INVESTMENT CASH FLOW SENSITIVITY : INTERNATIONAL EVIDENCE

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ABSTRACT

Several research studies in finance have investigated the effect of financial factors on investment decisions of firms. More recently, researchers have extended conventional models of firm-investment by incorporating a role for financing constraints in determining the firm's investment decision. Empirical work points to overwhelming evidence that in the presence of market imperfections, firm investments become sensitive to the availability of internal cash flows. However, the evidence regarding the patterns of these observed investment-cash flow sensitivities has been ambiguous.

In this study we examine the impact of financial development on the sensitivity of firm-level investment to internal cash flow. Using international data from 31 countries over the 1987-1997 period, we find that after controlling for growth opportunities (as measured by Tobin's *Q*), investment is more sensitive to cash flow for firms in less financially developed countries, indicating higher costs of information problems and lower availability of external capital in such countries. The results are robust to six different measures of financial development.

We also find a strong negative relationship between investment cash-flow sensitivity and size (as measured by log of total assets) across countries, though our results are mixed when we investigate this size effect within 6 OECD countries. Overall, these findings are consistent with

the notion that smaller firms face greater information costs and are therefore more dependent on internally generated capital for making their investment outlays.

Furthermore, we establish a direct connection between the investment cash flow sensitivity studies and a parallel literature on the allocational efficiency of capital markets. We also document important distortionary impacts of using log specifications in the empirical estimation, and of including negative cash flow observations in the sample, which explain the qualitative difference between our results and those of some earlier studies.

Finally, our results have important policy implications. Firms that are based in countries with poor standards of financial accounting and information disclosure are found to face greater challenges in accessing external capital markets. These firms are likely to experience high under-investment costs that, at a macro level, would translate into slower economic growth for the country.

DEDICATION

I DEDICATE THIS WORK

TO MY COUSIN

RUQAIYA

WHO PASSED AWAY IN A

TRAGIC ACCIDENT IN NOVEMBER, 2000.

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CHAPTER I

INTRODUCTION

The study of investment decisions of firms represents a prominent area of research in finance and economics, with the motivation being driven by both theoretical concerns such as debates over which model offers the best explanation of investment behavior, and policy-related questions like the effect of changes in monetary policy or tax policy on investment.

A large body of work in empirical finance has also looked at the investment decisions of firms and how these decisions are affected by various financial factors. Preliminary research in this area was greatly influenced by the seminal work of Modigliani and Miller (1958), where the idea of the financial structure of a firm being irrelevant for investment decisions (except for tax considerations) was proposed. Empirical research has, however, usually produced results inconsistent with the notion of financial irrelevance.

The past couple of decades have witnessed a number of researchers extending the conventional models of business fixed investment by incorporating a role for financing constraints in determining the firm's investment decisions. Once again, these research programs have proceeded in two steps. Firstly, models of asymmetric information and incentive-related agency problems in capital markets have been developed which in turn imply that information costs and internal resources of firms have an effect on the shadow cost of external funds for fixed investment, holding constant underlying investment opportunities. On the other hand, empirical research has tried to focus on ways and means of investigating firm-investment decisions independent of changes in investment opportunities, but in the presence of information costs and varying levels of internal resources.

The emphasis on capital market imperfections is certainly not a novel idea in empirical studies focusing on the investment behavior of firms. As far back as the work of Meyer and Kuh (1957), there has been an awareness of the significance of financing constraints on firm-level business investment. However, since the mid-1960's, most applied work attempted at isolating real firm decisions from purely financial factors. The justification for this approach stemmed from Modigliani and Miller (1958) demonstrating the irrelevance of financial structure and financial policy for real investment decisions, albeit under certain conditions. The central Modigliani-Miller result was that in frictionless capital markets, internal and external sources of capital become perfect substitutes thereby making real firm decisions, such as fixed investment, independent of financial factors such as firm-liquidity, leverage, or dividend policy.

As previously noted, empirical research has usually produced results that are at odds with the Modigliani-Miller propositions. However, a reconciliation of theoretical predictions with empirical results has been made possible by the use of models of market imperfections in which information asymmetries between borrowers and lenders introduce incentive problems in financial relationships that ultimately result in financing and investment decisions becoming interdependent in an explicit manner. In fact, much of the recent research has been in the direction of modeling the role of asymmetric information in linking movements in internal finance to investment outlays, holding constant underlying growth opportunities.

Starting with the work of Fazzari, Hubbard and Petersen (1988; hereafter FHP), there now exists an extensive literature that demonstrates the sensitivity of a firm's investments to its internally generated cash flow. The original FHP argument was that this sensitivity of corporate investments to internal cash flow would be the strongest for firms that faced the greatest wedge between the costs of internal and external funds, i.e., firms that have high financial constraints. They presented evidence consistent with this hypothesis by showing that firms having low dividend payout (their proxy for financial constraints) had higher investment-cash flow sensitivities than high dividend paying firms. Several studies following FHP provided supporting evidence, using data from a variety of contexts.

At the same time, Kaplan and Zingales (1997; hereafter KZ) and Cleary (1999) have presented evidence conflicting with the general notion that investment cash-flow sensitivity is a positive function of the degree of financial constraints. Their empirical findings indicate, in contrast, that investment is most sensitive to internal cash flow for the *least* constrained firms. The ambiguous nature of the evidence regarding the pattern of investment-cash flow sensitivity has in fact become the topic of a spirited debate in recent years (Hubbard (1998), Fazzari, Hubbard, and Petersen (2000), Kaplan and Zingales (2000)).

This debate over the relation between financial constraints and investment-cash flow sensitivity extends to the international context as well. Hoshi, Kashyap, and Scharfstein (1991), Schaller (1993), and Shin and Park (1998) present evidence from Japanese, Canadian, and Korean data, respectively, showing that the sensitivity is higher for more constrained firms. Love (2001) uses an Euler equation approach and confirms the FHP hypothesis by showing that firms in less developed countries show a greater sensitivity of investment to cash stock. In contrast, Kadapakkam, Kumar, and Riddick (1998) and Cleary (2001) find that in several developed countries, investment is more sensitive to cash flow for firms that are *a priori* expected to be less financially constrained. Also, in a recent paper on the efficiency of financial markets in allocating capital, Wurgler (2000) presents industry-level evidence indicating that investments are more responsive to value added in countries that have better developed financial markets. Arguing that value added is a useful proxy for measuring future profitability, he concludes from this evidence that development of the financial sector improves a country's ability to increase investments in growing industries, and decrease investments in declining industries, i.e., to allocate capital more effectively.

While Wurgler's conclusion is economically intuitive and reassuring from a policy perspective, it is important to examine if it follows necessarily from his findings. Given that Wurgler (2000) uses value added to measure future profitability, and that value added is closely related to cash flow, it is natural to ask the following question: does the estimated sensitivity of investment to value added truly measure the responsiveness of investment to future profitability, or does it in fact capture the sensitivity of investment to internal cash flow, as suggested by FHP and others? In other words, what does value added measure – future profitability or current cash flow? Wurgler (2000) presents evidence that value added is positively correlated with Tobin's q (widely used in the literature as a proxy for future profitability) for a subset of his sample[1], but it still does not settle the issue conclusively. Value added is likely to be positively correlated with both future profitability and current cash flow – the only way to disentangle the two effects is by

[1] For US data

controlling for future profitability through a separate proxy in the model specification. Unfortunately, this is not possible with the Wurgler (2000) data, since information on Tobin's *q* or other market-to-book ratios is not available at the industry level for the non-U.S. portions of his sample.

Finally, Allayannis and Mozumdar (2001) have recently shown that negative cash flow observations may have a serious distortionary impact on estimated investment-cash flow sensitivities. The intuition is that when firms are in sufficiently bad shape (incurring cash losses), investments are down to their lowest possible levels and cannot be cut any further. In such situations, therefore, investment-cash flow sensitivity is extremely low. Including such negative cash flow observations in the sample reduces the estimated sensitivity for the entire sample. Allayannis and Mozumdar (2001) show that such observations play an important role in explaining the startling results reported by KZ and Cleary (1999).

This study examines the impact of financial development on the sensitivity of firm-level investment on internal cash flow using international data from 31 countries over the 1987-1997 period. Using firm-level data allows us to calculate Tobin's *q*, and use it as a direct control for future profitability. Our main findings may be summarized as follows. We find that after controlling for firm size and future profitability (as measured by Tobin's *q*), investment is more sensitive to cash flow for firms in less financially developed countries, indicating higher costs of information problems and lower availability of external capital in such countries. The result is robust to six different measures of financial development and consistent with the original FHP hypothesis. Thus, in addition to the sensitivity of investments to future profitability as shown by Wurgler (2000), there is an important effect of internal cash signifying the importance of financing constraints. We also confirm the downward bias in estimated sensitivities induced by negative cash flow observations, as recorded earlier by Allayannis and Mozumdar (2001) for US data.

We also examine the impact of logs versus levels regression specifications that have been employed in the literature and find that the log-linear approach has a significant impact on the estimation results, since the log function nonlinearly transforms small positive data values to large negative ones. We provide evidence of this distortionary effect by showing that the log-linear investment model displays parameter instability.

Our contribution is also in terms of methodology. One of the concerns with earlier studies that relate the effect of financial development on the variable of interest (for example ‘value added’ in Wurgler (2000)) is methodological. It has been customary to estimate this effect in two steps. In the first step, the sensitivity of the variable of interest is estimated for each country from separate country-by-country regressions. In the second step, the estimated sensitivities are regressed on the measure of financial development. In this study, we estimate the impact of financial development on investment-cash flow sensitivity in a single step, specifically by interacting our measure of financial development with cash flow and estimating its impact on investment using a pooled sample of firms from all countries. This approach addresses the errors-in-variables problem of two-step estimation and yields more efficient estimates.

Finally, we also provide evidence of a strong negative relationship between investment cash-flow sensitivity and size (as measured by log of total assets) across countries though our results are mixed when we investigate this relationship within 6 of our largest OECD countries. The overall result is consistent with the FHP hypothesis and the notion that smaller firms face greater information costs and are therefore more dependent on internally generated capital for their investment outlays.

The remainder of the dissertation is organized as follows. Chapter II surveys the literature and provides an overview of existing evidence and how it is connected to this study. Chapter III describes the data and discusses the methodology employed. Chapter IV presents evidence on the cross sectional pattern of investment cash flow sensitivities across countries. Chapter V documents international evidence of a significant size-effect on investment cash flow sensitivities. Chapter VI deals with the issue of logs versus linear specifications and Chapter VII concludes the dissertation.

CHAPTER II

LITERATURE REVIEW

Internal capital markets are a major source of capital allocation in modern industrial economies. For example, Lamont (1997) has estimated that for the period 1981- 1991, internal funds accounted for more than three quarters of capital expenditure outlays for US non-financial corporations. This over-reliance on self-generated cash as a channel for investment has prompted researchers to investigate the relationship between firms' investment decisions and internal resources.

In a world where capital markets are perfect and all firms have free access to external sources of financing, investment decisions would be based solely on expected future profitability and, thus, not be affected by the availability of internally generated funds. Since expectations regarding future profits cannot be directly observed, a popular proxy used in the literature for these unobservable investment opportunities is Tobin's q. The general idea is that in an efficient market, higher expected future profitability should get incorporated in a higher current market value and therefore a higher q ratio.

The primary objective of studies of external financing constraints is to estimate the sensitivity of a firm's investment to the availability of internal funds, after controlling for future growth or investment opportunities. In a perfect world, if both investment opportunities (Tobin's q) and internal cash flow are included in the model describing investment behaviour, only q should have power as an explanatory variable and the coefficient for cash flow should not be significant. This is because internal and external sources of capital are perfect substitutes in such a world. However, a significantly positive coefficient for the internal cash flow variable can be interpreted as indicating the presence of external financing constraints.

A common feature of several theoretical models of asymmetric information in capital markets such as those developed by Leland & Pyle (1977) and Calomiris & Hubbard (1990) is that the level of internal net worth becomes a critical determinant of terms under which firms can borrow, holding constant true investment. One particular mechanism through which information asymmetries can result in a differential or wedge between the cost of internal and external finance making internal capital resources more valuable is a "lemon's market" problem in valuation. The pioneering argument, attributed to Akerlof (1970) is that some sellers with inside information regarding the quality of certain assets may be less willing to accept the terms offered by less informed buyers. In the extreme case, this may result in the market to break down, but at a more general level, it would lead to the sale of assets at prices lower than they would have commanded if all buyers and sellers had symmetric information. This idea has been applied to both equity and debt capital models in finance.

For equity finance, Myers and Majluf (1984) develop a model where new shareholders demand a premium to purchase the shares of relatively good firms to offset the losses arising from funding lemons. This premium in turn raises the cost of new equity finance faced by relatively high quality firms to a level where it exceeds the opportunity cost of internal finance for existing shareholders. Similarly, in debt markets, Stiglitz and Weiss (1981) demonstrate that in equilibrium, some form of credit rationing can arise in the presence of adverse selection[2].

In summary, either approach models the differential cost of external finance from equity and debt markets under asymmetric information and the role of internal capital resources in influencing the cost of finance. The implicit suggestion is that certain classes of borrowing firms may find it exorbitantly expensive to obtain financing through the direct issuance of securities in the open market and thereby become more dependent on internal capital markets or sources of funds.

Another fundamental feature of many models of capital market frictions based on asymmetric information is that firm heterogeneity is important. For example, large mature firms with substantial internal resources relative to their investment opportunities can be expected to be less likely to have their investments constrained by a lack of financial capital vis-à-vis younger and growing enterprises with lower levels of net worth.

[2] A similar point was made much earlier by Jaffee and Russell (1976) who showed that the cost of credit is, in general, higher under asymmetric information. They demonstrated that when lenders cannot distinguish between borrowers of differing credit quality, market interest rates increase and loan sizes may be limited.

The question then is to identify variables that can be used to estimate the severity of these external financing constraints. In the first study in this area, FHP used dividend payout ratio as a measure of (the lack of) financing constraint, the underlying argument being that the dividend payout ratio is a good indicator of a firm having surplus internal funds. Firms with low dividend payouts were identified as being financially constrained, while high dividend paying firms were categorized as financially unconstrained. FHP reported that the investment-cash flow sensitivity was highest for the lowest dividend payout group of firms and vice versa.

Devereux and Schiantarelli (1990) used an expanded version of the *q* model used by FHP wherein they included a cost of debt increasing in the level of debt, the increased cost being accounted for by the financial-distress related agency cost of debt. Their main finding was that cash-flow effects are particularly important for smaller and young firms.

A few studies also categorized firms as financially constrained or unconstrained on the basis of certain exogenous firm characteristics. As an example, Hoshi, Kashyap, and Scharfstein (1991) segregated their data of Japanese firms on the basis of their membership in a *keiretsu* organization. Their logic was that since member firms had access to the resources of the *keiretsu* and therefore did not need to rely solely on their internal sources for financing their investments, they were not likely to be financially constrained. They found supporting evidence that cash flow-investment sensitivity was higher for firms that were not part of a *keiretsu*. Shin and Park (1998) find similar results when they examine Korean firms that are/are not members of *chaebols*.

Calem and Rizzo (1995) find analogous results in the U.S. health care industry: stand-alone hospitals display greater investment-cash flow sensitivity than do hospitals that are members of national chains. Almost all the empirical work before Calem and Rizzo (1995) had provided evidence almost exclusively on firms in the manufacturing sector. Calem and Rizzo (1995) expanded upon earlier work in two aspects: first they demonstrated that financing constraints affect firms' investment decisions outside of the manufacturing sector, more specifically in the health care industry; secondly, by focusing on a single and narrowly defined industry, they managed to avoid problems of attributing observed differences in investment cash flow sensitivity relationships due to industry differences.

More recently, Houston and James (2001) find that the estimated sensitivity is higher for firms that are closely tied to a single bank than firms that have relationships with several banks. Using detailed information on the debt structure of 250 publicly traded US firms, they also find that investment cash flow sensitivity increases as a firm's reliance on bank financing increases. In their sample, bank-dependent firms tend to hold larger stocks of liquid assets and have lower dividend payout rates. However, for most levels of investment spending, bank dependent firms appear to be slightly less cash-flow constrained than firms with access to public debt markets only. Their explanation for this observation is that close banking relationships help to reduce information asymmetries and thereby improve the capital allocation process.

Still other researchers have used other segregating variables. For example, Gilchrist and Himmelberg (1995) differentiated firms on the basis of whether the firms had issued commercial paper or bonds that were rated. The underlying reasoning was that firms that issued commercial paper or bonds rated by external agencies had a more ready access to debt capital markets and were therefore not financially constrained. Schaller (1993) has used size and age (time since listing) as measures of (the lack of) financial constraints, arguing that older and larger firms have better access to external capital. Froot, Scharfstein, and Stein (1993) develop a theoretical model, and Geczy, Minton, and Schrand (1997) and Allayannis and Mozumdar (2000) provide supporting empirical evidence, showing that firms hedge with derivatives to reduce the impact of financial constraints on investment-cash flow sensitivity. Similarly, Kedia and Mozumdar (2001) show that firms hedge with foreign currency debt to reduce this impact.

The work of Lamont (1997) is in similar spirit and provides indirect evidence to the FHP investment cash flow hypothesis by means of a natural experiment. The motivation behind his study was based on the following observation: Although there exists a strong correlation between internal cash and investment, a direct causal connection between the two is harder to establish since both investment and cash flow can be driven by underlying shocks to profitability. Lamont pointed out that although prior studies had attempted to control for the profitability of investment by incorporating a measure such a proxy for Tobin's q or some market-to-book ratio in the estimated equation, current profitability could still be a better measure of future profitability of investment than that obtained from stock market data. The estimated investment cash-flow sensitivity coefficients in such a setting would be biased.

To address this problem, Lamont (1997) takes a different route by trying to focus on finding an exogenous instrument for cash. Using data from the oil industry, he is able to identify shocks to cash that are uncorrelated (or at least not positively correlated) with the returns to investment. More specifically, a simple perfect capital markets model would imply that when a company's oil segment experiences a cash shortfall, the same company's non-oil segment should be unaffected, provided the NPV of non-oil investment is unaffected. In contrast, a model incorporating market imperfections would imply that with the stiffening of financial constraints, the shadow cost of investment should rise for all projects leading to a fall in the amount of investment (ceteris paribus) for all divisions of the firm.

Lamont (1997) finds that decreases in the cash flows of oil segments of multi-segment firms gets translated to reduced investment spending in non-oil segments. The overall conclusion is that internal capital markets play a non trivial role in the allocation of capital and direct evidence of a causal effect between internal cash and investment is established.

The principal conclusion of the studies mentioned thus far is that investment-cash flow sensitivity is higher in financially constrained firms (as indicated by the particular choice of proxy), whereas financially unconstrained firms display lower investment-cash flow sensitivity. A secondary conclusion is that the degree of financial constraint is a function of various factors such as asymmetric information, agency problems, or transaction costs.

Although all the above studies had interpreted the positive relationship between investment and cash flow as some form of evidence of the existence of financial constraints, Kaplan & Zingales (1997; hereafter KZ) were the first to question the notion that this relationship was stronger for firms presumed to have less access to external capital markets based on selected observable characteristics. KZ criticized the fundamental assumption in the literature that investment cash flow sensitivities increase monotonically with the degree of financing constraints on the grounds that there is no widely accepted theoretical model that would imply this relationship. They further showed that within the low dividend payout subset of the FHP study, the least constrained firms had the highest estimated sensitivity.

KZ also develop a theory model to substantiate their point. They consider a firm which chooses a level of investment that maximizes profit, where the return on investment, *I*, is given by a production function, *F(I),* with *F'>0* and *F''<0*. Investments are financed either through internal funds, *W*, or by external funds, *E*. The additional cost of external funds is described by the *convex* function *C(E,k),* where k is a measure of the wedge between the internal and external costs of funds. Each firm's goal is, thus, to maximize:

$$F(I) - C(E,k) - I \text{ such that } I = W + E$$

KZ go on to demonstrate that the above simple model implies the following relationship (for C_{11} and F_{11} not equal to zero), where the subscripts denote partial derivatives with respect to the first or the second argument, i.e. w.r.t. *E* or *k*:

$$\frac{d^2 I}{d^2 W} = \left(\frac{F_{111}}{F_{11}^2} - \frac{C_{111}}{C_{11}^2} \right) . \frac{F_{11}^2 C_{11}^2}{(C_{11} - F_{11})^3}$$

Note that the left hand side of the expression, d^2I/dW^2, is simply the marginal change in investment cash flow sensitivity to a marginal change in internal liquidity and this expression can be either positive or negative depending on the sign of the bracketed term $[F_{111}/F_{11}^2 - C_{111}/C_{11}^2]$. KZ argue that for certain specific choices of production and cost functions, the theoretical relationship between investment cash flow sensitivity and degree of financing constraints can actually be negative, i.e. is the more constrained firm could display a smaller investment cash flow sensitivity.

The problem with the KZ model is that although it gives a mathematical description of the behavior of investment cash flow sensitivities, it fails to provide any economic intuition for the very relationship it tries to establish. More specifically, there is little economic meaning that can be attached to third and higher order derivatives of production and cost functions.

