Investment-Cash Flow Sensitivity and Financial Constraints–Evidences from British Firms

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Abstract

This paper investigates the relation between financial constraint and the sensitivity of investment to internal cash flow. The regressions are run by using a large panel of publicly traded non-financial British firms. The sample is sorted and divided into sub-samples by means of applying most objective and commonly used proxies of financing constraints including leverage and other proxies. Our result shows that investment cash flow sensitivity is neither monotonically increasing nor decreasing when the proxies change. The hypothesis of monotonicity is violated empirically in our study. Conversely, an M-shaped curve is observed when leverage is used as the proxy.

Keywords: Investment cash flow sensitivity; financing constraint; leverage; capital market imperfections

1 Introduction

Studies on the sensitivity of corporate investment to a firm's cash flow have been focused since last century. Econometrists want to know whether the investment expenditure of a firm is determined by the availability of its internal finance, and if it is, to what extent and how it is determined by the availability of its internal finance.

In traditional theories (MM theory) [13], external financing is considered to be a perfect substitute of internal financing. As the hypothesis of those traditional theories that the capital market is perfect does not hold in the real world, many literatures have pointed out that it is the imperfection of capital market that leads to the distinction between ways of financing. Pecking Order Theory (Stewart C. Myers in 1984)[15, 16] indicates that internal financing, including retained earnings, is considered to be a prior choice when finance is needed, while external financing including new shares issuing and debt issuing is the second choice, and debt issuing should be prior to shares issuing. Meanwhile, companies with different size and history may have different choices. Small firms without promising prospect may have larger difficulty on lending money from banks and issuing new shares than big firms, so they may be more willing to finance by retained earnings. Asymmetric information may be another explanation of the difference between internal finance and external finance. The essential factor that decides ways of financing is then considered to be the cash flow of the firm we are going to study, and the sensitivity of investments to cash flows depends on how much the firm needs such cash flows, i.e., to what extent the firm being studied is in financial constraint. Steven Fazzari, R. Glenn Hubbard [9], and Bruce C, Petersen (1988, FHP 1988 hereafter) [10] proposes that the investment-cash flow sensitivity is larger for firms that are more likely to face financing constraint, and many academicians follow his viewpoints. On the other hand, Kaplan and Zingales (1997, KZ 1997 hereafter) and Cleary (1999) [7] suggest an opposite opinion that this parameter should be lower for a more constrained company.

First, we notice that based on our data space, the regression of classic model of FHP (1988) [9] has a very small R-squared, which means there is only a very small part of changes in investment can be explained by Tobin's q and cash flow. For this reason, we plan to add some more variables into the regression, which can improve R-squared significantly to an acceptable level. This step can also obtain an estimate of investment-cash flow sensitivity which is more unbiased.

Second, there has been a lot of debate between FHP (1988) and KZ (1997), mostly focused on the criteria of ordering the proxies of financial constraint. But both sides argue that the monotonic relationship between investment-cash flow sensitivity and financial constraint.

Hence, whether the independent variables are able to explain the dependent variable and the ordering criteria are able to capture the extent of financial constraint are critical when analyzing the relationship. We have to notice that "financial constraint" is very difficult to be defined mathematically, which means measuring financial constraint by an observable financial magnitude is not so easy a thing. Although many proxies are used to measure financial constraint by former analysts, but none of them is free of criticism. So in this paper, we plan to add more variable hoping to explain the dependent variable better and use more criteria based on the same sample space. We do this to try to find common peculiarity of investment-cash flow sensitivity across different ordering criteria. If the monotonic relationship between sensitivities is empirically violated, we believe that the monotonicity condition can be

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doubted.

This paper is organized as follow. Section 2 is a review of important literatures about this topic. In section 3, theoretical framework and methodology are narrated. Section 4 is the description of the data we use. Section 5 is result and interpretation. Section 6 is the robustness analysis. Finally, section 7 represents the conclusion of this paper.

2 Literature Review

Modigliani and Miller (1958) [13] prove the irrelevance of the investment decision of a firm for the firm's capital structure under an extreme condition of perfection and completion of capital markets. When taxation and transaction costs are incorporated (trade-off model), there is an optimal leverage for the firm by balancing the costs and benefits of an additional pound of debt. Myers (1984) proposes another model that is the Pecking Order theory which argues that, considering the transaction costs associated with new shares issuing and the costs from agency problem and other asymmetric information problems, firms finance new investments first with retained earnings, then with safe debt, then with risky debt, and finally with new shares.

Some studies, however, find that the sensitivity of investment to cash flow is higher for firms that are in an economic environment of more capital imperfection. Literature in this area begins with the study of FHP (1988), who uses Value Line data for 422 large U.S. manufacturing firms over the 1970 to 1984 time period to analyze differences in investment behavior using a criterion of retained earnings. They work within the Tobin's q theory of investment, which has been used extensively in empirical studies and for tax policy evaluation. First, they build a model suggesting that, in an individual firm, there is a linear relationship between investment, Tobin's q, and cash flow. The parameter of cash flow is then considered to be the investment-cash flow sensitivity. After that, they divide their data into groups by using a particular criterion that is using another observable magnitude to measure financial constraint. In their paper, they choose dividend as the proxy. When a firm paid relatively high dividends, the firm could finance its investment by reducing its dividends. On the other hand, if the firm paid low dividends, the firm should rely on external sources of finance which were relatively costly. The estimates of the investment-cash flow sensitivities of different groups are then compared across such subspaces. They conclude that financial factors such as the availability of the relatively cheap internal funds do play an important role in determining investments of the firms, and firms with more severe financial constraints rely more on internal financing. They make an empirical investigation of financing constraints and investment given that marginal q equals to unity. In that famous paper, the authors believe that firms with lower dividend payout ratios are more likely to be liquidity constrained, and the result of FHP (1988) argues that investment decisions of firms with lower dividend payout ratios are more sensitive to changes in cash flows than the other.

