables in *X* to have heterogeneous slopes across firms would require too many parameters to estimate. As an alternative, we can assume that only *CF*, which is our main variable of interest, has variable slope across firms as suggested by Lee (2002). This is important because if the true model has variable slope coefficients, a homogeneous slope coefficient may give biased estimates [Baltagi (2008)]. Also, since the variable slope model uses information from the specification rather than the error term to give the ICFS estimates, it retains its uniqueness, which may be contested in the case of homogeneous slope model.[6] Both the models in equation (1) and (2) can be estimated with fixed firm effects, industry effects, time effects and robust standard errors. A likelihood ratio test can be performed to choose a better fit among the two methods.

3. Dataset and variables

We use PROWESS, corporate data directory of the Center for Monitoring of Indian Economy (CMIE) as the major data source. It contains detailed information on over 20,000 Indian firms. It includes a normalised database of the financials covering around 1,500 data items and ratios per company. We also use Reserve Bank of India (RBI) monthly bulletins to get data on price deflators for constructing replacement value of capital stock. Our study is based on major industries in the manufacturing sector from 1994 to 2009.

[6] The specifications in both the equations leave out some information (say, for example, credit rating of firms) because of data availability issue. The magnitude of bias is likely to be less in the case of the variable slope model.

The sample includes even those firms that no longer exist, so there is no survival bias. However, we do restrict our sample in the following ways: first, we require sale of goods to contribute at least 75 per cent of the total sales of the firm for at least two-third of the sample period. This is to ensure that the firms are mainly into manufacturing business and they have not diversified into some other activities such as trading. Second, we consider only private firms. Public and foreign firms are excluded since Investments by such firms are directly controlled by the Ministry of Industry and a foreign parent company, respectively. They cannot be analysed in the framework of this study. Third, to drop firms undergoing restructuring, we require firms should not have unreasonable jump in manufactured sales.[7] Fourth, we drop firms which do not have at least four years of continuous data. Additionally, to take care of the extreme values, we replace the extreme one percent observations at both ends by the numbers at the previous percentile.

Among the variables used in the analysis of ICFS, investment is defined as the change in replacement value of capital stock. We use perpetual inventory method to measure replacement value of capital stock.[8] Cash flow is defined as the sum of retained profits and depreciation. Besides cash flows, which is a flow measure of liquidity (besides capturing information on growth opportunities of firms), we also use slack which is a stock measure of liquidity. Slack is defined as the sum of cash and marketable securities. There are two contrasting strands in literature on the effect of slack on firms' investment. Kashyap, Lamont and Stein (1994) and Kaplan and Zingales (1997) suggest that investment by firms with ample cash reserves is not limited by a lack of finance. However, Fazzari and Petersen (1993); Calomiris, Himmelberg and Wachtel (1996) argue that firms which anticipate a shortage of liquidity for investment needs in the near future, maintain high levels of slack.

Accelerator and Tobin's *q* are expected to affect firm investment as proxy variables for growth opportunities. Accelerator is defined as the difference of operating income (sales) of a firm

[7] We allow up to 1000 percent jump if manufactured sales is up to Rs. 10 million; 500 percent if manufactured sales is between Rs. 10 million plus to Rs. 50 million; 300 percent if manufactured sales is between Rs. 50 million plus to Rs. 100 million; 200 percent if manufactured sales is between Rs. 100 million plus to Rs. 250 million and; 100 percent if manufactured sales is above Rs. 250 million. We tried various other numbers but these numbers are chosen to include maximum possible number of observations in the sample and yet putting a restriction on restructuring firms.

[8] This is standard in the literature. For a comprehensive note on the construction of replacement value of capital stock see Fazzari, Hubbard and Petersen (1988), Gomes (2001). Henceforth, capital means replacement value of capital stock in the paper.

in two consecutive years. Tobin's *q* is defined as the ratio of market value of a firm to its book value of assets. Market value is calculated by adding market value of equity and book value of debt. Firms with high growth opportunities indicate further scope for profitable investments. If such firms are well recognised by the market, it is less likely they would face problems in raising funds [Hovakimian and Titman (2006)]. However, their inability to signal scope for profitable investments may cause a bottleneck in raising funds.