In the appendix we have developed a simple firm investment model that serves our purpose of explaining why the relationship between investment cash flow sensitivities and the degree of financing constraint can be expected to be positive. As shown in the appendix, as long as there exists a difference between the costs of external and internal sources of funds due to market imperfections, the investment cash flow sensitivity of the financially constrained firm would be higher than that of the (relatively) unconstrained firm.

FHP (2000) have further criticized KZ (1997) on two grounds: First they argue that the KZ findings are difficult to interpret since they are based on a small subset of the 49 low-dividend firms in the original FHP (1988) study. FHP's contention is that these firms are relatively homogeneous for purposes of testing for capital market imperfections and that it would be extremely difficult to classify these firms finely by degree of financing constraints. Secondly, they also question the validity of the KZ classification scheme where firms are grouped into financially constrained and unconstrained categories on the basis of (possibly self-serving) managements' statements regarding firm liquidity.

A possible explanation that FHP (2000) present for the conflicting KZ finding is that KZ classify financially constrained (FC) firms as those having liquidity problems. The KZ subset of FC firms is therefore most likely to include firms that are close to a state of financial distress. They further argue that during years of financial distress, firms, possibly due to the presence of protective covenants or at the insistence of their creditors[3], are likely to use cash flow as a means of enhancing liquidity aimed at reducing the probability of bankruptcy, thereby resulting in little change in fixed investment as measured in a database such as Compustat. FHP highlight the fact that financially distressed firms (with low or negative cash flows) often sell off existing fixed assets or disinvest liquid assets such as working capital. Neither of these responses to low levels of internal cash are included in the Compustat database as measures of fixed investment and ignoring them is likely to cause a downward bias in the cash flow coefficient.

[3] KZ (1997) themselves observe that financially distressed firms could be restricted by creditors from using internal cash for investment and might therefore display a relatively low responsiveness of investment to internal cash flows.

The downward bias due to negative cash flows in the investment cash flow sensitivity estimation is also the focus of Allayanis & Mozumdar (2001) who show that elimination of these negative cash flow observations, which usually account for a small percentage of the total number of observations, significantly increases the magnitude of the investment cash flow sensitivity estimates. Moreover, since financially constrained firms are more likely to have a greater proportion of negative cash flow year observations, the sensitivities for this group is more susceptible to underestimation which in extreme cases may be misinterpreted as the insensitivity (or low sensitivity) of investment to internal cash flows.

More recently, the KZ (1997) study has found further support from Cleary (1999), who examined a large cross-section of firms and measured financing constraints by a more objective discriminant score analysis method. His results matched those of KZ's: the less constrained firms exhibited higher investment-cash flow sensitivities.

Two recent papers by Kadapakkam, Kumar, and Riddick (1998) and Cleary (2001) have explored the issue of investment cash flow sensitivity using international data and concluded that the KZ result holds in a more general setting. Both Kadapakkam et al (1998) and Cleary (2001) analyze firms in several OECD countries and find that within each country, larger firms which are *a priori* expected to have better access to external capital markets show higher investment-cash flow sensitivity.

Although Wurgler (2000) has posed his study in somewhat different terms (using a value added measure, defined as the difference between sales and cost of goods sold), the connection with the investment-cash flow sensitivity literature is clear. The important distinction is that in his framework, value added is the single independent variable, and captures the impacts of both investment opportunities and cash flow on investment. Consequently, his finding that the sensitivity of investment to value added is higher for financially more developed countries is consistent with either of two competing explanations:

(i) investment is more responsive to investment opportunities in financially developed countries, or

(ii) investment is more sensitive to cash flow in financially developed countries.

The first explanation appears more intuitive and comforting, and that is the one that Wurgler (2000) proposes, but the second explanation cannot be dismissed lightly either, given the earlier evidence by KZ, Kadapakkam et al (1998), and Cleary (1999, 2001).

Most studies mentioned in this literature review have focused primarily on analysing cross-sectional patterns in investment cash flow sensitivities within countries. The present study contributes to the literature by analyzing cross-sectional patterns in investment cash flow sensitivities *across* countries and relating the observed patterns to the degree of financial or capital market development across economies.

CHAPTER III

DATA AND METHODOLOGY

The firm-level data employed in the study come from the Disclosure Worldscope Global (October 1997) database which contains data on large publicly traded firms from around the globe. Although the data are more representative of larger-sized firms in different countries, it makes our analysis more compelling since finding a strong relationship between financial development and investment cash flow sensitivity would be more convincing if the results were true for large firms which are known to have better access to capital markets and external sources of funds.

The data span 11 years, i.e., between 1987-1997. Although firm level data are available for 50 countries, our final analysis uses data from 31 countries. This was due to imposition of the following restrictions on our data sample:

- Existence of at least 100 firm-year observations for each country
- Existence of at least 3 or more years of data for each firm

In addition, the sample does not include utilities and financial firms (four-digit SIC codes 4xxx and 6xxx respectively). The top and bottom 1 percentile of extreme observations are also eliminated prior to the analysis to reduce the impact of outliers. The resulting data set has 41,491 firm-year observations for a total of 6027 firms. Tables I and II give details of the sample coverage across countries.

Any empirical examination of the effects of capital market imperfections on investment decisions of individual firms faces several methodological challenges. First and foremost is the challenge of adequately controlling for firms' investment opportunities since changes in firms' internal cash may be linked to investment and output simply because they are accounted for by shifts in the firms' investment opportunities. For example, finding a strong link between changes in firm liquidity and investment need not support the predictions of models of costly external financing. Usually one uses cash flow as a proxy for changes in firm liquidity, where cash flow is assumed to be the accounting value of current revenues less cash expenses and taxes.

TABLE I

Sample Coverage Across Countries.

The firm-level data are from the Disclosure Worldscope (October, 1997) dataset and span the period 1987-1997. Only those countries with a minimum of 100 firm-level observations were included in the sample. The total number of countries in the selected sample is 31. Financial firms and utilities were excluded.

Country	No. of Observations	No. of Firms	Average no. of years per firm
AUSTRALIA	1013	138	7.3
AUSTRIA	262	40	6.6
BELGIUM	369	54	6.8
BRAZIL	139	29	4.8
CANADA	1947	264	7.4
CHILE	154	29	5.3
DENMARK	653	97	6.7
FINLAND	390	57	6.8
FRANCE	2466	373	6.6
GERMANY	2112	306	6.9
HONGKONG	368	62	5.9
INDIA	488	126	3.9
INDONESIA	194	49	4.0
IRELAND	304	42	7.2
ITALY	754	106	7.1
JAPAN	2016	310	6.5
MALAYSIA	685	132	5.2
MEXICO	255	46	5.5
NETHERLANDS	905	127	7.1
NORWAY	289	42	6.9
NEW ZEALAND	172	25	6.9
PORTUGAL	111	24	4.6
SOUTH AFRICA	654	91	7.2
SINGAPORE	419	71	5.9
SOUTH KOREA	322	70	4.6
SPAIN	440	69	6.4
SWEDEN	521	85	6.1
SWITZERLAND	684	97	7.1
THAILAND	341	86	4.0
UK	7364	987	7.5
USA	14700	1993	7.4
Total number of firms		6027	

TABLE II

Sample Descriptive Statistics.

The table shows the mean and median investment, cash flow, and Tobin's Q for each country. Investment and cash flow are normalized by beginning of the year capital stock, K. Investment is defined as the firm's capital expenditure during year t, and cash flow is defined as the sum of net income, depreciation & amortization. Tobin's Q is measured as the following ratio: (Book value of assets + Market value of equity - Book value of equity - Deferred taxes) / (Book value of assets)

Country	No. of Firms	Investment, I/K	Cash Flow, W/K	Q	Investment, I/K	Cash Flow, W/K	Q
		Sample Means			*Sample Medians*		
AUSTRALIA	138	0.245	0.325	1.401	0.183	0.263	1.234
AUSTRIA	40	0.294	0.362	1.415	0.257	0.303	1.227
BELGIUM	54	0.298	0.432	1.231	0.238	0.333	1.139
BRAZIL	29	0.475	0.683	1.029	0.333	0.261	0.958
CANADA	264	0.234	0.256	1.345	0.178	0.199	1.166
CHILE	29	0.263	0.317	1.614	0.190	0.254	1.369
DENMARK	97	0.230	0.306	1.213	0.192	0.256	1.105
FINLAND	57	0.314	0.291	1.170	0.245	0.247	1.093
FRANCE	373	0.309	0.501	1.235	0.258	0.399	1.117
GERMANY	306	0.332	0.376	1.450	0.283	0.335	1.307
HONGKONG	62	0.257	0.378	1.302	0.162	0.246	1.095
INDIA	126	0.331	0.385	1.811	0.243	0.289	1.455
INDONESIA	49	0.364	0.439	1.579	0.285	0.350	1.412
IRELAND	42	0.211	0.353	1.415	0.163	0.286	1.275
ITALY	106	0.271	0.384	1.142	0.214	0.290	1.056
JAPAN	310	0.236	0.262	1.566	0.208	0.224	1.411
MALAYSIA	132	0.262	0.370	1.973	0.192	0.259	1.729
MEXICO	46	0.174	0.175	1.390	0.140	0.189	1.194
NETHERLANDS	127	0.256	0.438	1.259	0.213	0.338	1.138
NORWAY	42	0.285	0.302	1.333	0.214	0.222	1.183
NEW ZEALAND	25	0.171	0.272	1.283	0.133	0.236	1.125
PORTUGAL	24	0.259	0.303	1.230	0.177	0.244	1.028
SOUTH AFRICA	91	0.289	0.533	1.465	0.262	0.425	1.285
SINGAPORE	71	0.262	0.356	1.552	0.191	0.229	1.328
SOUTH KOREA	70	0.361	0.213	1.139	0.292	0.172	1.070
SPAIN	69	0.221	0.342	1.321	0.167	0.285	1.151
SWEDEN	85	0.256	0.369	1.252	0.206	0.270	1.131
SWITZERLAND	97	0.238	0.318	1.213	0.185	0.243	1.079
THAILAND	86	0.302	0.350	1.585	0.242	0.250	1.384
UK	987	0.244	0.393	1.530	0.185	0.307	1.367
USA	1993	0.267	0.454	1.583	0.209	0.342	1.336

If cash flow is correlated with future profitability, a link between cash flow and investment for a given firm over time could reflect the link between expected profitability and investment emphasized by frictionless neoclassical models rather than the sensitivity of firm investments to internal cash flow. Accordingly, empirical tests must identify a suitable proxy for underlying investment opportunities.The second issue concerns the obvious simultaneity among contemporaneous values of a firm's income statement and balance sheet items. For example, investment and cash flow are determined simultaneously by profitability. However, one can argue that in an efficient market, investors form expectations of future value in Q. Thus changes in pre-determined cash flow should have no effect on investment once Q is controlled for.

We adopt the usual specification employed in this literature, i.e. investment and internal cash flow are described by the following relationship:

$$I_t \,/\, K_{t-1} \;=\; \alpha + \beta\, Q_t + \gamma\, W_t/K_{t-1} + FIRMDUM + YEARDUM + \varepsilon \qquad \textbf{(I)}$$

where $I_t \,/\, K_{t-1}$ is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's q at the beginning of the year and a proxy for the firm's investment opportunities; $W_t \,/K_{t-1}$ is cash flow during year t scaled by capital stock at the beginning of the year; and *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects.

Finally, because models of informational imperfections stress cross-sectional predictions, empirical research has to rely on panel data to distinguish between the decisions at any point in time between constrained and unconstrained firms. Panel data has its own set of associated problems. Particularly, when used in panel data and in the presence of firm-specific effects, OLS can be sometimes misleading if the fixed effects are correlated with the explanatory variables.

We estimate all our regressions by performing OLS on transformed mean-deviations data rather than the raw data themselves. The advantage is that the process of taking deviations from firm-level means effectively annihilates the fixed firm effects from the regression equation. This results in a drastic reduction in the size of the X'X matrix, leading to a considerable increase in the computation speed.

To establish the relationship between investment cash flow sensitivities and financial development of capital markets, we employ two approaches. The first is the traditional two-step approach employed in the literature where the country-wise investment cash flow sensitivity estimates obtained from model (I) are regressed on 3 different measures of financial development, *FINDEV*, as developed in La Porta, Lopez de Silanes, Shleifer, and Vishny (1997; hereafter LLSV), Rajan and Zingales (1998; hereafter RZ), and Wurgler (2000). The second step least squares estimated model is:

$$\gamma_i = \alpha_0 + \delta_0 FINDEV_i + \varepsilon \qquad \text{(II)}$$

where γ_i's are the ICFS estimates for each country obtained from model (I) and *FINDEV* is the financial development index corresponding to that country.

Note that the second-step least squares model produces estimates of standard errors that are biased upwards. This is because the dependent variable in the second step is estimated with error from the first step. Accordingly, the estimated variances and standard errors in the second step become larger than the case where there are no such errors of measurement and need to be adjusted using the estimated standard errors in the first-step. We avoid these econometric complexities by estimating the relationship between investment cash flow sensitivity and *FINDEV* in a single step as described below.

Our second, and more direct approach, is to estimate the following model:

$$I_t / K_{t-1} = \alpha + \beta Q_t + \gamma\, W_t / K_{t-1} + \delta\, W_t / K_{t-1} . FINDEV + FIRMDUM + YEARDUM + \varepsilon \qquad \text{(III)}$$

where $W_t / K_{t-1}.FINDEV$ is an interactive variable between cash and *FINDEV*, the measure of financial development for the country in which the firm is based. As mentioned above, this approach mitigates the errors-in-variables problems associated with two-step estimation and yields more efficient estimates.

Finally, to investigate the relationship between firm size and investment cash flow sensitivities, we employ a variation of the specification employed in model (III):

$$I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t/K_{t-1} + \delta W_t . FINDEV/K_{t-1} + \zeta W_t . SIZE_{t-1} /K_{t-1} + FIRMDUM + YEARDUM + \varepsilon \qquad \text{(IV)}$$

where $W_t . SIZE /K_{t-1}$ is an additional interactive variable between cash and firm size (measured as the log of total assets in US dollars).

CHAPTER IV

Investment Cash Flow Sensitivity and Financial Development

IV. A Country-wise Regressions

We start by estimating model (I) for each of the 31 countries in our data sample. Table III summarizes the results of these regressions. For all countries the investment-cash flow sensitivity, estimated as the coefficient γ, is positive and highly significant (except for Brazil and Chile which have positive but insignificant γ coefficients). Firm investments in all countries are positively dependent on internal cash confirming existing evidence that internal and external sources of funds are not perfect substitutes.

Table III also shows the correlations between the estimated investment cash-flow sensitivities and the measures of financial development for the 31 countries. A note on the different measures of financial development employed in the study is in order. The LLSV measure of financial development is based on the ratio of the stock market capitalization held by minorities to the gross national product of the country. The stock market capitalization held by minorities is computed as the product of the aggregate stock market capitalization and the average percentage of common shares not owned by the top three shareholders in the ten largest non-financial, privately owned domestic firms in a given country. The intuition behind this measure is provided through this argument in LLSV (1997), which we reproduce below:

"Conceptually it is not appropriate to look at just the ratio of stock market valuation to GNP. For example, if 90% of a firm's equity is held by insiders and 10% is held by outsiders, then looking at the market capitalization of the whole firm gives a ten-fold overestimate of how much has actually been raised externally"

Since we are interested in measuring financial development in relation to the ability of firms in different countries to raise external capital, the LLSV measure is a better measure than taking the raw equity market capitalization to GDP ratio as a proxy for financial development. At the same time, we are interested in the ability of firms to access not only equity markets but debt markets too. A financial development measure based purely on the size of equity markets is likely to underestimate the level of development of banking economies such as Germany and Japan which are known to have large credit markets.

Since the Wurgler (2000) measure of financial development (*FINDEV*) is based on the ratio of the aggregate size of equity and credit markets to the GDP of the country, it is perhaps a better measure of *FINDEV* in the context of the present study. However, there still remains the concern that the stock market capitalization component of the measure does not reflect the amount of funding actually obtained by firms in the form of equity capital. We therefore employ a third set of measures, as given in RZ, where the accounting standards in a country are used as a proxy for *FINDEV*. Although accounting standards only reflect the *potential* for obtaining finance rather than actual finance raised, RZ argue that the higher the standards of financial disclosure in a country, the easier it will be to raise funds from outside investors. RZ use an index created by the Center for International Financial Analysis and Research (CIFAR) and we use the same index as an alternative proxy for *FINDEV* in our study.

Going back to Table III, the following observation can be made regarding the correlations between investment cash flow sensitivity and our three measures of FINDEV. While investment cash flow sensitivity is positively correlated to the LLSV measure at 0.027, the correlations with Wurgler's and RZ's measures are -0.111 and -0.019. The evidence of the connection between the investment cash flow sensitivity and the degree of financial capital market development is thus equivocal at this level.

Allayannis and Mozumdar (2001) have documented the distortionary effect produced by negative cash flows and provided empirical evidence that negative cash flows cause a downward bias in investment cash flow sensitivity estimates. Table IV repeats the country-wise regressions after excluding all negative cash flow observations from the sample.

TABLE III

Country-wise Regression Estimates of Investment Cash Flow Sensitivities.

The estimated model is $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t / K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t / K_{t-1} is investment during year *t*, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t / K_{t-1} is cash flow during year *t* scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV), Wurgler (2000) and Rajan & Zingales (1998; RZ).

Country	***N***	R^2	***Intercept***		***Tobin's Q, Q_t***		***Cash, W_t***			***FINDEV***	
			α	**t-stat**	**β**	**t-stat**	**γ**	**t-stat**	**LLSV**	**Wurgler**	**RZ**
AUSTRALIA	1013	0.425	0.097	(0.630)	0.101	(6.070)	0.135	(6.250)	0.49	0.8	75
AUSTRIA	262	0.510	0.143	(1.750)	0.005	(0.150)	0.225	(5.660)	0.06	0.86	54
BELGIUM	369	0.484	0.226	(1.050)	0.177	(3.580)	0.238	(7.150)	0.17	0.55	61
BRAZIL	139	0.791	0.459	(2.190)	0.026	(0.240)	0.021	(0.520)	0.18	-	54
CANADA	1947	0.502	0.009	(0.120)	0.075	(7.270)	0.150	(10.630)	0.39	1.23	74
CHILE	154	0.411	0.213	(1.650)	0.016	(0.410)	0.143	(1.550)	0.8	0.85	52
DENMARK	653	0.316	-0.208	-(2.310)	0.130	(3.790)	0.119	(3.190)	0.21	0.72	62
FINLAND	390	0.505	-0.114	-(0.640)	0.157	(3.780)	0.205	(4.560)	0.25	0.81	77
FRANCE	2466	0.500	0.060	(0.510)	0.048	(3.300)	0.162	(13.600)	0.23	1.06	69
GERMANY	2112	0.458	0.087	(0.740)	0.053	(3.080)	0.220	(12.970)	0.13	1.22	62
HONGKONG	368	0.439	0.253	(2.030)	0.070	(2.010)	0.185	(3.840)	1.18	-	-
INDIA	488	0.438	0.079	(0.410)	0.022	(0.780)	0.299	(4.430)	0.31	0.36	57
INDONESIA	194	0.484	0.162	(1.090)	0.002	(0.040)	0.395	(3.070)	0.15	0.28	-
IRELAND	304	0.495	0.094	(1.070)	0.051	(2.140)	0.104	(3.810)	0.27	1.42	-
ITALY	754	0.416	0.123	(1.310)	-0.039	-(1.180)	0.199	(7.300)	0.08	0.69	62
JAPAN	2016	0.571	-0.140	-(2.080)	0.043	(4.700)	0.316	(13.770)	0.62	2.67	65
MALAYSIA	685	0.424	0.072	(0.510)	0.020	(1.220)	0.213	(5.720)	1.48	1.44	76
MEXICO	255	0.403	-0.006	-(0.100)	0.030	(1.420)	0.202	(3.020)	0.22	0.29	60
NETHERLANDS	905	0.487	-0.055	-(0.550)	0.002	(0.110)	0.198	(8.430)	0.52	1.56	64
NORWAY	289	0.424	0.207	(2.000)	0.051	(1.080)	0.164	(2.820)	0.22	1.11	74
NEW ZEALAND	172	0.461	0.034	(0.240)	0.020	(0.620)	0.283	(3.950)	0.28	0.79	70
PORTUGAL	111	0.538	0.268	(1.950)	-0.042	-(0.580)	0.301	(2.330)	0.08	0.82	36
SOUTH AFRICA	654	0.675	0.041	(0.690)	0.040	(2.640)	0.300	(12.500)	1.45	-	70
SINGAPORE	419	0.358	0.465	(1.830)	0.076	(2.550)	0.191	(4.760)	1.18	2.26	78
SOUTH KOREA	322	0.463	0.365	(2.690)	0.059	(0.580)	0.256	(2.510)	0.44	0.98	62
SPAIN	440	0.547	-0.654	-(3.300)	0.025	(1.120)	0.244	(8.660)	0.17	0.9	64
SWEDEN	521	0.568	-0.066	-(0.550)	0.027	(0.900)	0.340	(9.070)	0.51	1.43	83
SWITZERLAND	684	0.643	-0.008	-(0.100)	0.097	(4.400)	0.415	(13.070)	0.62	-	-
THAILAND	341	0.518	0.124	(0.960)	0.035	(1.280)	0.253	(3.930)	0.56	-	-
UK	7364	0.515	-0.080	-(1.520)	0.060	(12.160)	0.148	(24.350)	1	1.36	78
USA	14700	0.558	0.039	(0.260)	0.069	(23.070)	0.106	(27.890)	0.58	1.44	-

Correlation between investment cash flow sensitivity and Wurglers's *FINDEV* measure : -0.111
Correlation between investment cash flow sensitivity and LLSV's *FINDEV* measure : 0.026
Correlation between investment cash flow sensitivity and RZ's *FINDEV* measure : -0.019

Once again all γ coefficients, the investment-cash flow sensitivity estimates, are positive and significant at the 5% level or higher for 28 of the 31 countries in our sample. (Once more the exceptions are Brazil and Chile, in addition to Mexico). As with the previous table, correlations between the investment cash flow sensitivities and the financial development measures are estimated. Two interesting observations can be made:

- Correlations between investment-cash flow sensitivity estimates and all three measures of financial development are now negative (-0.141 with the LLSV measure, -0.166 with the Wurgler measure, and -0.121 with the RZ measure). After controlling for the impact of negative cash flow observations, investment cash flow sensitivity is clearly inversely related to the degree of financial market development.
- The estimated investment cash flow sensitivities in Table IV are, in general, higher when compared to the estimated sensitivities in Table III. For 25 countries, the estimated investment cash flow sensitivities went up when negative cash flow observations were eliminated; for 4 countries (Chile, Indonesia[4], Mexico and Sweden) they remained virtually unchanged. The only exception was Malaysia where the estimated-cash-flow investment sensitivity declined by about 7.5%. These findings confirm the Allayannis and Mozumdar (2001) hypothesis regarding the downward bias imparted by negative cash flow observations.