The same methodology of FHP (1988) is followed by some further studies, and they confirm FHP (1988) conclusion. Hoshi, Kashyap and Scharfstein (1991) [12] conclude that firms that are members of a large industrial group will show lower investment-cash flow sensitivity. Oliner and Rudebusch (1992) [17] conclude that investment-cash flow sensitivities of young firms whose stocks are traded over-the-counter, are relatively higher. Schaller (1993)[20] studies 212 Canadian firms over the 1973 to 1986 period, and concludes that investment for young, independent, and manufacturing firms with dispersed ownership concentration is more sensitive to cash flow than other firms. Mayer (1990) studies the sources of industry finance of eight developed countries over the period from 1970 to 1985, and he concludes that: first, retentions are the dominant source of financing in all countries; second, the average firm in any of these countries does not raise substantial amounts of financing from security markets in the form of short-term securities, bonds, or equities; and third, the majority of external financing comes from bank loans in all countries.

Some other papers, such as Whited (1992) [25], employ an Euler equation approach to test the first-order condition of an intertemporal maximization problem, in which methodology the measurement of Tobin's q is no longer needed. Imposing an exogenous constraint on external financing, the author tests whether financial constraint is binding for a particular group of firms, and concludes a positive answer, which supports FHP (1988) results.

With a similar approach, however, Kaplan and Luigi Zingales come up with an opposite view that the classification applied by FHP (1988) tends to assign firms incorrectly. They argue that there is no theoretical reasoning that the investment-cash flow sensitivity has a monotonically positive relationship with financing constraints. Their paper investigates the relation between investment-cash flow sensitivities and financial constraints by undertaking high sensitivity of investment to cash flow. In their sample, 49 firms are used, which are identified in FHP (1988) as firms with financial constraints according to the investment-cash flow criterion, and the size of the firms is also used as the criterion to measure the degree of financial constraint. They find that in only 15 percent of firm-years is there some question as to a firm's ability to access internal or external funds to increase investment, while in 85 percent of firm-years the firms were capable to increase their investment if they had so chosen. Those firms classified as less financially constrained exhibit significantly greater investment-cash flow sensitivity than those firms classified as more financially constrained. They attribute the differences between KZ (1998) and FHP (1988) to the different definitions of Q. The FHP (1988) measure is constructed with an average stock price in the previous year rather than the stock price at the beginning of the year while KZ suspect that their measure of Q provides better information about investment opportunities. Their conclusion is that the high sensitivity of investment to cash flow is not related to financially constrained firms in the sample they choose.

Cleary (1999) [6, 7] supports the small sample evidence as well. He finds that the most constrained companies have the lowest sensitivity by examining a large and heterogeneous sample of 1,317 US firms for the period 1987 to 1994, where the author divide the sample into three groups: firms with increasing dividends and being considered to be more likely not financially constrained;

firms cutting dividends and being considered to be likely financially constrained, and firms not changing dividends. Allayannis and Mozumdar (2001) [1, 3] suggest that the findings of Kaplan and Zingales (1997) can be explained by a few influential observations whereas the results of Cleary (1999) can be explained by observations of firms with negative cash flows.

Kaplan and Zingales (1997) and Cleary (1999) send us an important message that for firms under financial distress the cash flow sensitivity might be reduced, because the budget is no longer as flexible as before when the firms were not in financial constraint. Cleary (2004) argues that a firm's investment is a U-shaped function of its internal funds. In particular, for sufficiently low levels of internal funds, a further decrease leads to an increase in the firm's investment. Iona, Leonida and Ozkan (2006) observe an inverse U-shaped relationship.

Besides what we have mentioned, many other papers use investment-cash flow sensitivity as a measure of financing constraints, such as Bond (1994) [3], Bharat (2009) [4], Bettoni (2000) [5], Giannetti and Himmelberg (2002) [11], Mizen and Vermulen (2004), Pawlina and Renneborg (2004) [18], and Almeida and Campello (2004) [2].

3. Theoretical Framework and Methodology

Since the hypothesis seldom holds in real life, many economic magnitudes like taxation and transaction costs are hardly neglectable. MM theorem is challenged by many theoretical and empirical studies. Many literatures indicate that small firms have more limited access than large firms in raising external funds. Srini Vasan (1986) studies the differences in the reliance on internal and external finance across firms, and he finds that small and medium-sized manufacturing corporations are very dependent on internal finance. Taxation may be one explanation for the differences, as in corporate finance, dividend payment, interest payment and retained earnings are taxed at different levels. Dividend payment is taxed more heavily than capital gains, and sometimes interest payment is tax-deductable. This means retained earnings (internal finance) has its edge on taxation. Taxation alone leads to a financing hierarchy with a discontinuity between the effective costs of internal and external finance. (FHP, 1988) On the other hand, transaction costs also make sense in explaining the differences; it may augment or weaken the edge of internal finance depending on firms themselves.