We use two stock measures of firms' leverage- short term debt and long term debt. Short term debt is defined as the loans taken from all sources for a period of less than 12 months where as long term debt is defined as the loans taken from all sources for a period of more than 12 months. Jensen and Meckling (1976) and Myers (1977) suggest that firms with high debt signal higher probability of default during a business downturn. Therefore, they may face higher hurdles in accessing external sources of capital. However, Lensink, Bo and Sterken (2001) suggest that debts help in avoiding agency problem between stock holders and managers of the firm by disciplining the later. Hence, such firms are less likely to face hurdles in accessing external sources of capital. We also use interest coverage as the flow measure of leverage which represents debt servicing by firms. It is measured as the ratio of interest accrued to profits before taxes, interest payments, dividends and amortization (PBTIDA).

Firms' size and maturity are two other variables which are extensively used in the literature. Natural log of sales is used to represent size of firms. Firms with greater size command more resources and get more analysts' coverage than firms with smaller size. Hence, they are less likely to be constrained by funds [Hovakimian and Titman (2006); Devereux and Schiantarelli (1990); Oliner and Rudebusch (1992)]. Natural log of age is used to represent maturity of firms where is age is taken from the year of incorporation of the firms to the year 2010. For similar reasons as size, mature firms are less likely to face problems in raising funds. Along with size and age, asset tangibility also assesses firms' ability to obtain external capital. Asset tangibility is defined as the ratio of gross fixed assets to capital stock of the firms. Higher asset tangibility allows firms to borrow more since it increases the value that can be captured by creditors in default state [Almeida and Campello (2007); Hovakimian (2009)].

Among the additional variables, we use dividend payout, export sensitivity and group affiliation of firms. Dividend payout is defined as the sum of common and preference dividends. Since dividends and investment are competing uses of funds, firms facing hurdles in finding

external finance should choose low dividend payout [Fazzari, Hubbard, and Petersen (1988), Gilchrist and Himmelberg (1995)]. Export sensitivity is defined as the ratio of export of goods (fob) to sales. Firms which export more are more capable of surviving and doing well. Such firms are less likely to be constrained by funds from external sources [Ganesh-Kumar, Sen and Vaidya (2001); Silva (2011)]. Group affiliation is defined as a dummy which takes value 1 for a firm belonging to a group. Hoshi, Kashyap, and Scharfstein (1991); Lensink, van der Molen, and Gangopadhyay (2003) suggest that group firms have their internal capital market which acts as an additional source of funds. In contrary, Bertrand, Mehta and Mullainathan (2002), Molen and Lensink (2005) argue that some business groups mainly exist to the benefit of the typically small number of investors that control a group leading to the expropriation of minority shareholders. So, the complicated ownership structures of business groups may lead to more severe agency conflicts.

4. Descriptive statistics and preliminary analysis

In table 1 we present the summary statistic for the ICFS metric using alternative methods discussed in the section 2.[9] The variables which are included as controls include- accelerator, log sales, log age, gross fixed assets, short term debt, long term debt, interest coverage, slack, dividend payout, export sensitivity and group affiliation. All variables except log sales, interest coverage and export sensitivity are deflated by beginning-of-period capital stock. Both the models are estimated with fixed firm effects, industry effects, time effects and robust standard errors. The likelihood ratio test clearly suggests that variable slope model fits the data better than the homogeneous slope model. Moreover, ICFS estimates, using homogeneous slope model, at the extreme percentiles cannot be interpreted as reasonable numbers. Therefore, for all our subsequent analysis we use ICFS metric derived from the variable slope model.

We break the sample of firms into three groups, PCF-sensitive, NCF-sensitive and CF-insensitive, based on the following rule: first, we divide the positive and negative ICFS scores of firms into twenty clusters each, using hierarchical clustering technique and call them above-zero and below-zero clusters, respectively. Second, since finding the boundaries of the CF-insensitive group would get us all the three groups, we use different combinations from above-zero and below-

[9] The regression results are not presented in the paper to save space, they are available upon request.

zero clusters to get an insensitive cash flow coefficient in investment regression as specified by the following equation:

$$\left(I/k\right)_{it} = \alpha\left(\mathrm{CF}/\mathrm{K}\right)_{\mathrm{it}} + \beta X_{it} + \varepsilon_{it} \quad (4)$$

This specification is same as in equation (1) except we also have cash flows (CF_{it}) as one of the independent variables here.[10] Third, the stopping rule for the exercise is that we must find positively significant, negatively significant and insignificant cash flow coefficient for PCF-sensitive, NCF-sensitive and CF-insensitive groups, respectively, in investment regressions.