[4] Chile and Indonesia have only two and one negative cash flow observations, respectively, in our sample which explain the similar coefficients in the two tables.

TABLE IV

Country-wise Regression Estimates of Investment Cash Flow Sensitivities using Positive Cash Flow Observations.

The estimated model is $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t/K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t/K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t /K_{t-1} is cash flow during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV), Wurgler (2000) and Rajan & Zingales (1998; RZ).

Country	***N***	***R^2***	***Intercept***		***Tobin's Q, Q_t***		***Cash, W_t***		***FINDEV***		
			α	**t-stat**	**β**	**t-stat**	**γ**	**t-stat**	**LLSV**	**Wurgler**	**RZ**
AUSTRALIA	944	0.439	0.078	(0.500)	0.106	(5.730)	0.170	(5.710)	0.49	0.8	75
AUSTRIA	249	0.543	0.108	(1.340)	0.007	(0.190)	0.336	(6.920)	0.06	0.86	54
BELGIUM	347	0.545	0.175	(0.850)	0.172	(3.540)	0.357	(8.780)	0.17	0.55	61
BRAZIL	121	0.807	0.308	(1.450)	0.117	(1.040)	0.088	(1.710)	0.18	-	54
CANADA	1748	0.529	-0.021	-(0.280)	0.087	(7.750)	0.213	(11.430)	0.39	1.23	74
CHILE	152	0.410	0.211	(1.630)	0.014	(0.370)	0.140	(1.360)	0.8	0.85	52
DENMARK	620	0.362	-0.243	-(2.850)	0.125	(3.840)	0.300	(5.740)	0.21	0.72	62
FINLAND	367	0.508	-0.117	-(0.650)	0.156	(3.680)	0.224	(4.250)	0.25	0.81	77
FRANCE	2346	0.528	0.036	(0.270)	0.039	(2.640)	0.231	(15.900)	0.23	1.06	69
GERMANY	1976	0.470	0.058	(0.440)	0.052	(2.920)	0.322	(13.970)	0.13	1.22	62
HONGKONG	353	0.467	0.006	(0.050)	0.058	(1.690)	0.234	(4.320)	1.18	-	-
INDIA	467	0.443	0.059	(0.300)	0.020	(0.690)	0.322	(4.340)	0.31	0.36	57
INDONESIA	193	0.476	0.162	(1.090)	0.001	(0.030)	0.394	(3.060)	0.15	0.28	-
IRELAND	277	0.490	0.132	(1.360)	0.043	(1.440)	0.117	(3.200)	0.27	1.42	-
ITALY	700	0.433	0.119	(1.260)	-0.038	-(1.140)	0.231	(7.560)	0.08	0.69	62
JAPAN	1967	0.569	-0.138	-(2.040)	0.042	(4.450)	0.349	(13.840)	0.62	2.67	65
MALAYSIA	667	0.435	0.161	(1.100)	0.025	(1.460)	0.197	(5.150)	1.48	1.44	76
MEXICO	226	0.404	0.015	(0.240)	0.030	(1.260)	0.198	(1.710)	0.22	0.29	60
NETHERLANDS	877	0.533	-0.136	-(1.420)	-0.004	-(0.200)	0.286	(10.740)	0.52	1.56	64
NORWAY	265	0.457	0.216	(2.040)	0.030	(0.560)	0.230	(3.160)	0.22	1.11	74
NEW ZEALAND	168	0.465	0.036	(0.260)	0.015	(0.460)	0.305	(3.740)	0.28	0.79	70
PORTUGAL	105	0.551	0.385	(2.240)	-0.095	-(1.160)	0.307	(2.260)	0.08	0.82	36
SOUTH AFRICA	648	0.671	0.034	(0.560)	0.041	(2.660)	0.302	(12.470)	1.45	-	70
SINGAPORE	402	0.364	0.451	(1.750)	0.081	(2.640)	0.188	(4.530)	1.18	2.26	78
SOUTH KOREA	307	0.455	0.357	(2.580)	0.070	(0.680)	0.297	(2.440)	0.44	0.98	62
SPAIN	397	0.560	-0.523	-(4.680)	0.019	(0.770)	0.287	(8.070)	0.17	0.9	64
SWEDEN	498	0.572	-0.066	-(0.540)	0.029	(0.960)	0.338	(8.320)	0.51	1.43	83
SWITZERLAND	661	0.680	-0.141	-(1.730)	0.098	(4.630)	0.530	(15.310)	0.62	-	-
THAILAND	328	0.527	0.104	(0.800)	0.043	(1.500)	0.327	(4.580)	0.56	-	-
UK	6729	0.543	-0.089	-(1.720)	0.054	(10.460)	0.217	(27.290)	1.00	1.36	78
USA	13489	0.587	-0.050	-(0.340)	0.063	(20.310)	0.150	(29.950)	0.58	1.44	-

Correlation between investment cash flow sensitivity and Wurglers's *FINDEV* measure : -0.166
Correlation between investment cash flow sensitivity and LLSV's *FINDEV* measure : -0.141
Correlation between investment cash flow sensitivity and RZ's *FINDEV* measure : -0.121

IV. B Two Step Estimation:

To further investigate the relationship between investment cash flow sensitivity and financial development, we follow a two-step approach prevalent in the literature where we regress the country-wise investment cash flow sensitivities estimated in Tables III & IV on a measure of *FINDEV*, i.e. we estimate model (II) described as:

$$\gamma_i = \alpha_0 + \delta_0 FINDEV_i + \varepsilon$$

While Figures I and II show scatter plots of the investment cash flow sensitivities versus the three measures of *FINDEV,* the results from the second step estimation are summarized in the table below:

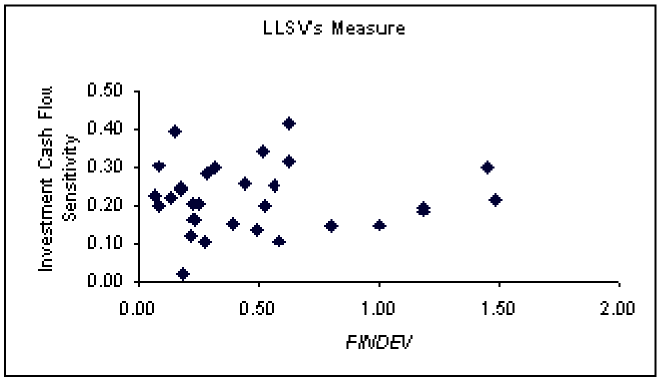
		Financial Development Measure		
		Wurgler	**LLSV**	**RZ**
All observations	δ_0	-0.0153	0.0058	-0.0001
	t-stat	-0.55	0.14	-0.09
Positive Cash observations	δ_0	-0.0226	-0.0321	-0.0008
	t-stat	-0.83	-0.77	-0.59

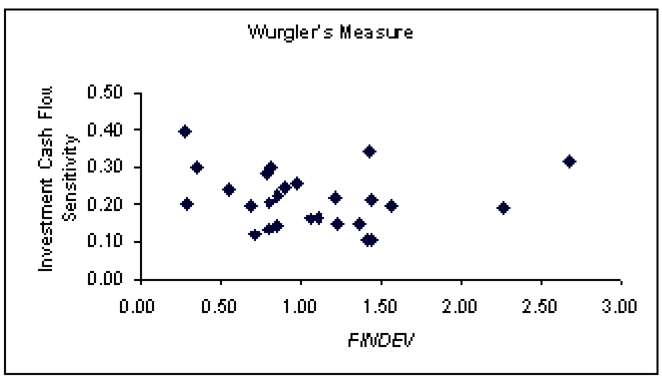
Although we observe δ_0 coefficients that are negative in sign, none of them are significant at conventional levels. The two step estimation procedure suggests the absence of a strong relationship between investment cash flow sensitivity and the level of financial development. However, the above inference is subject to the usual caveat that is applicable to any two step least-squares estimation procedure. First of all, our first stage estimates of investment cash flow sensitivities are, after all, only estimates and therefore calculated with some degree of error. Therefore, our second step estimation of model (II) is, in effect, equivalent to the case where there are errors of measurement in the dependent variable.

FIGURE I

Investment Cash Flow Sensitivity versus *FINDEV* : All Observations

The figures show scatter plots of investment cash flow sensitivities estimated for 31 countries in Table III versus three measures of financial development, FINDEV, as developed in La Porta et al (1997; LLSV), Wurgler (2000) and Rajan & Zingales (1998; RZ).





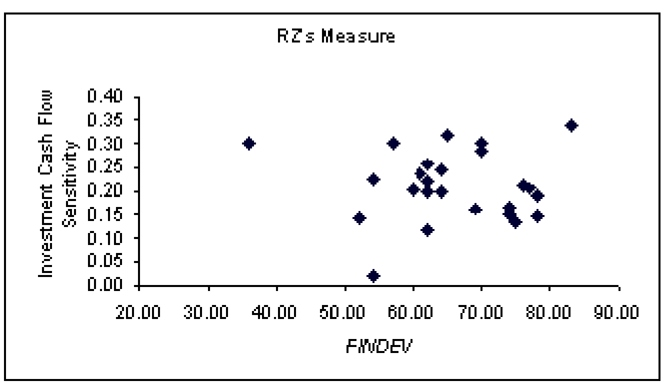
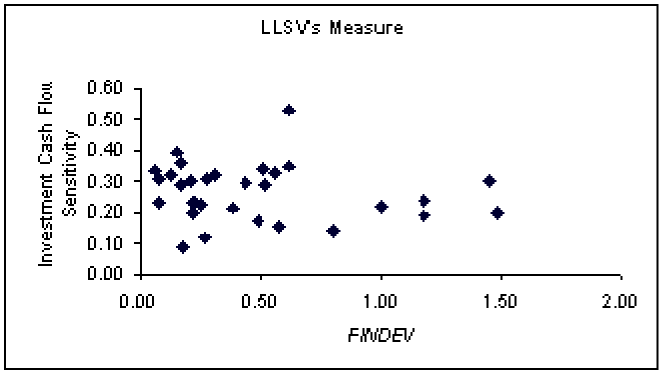
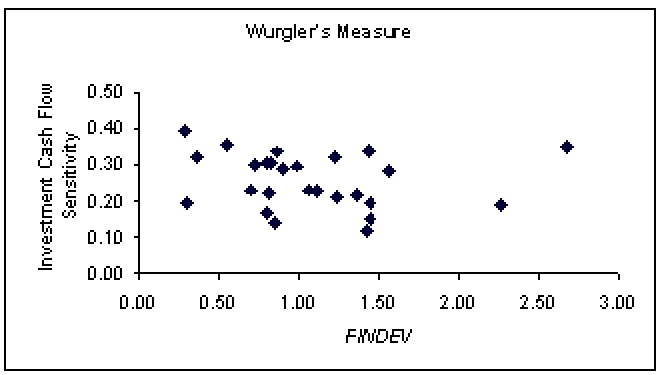


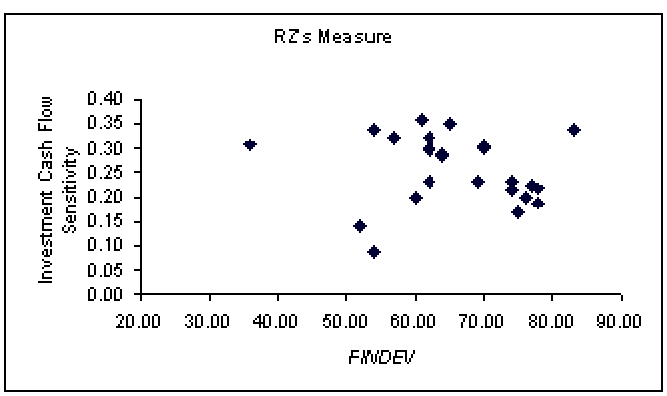
FIGURE II

Investment Cash Flow Sensitivity versus FINDEV : Positive Cash Flow Observations

The figures show scatter plots of investment cash flow sensitivities estimated for 31 countries in Table IV versus three measures of financial development, *FINDEV*, as developed in La Porta et al (1997; LLSV), Wurgler (2000) and Rajan & Zingales (1998; RZ).







It is a well known result that errors of measurement in the dependent variable[5] still give *unbiased* estimates of the parameters in the least squares estimation. However, the estimated variances become larger than the case where there are no such errors of measurement. The results that we have reported in the previous paragraph could very likely have been insignificant due to the measurement-error effect of inflating the estimated standard errors.

One way of overcoming the problem of inflated standard error in the second step is to use the information present in the standards errors of the γ-estimates from the first step and make certain adjustments to the standard error estimates in step two. However, as mentioned previously, we avoid these complexities altogether by estimating the relationship between investment cash flow sensitivity and *FINDEV* directly in one single step through our model (III) specification.

Another problem with our two-step estimation procedure is the potential loss of information in going from the first step to the second step OLS regression. The number of observations in the second step gets drastically reduced from more than 40,000 in the first step to 31, the number of countries in the data sample. Keeping in mind these glitches associated with our two-step process, we refrain from making any strong inferences regarding the cross-sectional behavior of investment cash flow sensitivities. We only claim that the predominantly negative sign of the δ_0 coefficients is suggestive of a negative relationship between the degree of financial development and observed cash-flow investment sensitivities.

IV. C Recursive Regressions using Pooled Data:

To overcome the problem of loss of information with the two-step estimation process, we consider using pooled data for the remainder of our study. As already mentioned, the negative correlations between investment cash flow sensitivities and the financial development indices in Tables III & IV and the predominantly negative sign of the δ_0 coefficients in the previous section suggest that investment cash flow sensitivities are likely to decline as one moves from emerging markets such as Indonesia and India to developed countries such as the United States

[5] Errors of measurement in the independent variables, however, lead to OLS estimators that are biased and inconsistent.

and Japan. One way of looking at the nature of this relationship is through recursive regressions[6]. First, the country-wise data are pooled and sorted on the financial development index (such that the first observation is for a firm based in the most undeveloped capital market, as per the financial development measure, and the last observation is for a firm based in the most developed market). Second, a window corresponding to the first 500 *sorted* observations is chosen and model (I) estimated for this window. Next, the window size is increased to the first 1,000 observations, model (I) re-estimated, and in each subsequent step the window size is increased by another 500 observations. Note that each new set of 500 observations added have a financial development index greater than or equal to *all* the observations in the previous recursive estimation i.e. increasing the size of the 'recursive' window can be thought of as moving along an imaginary financial development axis.

Figures III, IV and V show how the cash coefficient γ, the investment cash flow sensitivity estimate from model (I), varies as the recursive window is increased by increments of 500 observations. For each measure of financial development, there is clear evidence pointing to a decline in investment cash flow sensitivity as the degree of 'financial development' in the data increases. This evidence is consistent with the negative correlations already observed in Tables III & IV.

[6] Refer to Spanos (1986) regarding the method of recursive least squares in the context of heterogeneity.

FIGURE III

Recursive Estimates of Investment Cash Flow Sensitivity : Data sorted on Wurgler's *FINDEV*.

The estimated model is $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t / K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t / K_{t-1} is investment during year *t*, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t / K_{t-1} is cash flow during year *t* scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in Wurgler (2000). The data are sorted on the financial development index. The first observation is for a firm based in the most undeveloped capital market and the last observation is for a firm based in the most developed market. The model is estimated recursively using windows of observations of size 500, 1000, 1500 and so on. Increases in the window size correspond to a higher proportion of observations from more financially developed markets. The investment cash flow sensitivity estimate, γ, is plotted against the window size.

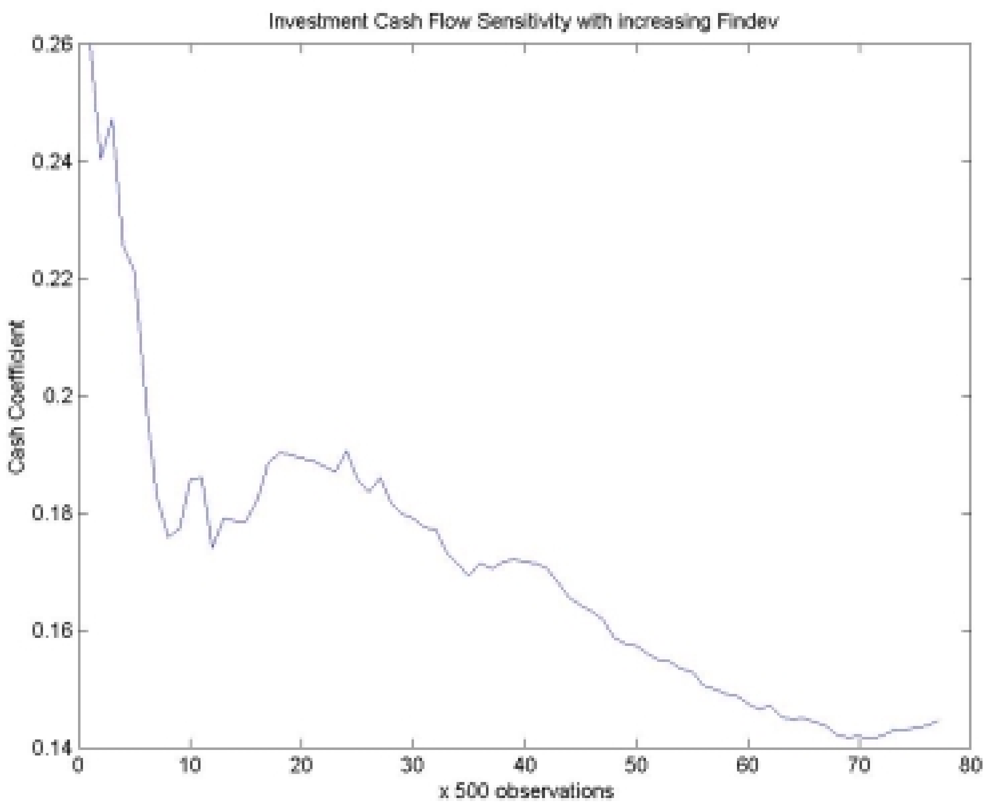


FIGURE IV

Recursive Estimates of Investment Cash Flow Sensitivity : Data sorted on LLSV's *FINDEV*.

The estimated model is $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t / K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t / K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t / K_{t-1} is cash flow during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV). The data are sorted on the financial development index. The first observation is for a firm based in the most undeveloped capital market and the last observation is for a firm based in the most developed market. The model is estimated recursively using windows of observations of size 500, 1000, 1500 and so on. Increases in the window size correspond to a higher proportion of observations from more financially developed markets. The investment cash flow sensitivity estimate, γ, is plotted against the window size.