In addition, agency problem cannot be ignored because the management and ownership are separated in most firms. Managers act on the interest of shareholders and sometimes themselves.

Asymmetric information is also an important theory in explaining the sensitivity of investment to cash flow. Important recent papers by Myers and Majluf (1984) [16] and Greenwald, Stiglitz, and Weiss (1984) explain why asymmetric information either eliminates any reliance on external finance in the market or causes suppliers of new equity to demand a large premium. In the model of Stiglitz and Weiss (1981) [21], borrowers have private information about the riskiness of their project returns, and lenders cannot necessarily discriminate "good borrowers" and "bad borrowers". Under this situation, adverse selection comes across and higher interest rate will be offered and higher probability of default will be borne by lenders. Calomiris and Hubbard (1986) also show that when multiple credit markets exist side by side, aggregate shocks to collateral value or cash flow make credit restrictions more likely to borrowers that rely only on bank markets. Degryse and Jong (2006) suggest that investment is positively sensitive to cash flow regardless of the firm's prospect. However, the sensitivity is more significant in those firms with lower value of Tobin's q, with an intuitive implication that agency problem may be a more sensible explanation.

There is a lot of debate about the viewpoints of FHP (1988) and KZ (1999). None of them including that followers are free from being criticized as there classification and ordering criteria are doubtable. On the one hand "financial constraint" is difficult to be defined mathematically, thus we have to find other magnitude to measure the status of financial constraint known as proxies, and furthermore, there is no single criterion to measure that to what extent a company is in constraint financially, so we are not sure of even the existence of an effective proxy of financial constraint. Even if the effective proxy of financial constraint does exist, there is only one thing that we are sure of, that is, this variable must be influenced not only by investment-cash flow sensitivity, but also by some other economic magnitudes. For example, cash flow can affect investment decision, but conversely, investment decision can affect cash flow in the future. If a firm has more retention, this may be because this firm is in better financial status, or because this firm has no better investment. In the FHP (1988) model, they consider Tobin's q and cash flow to be independent variable, but these two economic magnitudes can affect each other in a subtle way. In fact, it is the unknown causality between economic magnitudes either measureable or unmeasured that produces debate. Up to now what economists can do is try to find some at least plausible relationship between financial constraint and investment-cash flow sensitivity. This is why we plan to use some other data and order the data by different criteria.

FHP (1988) and KZ (1997) suggest different viewpoints, but they both believe that the relationship between financial constraint and investment-cash flow sensitivity is monotonic, which means theoretically, the sensitivity should be a function of financial constraint or its proxy, with first derivative equal to zero.

Tobin's q is a ratio comparing the value of a company given by financial markets with the value of a company's assets. The ratio was developed by James Tobin (Tobin 1969). It is calculated by dividing the market value of a company by the replacement value of its assets: Tobin's q = market value/total asset.

We start analysis from the most commonly used model of FHP (1988),

$$\left(\frac{I}{K}\right)_{it} = \beta_1 Q_{it} + \beta_2 \left(\frac{CF}{K}\right)_{it} + \varepsilon_{it} \tag{1}$$

Where, I is investment, K is the replacement value of the capital stock at the beginning of the period, and $\left(\frac{I}{K}\right)_{it}$ is investment ratio for firm i at time t. Q is the value of Tobin's q, which is market to book. CF represents cash flow of firm i at the beginning of period t. β_1 and β_2 are

coefficients of Q and $\left(\frac{CF}{K}\right)_{it}$ respectively. Finally, ε_{it} is a white noise terms.

One may argue that, other business cycles are all firms fixed effects, and can affect investment ratio. In this case, some extra variables are also considered in this paper, including leverage, dividend, tangible asset ratio, sale, sector dummies and year dummies. The main regression equation is as follow:

$$\left(\frac{I}{K}\right)_{it} = \beta_1\left(\frac{CF}{K}\right)_{it} + \beta_2 X_j + \varepsilon_{it} \quad (2)$$

Where, X includes Tobin's q, leverage, dividend payout ratio, tangible asset ratio, and logarithm of sale. Tobin's q is used in the classic model; leverage is used because total debt is an important index of the firm's default risk, and thus should be taken into account when investment decisions are made; tangible asset ratio captures the composition of a company,

In fact, many variables that can affect the investment ratio are not observable, but they may have significant influence on the dependent variable. For example, a company in London will never have exactly the same investment policy if it were a company that is located in Manchester. We are not able to measure the locations mathematically. Some of them have something in common, that is, they are fixed through time. Although these variables affect dependent variable substantially, they do not change over time. Hence, we use within group estimation to eliminate the fixed effect, in order to obtain more unbiased estimate of sensitivity.

After that, we are going to divide the data into 10 groups according to different proxy criteria, from which an approximate relationship between financial constraint and investment-cash flow sensitivity will be shown. The fact is that no criteria that are commonly used can be considered as a perfect proxy, which is free from criticism, so we want to use those criteria together, and hope to find some common peculiarity among them. If most of them show monotonic relationship, we then cannot reject the null hypothesis of monotonic relationship; otherwise, the monotonic relationship should be doubted.

Ordering by the leverage of financial constraints of firm individually, 1196 firms in this paper are divided into 10 groups proportionally. The order of different firms follows the average value of the proxy. The leverage ratio, for example, will generate a mean value, and firms will be ordered according to this mean value. The other proxies we are going to take into account are cash holdings, asset, liquid asset, dividend payout ratio, tangible asset ratio, sale, long-term leverage, and profit.