Table 1: Summary statistics for ICFS metric

	Homogeneous slope model	Variable slope model
Maximum	34.1935	0.1516
p99	1.5116	0.0828
p90	0.1924	0.0443
p75	0.0569	0.0318
Mean	-0.0028	0.0241
Median	-0.0017	0.0233
p25	-0.0612	0.0160
p10	-0.2042	0.0060
p1	-1.3747	-0.0355
Minimum	-31.4918	-0.0723
Standard Deviation	1.2688	0.0187
Number of Observations	25966	25949
Number of firms	2680	2676
LR test for variable slope (Prob > chi^2)		0.0000

Note: This table presents the summery statistics for ICFS estimates using alternative methods discussed in the Section 2. The models are estimated with fixed firm effects, industry effects, time effects and robust standard errors.

Following the aforementioned steps, we classify firms as PCF-sensitive if ICFS is greater than 0.0397, NCF-sensitive if ICFS is less than -0.0022 and as CF-insensitive if ICFS lies between -

[10] Here our motive is to investigate the ICFS for the three groups. So, we use specification as in the equation (4) rather than as in the equation (3).

0.0022 and 0.0397.[11] With these thresholds 149 firms are classified as NCF-sensitive, 2161 firms are classified as CF-insensitive and 366 firms are classified as PCF-sensitive. The investment regression in table 2 confirms this partitioning. This also suggests that the results obtained by splitting sample basexd on ICFS is directly comparable to those obtained in the existing literature which studies firms' financial constraints using ex ante criteria for separation.

Table 2: Investment regressions for full sample and ICFS-groups

Dependent variable: Investment/K	Full Sample	NCF-Sensitive	CF- Insensitive	PCF- Sensitive
Cash flow/K	0.0015	-0.1012***	-0.0087	0.1165***
Log sales	0.0220***	0.0293***	0.0182***	0.0285***
Accelerator/K	0.0058***	0.0033	0.0053***	0.0090***
Short term debt/K	-0.0247***	-0.0209**	-0.0243***	-0.0280***
Long term debt/K	0.0034	0.0036	0.0070*	0.0003
Slack/K	-0.0148***	-0.0120	-0.0178***	-0.0156
Tangible assets/K	-0.0207***	-0.0182*	-0.0270***	-0.0138**
Dividend payout/K	0.0762*	0.0951	0.0374	0.0539
Interest coverage	-0.0057**	-0.0122	-0.0025	-0.0175***
Export sensitivity	0.0054	-0.0256	0.0044	0.0576
Prob > F	0.0000	0.0000	0.0000	0.0000
Number of Observations	25949	1534	20922	3493
Number of Firms	2676	149	2161	366

Note: This table presents the results of regressions on investment using complete sample and then using each investment-cash flow sensitivity groups. Estimation is done with fixed firm effects, industry effects, time effects and robust standard errors. Variables are defined in section 2. Two variables, log age and group affiliation, are dropped because of high collinearity with the fixed firm effects. ***, ** and * represent level of significance at 0.1%, 1% and 5%, respectively.

Table 3 presents the descriptive statistics of variables for the complete sample and for each of the ICFS groups. The table indicates that the PCF-sensitive firms, on average, are bigger in terms of cash flows, growth opportunities, leverage variables, tangibility and export sensitivity; and smaller in terms of maturity and debt service burden than the CF-insensitive firms. On the other hand, NCF-sensitive firms, on average, are bigger in terms of cash flows, maturity, dividend payout and debt service burden; and smaller in terms of operating income than CF-insensitive firms.[12]

[11] Although the -0.0022 and 0.0397 cutoff levels are ad hoc, further results are not significantly sensitive to reasonable alternative choices of cut-off levels.

[12] Negative value (-0.0040) for interest coverage for NCF-sensitive firms indicate that such firms, on average, are loss making firms.