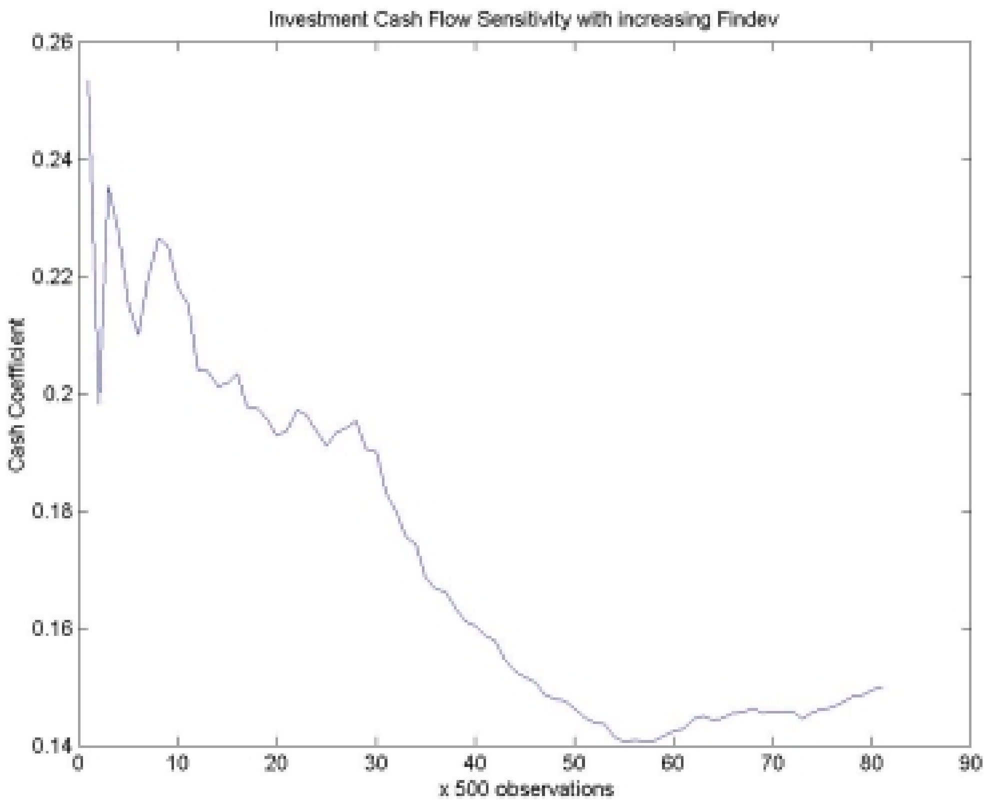
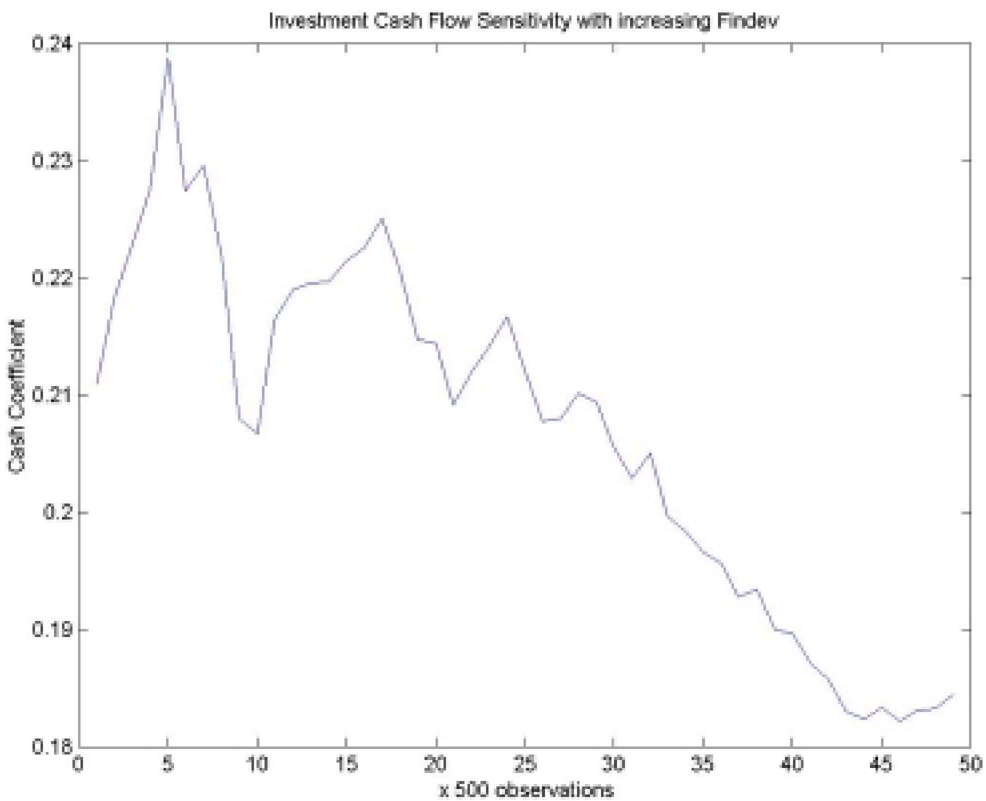


FIGURE V

Recursive Estimates of Investment Cash Flow Sensitivity : Data sorted on RZ's *FINDEV*.

The estimated model is $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t / K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t / K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t / K_{t-1} is cash flow during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in Rajan & Zingales (1998; RZ). The data are sorted on the financial development index. The first observation is for a firm based in the most undeveloped capital market and the last observation is for a firm based in the most developed market. The model is estimated recursively using windows of observations of size 500, 1000, 1500 and so on. Increases in the window size correspond to a higher proportion of observations from more financially developed markets. The investment cash flow sensitivity estimate, γ, is plotted against the window size.



IV. D Pooled Regressions – Developed versus Undeveloped Markets:

The relationship between investment cash flow sensitivities and the level of financial market development is further investigated by means of the following experiment. All firm-level observations sorted on the basis of the financial development index are divided into three equal groups. The first group comprises the top one-third of all observations, i.e., firm observations from countries which have less developed financial markets, the second group has firms from 'intermediate' developed financial markets, while group three comprises the bottom one-third of the observations, i.e., data on firms in financially developed countries. *A priori*, Group I firms are expected to be more financially constrained than Group III firms and the question of interest is to investigate which group of firms have investments that display a higher sensitivity to internal cash.

Table V shows the regression results on these two groups of firms. Regardless of the measure of financial index utilized, the investment cash flow sensitivity for Group I firms, i.e., firms that operate in less developed markets and are expected to be financially constrained, is higher than the investment cash flow sensitivity of Group III firms. As with the correlations estimated in Tables III and IV, results are stronger for Wurgler's and RZ's measures of financial than LLSV's measure. A Wald test for the difference in the cash flow coefficient for the two regressions further confirms that the estimated investment cash flow sensitivities are indeed significantly different for the two groups of firms. The results[7] remain qualitatively unchanged when only positive cash flow observations are used in the regression analysis.

An alternate way of grouping firms into financially constrained and unconstrained was done on the basis of whether the firm was based in an OECD country or not. The underlying assumption is that OECD countries are more developed and therefore firms based in these countries can be expected to be less financially constrained. Table VI reports the results of this experiment and the results are consistent with those of Table V - the average firm in non-OECD countries has a significantly higher investment cash flow sensitivity.

[7] Results not reported in Table V.

TABLE V

Investment Cash Flow Sensitivity Estimates for Groups Sorted on FINDEV.

The estimated model is $I_t\ /\ K_{t-1}\ =\ \alpha + \beta\ Q_t + \gamma\ W_t /K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. $I_t\ /\ K_{t-1}$ is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t /K_{t-1} is cash flow during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV), Rajan and Zingales (1998), and Wurgler (2000). Group I comprises firm observations from financially undeveloped countries (top one-third of all observations sorted on FINDEV) while Group III comprises firm observations from financially developed countries (bottom one-third of all observations sorted on FINDEV). Relevant t-stats are shown in parentheses.

All observations

Using Wurgler's Measure of FINDEV:

	GROUP I (Undev.)	**GROUP III (Dev)**	**t-stat : $\gamma_{GROUP\ I} \neq \gamma_{GROUP\ III}$**
Cash Flow, W_t /K_{t-1}	0.185 (31.91)	0.120 (27.68)	9.02
Q_t	0.062 (13.47)	0.071 (23.40)	

Using LLSV's Measure of FINDEV:

	GROUP I (Undev.)	**GROUP III (Dev)**	**t-stat : $\gamma_{GROUP\ I} \neq \gamma_{GROUP\ III}$**
Cash Flow, W_t /K_{t-1}	0.194 (34.90)	0.173 (36.62)	2.85
Q_t	0.061 (13.18)	0.065 (19.28)	

Non-US Data

Using RZ's Measure of FINDEV:

	GROUP I (Undev.)	**GROUP III (Dev)**	**t-stat : $\gamma_{GROUP\ I} \neq \gamma_{GROUP\ III}$**
Cash Flow, W_t /K_{t-1}	0.273 (29.22)	0.154 (27.46)	10.92
Q_t	0.037 (6.44)	0.066 (13.70)	

TABLE VI

Investment Cash Flow Sensitivity Estimates for OECD versus Non-OECD countries.

The estimated model is $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t / K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t / K_{t-1} *is* investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t / K_{t-1} is cash flow during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. The model is estimated for OECD and Non-OECD countries. Relevant t-stats are shown in parentheses.

	Non-OECD	**OECD**
Cash Flow, W_t	0.230 (10.75)	0.141 (52.63)
Q_t	0.022 (2.39)	0.072 (34.11)
Observations	1,864	36,901
Adj. R^2	0.075	0.171
t-stat : $\gamma_{Non\text{-}OECD} \neq \gamma_{OECD}$	***4.11***	

IV. E Pooled Regressions with Bootstrapped Test of Significance

Financial economists are aware of the limitations of traditional tests such as the Wald test and the Chow test in the context of panel data. For instance, the traditional Wald test requires independence of the error terms in the two sets of regressions being compared, while the Chow test assumes that the disturbance variance is the same for both regressions. For a study of this nature, where the panel data has a strong weightage on the cross-sectional dimension, the assumption of homoscedasticity in the resulting residuals is very likely violated. Thus, inferences based on traditional tests regarding significant differences in investment cash flow sensitivities for financially developed and undeveloped markets may be called into question.

As a means of circumventing these potential econometric problems, Cleary (1999) uses a bootstrapping methodology and generates empirical p-values to determine the significance of observed differences in coefficient estimates. We employ a similar methodology as a robustness check for our results obtained in the previous section.

The bootstrapping procedure estimates the likelihood of obtaining the observed differences in coefficient estimates from the two sets of regressions if the true coefficients are in reality equal. Suppose that the observed difference in the cash coefficients for Group I firms and Group III firms is $d_{observed}$. For example, using Wurgler's measure of *FINDEV*, $d_{observed} = 0.065$ (the difference between 0.185 and 0.120 in Table V). The null hypothesis is that the two cash coefficients are in fact identical, i.e. $d_{real} = 0$. The bootstrapping procedure randomly assigns firms to Groups I and III and calculates the difference in coefficient estimates, d_i, for each simulation. The empirical p-value is calculated as the percentage of simulations where d_i exceeds $d_{observed}$ and tests against the alternate hypothesis that $d_{real} > 0$ i.e. investment cash flow sensitivity of firms based in undeveloped markets (Group I firms) is higher than that of firms in developed markets. For example, an empirical p-value of 0.0164 in Table VII for the LLSV measure of *FINDEV* indicates that only 1.64% of all simulations (i.e. 164 outcomes out of 10,000 simulations in our case) had $d_i > d_{observed}$, thus strongly supporting the notion that the sample difference $d_{real} > 0$.

Our bootstrap procedure uses two underlying sets of observations for the empirical p-value estimation. In the first, the entire set of N observations is used. N/3 firm observations from this set are randomly selected and assigned to Group I while another N/3 random observations are assigned to Group III. Model I is estimated for the two groups and the difference in the cash coefficients, d_i, compared with $d_{observed}$ for each simulation. This process is repeated 10,000 times and the empirical p-value calculated as described above.

In the second approach, the underlying dataset for the bootstrap is the pooled set of our original Group I and Group III firms sorted on *FINDEV* i.e. the underlying dataset has 2N/3 observations. Out of these, half are randomly selected and assigned to Group I and the remaining half assigned to Group III. Note that this test is biased *against* rejecting the null hypothesis of $d_{real} = 0$.[8]

Table VII reports results for the bootstrap procedure. Using Wurgler's and RZ's measures of *FINDEV*, the empirical p-values are zero for both approaches, i.e. not a single outcome produced differences in coefficients which exceeded $d_{observed}$ lending strong support to the inference that the significantly higher investment cash flow sensitivity estimate for undeveloped markets is not at all likely to be a chance finding.

Using LLSV's measure of *FINDEV,* we get non-zero but very low empirical p-values which are consistent and with our overall result. As expected, the p-value for the second approach is higher than for the case when all observations are used in the bootstrap procedure. Our conclusion that investment cash flow sensitivity is negatively related to the degree of financial development is robust to all three measures of financial development.

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[8] Elementary combinatorial analysis suggests that while the probability of selecting random samples of Group I and Group III firms which are *identical* to our original Group I and Group III firms is $(N/3)!^3 / N!$ with the first approach, this probability *increases* to $(N/3)!^2 / (2N/3)!$ with the second approach.

TABLE VII

Bootstrapped P-Values: Investment Cash Flow Sensitivity Estimates for Groups Sorted on FINDEV.

The estimated model is $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t/K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t/K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t/K_{t-1} is cash flow during year t scaled by beginning of the year capital stock; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects; FINDEV is a country's financial development index as given in La Porta et al (1997; LLSV), Rajan & Zingales (1998), and Wurgler (2000). Group I comprises firm observations from financially undeveloped countries (top one-third of all observations sorted on FINDEV) and Group III comprises firm observations from financially developed countries (bottom one-third of all observations sorted on FINDEV). Relevant t-stats from the regressions are shown in parentheses. Two sets of bootstrapped p-values are generated, one using all observations and the second using a pool of observations of Group I & Group III firms. The empirical p-values are the percentage of simulations where the difference between the cash flow coefficient estimate (γ) for Group I & Group III firms is greater than the actual observed difference in coefficient estimates. Empirical p-values are generated using 10,000 simulations.

Groups formed using Wurgler's measure of FINDEV:

Regression Estimates	γ	β
Group I (Undev.)	0.185 (31.91)	0.062 (13.47)
Group III (Dev)	0.120 (27.68)	0.071 (23.40)
Empirical p-values for Group I versus Group III		
All observations	0.0000	
Pooled observations from Groups I & III	0.0000	

Groups formed using LLSV's measure of FINDEV:

Regression Estimates	γ	β
Group I (Undev.)	0.194 (34.90)	0.061 (13.18)
Group III (Dev)	0.173 (36.62)	0.065 (19.28)
Empirical p-values for Group I versus Group III		
All observations	0.0164	
Pooled observations from Groups I & III	0.0308	

Groups formed using RZ's measure of FINDEV:

Regression Estimates	γ	β
Group I (Undev.)	0.273 (29.22)	0.037 (6.44)
Group III (Dev)	0.154 (27.46)	0.066 (13.70)
Empirical p-values for Group I versus Group III		
All observations	0.0000	
Pooled observations from Groups I & III	0.0000	

IV. F Pooled Regressions – A Direct Approach:

As a final investigation of the relationship between investment cash flow sensitivity and financial development, we carry out the following pooled regression corresponding to our model (III):

$$I_t/K_{t-1} = \alpha + \beta Q_t + \gamma\, W_t/K_{t-1} + \delta\, W_t/K_{t-1}.FINDEV + FIRMDUM + YEARDUM + \varepsilon$$

where $W_t/K_{t-1}.FINDEV$ is an interactive variable between cash and *FINDEV*, the measure of financial development for the country in which the firm is based. If there is indeed a negative relationship between investment cash flow sensitivity and *FINDEV*, then we should obtain a significantly negative δ coefficient in the above regression model.

Table VIII shows the regression results for the three measures of *FINDEV*. Using all observations, the coefficient δ is negative and highly significant using Wurgler's and RZ's measures of financial development. However, δ is insignificant though having the expected negative sign using the LLSV measure.

The regressions are next carried out using only positive cash flow observations and similar results are obtained. Once again the downward bias caused by negative cash flows in the investment-cash flow sensitivity estimates is clearly evident with the γ coefficients for the positive cash flow sample being much greater than those for the entire sample[9]. The coefficient is now significantly different from zero at the 10% level of significance for the LLSV measure as well, in addition to being strongly significant for the Wurgler and RZ measures. Note that the investment cash flow sensitivity for the average firm in a country having a certain *FINDEV* is given by $\gamma + \delta.FINDEV$ as per the above model. Table IX shows the country-wise investment cash flow sensitivities[10] as per the Wurgler measure of financial development and once again the downward distortionary impact of negative cash flow observations is clearly evident.

[9] R^2 of the regressions with positive cash flows is always higher too.

[10] The investment cash flow sensitivity thus calculated would be that for the 'average' firm in that particular country.

TABLE VIII

Pooled Regression - Financial Development Effect.

The estimated model is $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t / K_{t-1} + \delta W_t . FINDEV/K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t / K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t / K_{t-1} is cash flow during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV), Rajan & Zingales (1998), and Wurgler (2000). Relevant t-stats are shown in parentheses.

A: Wurgler's Measure of FINDEV:

	All observations	Positive Cash observations	Non-US data
W_t / K_{t-1}	0.210 (15.90)	0.276 (18.09)	0.256 (16.03)
Q_t	0.068 (33.18)	0.061 (28.59)	0.055 (17.98)
$W_t . FINDEV / K_{t-1}$	-0.049 (-5.06)	-0.053 (-4.79)	-0.010 (-0.8)
No. of Observations	38,765	35,697	22,564
Adj. R^2	0.161	0.177	0.197

B: LLSV's Measure of FINDEV:

	All observations	Positive Cash observations	Non-US data
W_t / K_{t-1}	0.157 (27.03)	0.222 (31.72)	0.271 (33.33)
Q_t	0.067 (33.10)	0.060 (28.69)	0.056 (19.12)
$W_t . FINDEV / K_{t-1}$	-0.009 (-1.11)	-0.017 (-1.67)	-0.030 (-2.82)
No. of Observations	40,868	37,712	24,579
Adj. R^2	0.163	0.182	0.205

C: RZ's Measure of FINDEV for Non-US data:

	All observations	Positive Cash observations
W_t / K_{t-1}	0.324 (9.76)	0.374 (9.55)
Q_t	0.061 (20.91)	0.056 (18.69)
$W_t . FINDEV / K_{t-1}$	-0.002 (-4.23)	-0.002 (-3.26)
No. of Observations	24,599	22,837
Adj. R^2	0.189	0.206

TABLE IX

Country-wise Investment Cash Flow Sensitivity Estimates from Pooled Regressions and Wurgler's *FINDEV*

Investment cash flow sensitivities are calculated using the estimates of γ and δ from the pooled regression results shown in Table VIII and Wurgler's measure of *FINDEV*.

Country	**Wurgler's *FINDEV***	**Investment-Cash Flow Sensitivity Estimate**	
		All observations	***Positive cash flows***
AUSTRALIA	0.80	0.171	0.233
AUSTRIA	0.86	0.168	0.230
BELGIUM	0.55	0.183	0.246
CANADA	1.23	0.150	0.210
CHILE	0.85	0.169	0.230
DENMARK	0.72	0.175	0.237
FINLAND	0.81	0.171	0.232
FRANCE	1.06	0.158	0.219
GERMANY	1.22	0.150	0.211
INDIA	0.36	0.193	0.256
INDONESIA	0.28	0.197	0.261
IRELAND	1.42	0.141	0.200
ITALY	0.69	0.177	0.239
JAPAN	2.67	0.079	0.133
MALAYSIA	1.44	0.140	0.199
MEXICO	0.29	0.196	0.260
NETHERLAND	1.56	0.134	0.192
NORWAY	1.11	0.156	0.216
NEW ZEALAND	0.79	0.172	0.234
PORTUGAL	0.82	0.170	0.232
SINGAPORE	2.26	0.099	0.155
SOUTH KOREA	0.98	0.162	0.223
SPAIN	0.90	0.166	0.228
SWEDEN	1.43	0.140	0.199
UK	1.36	0.144	0.203
USA	1.44	0.140	0.199

The RZ index of financial development does not include a measure for United States. Hence estimation of model (III) using RZ's measure of *FINDEV* is based on firms from countries other than the USA. Since observations from US firms comprise almost a third of the data, and to make the results comparable across all three measures of *FINDEV*, model (III) is re-estimated for the Wurgler and LLSV measures but using non-US data. The third column in Table VIII shows the regression results for this case. The δ coefficient is negative for either measure though significantly different from zero only with the LLSV measure. These regression results are not only supportive of our main result regarding the negative relationship between investment cash flow sensitivity and financial development but also provide evidence against the possibility that our earlier results were driven by the disproportionately large number of observations from US firms in the Disclosure Worldscope dataset.

IV. G Robustness checks:

We have chosen the dependent investment variable in our regressions to be the firm's capital expenditure in a given year. Capital expenditure is usually investment in long-term assets such as new plant, equipment and machinery. These assets can generally be assumed to produce cash flows which occur with a delay. However, since we have used annual accounting data, there is albeit a small possibility that investments that occurred at the beginning of the accounting year could have produced cash flows towards the end of the year and were therefore recorded in the same accounting period as the investment outflow. Such a situation would, by default, lead to our observed positive relationship between firm investment and internal cash flow.