Leverage is commonly used to measure financial constraint of a firm, if the leverage of a firm is very high, it would be rather difficult for this firm to raise money from external channels. Conversely, if a firm of the same type has a relatively lower leverage, external financing could be much easier, as the default risk of this firm is much lower than the firm with high leverage. Cash holding, asset size, liquid asset can also be used as a proxy of financial constraint, because a firm with high cash holding or other form of liquid asset can deal with unexpected events much easier, and thus in lower level of financial constraint. We add tangible asset ratio into the regression because it reflect the type of a company to some extent. For example, large hotels will commonly have high leverage, but high-tech companies usually have low leverage, this is because debt holder lose much smaller amount of money if he lend the money to a firm with high tangible asset when liquidation. In addition, profits can reflect a firm's ability and confidence for earning future cash flow, which influence the investment decision substantially.

4 Data description

We use unbalanced panel data of 1,196 nonfinancial UK firms ranging from 1984 to 2002 to test the significance of financial constraints in explaining investment. In this data, we use standard accounting variables. All financial variables are for the end of the fiscal year. We measure leverage as total debt, cash flow as pre-tax profit plus depreciation, and investment as capital expenditures. All the variables in this paper, including dividends, are normalized by total assets, apart from the market-to-book ratio, which has already been measured as the ratio of book value of total assets minus the book value of equity plus the market value of equity to book value of assets. Finally, we use total assets to proxy for the size of the firms.

TABLE 1 Summary Statistics for Total Sample

Variable	Observations	Mean	Std. Dev.	Min	Max
Investment	14630	0.0821239	0.0841656	0	1.15954
Q	14638	1.628687	1.18519	0.1882875	9.8942
Cash flow	14638	0.0685927	0.1677075	-2	2
Leverage	14638	0.1788819	0.1504841	0	1
Dividend	14638	0.0900117	3.528197	-362	1.119762
Tangible asset	14638	0.5697667	0.3947482	0	25.625
Asset	14638	10.82014	1.940567	1.277842	18.44716
Liquid asset	14638	0.0324287	0.6218463	-42.5	0.605284
Profit	14575	0.1841991	2.495124	-230.7288	111.0714
Sale	14615	10.92712	2.003879	-0.303424	18.09492

We measure the degree of financial constraints mainly by taking into account the firm's leverage, because if the leverage of a firm is high, the capacity of raising money from external sources. Therefore, average dividend payout ratio is the criterion to divide firms into groups. All of the firms in this sample are publicly traded in the market, and they are taken from various sectors (sector codes between 1 and 200). Time horizons are in the range from 7 to 15 years, as neither too short a time horizon, nor too long a time horizon we need. If the time horizon is too short, the period may not be long enough to obtain an adequate time-series variation; if the period is too long, financial constraints may be unapparent as long lived firms may recover from constraints in the long run, and thus reducing the level of the relationship between sensitivity and financial constraints.

5 Empirical result Description

The table below reports descriptive statistics on the main financial variables used in the main regression. Hereafter, OLS1 represents the classic analysis of FHP based on UK firms' data. OLS2 add some more variables in the regression, and finally we eliminate the fixed effect in the third column.

The number above in each row is the estimate of the coefficient of each variable with the standard error in brackets below. The R-squared increases significantly after independent variables added, which means adding them into the regression is not a bad thing, most of the estimates are significant at 1% level.

TABLE 2. Result of the main regression

	OLS1	OLS2	FIXED EFFECT
Cash flow	0.0459*** [0.0041]	0.0482*** [0.0088]	0.0197*** [0.0043]
Q	0.0057*** [0.0006]	0.0074*** [0.0011]	0.0054*** [0.0007]
Leverage		0.0390*** [0.0074]	0.0074 [0.0057]
Dividend		-0.0011** [0.0004]	-0.0009*** [0.0002]
Tangible1		0.0541*** [0.0173]	0.0144*** [0.0022]
Sale		-0.0015*** [0.0004]	-0.0007 [0.0010]
Constant	0.0697*** [0.0012]	0.0437*** [0.0110]	0.0864*** [0.0117]
R-squared	0.014	0.158	0.073
F statistic	105.332	43.06857	43.69535
No. observations	14630	14609	14609

* p<0.10, ** p<0.05, *** p<0.01

We then class the data into 10 groups by their average leverage. In each group, we use the same way to estimate the investment-cash flow sensitivity.

TABLE 3. result from the first group

	OLS1	OLS2	FIXED EFFECT
Cash flow	0.0465*** [0.0111]	0.0284* [0.0156]	0.0186 [0.0139]
Market to book	0.0063*** [0.0011]	0.0099*** [0.0011]	0.0051*** [0.0013]
Leverage		0.2524*** [0.0713]	0.2293*** [0.0447]
Dividend		-0.0037 [0.0024]	0.0006 [0.0029]
Tangible asset		0.1015*** [0.0085]	0.0607*** [0.0131]
Log of sale		-0.0031* [0.0017]	-0.0062* [0.0033]
Constant	0.0521*** [0.0033]	0.0057 [0.0246]	0.0926*** [0.0337]
R-squared	0.032	0.274	0.099
F statistic	21.65558	12.79517	5.406685
No. observations	1325	1325	1325

* p<0.10, ** p<0.05, *** p<0.01

Table 3 provides the first sub-sample including 120 firms with the first lowest mean leverage.