Table 3: Descriptive statistics of full sample and ICFS-groups

Panel A: Full Sample

Variables	Maximum	Mean	Median	Minimum	SD
Investment/K	0.6054	0.0972	0.0554	-0.3022	0.1628
Cash flow/K	2.2660	0.1466	0.1127	-1.2215	0.3981
Log sales	7.6132	3.5545	3.6689	-2.3026	1.8417
Accelerator/K	9.6799	0.4765	0.1810	-4.8491	1.6975
Log age	5.2204	3.3619	3.2581	0.6931	0.5036
Short term debt/K	5.1653	0.5958	0.3667	0.0000	0.7928
Long term debt/K	6.5322	0.6125	0.4162	0.0000	0.7891
Slack/K	4.9954	0.2576	0.0625	0.0000	0.6708
Tangible assets/K	10.0478	1.8244	1.4403	1.0659	1.2595
Dividend payout/K	0.3563	0.0217	0.0000	0.0000	0.0538
Interest coverage	1.7925	0.0268	0.0000	-2.0000	0.4347
Export Sensitivity	0.9336	0.1281	0.0074	0.0000	0.2302
No. of observations	25949				
No. of firms	2676				

Panel B: NCF-sensitive group

Variables	Maximum	Mean	Median	Minimum	SD
Investment/K	0.6054	0.0597	0.0354	-0.3022	0.1929
Cash flow/K	2.2660	0.2734*	0.1550*	-1.2215	0.6912
Log sales	7.6132	3.3157*	3.4509*	-2.3026	1.9835
Accelerator/K	9.6799	0.8263	0.2063*	-4.8491	2.8580
Log age	4.7005	3.4252*	3.3322*	1.7918	0.5117
Short term debt/K	5.1653	0.8620*	0.3926	0.0000	1.2254
Long term debt/K	6.5322	0.8290	0.3508*	0.0000	1.2837
Slack/K	4.9954	0.6769	0.1443	0.0000	1.2317
Tangible assets/K	10.0478	2.4401	1.7047*	1.0659	1.9351
Dividend payout/K	0.3563	0.0493*	0.0000	0.0000	0.0988
Interest coverage	1.7925	-0.0040*	0.0000*	-2.0000	0.4273
Export Sensitivity	0.9336	0.1413	0.0017*	0.0000	0.2612
No. of observations	1534				
No. of firms	149				

Panel C: CF-insensitive group

Variables	Maximum	Mean	Median	Minimum	SD
Investment/K	0.6054	0.0899	0.0519	-0.3022	0.1476
Cash flow/K	2.2660	0.1278	0.1064	-1.2215	0.3317
Log sales	7.6132	3.5717	3.6836	-2.3026	1.8091
Accelerator/K	9.6799	0.4106	0.1689	-4.8491	1.4821
Log age	5.2204	3.3668	3.2581	0.6931	0.5065
Short term debt/K	5.1653	0.5507	0.3541	0.0000	0.7120
Long term debt/K	6.3844	0.5646	0.4036	0.0000	0.6936
Slack/K	4.9954	0.2001	0.0569	0.0000	0.5290
Tangible assets/K	10.0478	1.7197	1.4100	1.0659	1.0663
Dividend payout/K	0.3563	0.0185	0.0000	0.0000	0.0462
Interest coverage	1.7925	0.0321	0.0000	-2.0000	0.4323
Export Sensitivity	0.9336	0.1247	0.0075	0.0000	0.2243
No. of observations	20922				
No. of firms	2161				

Panel D: PCF-sensitive group

Variables	Maximum	Mean	Median	Minimum	SD
Investment/K	0.6054	0.1578	0.1103*#	-0.3022	0.2130
Cash flow/K	2.2660	0.2035*#	0.1621*#	-1.2215	0.5444
Log sales	7.6132	3.5563#	3.7046#	-2.3026	1.9608
Accelerator/K	9.6799	0.7174*	0.3071*#	-4.8491	2.1275
Log age	4.9904	3.3042*#	3.2581*#	2.0794	0.4773
Short term debt/K	5.1653	0.7492*	0.4636*	0.0000	0.9524
Long term debt/K	6.5167	0.8047*	0.5366*#	0.0000	0.9744
Slack/K	4.9954	0.4182	0.0877*#	0.0000	0.9371
Tangible assets/K	10.0478	2.1808*	1.6026*#	1.0659	1.7240
Dividend payout/K	0.3563	0.0289#	0.0000*#	0.0000	0.0629
Interest coverage	1.7925	0.0082*#	0.0000*	-2.0000	0.4509
Export Sensitivity	0.9336	0.1432*	0.0100*#	0.0000	0.2494
No. of observations	3493				
No. of firms	366				