As a verification of the hypothesis that the causal relationship is the direction of internal cash flow leading to investment, we estimate model (III) with cash flow defined as previous year's net income and non-cash expenses Table X shows the results of using lag of cash flow in the regression model for the three measures of financial development. The coefficient on the lag of cash flow is positive and highly significant for each measure of FINDEV, confirming the hypothesis that internal cash drives investment and not vice-versa. The coefficient δ on the interactive *CASH* x *FINDEV* variable is negative and significant at the 10% level for Wurgler's measure, negative and significant at the 5% level for RZ's measure, but insignificant using the LLSV measure.

As a further robustness check, we repeat the exercise replacing current cash flow with the average of the current and previous years' (i.e. lagged) cash flows. The results, reported in Table XI, are similar to those of Table X. Cash flow is significantly positive for each measure of *FINDEV* and the interactive *CASH* x *FINDEV* variable is negative though significant only for the Wurgler and RZ measures. Our main results regarding the significance of internal cash in the firm investment decision and the negative relationship between investment cash flow sensitivity and financial development are further established.

Finally, we investigated the effect of financial development on the relationship between investment and internal cash by using firm-level average investment and cash values for the 1987-1997 period. The advantage of using mean values is two-fold: Firstly, it reduces the amount of noise in the observed cash and investment variable values at the firm level – noise that may be due to the presence of abnormal shocks in variables such as cash flow from one year to another; secondly, random measurement errors in the data can be expected to cancel out by the process of averaging across time. Table XII re-estimates specification (III)[11] by using average investment, cash and *q* values for each firm. The negative relationship between investment cash flow sensitivity and financial market development, observed in the form of highly significant negative coefficients on our interactive variable (*W.FINDEV)* and for each measure of *FINDEV*, confirms our principal finding. A secondary observation in Table XII is that the R^2 for the regressions using firm-level means are much higher. The process of averaging across time indeed gives a much cleaner description of the cross-sectional variation in investment cash flow sensitivity with respect to the financial development of capital markets.

[11] Since we are using average values, the dummy variables controlling for fixed firm and year effects are dropped.

TABLE X

Pooled Regression - Financial Development Effect with Lag of Cash.

The estimated model is $I_t /K_{t-1} = \alpha + \beta Q_t + \gamma W_t /K_{t-1} + \delta W_t \cdot FINDEV/K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t / K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t /K_{t-1} is cash flow during year t-1 scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV), Rajan & Zingales (1998), and Wurgler (2000). Relevant t-stats are shown in parentheses.

A: Wurgler's Measure of FINDEV:

W_t /K_{t-1}	0.167 (10.32)
Q_t	0.076 (37.32)
$W_t \cdot FINDEV /K_{t-1}$	-0.020 (-1.68)
No. of Observations	38,708
Adj. R^2	0.145

B: LLSV's Measure of FINDEV:

W_t /K_{t-1}	0.143 (20.57)
Q_t	0.076 (37.69)
$W_t \cdot FINDEV /K_{t-1}$	0.001 (0.12)
No. of Observations	40,805
Adj. R^2	0.144

C: RZ's Measure of FINDEV for Non-US data:

W_t /K_{t-1}	0.261 (5.86)
Q_t	0.070 (23.52)
$W_t \cdot FINDEV /K_{t-1}$	-0.001 (-2.30)
No. of Observations	24,429
Adj. R^2	0.155

TABLE XI

Pooled Regression - Financial Development Effect with Average of Current & Lag of Cash

The estimated model is $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t / K_{t-1} + \delta W_t . FINDEV/K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t / K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t / K_{t-1} is average of cash flows during years t and t-1, scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV), Rajan & Zingales (1998), and Wurgler (2000). Relevant t-stats are shown in parentheses.

A: Wurgler's Measure of FINDEV:

W_t / K_{t-1}	0.289 (16.08)
Q_t	0.058 (29.96)
$W_t . FINDEV / K_{t-1}$	-0.039 (-2.93)
No. of Observations	35,745
Adj. R^2	0.182

B: LLSV's Measure of FINDEV:

W_t / K_{t-1}	0.246 (30.96)
Q_t	0.057 (27.12)
$W_t . FINDEV / K_{t-1}$	-0.002 (-0.21)
No. of Observations	37,782
Adj. R^2	0.185

C: RZ's Measure of FINDEV for Non-US data:

W_t / K_{t-1}	0.509 (10.59)
Q_t	0.053 (17.35)
$W_t . FINDEV / K_{t-1}$	-0.003 (-4.85)
No. of Observations	22,744
Adj. R^2	0.201

Specification (III) employed above could be criticized on the grounds that if there did not exist sufficient variability in the *FINDEV* index measure, the W_t and W_t.*FINDEV* variables could be highly collinear. Although the regression results are free from the usual symptoms of multicollinearity i.e. a high R^2 with insignificant t-ratios for the regression coefficients, we nonetheless carried out various robustness tests not reported here. Multicollinearity was not found to be an issue and within generally accepted levels. For instance, collinearity diagnostics in *SAS* produced a maximum condition index number of 11.2. A condition index in excess of 30 is considered to be indicative of multicollinearity being a problem. (*Refer* Gujarati, "Basic Econometrics", 2nd Edition, pg. 301.)

As a further check, we repeated our tests after eliminating 5% of the most influential observations from our sample and the results were virtually unchanged. Our reported results are thus unlikely to have been driven by a few extreme observations.

There is one additional concern which we have not considered to this point and that is the impact of dividend policy on a firm's internal cash holdings and subsequently its investments. The standard practice in the investment cash flow sensitivity literature is to define internal cash flow as net income plus non cash expenses such as depreciation and amortization. This definition implicitly assumes that the firm's entire cash flows, net of interest expenses and taxes, are also available for investment. However, there exists a substantial body of evidence regarding firms' use of dividend policy as a signaling tool in the presence of information asymmetries between the firm's insiders and outside investors. For example, Bhattacharya (1979) and Miller & Rock (1985) have extended the standard models of finance by incorporating a role for dividends as a signal for future expected cash flows. Firms, therefore, have a preference for maintaining a consistent dividend policy at the expense of a certain cost of under-investment.

Given a firm's reluctance to align its dividend payments with actual cash flows, the sum of the firm's retained earnings plus non cash expenses is likely to be a better measure of the actual amount of internal funds available for investment. We therefore employ this measure of available cash flow as an additional robustness check in our investigation of the relationship describing the dependence of a firm's investment on its level of internally generated funds.

TABLE XII

Pooled Regressions Using Firm-level Mean Data - Financial Development Effect.

The estimated model is $I / K = \alpha + \beta Q + \gamma W/K + \delta W.FINDEV/K + \varepsilon$. I / K is the mean firm investment during the period 1987-1997, scaled by average beginning of the year capital stock; Q is average Tobin's Q for the same period; W/K is the average cash flow scaled by average beginning of the year capital stock; FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV), Rajan & Zingales (1998; RZ) and Wurgler (2000). Relevant t-stats are shown in parentheses.

A: Wurgler's Measure of FINDEV:

	All observations	Positive Cash-Flow observations
W/K	0.21313 (16.51)	0.22105 (17.41)
Q	0.04091 (13.27)	0.03550 (11.19)
W.FINDEV/K	-0.05888 (-6.42)	-0.05771 (-6.43)
No. of firms	5,661	5,438
R^2	0.2181	0.2240

B: LLSV's Measure of FINDEV:

	All observations	Positive Cash-Flow observations
W/K	0.19149 (27.03)	0.19930 (28.36)
Q	0.04093 (13.55)	0.03634 (11.72)
W.FINDEV/K	-0.08496 (-9.23)	-0.08258 (-9.26)
No. of firms	6,026	5,788
R^2	0.2266	0.2346

C: RZ's Measure of FINDEV with Non-US data:

	All observations	Positive Cash-Flow observations
W/K	0.50672 (13.85)	0.50002 (13.92)
Q	0.02690 (6.73)	0.02363 (5.76)
W.FINDEV/K	-0.00515 (-10.15)	-0.00494 (-9.95)
No. of firms	3,697	3,561
R^2	0.187	0.1916

Table XIII presents the results for these new sets of regressions where model (III) is re-estimated with internal cash flow defined as retained earnings plus non-cash expenses. All regression coefficients are highly significant and the results are consistent with our earlier findings regarding the cross-sectional pattern of investment cash flow sensitivities across the 31 countries in our sample. Investment is not only dependent on the availability of available internal cash but also investments of firms in less developed countries are more sensitive to the level of self-generated capital. The downward bias in the investment cash flow sensitivity estimates due to the presence of negative cash flow observations is also observed for the Wurgler and LLSV measures of *FINDEV*.

TABLE XIII

Pooled Regression - Financial Development Effect with Cash as Retained Earnings plus Depreciation & Amortization.

The estimated model is $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t/K_{t-1} + \delta W_t . FINDEV/K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t / K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t / K_{t-1} is cash flow during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV), Rajan & Zingales (1998), and Wurgler (2000). Relevant t-stats are shown in parentheses.

A: Wurgler's Measure of FINDEV:

	All observations	Positive Cash observations
W_t/K_{t-1}	0.098 (13.18)	0.105 (13.27)
Q_t	0.086 (39.76)	0.085 (37.41)
$W_t.FINDEV/K_{t-1}$	-0.017 (-3.31)	-0.017 (-3.15)
No. of Observations	35,351	32,459
R^2	0.143	0.141

B: LLSV's Measure of FINDEV:

	All observations	Positive Cash observations
W_t/K_{t-1}	0.097 (22.99)	0.222 (31.72)
Q_t	0.086 (40.46)	0.060 (28.69)
$W_t.FINDEV/K_{t-1}$	-0.032 (-5.35)	-0.034 (-1.67)
No. of Observations	37,376	34,426
R^2	0.143	0.143

C: RZ's Measure of FINDEV for Non-US data:

	All observations	Positive Cash observations
W_t/K_{t-1}	0.291 (9.65)	0.250 (7.16)
Q_t	0.079 (24.62)	0.077 (22.76)
$W_t.FINDEV/K_{t-1}$	-0.002 (-5.85)	-0.001 (-3.07)
No. of Observations	19,470	17,667
R^2	0.194	0.200

IV. H New measures of financial development:

A potential problem with the three measures of financial development employed so far in this study is that they are based on financial data that are not concurrent with our sample period. For example, the Wurgler measure is based on the average of equity and credit market data for the years 1980, 1985 and 1990 and GDP data for the year 1960. There is therefore the possibility that these measures do not adequately capture the 'correct' degree of financial market development for our 1987-1997 sample period.

In order to correct for any bias arising due to the above, we develop three additional measures of FINDEV using financial market data corresponding to our sample period. The first measure is the equivalent of the RZ measure where we use an accounting based index developed by the Center for International Financial Analysis & Research (CIFAR), Inc. This index attempts to capture the degree of accounting transparency for a country by analyzing annual reports of companies and a score based on the inclusion or omission of items from predetermined list of 90 reporting variables is then calculated.

The 90 reported variables are divided into seven broad groups:

- General Information (8 variables)
- Income Statement (11 variables)
- Balance Sheet (14 variables)
- Funds Flow Statement (5 variables)
- Accounting policies (20 variables)
- Stockholders' Information (20 variables)
- Other Supplementary Information Items (12 variables)

A country specific score is obtained by averaging the individual scores of the companies based in that particular country.

The number of representative companies in each country whose annual reports are scrutinized in the 1993 CIFAR survey report[12] varies from a low of 4 firms for countries such as Chile and

[12] The annual reports analyzed in the 1993 survey report are actually for the year 1991. If the 1991 report was unavailable, the previous year's annual report was used.

Ireland to a high of 276 companies for the USA. The first column of Table XIV shows these accounting-standards based scores for the 31 countries in our dataset. We have simply called this measure of financial development as the CIFAR index.

Our second measure of financial development is the average ratio of stock market capitalization to GDP for each country and for the years 1987-1997, the time period corresponding to our dataset. The stock market capitalization data were obtained from International Finance Corporation's (IFC) *Emerging Stock Markets Handbook*. The GDP data were obtained from IFC's *International Financial Statistics Yearbook*. We have called this measure of *FINDEV* the Equity-Based measure and we report it in column two of Table XIV.

We also attempted to form a measure based on the ratio of the size of a country's credit market[13] to GDP but were unable to resolve problems associated with frequent changes in accounting systems of several countries in our dataset. A case in point is Brazil which, for the period 1987-1997, had financial variables recorded under 4 different accounting systems, with every change accompanied by extreme swings in the reported credit-market items found in IFC's *International Financial Statistics Yearbook*. Equity market data, on the other hand, is based on observed *forward-looking* rational expectations of market participants. It is therefore more unlikely to be drastically affected by changes in the system of reporting historical financial information and thus, in our opinion, a better indicator of financial market development for our dataset.

Our last measure of financial development is based on a simple combination of the CIFAR and Equity based measures of *FINDEV;* we have called it the Combined measure. The third column of Table XIV shows these country-wise Combined measures of *FINDEV*. In particular, the Combined *FINDEV* for country *i* is equal to:

$$(Combined\ FINDEV)_i = 0.5 \times [(CIFAR)_i / \text{Max}\ (CIFAR) + (Equity)_i / \text{Max}\ (Equity)]$$

where Max (*CIFAR*) is the highest CIFAR score within our sample, namely Sweden with a score of 80, and likewise Max (*Equity*) is the country with the highest stock market capitalization to GDP ratio, namely Hong Kong with a score of 1.879. The rationale behind the Combined

[13] For estimating the size of the credit markets, we utilized IFC's *International Financial Statistics Yearbook* and looked for items that were equivalent to claims on the private and non-financial public sectors.

measure of FINDEV is thus: A country with a high CIFAR score is more likely to have a high Equity based score, and vice versa. Similarly, a country with a low CIFAR score would be expected to have a low Equity based score, and vice versa. Thus, if both the CIFAR and Equity based measures are 'correctly' measured and of similar magnitudes, the combined measure would also be of equivalent magnitude. However, if the two indices are of vastly different magnitudes, one of the two is likely to have been mis-measured and the process of averaging would reduce the measurement error. For example, a country with a low CIFAR score could have temporarily witnessed a stock market run-up towards the end of the year which got reflected in an abnormally high equity-based measure. On the other hand, a country such as Austria with a relatively better developed equity market than, say, Pakistan could have a lower CIFAR rating purely by chance if the small group of 9 Austrian firms that were scrutinized for the 1993 CIFAR survey were not representative of the typical Austrian firm.

TABLE XIV

New Financial Development (FINDEV) Measures

The 3 new measures of *FINDEV* are developed using country-specific financial information for the period 1987-1997, as explained in Section IV.H

Country	*CIFAR measure*	*Equity-Based measure*	*Combined Measure*
AUSTRALIA	78	0.716	0.678
AUSTRIA	57	0.118	0.388
BELGIUM	68	0.372	0.524
BRAZIL	64	0.186	0.450
CANADA	70	0.577	0.591
CHILE	65	0.739	0.603
DENMARK	66	0.322	0.498
FINLAND	74	0.294	0.541
FRANCE	74	0.313	0.546
GERMANY	65	0.241	0.470
HONGKONG	73	1.879	0.956
INDIA	52	0.246	0.390
INDONESIA	-	0.151	0.080
IRELAND	74	0.257	0.531
ITALY	65	0.173	0.452
JAPAN	70	0.893	0.675
MALAYSIA	74	1.784	0.937
MEXICO	65	0.267	0.477
NETHERLANDS	69	0.670	0.610
NORWAY	76	0.246	0.540
NEW ZEALAND	71	0.997	0.709
PORTUGAL	50	0.188	0.363
SOUTH AFRICA	72	1.544	0.861
SINGAPORE	73	1.335	0.812
SOUTH KOREA	68	0.396	0.530
SPAIN	65	0.308	0.488
SWEDEN	80	0.616	0.664
SWITZERLAND	70	1.073	0.723
THAILAND	60	0.479	0.502
UK	79	1.109	0.789
USA	72	0.774	0.656

As a final robust check, we now re-estimate our model (III) specification using the three new measures of FINDEV. Table XV reports the results for these new sets of regressions. Column I reports the results using all observations while column II estimates the regression model after eliminating negative cash flow observations. Our results from this table are by far the strongest (all regression coefficients using all three measures are highly significant) and each of our hypotheses is further confirmed. Our conclusions from this section are summarized below:

1. Investment is sensitive to the level of internal cash generated by the firm and there is strong evidence supporting the hypothesis that internal funds have a non-trivial role in describing a firm's investment behavior.
2. The cross-sectional pattern of investment cash flow sensitivities observed across different countries provides international evidence in support of the FHP hypothesis: Firms based in less developed countries and emerging markets face greater financing constraints which are reflected in their higher sensitivity of investment to internal cash.
3. There is a distinct downward bias in the investment cash flow sensitivity estimates due to the inclusion of negative cash flow observations. This is strong evidence in support of Allayanis and Mozumdar (2001) who were the first to document the distortionary impact of negative cash flow observations in the empirical examination of the relationship between firm investment and internal funds.

TABLE XV

Pooled Regression - Financial Development Effect – New FINDEV Measures

The estimated model is $I_t /K_{t-1} = \alpha + \beta Q_t + \gamma W_t /K_{t-1} + \delta W_t . FINDEV/K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t /K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t /K_{t-1} is cash flow during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. *FINDEV* is a measure of a country's financial development as explained in section IV.H

A: CIFAR Measure of FINDEV:

	All observations	Positive Cash observations
W_t /K_{t-1}	0.287 (7.14)	0.362 (7.46)
Q_t	0.067 (33.32)	0.060 (28.87)
$W_t . FINDEV /K_{t-1}$	-0.002 (-3.41)	-0.002 (-3.10)
No. of Observations	40,683	37,530
R^2	0.165	0.184

B: Equity Market Based Measure of FINDEV:

	All observations	Positive Cash observations
W_t /K_{t-1}	0.163 (24.85)	0.228 (29.22)
Q_t	0.067 (33.15)	0.060 (28.73)
$W_t . FINDEV /K_{t-1}$	-0.016 (-2.02)	-0.021 (-2.28)
No. of Observations	40,868	37,712
R^2	0.163	0.182

C: Combined Measure of FINDEV :

	All observations	Positive Cash observations
W_t /K_{t-1}	0.194 (12.40)	0.665 (14.29)
Q_t	0.067 (33.20)	0.060 (28.76)
$W_t . FINDEV /K_{t-1}$	-0.066 (-2.80)	-0.080 (-2.88)
No. of Observations	40,868	37,712
R^2	0.163	0.182

CHAPTER V

INVESTMENT CASH FLOW SENSITIVITY AND SIZE

Our results from the previous chapter are in direct contrast to two recent investment cash flow sensitivity studies using international data. Kadapakkam, Kumar & Riddick (1998) examine the influence of cash flow on firm investment in six OECD countries and find that contrary to their a priori expectations, cash-flow investment sensitivity was higher in larger firms than for smaller firms that are known to have less access to external capital markets. In other words, larger unconstrained firms displayed greater investment cash flow sensitivity, a result consistent with the KZ proposition.

From the investment cash flow sensitivity perspective, the Kadapakkam et al (1998) result is surprising due to the following reasons. First of all, large firms face lower flotation and transactions costs when they raise money from external capital markets. Secondly, large firms are less likely to suffer from information asymmetry problems on account of several reasons: there is more easily-accessible public information available for them, they are actively monitored by investment advisors and securities analysts, and they very often have large institutional shareholdings in them.

A more recent study in similar spirit, and using international data, is Cleary (2001) who uses panel data from 7 OECD countries and finds that for 6 of the 7 countries in his sample, the more constrained firm within each country displays the lower investment cash flow sensitivity[14]. Cleary (2001) also categorizes firms into size groups according to total assets and once again finds that in 6 of his 7 countries, the larger firms display a greater investment cash flow sensitivity. At first sight, the Cleary (2001) results appear similar to those of Kadapakkam et al (1998). However, there is a difference in the way Cleary (2001) controls for expected future profitability in his regression equation. To be more specific, Cleary uses the firm's market-to-

[14] Cleary (2001) follows the approach of Cleary (1999) and classifies firms into constrained and unconstrained categories on the basis of an index that is determined using multiple discriminant analysis. Discriminant analysis transforms a series of firm specific financial characteristics such as current ratio, debt ratio, net income margin etc. into a univariate score which is then used as a proxy for the degree of financing constraints.

book ratio as a control for growth opportunities in his regressions and the results suggest that for his particular sample, the M/B ratio does a very poor job of controlling for growth opportunities since for 5 of the 7 countries, the M/B coefficient is not only insignificant for at least two of the three size tertiles but also very often *negative*. It is improbable that investment would be insignificantly related to future growth opportunities, and even less probable that the relation be negative. We are therefore skeptical of this particular study's conclusion that the larger firm displays greater investment cash flow sensitivity for these countries and think it worthwhile to explore the cross-sectional pattern of investment cash flow sensitivities across firm size in our dataset.