Table 4 provides the first sub-sample including 120 firms with the second lowest mean leverage.

TABLE 4. result of the second group

	OLS1	OLS2	FIXED EFFECT
Cash flow	0.0129 [0.0104]	-0.0073 [0.0200]	-0.0289 [0.0114]
Market to book	0.0066*** [0.0013]	0.0090*** [0.0017]	0.0078*** [0.0014]
Leverage		0.0494** [0.0227]	0.032 [0.0253]
Dividend		0 [0.0001]	-0.0001 [0.0003]
Tangible asset		0.0988*** [0.0059]	0.0907*** [0.0102]
Log of sale		-0.0035*** [0.0013]	0.0039 [0.0028]
Constant	0.0559*** [0.0030]	0.0927* [0.0491]	-0.0059 [0.0300]
R-squared	0.021	0.334	0.165
F statistic	14.72453	19.06734	10.36114
No. observations	1402	1399	1399

* p<0.10, ** p<0.05, *** p<0.01

Table 5 provides the first sub-sample including 120 firms with the third lowest mean leverage.

TABLE 5. result of the third group

	OLS1	OLS2	FIXED EFFECT
Cash flow	0.0631*** [0.0098]	0.0458*** [0.0093]	0.0309*** [0.0092]
Market to book	0.0067*** [0.0015]	0.0110*** [0.0017]	0.0058*** [0.0017]
Leverage		0.0415** [0.0188]	0.0490*** [0.0168]
Dividend		0.0002 [0.0018]	-0.0003 [0.0031]
Tangible asset		0.0973*** [0.0062]	0.0556*** [0.0094]
Log of sale		-0.0023** [0.0011]	-0.0036 [0.0024]
Constant	0.0550*** [0.0030]	-0.0317 [0.0273]	0.0519* [0.0287]
R-squared	0.044	0.309	0.12
F statistic	34.45691	14.75417	7.618467
No. observations	1487	1485	1485

* p<0.10, ** p<0.05, *** p<0.01

Table 6 provides the first sub-sample including 120 firms with the fourth lowest mean leverage.

TABLE 6. result of the fourth group

	OLS1	OLS2	FIXED EFFECT
Cash flow	0.0797*** [0.0108]	0.0472*** [0.0175]	0.0322*** [0.0119]
Market book	0.0107*** [0.0013]	0.0104*** [0.0016]	0.0087*** [0.0016]
Leverage		0.0420** [0.0196]	0.0486*** [0.0148]
Dividend		-0.0064*** [0.0019]	-0.0043* [0.0025]
Tangible asset		0.0643*** [0.0071]	0.0317*** [0.0095]
Log of sale		-0.0003 [0.0009]	-0.0078*** [0.0025]
Constant	0.0464*** [0.0026]	-0.0026 [0.0136]	0.0886*** [0.0318]
R-squared	0.083	0.297	0.156
F statistic	68.03184	19.07102	10.51657
No. observations	1506	1506	1506

* p<0.10, ** p<0.05, *** p<0.01

Table 7 provides the first sub-sample including 120 firms with the fifth lowest mean leverage.

TABLE 7. result of the fifth group

	OLS1	OLS2	FIXED EFFECT
Cash flow	0.0112 [0.0139]	-0.0019 [0.0260]	0.0073 [0.0132]
Market to book	0.0076*** [0.0020]	0.0095*** [0.0021]	0.0098*** [0.0025]
Leverage		0.0353 [0.0272]	0.0263 [0.0206]
Dividend		-0.002 [0.0021]	0.0016 [0.0033]
Tangible asset		0.1281***	0.1477***

		[0.0116]	[0.0114]
Log of sale		-0.0036*** [0.0014]	0.0004 [0.0032]
Constant	0.0759*** [0.0041]	0.0336 [0.0243]	0.0066 [0.0369]
R-squared	0.01	0.266	0.178
F statistic	7.435927	16.41672	12.46499
No. observations	1523	1522	1522

* p<0.10, ** p<0.05, *** p<0.01

Table 8 provides the first sub-sample including 120 firms with the sixth lowest mean leverage.

TABLE 8. result of the sixth group

	OLS1	OLS2	FIXED EFFECT
Cash flow	0.0592*** [0.0149]	0.0252 [0.0159]	0.0051 [0.0154]
Market to book	0.0071*** [0.0018]	0.0074*** [0.0022]	0.0024 [0.0024]
Leverage		0.0423** [0.0200]	0.0417** [0.0167]
Dividend		0.0004 [0.0003]	0.0007 [0.0007]
Tangible asset		0.0758*** [0.0072]	0.0619*** [0.0109]
Log of sale		-0.0003 [0.0011]	0.0012 [0.0035]
Constant	0.0637*** [0.0034]	0.0221 [0.0216]	-0.0037 [0.0430]
R-squared	0.022	0.237	0.113
F statistic	17.11958	13.98479	7.435863
No. observations	1544	1543	1543

* p<0.10, ** p<0.05, *** p<0.01

Table 9 provides the first sub-sample including 120 firms with the seventh lowest mean leverage.