Note: The table presents the descriptive statistics of variables for the complete sample and then for each ICFS groups. The variables are defined in section 2. * represents level of significance at 5% for difference from CF-insensitive firms. # represents level of significance at 5% for difference from NCF-sensitive firms.

There are significant differences between PCF-sensitive and NCF-firms too. The PCF-sensitive firms, on average, have higher operating income but have smaller cash flows, maturity, dividend payout and debt service burden. Overall, on account of high leverage and debt service burden, the NCF-sensitive firms are likely to be most constrained followed by PCF-sensitive firms. But, the same cannot be said by looking at other variables such as operating income and cash flows. Importantly, however, we can notice that ICFS is non-monotonic with respect to all considered variables except investment expenditure and maturity.

5. What drives the relationship between investment and cash flows for the three ICFS groups

To explore what drives the relationship between investment and cash flows for the three ICFS group, we estimate the following model:

$$\begin{aligned} Dependent\ Variable_{it} &= \alpha_1 * NCFsensitivity\ dummy_{it} + \alpha_2 * PCFsensitivity\ dummy_{it} \\ &+ \alpha_3 * CFinsensitive\ dummy_{it} + \alpha_4 * Age * NCFsensitivity\ dummy_{it} \\ &+ \alpha_5 * Age * PCFsensitivity\ dummy_{it} + \alpha_6 * Age * CFinsensitive\ dummy_{it} \\ &+ \varepsilon_{it} \end{aligned} \quad (5)$$

In Equation (5), the $Dependent\ Variable_{it}$ is investment or cash flow for firm *i* at time *t*, deflated by the beginning of period capital stock and ε_{it} is the error term. $NCFsensitivity\ dummy_{it}$ and $PCFsensitivity\ dummy_{it}$ and $CFinsensitive\ dummy_{it}$ are set to one if the firm is classified as NCF-sensitive, PCF-sensitive, or CF-insensitive, respectively. Age is number of years since the incorporation of the firm.

The estimation results are presented in the table 4. At start-up the NCF-sensitive firms have positively significant investment but negatively significant cash flows implying they are mainly financed by external sources. Moreover, this forms a pattern and drives the negative relationship between investment and cash flows for such firms since both the variables remain stationary with age. But, this is contrary to the experiences in the developed countries where such firms are found to have falling investment and rising cash flows with age [Hovakimian (2009)].

Table 4: Investment and cash flow of the three groups with age

	Dependent variable - Investment	Dependent variable - Cash flow
NCF- Sensitivity Dummy	0.1732*	-0.0446*
CF- Insensitivity Dummy	0.1812***	-0.0092
PCF- Sensitivity Dummy	0.2358***	0.3961***
Age* NCF- Sensitivity Dummy	0.0014	-0.0041
Age* CF- Insensitivity Dummy	-0.0007	0.0025*
Age* PCF- Sensitivity Dummy	-0.0017	-0.0031
Prob > F	0.0000	0.0000
Number of NCF-sensitive firms	149	
Number of CF-insensitive firms	2161	
Number of PCF-sensitive firms	366	

Note: This table presents the effect of age on investment and cash flow in the three group of firms based on their ICFS scores. ***, ** and * represent level of significance at 0.1% 1% and 5% respectively.