V. A Size Effect - Within Countries:

We choose 6 OECD countries that are common to the Kadapakkam et al (1998) and Cleary (2001) studies. These countries are Canada, France, Germany, Japan, UK and USA. We follow the approach of Cleary (2001) and form tertiles based on firms' total assets. We estimate our model (I) and compare the cash flow coefficients for the largest and smallest size tertiles.

Table XVI reports the results for these country-wise regressions. We find that for 3 of our 6 countries, namely Canada, France and Germany, the investment cash flow sensitivity of the smallest tertile of firms is as reported by Kadpakkam et al (1998) and Cleary (2001), i.e the investment cash flow sensitivity of smaller firms is lower. However, the difference in the cash flow coefficient estimates for the large versus small groups of firms is significant (at the 10% level or higher) only for Canada.

The other 3 countries in our sample, namely Japan, UK and USA convey a different picture. The investment cash flow sensitivity of the smaller firm is greater in these countries, a result consistent with the FHP hypothesis. However, once again, the difference in the cash flow coefficient estimates for the large versus small groups of firms is significant (at the 5% level or higher) for one country, UK, and marginally significant (at the 10% level) for Japan. US firms do not display any significant size effect in our sample.

We offer the following explanation for the lack of a significant size effect that we observe within each country. As mentioned earlier, the Disclosure Worldscope database compiles financial information on large, publicly traded firms only. It is therefore possible that within our sample, there is not sufficient heterogeneity in terms of firm size to enable one to segregate firms into distinct large and small group tertiles and this, perhaps, gets reflected in the similar investment cash flow sensitivities across size groupings for 3 of our 6 countries. However, firms *across* countries are more likely to differ in terms of size, enabling us to pick up a size effect if one exists. We pursue this line of enquiry next.

TABLE XVI

Country-Wise Size Effect:

The estimated model is $I_t\ /\ K_{t-1}\ =\ \alpha + \beta\ Q_t + \gamma\ W_t\ /K_{t-} + FIRMDUM + YEARDUM + \varepsilon$. $I_t\ /\ K_{t-1}$ is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; $W_t\ /K_{t-1}$ is cash flow during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. GROUP_SMALL comprises firm observations from the top tertile of all observations sorted on total assets while GROUP_LARGE comprises firm observations from the bottom tertile .

Country : CANADA

	N	Median firm size	$W_t\ /K_{t-1}$	Q_t	Adj. R^2
GROUP_SMALL	575	$72.3 m	0.151 (5.20)	0.115 (6.29)	0.14
GROUP_LARGE	574	$1522.1 m	0.296 (8.13)	0.071 (3.32)	0.17

T-stat for difference of cash flow coefficient : -3.11

Country : FRANCE

	N	Median firm size	$W_t\ /K_{t-1}$	Q_t	Adj. R^2
GROUP_SMALL	774	$56.7 m	0.258 (10.84)	0.060 (2.55)	0.16
GROUP_LARGE	773	$2974.9 m	0.298 (12.56)	0.02 (0.90)	0.18

T-stat for difference of cash flow coefficient : -1.19

Country : GERMANY

	N	Median firm size	$W_t\ /K_{t-1}$	Q_t	Adj. R^2
GROUP_SMALL	654	$56.1 m	0.284 (7.64)	0.052 (1.90)	0.09
GROUP_LARGE	653	$2045.3 m	0.366 (10.26)	0.125 (4.13)	0.19

T-stat for difference of cash flow coefficient : -1.59

Country : JAPAN

	N	Median firm size	$W_t\ /K_{t-1}$	Q_t	Adj. R^2
GROUP_SMALL	654	$702.3 m	0.449 (10.87)	0.074 (6.01)	0.26
GROUP_LARGE	654	$9625.3 m	0.354 (9.67)	0.104 (7.84)	0.29

T-stat for difference of cash flow coefficient : 1.72

Country : UK

	N	Median firm size	W_t/K_{t-1}	Q_t	Adj. R^2
GROUP_SMALL	2212	$21.5 m	0.290 (21.68)	0.075 (8.37)	0.26
GROUP_LARGE	2211	$732.8 m	0.196 (15.99)	0.044 (5.54)	0.13

T-stat for difference of cash flow coefficient : 5.18

Country : USA

	N	Median firm size	W_t/K_{t-1}	Q_t	Adj. R^2
GROUP_SMALL	4377	$64.7 m	0.159 (20.47)	0.059 (11.49)	0.15
GROUP_LARGE	4378	$1727.5 m	0.146 (17.98)	0.051 (11.36)	0.13

T-stat for difference of cash flow coefficient : 1.16

V. B Size Effect - Across Countries:

We start with pooling observations from all countries, sorting them on firm size (defined as the log of total assets in US dollars), and recursively estimating model (I) for increasing windows of observations[15]. Figure VI shows the behavior of investment cash flow sensitivities with increasing firm size. Although we observe a steep decline initially as firm size increases, the decline is not monotonic and becomes more or less constant once firm size reaches a certain level. We repeat the recursive estimation with only positive cash flow observations and show the results in Figure VII.

The interesting difference between Figures VI and VII is that the decline in Figure VII is more steady compared to the abrupt fluctuations observed in Figure VI. Once again there is evidence that inclusion of negative cash flow observations 'corrupts' the data in specific ways.

Figures VI and VII can also explain our inability to find a significant size effect *within* the 6 OECD countries that we examined in the previous section. Investment cash flow sensitivities are observed to decline steadily at first but as firm size reaches a certain 'threshold' level, these sensitivities become more or less constant. In fact our sample of firms from the 6 OECD countries is most likely comprised almost entirely of firms that are greater in size than this 'threshold' level and lie on the right-hand portions of Figures VI and VII. Evidently there is no significant size effect in the right-hand side of these graphs.

[15] The process is akin to the recursive regressions we carried out in our investigation of the effect of financial development in the previous chapter.

FIGURE VI

Recursive Estimates of Investment Cash Flow Sensitivity : Data Sorted on Size (All Observations)

The estimated model is $I_t / K_{t-1} = \alpha + \beta\, Q_t + \gamma\, W_t / K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t / K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t / K_{t-1} is cash flow during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. The data are sorted on firm size with size defined as the log of total firm assets (in US$). The first observation is for the smallest firm and the last observation is for a largest firm in terms of total assets. The model is estimated recursively using windows of observations of size 500, 1000, 1500 and so on. Increases in the window size correspond to a higher proportion of observations from more financially developed markets. The investment cash flow sensitivity estimate, γ, is plotted against the window size.

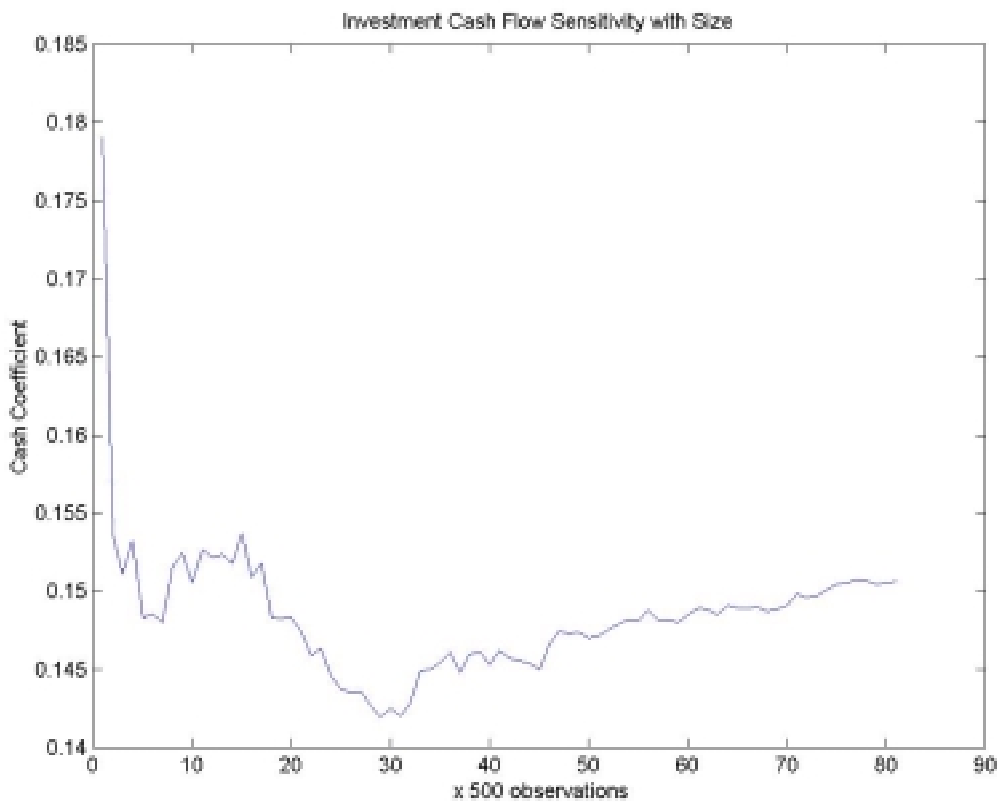
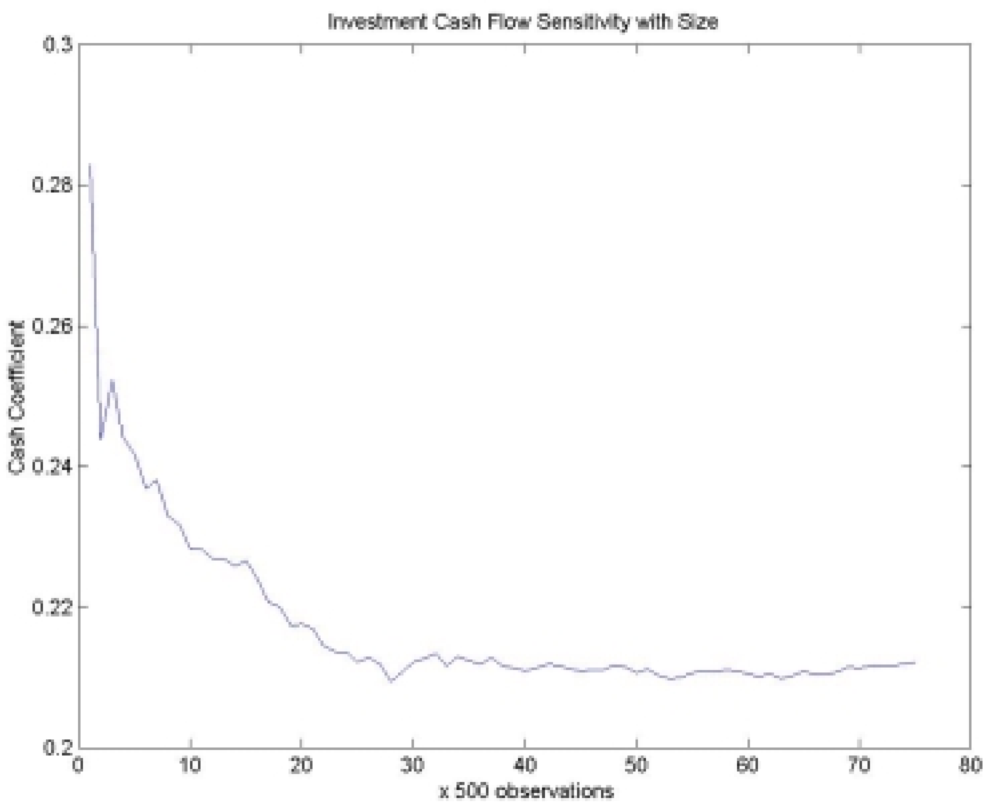


FIGURE VII

Recursive Estimates of Investment Cash Flow Sensitivity : Data sorted on Size (Positive cash flow observations)

The estimated model is $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t / K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. I_t / K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t / K_{t-1} is cash flow during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. The data are sorted on firm size with size defined as the log of total firm assets (in US$). The first observation is for the smallest firm and the last observation is for a largest firm in terms of total assets. The model is estimated recursively using windows of observations of size 500, 1000, 1500 and so on. Increases in the window size correspond to a higher proportion of observations from more financially developed markets. The investment cash flow sensitivity estimate, γ, is plotted against the window size.



In general, Figures VI and VII are similar to Figures III-V in the previous chapter where we investigated the pattern of investment cash flow sensitivities across countries with varying degree of financial market development. This raises an issue that we have not considered till now: It is very likely that firms based in more developed countries may be larger in size too since better access to external capital markets would lead to reduced under-investment costs in these markets and subsequently a higher equilibrium level of total investments. This conjecture is also borne out by the simple investment model shown in the appendix. As seen from the figure on page 103, for the same level of initial internal wealth and investment opportunities, the equilibrium total investment for the firm based in the more developed market, corresponding to the point B, is greater than point A, the total investment for the firm based in the less developed country.

Given this scenario, could it be possible that the negative relationships between investment cash flow sensitivity and financial development that we have documented so far were actually a manifestation of the size effect, with the *FINDEV* index of a country proxying for the average firm size in that country? Conversely, the negative relationship between firm size and investment cash flow sensitivity observed in Figures VI-VII could purely be the effect of financial development on investment cash flow sensitivity, with average firm size proxying for the degree of financial market development in this case. The only way we can be certain of both a financial development effect and a size effect is to have both explanatory variables present in our model specification.

We therefore employ a variation of our model (III) specification by interacting the cash flow term with both *SIZE* and *FINDEV*, i.e. our regression equation is:

$$I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t/K_{t-1} + \delta W_t . FINDEV/K_{t-1} + \zeta W_t . SIZE_{t-1}/K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$$

Table XVII reports our regression results for this specification using our three previous measures of *FINDEV* available in the literature, i.e. the Wurgler, LLSV, and RZ measures. Since the RZ measure is available only for countries other than the US, and to make our results comparable, we also estimate our regression model using only non-US data. For Wurgler's measure of *FINDEV*, the δ and ζ coefficients are negative and highly significant together for positive cash flow observations. With all observations and non-US data, they always have the 'correct' negative sign, but only one of the two coefficients is significantly different from zero. For the LLSV measure, both coefficients are significantly negative with positive cash flow observations and with non-US data but the results are insignificant when negative cash flows are included in the estimation. For the RZ measure, both coefficients are always negative, whether negative cash flow observations are included or not. Table XVII leads us to conclude that both financial development and firm size have power in explaining the observed cross-sectional patterns of cash-flow investment sensitivity.

As a further check, we re-estimate our regression model using the three new measures of *FINDEV* developed in section IV.H. Recall that these measures were developed using financial information for 1987-1997 so as to be concurrent with our firm-level data sample period. Table XVIII, panels A to C, reports the results for the CIFAR, Equity market-based and Combined measures of *FINDEV* respectively. The results are similar to those of the previous table. Both δ and ζ coefficients are negative and highly significant for positive cash flow observations, but only the *FINDEV* coefficient is consistently significant when all observations are included.

TABLE XVII

Pooled Regression - Financial Development and Size Effect.

The estimated model is $I_t\ /\ K_{t-1}\ =\ \alpha + \beta\ Q_t + \gamma\ W_t\ /K_{t-1} + \delta\ W_t\ .\ FINDEV/K_{t-1} + \zeta\ W_t\ .SIZE_{t-1}\ /K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. $I_t\ /\ K_{t-1}$ is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; $W_t\ /K_{t-1}$ is cash flow during year t scaled by capital stock at the beginning of the year; $\boldsymbol{SIZE_{t-1}}$ is the log of the firm's total assets (in US$) at the beginning of the year. *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV), Rajan & Zingales (RZ; 1998), and Wurgler (2000). Relevant t-stats are shown in parentheses.

A: Wurgler's Measure of FINDEV:

	All observations	Positive Cash observations	Non-US data
$W_t\ /K_{t-1}$	0.235 (10.86)	0.346 (13.61)	0.354 (10.90)
Q_t	0.068 (33.21)	0.062 (28.69)	0.055 (17.95)
$W_t\ .FINDEV\ /K_{t-1}$	-0.049 (-5.01)	-0.051 (-4.53)	-0.007 (-0.59)
$W_t\ .\boldsymbol{SIZE_{t-1}}\ /K_{t-1}$	-0.002 (-1.43)	-0.006 (-3.47)	-0.009 (-3.48)
No. of Observations	38,765	35,697	22,564
Adj. R^2	0.161	0.177	0.198

B: LLSV's Measure of FINDEV:

	All observations	Positive Cash observations	Non-US data
$W_t\ /K_{t-1}$	0.162 (8.32)	0.286 (12.22)	0.359 (11.58)
Q_t	0.067 (33.08)	0.060 (28.78)	0.056 (19.14)
$W_t.FINDEV\ /K_{t-1}$	-0.010 (-1.11)	-0.022 (-2.17)	-0.037 (-3.42)
$W_t\ .\boldsymbol{SIZE_{t-1}}\ /K_{t-1}$	-0.0004 (-0.27)	-0.005 (-2.86)	-0.007 (-2.96)
No. of Observations	40,868	37,712	24,579
Adj. R^2	0.163	0.182	0.205

C: RZ's Measure of FINDEV for Non-US data:

	All observations	Positive Cash observations
$W_t\ /K_{t-1}$	0.432 (9.11)	0.539 (9.65)
Q_t	0.061 (20.93)	0.056 (18.70)
$W_t.FINDEV\ /K_{t-1}$	-0.002 (-4.95)	-0.002 (-4.26)
$W_t\ .\boldsymbol{SIZE_{t-1}}\ /K_{t-1}$	-0.007 (-3.18)	-0.010 (-4.14)
No. of Observations	24,599	22,837
Adj. R^2	0.190	0.207

TABLE XVIII

Pooled Regression - Financial Development and Size Effect using our measures of FINDEV.

The estimated model is $I_t\ /\ K_{t-1}\ =\ \alpha + \beta\ Q_t + \gamma\ W_t\ /K_{t-1} + \delta\ W_t\ .\ FINDEV/K_{t-1} + \zeta\ W_t\ .\mathbf{SIZE}_{t-1}\ /K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$. $I_t\ /\ K_{t-1}$ is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; $W_t\ /K_{t-1}$ is cash flow during year t scaled by capital stock at the beginning of the year; $\mathbf{SIZE}_{t-1}$ is the log of the firm's total assets (in US$) at the beginning of the year. *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as explained in section IV.H. Relevant t-stats are shown in parentheses.

A: CIFAR Measure of FINDEV:

	All observations	Positive Cash observations
$W_t\ /K_{t-1}$	0.305 (6.41)	0.459 (8.00)
Q_t	0.067 (33.32)	0.061 (28.96)
$W_t\ .FINDEV\ /K_{t-1}$	-0.002 (-3.48)	-0.002 (-3.66)
$W_t\ .\mathbf{SIZE}_{t-1}\ /K_{t-1}$	-0.001 (-0.70)	-0.006 (-3.16)
No. of Observations	40,683	37,530
Adj. R^2	0.165	0.184

B: Equity Market Based Measure of FINDEV:

	All observations	Positive Cash observations
$W_t\ /K_{t-1}$	0.170 (8.70)	0.292 (12.43)
Q_t	0.067 (33.14)	0.060 (28.82)
$W_t.FINDEV\ /K_{t-1}$	-0.016 (-2.06)	-0.025 (-2.68)
$W_t\ .\mathbf{SIZE}_{t-1}\ /K_{t-1}$	-0.001 (-0.39)	-0.005 (-2.87)
No. of Observations	40,868	37,712
Adj. R^2	0.163	0.182

C: Combined Measure of FINDEV :

	All observations	Positive Cash observations
$W_t\ /K_{t-1}$	0.205 (8.02)	0.338 (11.09)
Q_t	0.067 (33.19)	0.060 (28.86)
$W_t.FINDEV\ /K_{t-1}$	-0.068 (-2.86)	-0.094 (-3.34)
$W_t\ .\mathbf{SIZE}_{t-1}\ /K_{t-1}$	-0.001 (-0.56)	-0.006 (-3.02)
No. of Observations	40,868	37,712
Adj. R^2	0.163	0.182

Our conclusions from this section are summarized below:

1. We confirm the fact that investment is sensitive to the level of internal cash generated by the firm and that internal funds have a non-trivial role in describing a firm's investment behavior.
2. We confirm the negative relationship between cash-flow sensitivity of investment to the degree of financial market development after controlling for firm size.
3. We document international evidence of a significant size effect that is in accordance with the FHP hypothesis. After controlling for the level of financial development, smaller firms exhibit greater investment cash flow sensitivities.
4. We once again highlight the problems and distortions caused by the inclusion of negative cash flow observations in the investment cash flow sensitivity estimation procedure, thereby providing further support for Allayanis and Mozumdar (2001).

CHAPTER VI

CASH FLOW VERSUS VALUE-ADDED AND THE MODEL SPECIFICATION PROBLEM

In a recent paper on the efficiency of financial markets in allocating capital, Wurgler (2000) presented industry-level evidence indicating that investments are more responsive to value added in countries that have better developed financial markets. Arguing that value added is a useful proxy for measuring future profitability, he concluded from this evidence that development of the financial sector improves a country's ability to increase investments in growing industries, and decrease investments in declining industries, i.e., to allocate capital more effectively.