TABLE 9. result of the seventh group

	OLS1	OLS2	FIXED EFFECT
Cash flow	0.0823*** [0.0136]	0.0449** [0.0188]	0.0169 [0.0130]
Market to book	0.0202*** [0.0025]	0.0230*** [0.0043]	0.0248*** [0.0028]
Leverage		0.0245 [0.0207]	0.0158 [0.0151]
Dividend		0.0019 [0.0051]	-0.0003 [0.0047]
Tangible asset		0.0813*** [0.0064]	0.0503*** [0.0101]
Log of sale		-0.0026** [0.0011]	0.0017 [0.0023]
Constant	0.0503*** [0.0040]	0.0001 [0.0165]	-0.0189 [0.0310]
R-squared	0.068	0.253	0.147
F statistic	57.53974	13.24759	10.30539
No. observations	1575	1574	1574

* p<0.10, ** p<0.05, *** p<0.01

Table 10 provides the first sub-sample including 120 firms with the eighth lowest mean leverage.

TABLE 10. result of the eighth group

	OLS1	OLS2	FIXED EFFECT
Cash flow	0.1043*** [0.0149]	0.0807*** [0.0176]	0.0483*** [0.0159]
Market to book	0.0091*** [0.0023]	0.0108*** [0.0027]	0.0127*** [0.0028]
Leverage		0.024 [0.0191]	0.0296* [0.0170]
dividend		0.0006*** [0.0002]	0.0004 [0.0008]
Tangible asset		0.0820*** [0.0072]	0.0239** [0.0110]
Log of sale		-0.0028** [0.0014]	-0.0011 [0.0031]
Constant	0.0723*** [0.0044]	0.0858** [0.0360]	0.0880** [0.0371]
R-squared	0.035	0.265	0.156
F statistic	27.6366	14.92547	10.50903
No. observations	1511	1510	1510

* p<0.10, ** p<0.05, *** p<0.01

Table 11 provides the first sub-sample including 120 firms with the ninth lowest mean leverage.

TABLE 11. result of the ninth group

	OLS1	OLS2	FIXED EFFECT
Cash flow	0.0593*** [0.0154]	0.0645*** [0.0225]	0.0385** [0.0171]
Market to book	0.0080*** [0.0025]	0.0097*** [0.0027]	0.0102*** [0.0031]
Leverage		0.0014 [0.0231]	0.0094 [0.0184]
Dividend		-0.0064** [0.0027]	-0.007 [0.0046]
Tangible asset		0.0448*** [0.0122]	-0.0177 [0.0108]
Log of sale		-0.0021 [0.0017]	-0.0080* [0.0041]
Constant	0.0758*** [0.0046]	0.0801*** [0.0267]	0.2081*** [0.0488]
R-squared	0.016	0.138	0.1
F statistic	11.54176	6.944849	6.027295
No. observations	1451	1451	1451

* p<0.10, ** p<0.05, *** p<0.01

Table 12 provides the first sub-sample including 116 firms with the highest mean leverage.

TABLE 12. result of the tenth group

	OLS1	OLS2	FIXED EFFECT
Cash flow	0.0381*** [0.0146]	0.0364*** [0.0123]	0.0222 [0.0145]
Market to book	-0.0042 [0.0027]	-0.0027 [0.0025]	-0.0022 [0.0033]
Leverage		-0.0264 [0.0196]	-0.0438** [0.0191]
Dividend		-0.0012*** [0.0002]	-0.0012*** [0.0003]
Tangible asset		0.0149* [0.0088]	0.0044 [0.0048]
Log of sale		-0.0021 [0.0020]	-0.0008 [0.0045]
Constant	0.1128*** [0.0061]	0.0698* [0.0412]	0.1137 [0.0698]
R-squared	0.008	0.153	0.067
F statistic	5.482018	11.67914	3.466088
No. observations	1306	1294	1294

* p<0.10, ** p<0.05, *** p<0.01

The figure below provides a summary of the above analysis on the relationship between leverage and investment-cash flow sensitivity, and a non-monotonic behavior is shown.

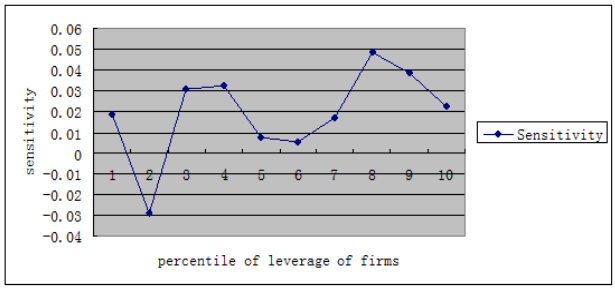

FIGURE 1 summary of the results

Although a negative parameter appears in the second row, the estimates are generally positive as what we have, and it is not significant at least at 10% level. If we ignore the

insignificant negative estimate, the general trend of the relationship between financial constraint and investment-cash flow sensitivity shows an 'M'-shaped curve. This might be explained as follow. Firms with very low leverage are likely to be the firms that holding debt is very expensive to them, like those high-tech companies. They usually keep very low leverage. On the other side, Firms with very high leverage are likely to be the firms that have a lot of realty which means lenders are more willing to hold debt of this kind of firms. Firms with either high or low leverage indicate that they are of single type, and have channels of investment that are relatively simple. Their sensitivities are relatively high, because when the firms' sector is influenced as a whole in the economy, their investments would be influenced in the same direction, which means the investment decisions are very sensitive to cash flows. To be compared, those comprehensive firms have relatively intermediate leverage, and have more complex channels of investments; hence, the influence caused by the cash flow should be smaller.