The estimates with CF-insensitive firms suggest that such firms start with high level of investment and an insignificant level of cash flows. With age, their investments remain stationary and the cash flows rise. This comes in support of an insignificant relationship between investment and cash flows for such firms. The estimates with PCF-sensitive firms suggest that such firms start with higher level of investment than the other two groups and their cash flow level is also higher. With age, their investments and cash flows both remain stationary. This comes in support of a positive relationship between investment and cash flows for such firms. However, if the pattern of investment and cash flows, as noted in the table 4, is driving the reputation of these two groups of firms in the credit market, it is less likely to interpret CF-insensitive and PCF-sensitive firms as financially unconstrained and financially constrained firm, respectively. It rather comes in support of Kaplan and Zingales (1997) finding that high ICFS is driven by managers' choice to rely primarily on internal cash flows to invest despite the availability of additional low cost external funds. It also comes in support of the growing literature which suggests that cash flow is noisy variable to represent only internal liquidity of firms, ignoring the information about growth opportunities contained in it [Gilchrist and Himmelberg (1995), Hovakimian and Titman (2006)].

5. Determinants of investment-cash flow sensitivity

In this section we investigate the propensity of firms being in any particular group compared to the other groups. First, we use a multinomial logistic regression to examine the factors

that are likely to influence firms in being classified as PCF-sensitive or NCF-sensitive to the base case of being CF-insensitive.[13] Next, we contrast between NCF-sensitive and PCF-sensitive firms by using a simple logistic regression. Since there are many unlisted firms in our sample, it has not been possible to get an estimate of the Tobin's *q* to represent their growth opportunities for all the firms. Therefore, we use sales accelerator to represent growth opportunities of firms. For a smaller sub-sample of firms that are listed we conduct the entire empirical exercise using the Tobin's *q* together with the sales accelerator.

5.1. Determinants of ICFS for complete sample of listed and unlisted firms

The results from the multinomial logistic regression are in table 5. The independent variables for the regressions are same as used in the regression in table 2. Contrasting the PCF-sensitive versus from CF-insensitive firm, it suggests that firms with higher cash flows, leverage, tangible assets, export sensitivity and firms with group affiliation are more likely to be PCF-sensitive than CF-insensitive. It also suggests that firms with higher maturity and debt service burden are less likely to be PCF-sensitive than CF-insensitive. If we interpret the PCF-sensitive firms as financially constrained and the CF-insensitive firms as financially unconstrained, some of these variables are contrary to the popular notion in the literature. Specifically, firms with higher cash flows, more tangibility, lower debt service burden and higher export sensitivity are argued as financially unconstrained in the literature which the results here find otherwise.

The second column of Table 5, contrasting between NCF-sensitive and CF-insensitive firms, suggests that the firms with higher maturity, dividend payout and firms with group affiliation are more likely to be NCF-sensitive than CF-insensitive. It also suggests that firms with higher cash flows and operating income are less likely to be NCF-sensitive than CF-insensitive. If we interpret the NCF-sensitive firms as distressed and the CF-insensitive firms as financially unconstrained, some of these variables are contrary to the popular notion in the literature. Specifically, firms with

[13] If the groups are to be interpreted based on financing constraints, the firms in the three groups may be competing for external funds. In an alternative scenario, there may be within group competition between firms for funds if the differences (say, on reputation of firms) are explicit to the credit market. These possibilities need an investigation of the assumption of independence of irrelevant alternative assumption (IIA). If this assumption is violated estimation would require an alternative specific multinomial logistic regression or an ordered logistic regression. We performed Hausman test and Small-Hsiao test to check for this. The tests could not reject IIA hypothesis. For details on these tests see MLOGTEST in STATA.

higher maturity and dividend payout are argued as financially unconstrained in the literature, which the results here find otherwise.

Table 5: Multinomial Logistic Regression (Full Sample)

Dependent variable: ICFS-dummy	PCF- Sensitive	NCF-Sensitive
Cash flow/K	0.0222***	-0.0267**
Log sales	-0.0076	-0.0753***
Accelerator/K	0.0012	0.0005
Log age	-0.2352***	0.2120***
Short term debt/K	0.0089*	0.0105
Long term debt/K	0.0085**	0.0014
Slack/K	-0.0027	0.0178
Tangible assets	0.0227***	-0.0032
Dividend payout/K	-0.0890	0.5364**
Interest coverage	-0.1438***	0.0156
Export sensitivity	0.0764*	0.0526
Group affiliation	0.1203**	0.2228***
Prob > chi^2	0.000	
Number of NCF-sensitive firms	149	
Number of CF-insensitive firms	2161	
Number of PCF-sensitive firms	366	

Note: This table presents the results of multinomial logistic regression with CF-insensitive firms as base group. Estimation is done with fixed firm effects, industry effects, time effects and robust standard errors. Variables are defined in section 2. ***, ** and * represent level of significance at 0.1% 1% and 5% respectively.