Although Wurgler's conclusions seem economically intuitive, it is important to examine if they necessarily follow from his findings, particularly in the context of the investment cash flow sensitivity literature which has been the primary focus of this study. Wurgler (2000) uses value added to measure future profitability and given that value added is the difference between revenues and cost of goods sold, it would be closely related to cash flow. Thus, under this scenario, it is natural to ask whether value added measures future profitability or current cash flow. Although Wurgler (2000) presents evidence that value added is positively correlated with Tobin's *q* for a subset of his sample[16], it does not settle the issue conclusively since value added is likely to be positively correlated with both future profitability and current cash flow. The only way to isolate the two effects would be to control for future profitability through a separate proxy in the model specification. Unfortunately, this is not possible with the Wurgler (2000) data, since information on Tobin's *q* or other market-to-book ratios is not available at the industry level for the non-U.S. portions of his sample.

Wurgler (2000) recognizes the potential severity of the problem himself. However, he argues that the nature of his results is not consistent with an explanation based on FHP's internal cash hypothesis, since that would imply that investment in countries with more developed financial markets have to rely more on internal cash. Specifically, he states:

[16] For the U.S. data.

"[F]irms in some countries can be differentially financially constrained, which could show up as a higher sensitivity of investment to current cash flow by the logic of Fazzari et al. (1988). This could be a problem if value added growth measures internal cash flow more than investment opportunities. However, the pattern of elasticity estimates across countries is inconsistent with this interpretation. One would need to explain why firms in Germany and the U.S. (which have comparatively high elasticity estimates) are more financially constrained than firms in India and Indonesia, for example. Only the reverse pattern is plausible."

We have, however, already mentioned the recent evidence such as KZ (1997) and Cleary (1999) that supports the cross-sectional pattern of investment-cash flow sensitivity that Wurgler (2000) characterizes as implausible. It is therefore worthwhile to investigate the Wurgler result in the context of the investment cash flow sensitivity literature.

VI.A A closer look at Wurgler (2000):

The main result of Wurgler (2000) is that investments are more strongly related to value added for firms that are based in more developed financial markets, where value added is defined as the difference between sales and cost of goods sold. Value added is thus an approximate measure of gross operating profit and is likely to be highly correlated to internal cash flow. In other words, we should expect similar results if cash, W_t, in our model (III) was replaced with value added, V_t. Accordingly, we estimated the following specification:

$$I_t / K_{t-1} = \alpha + \beta Q_t + \gamma V_t / K_{t-1} + \delta V_t . FINDEV / K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$$

Table XIX displays results for our six measures of *FINDEV*. The results are indeed very similar to those in Tables VIII and XV where internal cash was the independent variable. The striking observation is that the coefficient δ is significantly negative with all measures of *FINDEV* - evidence that is totally contrary to the Wurgler result.

TABLE XIX

Pooled Regressions with Value Added as Independent Variable : Levels specification

The estimated model is: $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma V_t /K_{t-1} + \delta V_t .FINDEV/K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$ where I_t/K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; V_t /K_{t-1} is 'value added' defined, as in Wurgler (2000), as sales minus cost of goods sold during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV), Rajan & Zingales (1998; RZ) and Wurgler (2000) or as developed in Section IV.H. Relevant t-stats are shown in parentheses.

1. Wurgler's Measure of FINDEV:

V_t /K_{t-1}	0.135 (21.62)
Q_t	0.066 (32.58)
$V_t.FINDEV /K_{t-1}$	-0.025 (-5.60)
Observations	40,384
Adj. R^2	0.178

2. LLSV's Measure of FINDEV:

V_t /K_{t-1}	0.119 (36.26)
Q_t	0.065 (32.84)
$V_t.FINDEV /K_{t-1}$	-0.022 (-4.56)
Observations	42,776
Adj. R^2	0.182

3. RZ's Measure of FINDEV:

V_t /K_{t-1}	0.246 (13.10)
Q_t	0.067 (22.47)
$V_t.FINDEV /K_{t-1}$	-0.002 (-6.91)
Observations	26,300
Adj. R^2	0.195

4. CIFAR Measure of FINDEV:

V_t /K_{t-1}	0.276 (12.46)
Q_t	0.065 (32.77)
$V_t.FINDEV /K_{t-1}$	-0.002 (-7.73)
Observations	42,571
Adj. R^2	0.183

5. Equity Measure of FINDEV:

V_t /K_{t-1}	0.124 (33.63)
Q_t	0.066 (32.94)
$V_t.FINDEV /K_{t-1}$	-0.025 (-5.46)
Observations	42,563
Adj. R^2	0.183

6. Combined Measure of FINDEV:

V_t /K_{t-1}	0.166 (19.24)
Q_t	0.066 (32.98)
$V_t.FINDEV /K_{t-1}$	-0.093 (-7.14)
Observations	42,563
Adj. R^2	0.184

TABLE XX

Pooled Regressions with Value Added as Independent Variable : Logs specification

The estimated model is: $ln\ (I_t\_/\ K_{t-1}) = \alpha + \beta\ ln(\ Q_t\ ) + \gamma\ ln(\ V_t\ /K_{t-1}) + \delta\ ln(\ V_t\ /K_{t-1}\ ).FINDEV + FIRMDUM + YEARDUM + \varepsilon$. I_t/K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; $V_t\ /K_{t-1}$ is 'value added' defined, as in Wurgler (2000), as sales minus cost of goods sold during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV), Rajan & Zingales (1998; RZ) and Wurgler (2000) or as developed in Section IV.H. Relevant t-stats are shown in parentheses.

1. Wurgler's Measure of FINDEV:

$ln(\ V_t/K_{t-1})$	0.247 (11.45)
$ln(Q_t)$	0.526 (40.36)
$ln(\ V_t/K_{t-1}\ ).FINDEV$	0.167 (10.42)
Observations	40,192
Adj. R^2	0.222

2. LLSV's Measure of FINDEV:

$ln(\ V_t/K_{t-1})$	0.419 (35.22)
$ln(Q_t)$	0.535 (42.33)
$ln(\ V_t/K_{t-1}\ ).FINDEV$	0.075 (4.42)
Observations	42,563
Adj. R^2	0.221

3. RZ's Measure of FINDEV:

$ln(\ V_t/K_{t-1})$	0.325 (4.74)
$ln(Q_t)$	0.539 (30.14)
$ln(\ V_t/K_{t-1}\ ).FINDEV$	0.001 (1.52)
Observations	26,300
Adj. R^2	0.231

4. CIFAR Measure of FINDEV:

$ln(\ V_t/K_{t-1})$	0.226 (2.70)
$ln(Q_t)$	0.539 (42.69)
$ln(\ V_t/K_{t-1}\ ).FINDEV$	0.003 (2.82)
Observations	42,358
Adj. R^2	0.223

5. Equity Measure of FINDEV:

$ln(\ V_t/K_{t-1})$	0.420 (33.14)
$ln(Q_t)$	0.535 (42.32)
$ln(\ V_t/K_{t-1}\ ).FINDEV$	0.057 (3.96)
Observations	42,563
Adj. R^2	0.222

6. Combined Measure of FINDEV:

$ln(\ V_t/K_{t-1})$	0.348 (11.46)
$ln(Q_t)$	0.535 (42.35)
$ln(\ V_t/K_{t-1}\ ).FINDEV$	0.177 (3.86)
Observations	42,563
Adj. R^2	0.222

The normal practice in the literature on investment-cash flow sensitivity is to estimate the specification which we have employed above, i.e. investment is assumed to be a linear function of the explanatory variables such as internal cash and Tobin's *Q*. However, Wurgler (2000) departs from the norm by assuming a log-linear relationship between investment and value added. In effect, his estimated model is similar to the following specification:

$$ln\,(I_t / K_{t-1}) = \alpha + \beta\, Q_t + \gamma\, ln(V_t/K_{t-1}) + \delta\, ln(V_t/K_{t-1}).FINDEV + FIRMDUM + YEARDUM + \varepsilon.$$

We next test if our results change if instead of using the actual investment and value-added data, we use their log transforms. Table XX shows the results for the six measures of *FINDEV*. The surprising finding is that the coefficient δ is now positive, in accordance with the result of Wurgler (2000), and highly significant for all measures of *FINDEV* except RZ's measure. The unexpected difference in the results of Tables XIX and XX, i.e., without and with logs respectively, motivated us to look more closely at our sample data. The first observation is that a large portion of the data used in studies such as ours comprises numbers that are of very small magnitude. For instance, in our sample, close to 50% of the investment variable values (scaled by capital stock) are less than 0.2 in magnitude. Due to the property of the log function, small investment and value added numbers in such a dataset get transformed to relatively large negative numbers by performing the log operation, perhaps causing a distortionary effect.

The conflicting evidence provided by the levels (i.e. linear) and logs specification motivates us to perform several tests in our endeavor to ascertain which of the two models is more appropriate. Specifically we perform the following tests on our linear and log-linear specifications:

- A linear versus log-linear test developed by MacKinnon, White and Davidson (1983).
- Maximum likelihood estimation of a non-linear Box-Cox model and comparison of the Box-Cox parameter with the equivalent linear and log-linear models.
- A test for log versus log-linear specification within the Box-Cox framework as suggested in Pindyck and Rubinfeld (1998)[17].
- A simple experiment to test the response of each model to a shift in the origin of the regression space.

[17] Pages 277-278.

The first two tests yielded inconclusive results, whereby we failed to accept one specification over the other; the latter two tests, however, indicated stronger support for the levels specification. We next describe each of these approaches in detail.

1. **Linear versus log-linear specification:**

In order to differentiate between the contradictory results of the levels and logs specifications, we first employ a simple test suggested by MacKinnon et al. (1983) for evaluating linear versus log-linear models. We have the two competing models denoted by:

$$H_0: y = \mathbf{x}'\beta + \varepsilon$$

$$H_1: \ln y = \ln(\mathbf{x})'\gamma + \in$$

The test for H_1 as an alternative to H_0 is carried out by testing the coefficient of α in the model:

$$y = \mathbf{x}'\beta + \alpha\,[\widehat{\ln y} - \ln(\mathbf{x}'\beta)] + \varepsilon \qquad (A)$$

Note that the second term is the difference between predictions of y obtained directly from the log-linear model and obtained as the log of the prediction from the linear model. If the coefficient α is significant, we fail to accept the linear model.

One can also reverse the roles of the two formulas and test H_0 as the alternative where the compound regression is:

$$\ln y = \ln(\mathbf{x})'\gamma + \alpha\,[\,\hat{y} - e^{\ln(\mathbf{x})'\gamma})] + \varepsilon \qquad (B)$$

As before, if the coefficient α is significant, we fail to accept the log-linear model.

The table below shows the estimates of α for models *(A)* and *(B),* and for our six measures of *FINDEV*, where:

$y = [I_t / K_{t-1}]$, the *N* x *1* vector of the dependent variable values,

$\mathbf{x} = [Q_t \quad V_t / K_{t-1} \quad V_t\,.FINDEV/K_{t-1}]$, the corresponding *N* x *3* matrix of explanatory variables values.

		LLSV	***Wurgler***	***RZ***	***CIFAR***	***Equity***	***Combined***
Model (A)	α	0.085	0.079	0.049	0.057	0.089	0.070
	t-stat	*14.79*	*12.53*	*5.86*	*9.10*	*15.50*	*11.67*
Model (B)	α	0.155	0.402	0.607	0.328	0.173	0.553
	t-stat	*1.36*	*3.45*	*4.36*	*2.72*	*1.54*	*4.95*

Since α is significant for all measures of *FINDEV* for Model (A), we fail to accept the linear model over the log-linear specification. At the same time, α is significant for 4 of the 6 measures of *FINDEV* for Model (B) and we fail to accept the log-linear specification over the levels specification.

Our conclusion from this simple test is that there is no clear indication regarding the suitability of one specification over the other.

2. **The Box Cox Transformation Test:**

To further investigate the appropriateness of the logs versus levels specifications, we employ a general non-linear specification such as the Box-Cox Model and evaluate the linear and log-linear models as special cases of this non-linear model.

The Box-Cox model can be described by the following general specification:

$$\frac{Y_i^\lambda - 1}{\lambda} = \alpha + \beta\left(\frac{X_i^\lambda - 1}{\lambda}\right) + \varepsilon_i$$

When $\lambda = 1$, the above reduces to the basic linear regression model with dependent variable *Y-1* and independent variable *X-1*. However, for $\lambda \neq 1$, one can do a Taylor series expansion and express Y_i^λ as:

$Y_i^\lambda = \exp(\lambda \log Y_i) = 1 + (\lambda \log Y_i) + (\lambda \log Y_i)^2/2 + \ldots$, *i.e.*

$(Y_i^\lambda - 1)/\lambda = \log Y_i + \lambda (\log Y_i)^2/2 + \ldots$

Thus, for the special case $\lambda = 0$:

$(Y_i^\lambda - 1)/\lambda = \log Y_i$

and the Box-Cox transformation yields the log-linear model:

$\log Y_i = \alpha + \beta \log X_i + \varepsilon_i$

Assuming that Y_i is normally distributed with variance σ^2, one could do a maximum-likelihood estimation to find the parameter λ by maximizing the corresponding log-likelihood function given by:

$$L = (\lambda - 1)\sum \log Y_i - \left(\frac{N}{2}\right)\log(2\pi) - \left(\frac{N}{2}\right)\log(\sigma^2) - \frac{1}{2\sigma^2}\sum \left[\frac{Y_i^\lambda - 1}{\lambda} - \alpha - \beta\left(\frac{X_i^\lambda - 1}{\lambda}\right)\right]^2$$

Using the above approach, the maximum likelihood value of the parameter λ was estimated for the Box-Cox model where, as before, Y_i is the *N* x *1* vector of dependent variable values and X_i is the *N* x *3* matrix of explanatory variables.

The results of the Box-Cox transformation test can be inferred in the following manner: If the estimated Box-Cox parameter, λ_{MLE}, is insignificantly different from zero, the log-linear specification is the more appropriate specification; on the other hand, a value of λ_{MLE} insignificantly different from one implies that the linear specification is more appropriate. Any other value of λ_{MLE} indicates a non-linear regression model.

The table below shows the maximum likelihood estimates and standard errors of the Box-Cox models corresponding to our six measures of FINDEV.

	LLSV	***Wurgler***	***RZ***	***CIFAR***	***Equity***	***Combined***
Box-Cox Parameter, λ_{MLE}	0.1124**	0.1184**	0.1205**	0.1155**	0.1137**	0.1153**
Standard Error	0.0043	0.0045	0.0055	0.0043	0.0043	0.0043

*** Significant at 1% or higher*

The results from this table suggest that the 'true' model is non-linear in nature. Although in terms of magnitude the values of λ_{MLE} are closer to 0 than 1, they are all significantly different from zero. Thus, based on the λ_{MLE} estimates, we are unable to prefer the linear specification over the log-linear or vice versa.

3. **A test for linear versus log-linear model in the Box Cox framework:**

Pindyck and Rubinfeld (1998) have suggested that for the case where the objective is to simply decide between the log and log-linear specifications (i.e. ignoring the case of non-linearity in the model), one can normalize the dependent variable, *Y,* by its geometric mean and then estimate the R^2 for the regressions corresponding to $\lambda = 0$ and $\lambda = 1$[18]. The model that yields the smaller error sum of squares, or equivalently the higher R^2, is the more appropriate model[19].

The table below shows the results of this test for the different measures of *FINDEV,* i.e. the R^2 values for the Box-Cox models corresponding to $\lambda = 0$ and $\lambda = 1$.

		R^2					
Model Description	***Box-Cox parameter,*** λ_{MLE}	***LLSV***	***Wurgler***	***RZ***	***CIFAR***	***Equity***	***Combined***
Log linear specification	λ=0.000	0.101	0.165	0.065	0.087	0.104	0.098
Linear specification	λ=1.000	0.117	0.120	0.105	0.117	0.199	0.120

The results of this test show that the R^2 for the Box-Cox models corresponding to the values of λ=1 are higher than their counterparts with λ=0 for 5 of the 6 measures of *FINDEV* (the exception being Wurgler's measure). Thus, for the simple case of testing the suitability of the linear versus log-linear model, and ignoring issues of non-linearity, the linear specification appears more appropriate. At the same time, one must also express a note of caution: In our research, we did not come across any method of testing whether the difference in observed R^2 for the two cases is significant. As an example, for the LLSV measure of *FINDEV*, the R^2 values corresponding to $\lambda = 0$ and $\lambda = 1$ are 0.101 and 0.117 respectively. The R^2 corresponding to $\lambda = 1$ is higher but whether this value is significantly higher is debatable.

The general inference is somewhat similar to that from the previous section. The modified Box-Cox transformation test fails to give precise indications regarding the choice of one specification over the other. However, there is some support that the levels specification provides a better fit to

[18] Comparing the R^2 obtained using OLS on the transformed data becomes equivalent to comparing the value of the log-likelihood function corresponding to $\lambda = 0$ and $\lambda = 1$ in this special case.

[19] However, Spitzer (1984) points out that least squares techniques generate biased estimates of standard errors.

the observed data vis-à-vis the logs specification, as evidenced by the higher R^2 for the equivalent linear models.

4. Sensitivity of the models to a shift in the origin.

To determine which specification is more appropriate, we conduct one final experiment: we add a constant *k*[20] to all the investment and value added variable values and re-estimate the log and non-log specifications of the model[21]. If the model is correctly specified, then an across-the-board addition of a constant should be absorbed in the regression intercept, leaving the sign of the coefficients on the independent variables unaffected. This is because the log transform is a monotonic transform and preserves the natural ordering in the data. Changes in the magnitude of the coefficients can be, however, expected in the log-linear model since logs do not transform data linearly. In the case of a correctly specified linear model though, the regression coefficients should remain identical in sign and magnitude.

Table XXI reports the results of this experiment. Specifications I-A and II-A report results for the linear and log linear specifications when no constant is added while Specifications I-B and II-B report results for the case when an across-the-board constant is added to the the investment and value-added variables. The interesting observation is that while the linear specification expectedly yields *identical* coefficients for all six measures of *FINDEV* (i.e. all the coefficients with specification I-A are identical to those of I-B), the log specification shows an altogether different picture. The addition of a constant *k* produces very dissimilar coefficients (expectedly) in the log specification but surprisingly the sign on the coefficient δ, which measures the effect of *FINDEV*, switches to negative (in accordance with our result). The switching of the signs is witnessed across all measures of FINDEV and the negative coefficients become increasingly significant as the value of the across-the-board added constant increases. For instance, with the CIFAR measure of *FINDEV* and the case when no constant is added (i.e. k=0) the δ coefficient is significantly positive with a t-stat of 2.82. Addition of a constant k=1 makes the coefficient *significantly negative* with a t-stat of -4.37, and with k=3 and k=10 the t-stats are, respectively, -

[20] Although we report results only for the case k = 1, 3, and 10, the results were similar for various other positive values of *k*.
[21] In graphical terms, the addition of an across-the-board constant is equivalent to shifting the origin of the regression space.

6.24 and -7.30. We believe this to be strong evidence that the log specification displays parameter instability and are therefore skeptical whether inferences based on this specification can be thought of as consistent and reliable.

The above experiment was repeated using cash instead of value added as the independent variable and the results, reported in Table XXII, were as striking. While the addition of a constant *k* once again had absolutely *no effect* on the levels or linear version of the model, (once again Specifications I-A and I-B produced identical coefficients), the log form of the model switched signs with the addition of an across-the-board constant. Tables XXI and XXII lead us to the conclusion that the Wurgler (2000) result is more a consequence of the model specification employed rather than an explanation of the relationship between firm investment and the degree of financial and capital market development.

TABLE XXI

Distortionary Effect of Log Transformations: Pooled Regressions with Value Added as Independent Variable

The estimated models are:
Specification I: $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma V_t /K_{t-1} + \delta V_t .FINDEV/K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$
Specification II: $ln (I_t / K_{t-1}) = \alpha + \beta ln(Q_t) + \gamma ln(V_t /K_{t-1}) + \delta ln(V_t /K_{t-1}).FINDEV + FIRMDUM + YEARDUM + \varepsilon$.
I_t / K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; V_t /K_{t-1} is 'value added' defined, as in Wurgler (2000), as sales minus cost of goods sold during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV), Rajan & Zingales (1998; RZ) and Wurgler (2000) or as developed in section IV. H. Specifications I-A and II-A use the actual data. Specifications I-B and II-B add a constant (k) to the dependent variable I_t/K_{t-1} and the independent variable V_t /K_{t-1} before taking logs. Relevant t-stats are shown in parentheses.