Further, if we divide the curve into two in the middle, two inverse U-shaped curves would be obtained. This step means that we divide all the nonfinancial firms into two groups. For firms with leverage lower than 0.5, 0.45 might be a high number, indicating that this firm is likely to be in financial constraint. Conversely, for firms with high leverage, 0.55 might be a low leverage.

The two U-shaped curves indicate that for each kind of firms, the sensitivities are low either if they are extremely constrained or in extremely unconstrained. If a company is operated healthily, the management will have no motivation to change their investment decision. On the other hand, if the company is operated badly and is close to bankruptcy, the manager will have not many choices as the poor situation of his company so that the sensitivity is low as well. For the firms with neither too high nor too low leverage, the investment decisions are made rather more flexible than others. Managers whose companies are not likely to be financially constrained are more aggressive when investing funds. This finding is consistent with Iona, Leonida and Ozkan (2006), who suggest an inverse "U-shaped" relationship between the sensitivity of investment to cash flow and the extent of financing constraints. In their paper, leverage is believed to be a poor proxy of financial constraint. I think this is because a certain degree of leverage may be very low for companies with high real estate, but may be very high for companies with high intangible assets like some high-tech companies. If leverage is taken into account, companies should be split into two groups, and the conclusion would be consistent with Iona et al (2006)

From the above analysis, although we give the implication that why we can hardly find any monotonic relationship between leverage and investment-cash flow sensitivity, it is still necessary to run the regression by using other proxies the test the robustness.

6 Robustness analysis

As a robustness analysis, we order the data by other proxies and obtain the corresponding coefficients of cash flow as well. From this table, we can not find apparent monotonic changes when proxies are changing, furthermore, the values of sensitivity are generally relatively low, while the peak values appear when the financial constraint proxies are at intermediate levels. This result can also reject the null hypothesis of monotonicity condition, which is consistent with what we have analyzed according to leverage above.

TABLE 13 monotonicity condition test

Group	Cash holding	Log of asset	Liquidity asset	Dividend
1	0.0470*** [0.0172]	-0.0067 [0.0088]	0.0041 [0.0138]	-0.0148 [0.0142]
2	0.0683*** [0.0201]	0.0024 [0.0133]	-0.0192 [0.0171]	0.0035 [0.0110]
3	0.0309* [0.0184]	0.0151 [0.0147]	0.0059 [0.0143]	0.0096 [0.0113]
4	0.0208 [0.0193]	0.0120 [0.0147]	0.0666*** [0.0163]	0.0329* [0.0185]
5	0.0702*** [0.0173]	0.0398** [0.0156]	0.0356*** [0.0137]	0.0905*** [0.0174]
6	0.0558*** [0.0148]	0.0701*** [0.0217]	0.0140 [0.0147]	0.0556*** [0.0188]
7	0.0384*** [0.0112]	0.0498*** [0.0169]	-0.0007 [0.0109]	0.0021 [0.0176]
8	0.0219** [0.0099]	0.0920*** [0.0233]	0.0213** [0.0108]	0.0296* [0.0170]
9	0.0086 [0.0118]	0.0199 [0.0174]	0.0342** [0.0148]	0.0414** [0.0186]
10	-0.0327*** [0.0090]	-0.0116 [0.0212]	0.0289*** [0.0094]	0.0140 [0.0217]

* p<0.10, ** p<0.05, *** p<0.01

TABLE 14. monotonicity condition test (Continued)

Group	Tangible asset	Log of sale	Long leverage	profit
1	0.0110 [0.0068]	-0.0009 [0.0127]	0.0280** [0.0120]	-0.0090 [0.0107]
2	0.0033 [0.0078]	0.0185 [0.0140]	-0.0006 [0.0103]	0.0224 [0.0160]
3	0.0146** [0.0069]	0.0109 [0.0129]	-0.0024 [0.0100]	0.0235 [0.0155]
4	0.0263** [0.0127]	0.0509*** [0.0155]	0.0085 [0.0125]	0.0239 [0.0230]
5	0.0115 [0.0129]	0.0183 [0.0162]	0.0403*** [0.0126]	0.0296 [0.0200]
6	-0.0177 [0.0150]	0.0132 [0.0127]	0.0180 [0.0110]	0.0129 [0.0184]
7	0.1015*** [0.0189]	0.0552*** [0.0171]	0.0369* [0.0192]	0.0054 [0.0271]
8	0.0479** [0.0215]	0.0549*** [0.0183]	0.0350* [0.0179]	0.0269 [0.0290]
9	0.0209 [0.0225]	-0.0072 [0.0174]	0.0167 [0.0166]	0.1006*** [0.0194]
10	0.0352 [0.0223]	0.0114 [0.0177]	0.0205 [0.0172]	0.0193* [0.0101]

* p<0.10, ** p<0.05, *** p<0.01

There are some negative estimates coming out in our results from figure 2 to figure 8. One thing that has to be noticed is that most of them appear at extreme values, and this phenomenon may be explained to be a conservative policy a company may choose when they in extreme constraint or in extreme unconstraint.