In order to explore whether there are significant differences between PCF-sensitive and NCF-sensitive firms, we estimate of a simple logistic regression. The results are presented in the table 6. It suggests that firms with higher cash flows, operating income and lower maturity, dividend payout and debt service burden are more likely to be PCF-sensitive than NCF-sensitive. If we interpret the NCF-sensitive firms as more financially constrained or distressed than the PCF-sensitive firms, some of these variables are contrary to the popular notion in the literature. Specifically, firms with higher maturity and dividend payout are argued as less financially constrained in the literature, which the results here find otherwise.

Table 6: Logistic Regression (Full Sample)

Dependent variable: ICFS-dummy	Coefficients
Cash flow/K	0.0538***
Log sales	0.0343*
Accelerator/K	-0.0002
Log age	-0.4139***
Short term debt/K	-0.0049
Long term debt/K	0.0073
Slack/K	-0.0235
Asset tangibility	0.0226
Dividend payout/K	-0.5302**
Interest coverage	-0.1600**
Export sensitivity	0.0655
Group Affiliation	-0.0558
Prob > chi^2	0.000
Number of NCF-sensitive firms	149
Number of PCF-sensitive firms	366

Note: This table presents the results of a simple logistic regression to investigate a firm's propensity to be classified as PCF-sensitive as opposed to NCF-sensitive. Estimation is done with fixed firm effects, industry effects, time effects and robust standard errors. Variables are defined in the section 2. ***, ** and * represent level of significance at 0.1% 1% and 5% respectively.

5.2. Determinants of ICFS groups for only listed firms

In this sub-section we use Tobin's *q* together with sales accelerator to represent growth opportunities of firms. This makes our results comparable to the existing literature which uses Tobin's *q* to represent growth opportunities of firms. We use the same method as we used earlier to divide firms into the three ICFS groups: NCF-sensitive, CF-insensitive and PCF-sensitive firms. We classify firms as PCF-sensitive if CFS is greater than 0.0457, NCF-sensitive if CFS is less than -0.0272 and as CF-insensitive if CFS lies between -0.0272 and 0.0457. Based on this classification 85 firms are classified as NCF-sensitive, 511 firms as CF-insensitive and 173 firms as PCF-sensitive.

Table 7 presents the results of the multinomial logistic regression to examine the factors that are likely to influence firms in being classified as PCF-sensitive or NCF-sensitive to the base case of being CF-insensitive. The results in the first column present the propensity of a firm to be in PCF-sensitive group against CF-insensitive group. It suggests that firms with higher operating income and growth opportunities as measured by Tobin's *q* are more likely to be PCF-sensitive than CF-insensitive. However, PCF-sensitive firms are likely to be less mature and have lower slack and debt service burden. The results on operating income and debt service burden is contrary to the

popular notion in the literature, if we interpret the PCF-sensitive firms as financially constrained and the CF-insensitive firms as financially unconstrained.

The results in the second column present the propensity of a firm to be in NCF-sensitive group against CF-insensitive group. It suggests that firms with firms with higher growth opportunities as measured by Tobin's *q*, higher dividend payout and lower maturity are more likely to be NCF-sensitive than CF-insensitive. The result on dividend payout is contrary to the popular notion in the literature, if we interpret the NCF-sensitive firms as distressed or most financially constrained and the CF-insensitive firms as financially unconstrained.

Table 7: Multinomial Logistic Regression (Only listed firms)

Dependent variable: ICFS-dummy	PCF- Sensitive	NCF-Sensitive
Cash flow/K	0.0291	-0.0042
Log sales	0.1118***	0.0023
Accelerator/K	-0.0023	0.0019
Tobin's *q*	0.1717**	0.2978***
Log age	-0.6108***	-0.5763***
Short term debt/K	0.0120	0.0122
Long term debt/K	0.0151	0.0039
Slack/K	-0.0651*	0.0102
Tangible assets/K	0.0042	0.0089
Dividend payout/K	0.0887	1.5805***
Interest coverage	-0.1398*	0.0010
Export sensitivity	0.1878*	-0.0468
Group affiliation	0.0758	0.1371
Prob > chi^2	0.000	
Number of NCF-sensitive firms	85	
Number of CF-insensitive firms	511	
Number of PCF-sensitive firms	173	

Note: This table presents the results of multinomial logistic regression with CF-insensitive firms as base group. Estimation is done with fixed firm effects, industry effects, time effects and robust standard errors. Variables are defined in section 2. ***, ** and * represent level of significance at 0.1% 1% and 5% respectively.