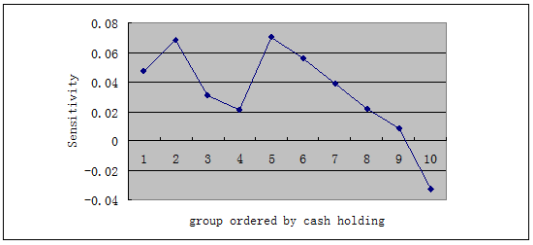

FIGURE 2 Sensitivity of group ordered by cash holding

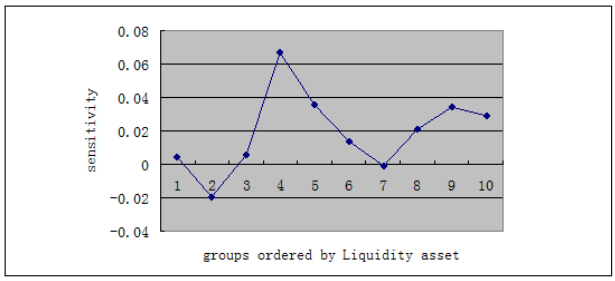

FIGURE 3 Sensitivity of group ordered by liquidity asset

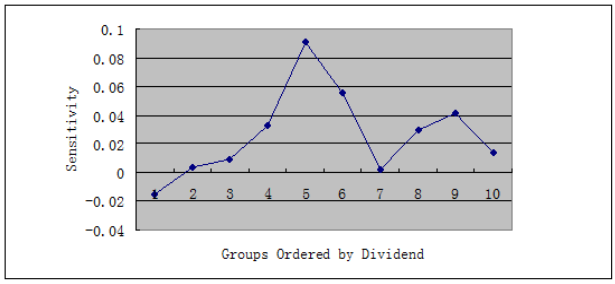

FIGURE 4 Sensitivity of group ordered by dividend

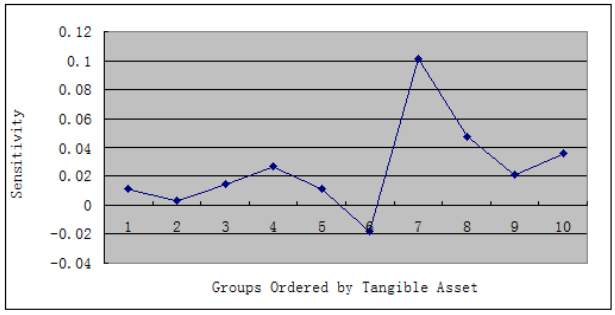

FIGURE 5 Sensitivity of group ordered by tangible asset

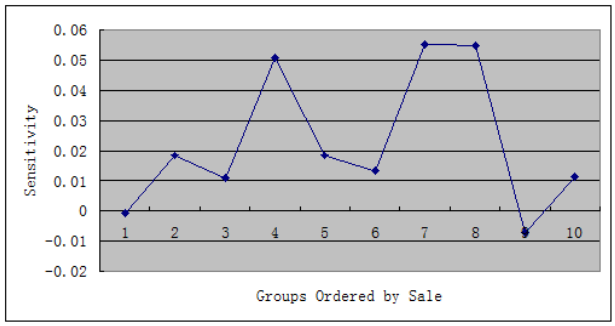

FIGURE 6 Sensitivity of group ordered by sale

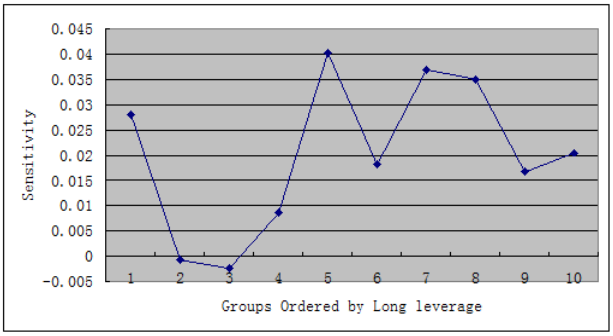

FIGURE 7 Sensitivity of group ordered by long leverage

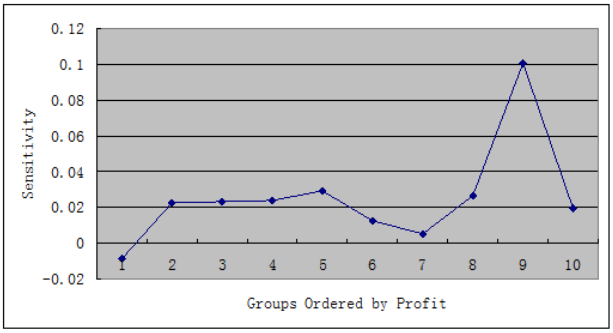

FIGURE 8 Sensitivity of group ordered by profit

7 Conclusion

The relationship between financial constraint and investment-cash flow sensitivity is studied in this paper, and we hope to test that to what extent, the monotonicity condition holds according to relevant proxies. Hence, we add some extra variables, and divide the data into 10 groups. The monotonic relationship between financial constraint and investment-cash flow sensitivity is empirically violated according to all the analysis above. This means that at least in the UK, among the proxies that we use in the paper, none of the classifications shows a monotonic relation between financial constraints and the sensitivities. We conclude that, under the condition of the absence of precise definition of financial constraint, it is likely to be plausible to get either a positive or negative relationship between financial constraint and investment-cash flow sensitivity. Furthermore, we find an M-shaped relationship between them when leverage is used as the ordering criteria. This result is consistent with that of Iona, et al (2006), although it suggests that leverage is a poor proxy of financial constraint.

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