The results in the table 8, using a simple logistic regression, present the propensity of a firm to be PCF-sensitive against NCF-sensitive. It suggests that firms with higher operating income and lower dividend payout are more likely to be PCF-sensitive than NCF-sensitive. The result on dividend payout is contrary to the popular notion in the literature, if we interpret the PCF-sensitive firms as less financially constrained than the NCF-sensitive firms.

Table 8: Logistic Regression (only listed firms)

Dependent variable: ICFS-dummy	Coefficients
Cash flow/K	0.0304
Log sales	0.1149**
Accelerator/K	-0.0056
Tobin's *q*	-0.1446
Log age	-0.0592
Short term debt/K	0.0005
Long term debt/K	0.0166
Slack/K	-0.0618
Asset tangibility	-0.0169
Dividend payout/K	-1.1956***
Interest coverage	-0.1214
Export sensitivity	0.2713
Group Affiliation	-0.1245
Prob > chi^2	0.000
Number of NCF-sensitive firms	85
Number of PCF-sensitive firms	173

Note: This table presents the results of a simple logistic regression to investigate a firm's propensity to be classified as PCF-sensitive as opposed to NCF-sensitive. Estimation is done with fixed firm effects, industry effects, time effects and robust standard errors. Variables are defined in the section 2. ***, ** and * represent level of significance at 0.1% 1% and 5% respectively.

The overall results suggest that the interpretation of NCF-sensitive, PCF-sensitive and CF-insensitive as distressed, financially constrained and financially unconstrained, respectively, can be contested based on the signs of the coefficients. The possible reasons for this, as argued before, can be: first, if cash flow is used to measure internal liquidity of firms without accounting for the information contained in it about growth opportunities of firms, we may get biased results. Second, not allowing firms to change regime in the sample period is too restrictive because their regime may change with any new shock, positive or negative. Moreover, the assumption of monotonic pattern of ICFS with the sorting variable(s) is also contested by some of the variables.

7. Conclusion

An important debate in the literature relates to the use of investment-cash flow sensitivity to measure finance constraint faced by firms. This debate is mainly grounded on four issues: Firstly, a priori sorting of firms based on their likelihood of financing constraint which implicitly assumes a monotonic relationship of the sorting variable(s) with financing constraint. Secondly, the treatment

of distressed firms in the analysis of finance constraint faced by firms. Thirdly, the use of cash flow to represent only internal funds of firms, neglecting information contained in it about future growth opportunities of firms. Fourthly, not allowing firms to change regime in the sample period, which may potentially change with any new positive or negative shock is restrictive.

In order to explore these issues, this paper examines the determinants of investment-cash flow sensitivity without relying on ex ante classification of firms into distressed, constrained and unconstrained groups. We use firm level estimates of investment-cash flow sensitivity and use them to group firms into NCF-sensitive firms, CF-insensitive firms and, PCF-sensitive firms. This overall evidence suggests that, at start-up, the NCF-sensitive firms have positively significant investment but negatively significant cash flows implying they are mainly financed by external sources. Moreover, this negative relationship forms a pattern since both the variables remain stationary with age. The CF-insensitive firms start with high level of investment and an insignificant level of cash flows. But, their investments remain stationary and the cash flows rise with age. The PCF-sensitive firms start with higher level of investment than the other two groups and their cash flow level is also higher. But, their investments and cash flows both remain stationary with age. Further, we use a multinomial logistic regression model to study the determinants of ICFS in the three groups. The results suggest that the interpretation of NCF-sensitive, PCF-sensitive and CF-insensitive as distressed, financially constrained and financially unconstrained, respectively, can be contested by the data. We suspect that the possible reasons for this can be the aforementioned four criticisms.

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