CASE : $k = 1$

1. Wurgler's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t /K_{t-1}	0.135 (21.62)	0.135 (21.62)	$ln(V_t /K_{t-1})$	0.247 (11.45)	0.235 (21.70)
Q_t	0.066 (32.58)	0.066 (32.58)	$ln(Q_t)$	0.526 (40.36)	0.095 (35.8)
$V_t.FINDEV /K_{t-1}$	-0.025 (-5.60)	-0.025 (-5.60)	$ln(V_t /K_{t-1}).FINDEV$	0.167 (10.42)	-0.004 (-0.47)
Observations	40,384	40,384	Observations	40,192	40,192
Adj. R^2	0.178	0.177	Adj. R^2	0.222	0.222

2. LLSV's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t /K_{t-1}	0.119 (36.26)	0.119 (36.26)	$ln(V_t /K_{t-1})$	0.419 (35.22)	0.238 (39.92)
Q_t	0.065 (32.84)	0.065 (32.84)	$ln(Q_t)$	0.535 (42.33)	0.094 (36.48)
$V_t.FINDEV /K_{t-1}$	-0.022 (-4.56)	-0.022 (-4.56)	$ln(V_t /K_{t-1}).FINDEV$	0.075 (4.42)	-0.001 (-0.14)
Observations	42,776	42,776	Observations	42,563	42,563
Adj. R^2	0.182	0.180	Adj. R^2	0.221	0.226

3. RZ's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.246 (13.10)	0.246 (13.10)	$ln(V_t/K_{t-1})$	0.325 (4.74)	0.347 (10.24)
Q_t	0.067 (22.47)	0.067 (22.47)	$ln(Q_t)$	0.539 (30.14)	0.090 (24.67)
$V_t.FINDEV/K_{t-1}$	-0.002 (-6.91)	-0.002 (-6.91)	$ln(V_t/K_{t-1}).FINDEV$	0.001 (1.52)	-0.001 (-3.13)
Observations	26,300	26,300	Observations	26,300	26,300
Adj. R^2	0.195	0.194	Adj. R^2	0.231	0.236

4. CIFAR Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.276 (12.46)	0.276 (12.46)	$ln(V_t/K_{t-1})$	0.226 (2.70)	0.414 (10.19)
Q_t	0.065 (32.77)	0.065 (32.77)	$ln(Q_t)$	0.539 (42.69)	0.094 (36.66)
$V_t.FINDEV/K_{t-1}$	-0.002 (-7.73)	-0.002 (-7.73)	$ln(V_t/K_{t-1}).FINDEV$	0.003 (2.82)	-0.002 (-4.37)
Observations	42,571	42,571	Observations	42,358	42,358
Adj. R^2	0.183	0.183	Adj. R^2	0.223	0.222

5. Equity Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.124 (33.63)	0.124 (33.63)	$ln(V_t/K_{t-1})$	0.420 (33.14)	0.238 (36.24)
Q_t	0.066 (32.94)	0.066 (32.94)	$ln(Q_t)$	0.535 (42.32)	0.094 (36.44)
$V_t.FINDEV/K_{t-1}$	-0.025 (-5.46)	-0.025 (-5.46)	$ln(V_t/K_{t-1}).FINDEV$	0.057 (3.96)	-0.001 (-0.10)
Observations	42,563	42,563	Observations	42,563	42,563
R^2	0.183	0.182	R^2	0.222	0.226

6. Combined Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.166 (19.24)	0.166 (19.24)	$ln(V_t/K_{t-1})$	0.348 (11.46)	0.264 (16.80)
Q_t	0.066 (32.98)	0.066 (32.98)	$ln(Q_t)$	0.535 (42.35)	0.094 (36.55)
$V_t.FINDEV/K_{t-1}$	-0.093 (-7.14)	-0.093 (-7.14)	$ln(V_t/K_{t-1}).FINDEV$	0.177 (3.86)	-0.041 (-1.72)
Observations	42,563	42,563	Observations	42,563	42,563
Adj. R^2	0.184	0.184	Adj. R^2	0.222	0.227

CASE : *k*=3.

1. Wurgler's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.135 (21.62)	0.135 (21.62)	$ln(V_t/K_{t-1})$	0.247 (11.45)	0.192 (22.52)
Q_t	0.066 (32.58)	0.066 (32.58)	$ln(Q_t)$	0.526 (40.36)	0.040 (35.18)
$V_t.FINDEV/K_{t-1}$	-0.025 (-5.60)	-0.025 (-5.60)	$ln(V_t/K_{t-1}).FINDEV$	0.167 (10.42)	-0.021 (-3.47)
Observations	40,384	40,384	Observations	40,192	40,192
R^2	0.178	0.177	R^2	0.222	0.206

2. LLSV's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.119 (36.26)	0.119 (36.26)	$ln(V_t/K_{t-1})$	0.419 (35.22)	0.179 (38.67)
Q_t	0.065 (32.84)	0.065 (32.84)	$ln(Q_t)$	0.535 (42.33)	0.039 (35.59)
$V_t.FINDEV/K_{t-1}$	-0.022 (-4.56)	-0.022 (-4.56)	$ln(V_t/K_{t-1}).FINDEV$	0.075 (4.42)	-0.016 (-2.30)
Observations	42,776	42,776	Observations	42,563	42,563
Adj. R^2	0.182	0.180	Adj. R^2	0.221	0.210

3. RZ's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.246 (13.10)	0.246 (13.10)	$ln(V_t/K_{t-1})$	0.325 (4.74)	0.308 (11.65)
Q_t	0.067 (22.47)	0.067 (22.47)	$ln(Q_t)$	0.539 (30.14)	0.038 (24.03)
$V_t.FINDEV/K_{t-1}$	-0.002 (-6.91)	-0.002 (-6.91)	$ln(V_t/K_{t-1}).FINDEV$	0.001 (1.52)	-0.002 (-4.89)
Observations	26,300	26,300	Observations	26,300	26,300
Adj. R^2	0.195	0.194	Adj. R^2	0.231	0.220

4. CIFAR Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.276 (12.46)	0.276 (12.46)	$ln(V_t/K_{t-1})$	0.226 (2.70)	0.365 (11.62)
Q_t	0.065 (32.77)	0.065 (32.77)	$ln(Q_t)$	0.539 (42.69)	0.039 (35.68)
$V_t.FINDEV/K_{t-1}$	-0.002 (-7.73)	-0.002 (-7.73)	$ln(V_t/K_{t-1}).FINDEV$	0.003 (2.82)	-0.002 (-6.24)
Observations	42,571	42,571	Observations	42,358	42,358
Adj. R^2	0.183	0.183	Adj. R^2	0.223	0.212

5. Equity Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.124 (33.63)	0.124 (33.63)	$ln(V_t/K_{t-1})$	0.420 (33.14)	0.182 (35.36)
Q_t	0.066 (32.94)	0.066 (32.94)	$ln(Q_t)$	0.535 (42.32)	0.039 (35.62)
$V_t.FINDEV/K_{t-1}$	-0.025 (-5.46)	-0.025 (-5.46)	$ln(V_t/K_{t-1}).FINDEV$	0.057 (3.96)	-0.016 (-2.58)
Observations	42,563	42,563	Observations	42,563	42,563
Adj. R^2	0.183	0.182	Adj. R^2	0.222	0.210

6. Combined Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.166 (19.24)	0.166 (19.24)	$ln(V_t/K_{t-1})$	0.348 (11.46)	0.222 (18.17)
Q_t	0.066 (32.98)	0.066 (32.98)	$ln(Q_t)$	0.535 (42.35)	0.039 (35.70)
$V_t.FINDEV/K_{t-1}$	-0.093 (-7.14)	-0.093 (-7.14)	$ln(V_t/K_{t-1}).FINDEV$	0.177 (3.86)	-0.081 (-4.34)
Observations	42,563	42,563	Observations	42,563	42,563
Adj. R^2	0.184	0.184	Adj. R^2	0.222	0.210

CASE : *k*=10.

1. Wurgler's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.135 (21.62)	0.135 (21.62)	$ln(V_t/K_{t-1})$	0.247 (11.45)	0.159 (22.31)
Q_t	0.066 (32.58)	0.066 (32.58)	$ln(Q_t)$	0.526 (40.36)	0.014 (35.48)
$V_t.FINDEV/K_{t-1}$	-0.025 (-5.60)	-0.025 (-5.60)	$ln(V_t/K_{t-1}).FINDEV$	0.167 (10.42)	-0.027 (-5.17)
Observations	40,384	40,384	Observations	40,192	40,192
Adj. R^2	0.178	0.177	Adj. R^2	0.222	0.193

2. LLSV's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.119 (36.26)	0.119 (36.26)	$ln(V_t/K_{t-1})$	0.419 (35.22)	0.141 (37.15)
Q_t	0.065 (32.84)	0.065 (32.84)	$ln(Q_t)$	0.535 (42.33)	0.013 (35.75)
$V_t.FINDEV/K_{t-1}$	-0.022 (-4.56)	-0.022 (-4.56)	$ln(V_t/K_{t-1}).FINDEV$	0.075 (4.42)	-0.021 (-3.78)
Observations	42,776	42,776	Observations	42,563	42,563
Adj. R^2	0.182	0.180	Adj. R^2	0.221	0.197

3. RZ's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.246 (13.10)	0.246 (13.10)	$ln(V_t/K_{t-1})$	0.325 (4.74)	0.274 (12.57)
Q_t	0.067 (22.47)	0.067 (22.47)	$ln(Q_t)$	0.539 (30.14)	0.013 (24.14)
$V_t.FINDEV/K_{t-1}$	-0.002 (-6.91)	-0.002 (-6.91)	$ln(V_t/K_{t-1}).FINDEV$	0.001 (1.52)	-0.002 (-6.16)
Observations	26,300	26,300	Observations	26,300	26,300
Adj. R^2	0.195	0.194	Adj. R^2	0.231	0.207

4. CIFAR Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.276 (12.46)	0.276 (12.46)	$ln(V_t/K_{t-1})$	0.226 (2.70)	0.315 (12.26)
Q_t	0.065 (32.77)	0.065 (32.77)	$ln(Q_t)$	0.539 (42.69)	0.013 (35.77)
$V_t.FINDEV/K_{t-1}$	-0.002 (-7.73)	-0.002 (-7.73)	$ln(V_t/K_{t-1}).FINDEV$	0.003 (2.82)	-0.003 (-7.30)
Observations	42,571	42,571	Observations	42,358	42,358
Adj. R^2	0.183	0.183	Adj. R^2	0.223	0.199

5. Equity Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.124 (33.63)	0.124 (33.63)	$ln(V_t/K_{t-1})$	0.420 (33.14)	0.145 (34.24)
Q_t	0.066 (32.94)	0.066 (32.94)	$ln(Q_t)$	0.535 (42.32)	0.013 (35.82)
$V_t.FINDEV/K_{t-1}$	-0.025 (-5.46)	-0.025 (-5.46)	$ln(V_t/K_{t-1}).FINDEV$	0.057 (3.96)	-0.023 (-4.38)
Observations	42,563	42,563	Observations	42,563	42,563
Adj. R^2	0.183	0.182	Adj. R^2	0.222	0.197

6. Combined Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
V_t/K_{t-1}	0.166 (19.24)	0.166 (19.24)	$ln(V_t/K_{t-1})$	0.348 (11.46)	0.189 (18.85)
Q_t	0.066 (32.98)	0.066 (32.98)	$ln(Q_t)$	0.535 (42.35)	0.013 (35.88)
$V_t.FINDEV/K_{t-1}$	-0.093 (-7.14)	-0.093 (-7.14)	$ln(V_t/K_{t-1}).FINDEV$	0.177 (3.86)	-0.093 (-6.12)
Observations	42,563	42,563	Observations	42,563	42,563
Adj. R^2	0.184	0.184	Adj. R^2	0.222	0.198

TABLE XXII

Distortionary Effect of Log Transformations: Pooled Regressions with Internal Cash as Independent Variable

The estimated models are:
Specification I: $I_t / K_{t-1} = \alpha + \beta Q_t + \gamma W_t/K_{t-1} + \delta W_t .FINDEV/K_{t-1} + FIRMDUM + YEARDUM + \varepsilon$, and
Specification II: $ln (I_t / K_{t-1}) = \alpha + \beta Q_t + \gamma ln(W_t/K_{t-1}) + \delta ln(W_t/K_{t-1}).FINDEV + FIRMDUM + YEARDUM + \varepsilon$.
I_t / K_{t-1} is investment during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year; W_t/K_{t-1} is cash flow during year t scaled by capital stock at the beginning of the year; *FIRMDUM* and *YEARDUM* are dummies to control for fixed firm and year effects. FINDEV is a measure of a country's financial development as given in La Porta et al (1997; LLSV), Rajan & Zingales (1998; RZ) and Wurgler (2000) or as developed in section IV. H. Specifications I-A and II-A use the actual data. Specifications I-B and II-B add a constant (k) to the dependent variable I_t/K_{t-1} and the independent variable W_t/K_{t-1} before taking logs. Relevant t-stats are shown in parentheses.

CASE : *k*=1.

1. Wurgler's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.210 (15.90)	0.210 (15.90)	$ln (W_t/K_{t-1})$	0.224 (12.36)	0.332 (18.90)
Q_t	0.068 (33.18)	0.068 (33.18)	$ln (Q_t)$	0.502 (37.15)	0.086 (30.78)
$W_t.FINDEV/K_{t-1}$	-0.049 (-5.06)	-0.049 (-5.06)	$ln(W_t/K_{t-1}).FINDEV$	0.041 (3.13)	-0.038 (-2.98)
Observations	38,765	38,765	Observations	35,697	35,697
Adj. R^2	0.161	0.160	Adj. R^2	0.197	0.208

2. LLSV's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.157 (27.03)	0.157 (27.03)	$ln(W_t/K_{t-1})$	0.235 (23.60)	0.288 (33.09)
Q_t	0.067 (33.10)	0.067 (33.10)	$ln (Q_t)$	0.497 (37.92)	0.083 (30.99)
$W_t.FINDEV/K_{t-1}$	-0.009 (-1.11)	-0.009 (-1.11)	$ln(W_t/K_{t-1}).FINDEV$	0.088 (6.00)	0.003 (0.28)
Observations	40,868	40,868	Observations	37,712	37,712
Adj. R^2	0.163	0.160	Adj. R^2	0.199	0.213

3. RZ's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.324 (9.76)	0.324 (9.76)	$ln\ (W_t/K_{t-1})$	0.118 (2.09)	0.405 (8.38)
Q_t	0.061 (20.91)	0.061 (20.91)	$ln(Q_t)$	0.477 (25.88)	0.076 (20.34)
$W_t.FINDEV/K_{t-1}$	-0.002 (-4.23)	-0.002 (-4.23)	$ln(W_t/K_{t-1}).FINDEV$	0.003 (3.48)	-0.001 (-1.48)
Observations	24,599	24,599	Observations	22,837	22,837
Adj. R^2	0. 189	0.188	Adj. R^2	0.220	0.238

4. CIFAR Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.287 (7.14)	0.287 (7.14)	$ln(W_t/K_{t-1})$	0.001 (0.01)	0.375 (6.31)
Q_t	0.067 (33.32)	0.067 (33.32)	$ln(Q_t)$	0.503 (38.37)	0.084 (31.24)
$W_t.FINDEV/K_{t-1}$	-0.002 (-3.41)	-0.002 (-3.41)	$ln(W_t/K_{t-1}).FINDEV$	0.004 (4.17)	-0.001 (-1.45)
Observations	40,683	40,683	Observations	37,530	37,530
Adj. R^2	0. 165	0. 165	Adj. R^2	0.184	0.214

5. Equity Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.163 (24.85)	0.163 (24.85)	$ln(W_t/K_{t-1})$	0.234 (21.19)	0.295 (30.66)
Q_t	0.067 (33.15)	0.067 (33.15)	$ln(Q_t)$	0.497 (37.87)	0.084 (31.02)
$W_t.FINDEV/K_{t-1}$	-0.016 (-2.02)	-0.016 (-2.02)	$ln(W_t/K_{t-1}).FINDEV$	0.070 (5.31)	-0.008 (-0.67)
Observations	40,868	40,868	Observations	37,712	37,712
Adj. R^2	0.163	0.162	Adj. R^2	0.199	0.213

6. Combined Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.194 (12.40)	0.194 (12.40)	$ln(W_t/K_{t-1})$	0.150 (5.68)	0.315 (13.82)
Q_t	0.067 (33.20)	0.067 (33.20)	$ln(Q_t)$	0.497 (37.93)	0.084 (31.04)
$W_t.FINDEV/K_{t-1}$	-0.066 (-2.80)	-0.066 (-2.80)	$ln(W_t/K_{t-1}).FINDEV$	0.209 (5.25)	-0.038 (-1.11)
Observations	40,868	40,868	Observations	37,712	37,712
Adj. R^2	0.163	0.163	Adj. R^2	0.199	0.213

CASE : *k*=3.

1. Wurgler's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.210 (15.90)	0.210 (15.90)	$ln(W_t/K_{t-1})$	0.224 (12.36)	0.307 (18.64)
Q_t	0.068 (33.18)	0.068 (33.18)	$ln(Q_t)$	0.502 (37.15)	0.036 (31.22)
$W_t.FINDEV/K_{t-1}$	-0.049 (-5.06)	-0.049 (-5.06)	$ln(W_t/K_{t-1}).FINDEV$	0.041 (3.13)	-0.050 (-4.13)
Observations	38,765	38,765	Observations	35,697	35,697
Adj. R^2	0.161	0.160	Adj. R^2	0.197	0.196

2. LLSV's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.157 (27.03)	0.157 (27.03)	$ln(W_t/K_{t-1})$	0.235 (23.60)	0.254 (32.25)
Q_t	0.067 (33.10)	0.067 (33.10)	$ln(Q_t)$	0.497 (37.92)	0.035 (31.36)
$W_t.FINDEV/K_{t-1}$	-0.009 (-1.11)	-0.009 (-1.11)	$ln(W_t/K_{t-1}).FINDEV$	0.088 (6.00)	-0.008 (-0.67)
Observations	40,868	40,868	Observations	37,712	37,712
Adj. R^2	0.163	0.160	Adj. R^2	0.199	0.201

3. RZ's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.324 (9.76)	0.324 (9.76)	$ln\ (W_t/K_{t-1})$	0.118 (2.09)	0.394 (9.00)
Q_t	0.061 (20.91)	0.061 (20.91)	$ln(Q_t)$	0.477 (25.88)	0.032 (20.55)
$W_t.FINDEV/K_{t-1}$	-0.002 (-4.23)	-0.002 (-4.23)	$ln(W_t/K_{t-1}).FINDEV$	0.003 (3.48)	-0.001 (-2.38)
Observations	24,599	24,599	Observations	22,837	22,837
Adj. R^2	0. 189	0.188	Adj. R^2	0.220	0.225

4. CIFAR Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.287 (7.14)	0.287 (7.14)	$ln(W_t/K_{t-1})$	0.001 (0.01)	0.374 (6.91)
Q_t	0.067 (33.32)	0.067 (33.32)	$ln(Q_t)$	0.503 (38.37)	0.035 (31.58)
$W_t.FINDEV/K_{t-1}$	-0.002 (-3.41)	-0.002 (-3.41)	$ln(W_t/K_{t-1}).FINDEV$	0.004 (4.17)	-0.002 (-2.32)
Observations	40,683	40,683	Observations	37,530	37,530
Adj. R^2	0. 165	0. 165	Adj. R^2	0.184	0.202

5. Equity Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.163 (24.85)	0.163 (24.85)	$ln(W_t/K_{t-1})$	0.234 (21.19)	0.262 (29.89)
Q_t	0.067 (33.15)	0.067 (33.15)	$ln(Q_t)$	0.497 (37.87)	0.035 (31.40)
$W_t.FINDEV/K_{t-1}$	-0.016 (-2.02)	-0.016 (-2.02)	$ln(W_t/K_{t-1}).FINDEV$	0.070 (5.31)	-0.016 (-1.52)
Observations	40,868	40,868	Observations	37,712	37,712
Adj. R^2	0.163	0.162	Adj. R^2	0.199	0.201

6. Combined Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t / K_{t-1}	0.194 (12.40)	0.194 (12.40)	$ln(W_t / K_{t-1})$	0.150 (5.68)	0.291 (14.07)
Q_t	0.067 (33.20)	0.067 (33.20)	$ln(Q_t)$	0.497 (37.93)	0.035 (31.42)
$W_t.FINDEV / K_{t-1}$	-0.066 (-2.80)	-0.066 (-2.80)	$ln(W_t / K_{t-1}).FINDEV$	0.209 (5.25)	-0.063 (-2.04)
Observations	40,868	40,868	Observations	37,712	37,712
Adj. R^2	0.163	0.163	Adj. R^2	0.199	0.201

CASE : *k*=10.

1. Wurgler's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.210 (15.90)	0.210 (15.90)	$ln(W_t/K_{t-1})$	0.224 (12.36)	0.286 (18.22)
Q_t	0.068 (33.18)	0.068 (33.18)	$ln(Q_t)$	0.502 (37.15)	0.012 (31.84)
$W_t.FINDEV / K_{t-1}$	-0.049 (-5.06)	-0.049 (-5.06)	$ln(W_t/K_{t-1}).FINDEV$	0.041 (3.13)	-0.053 (-4.66)
Observations	38,765	38,765	Observations	35,697	35,697
Adj. R^2	0.161	0.160	Adj. R^2	0.197	0.187

2. LLSV's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.157 (27.03)	0.157 (27.03)	$ln(W_t/K_{t-1})$	0.235 (23.60)	0.230 (31.39)
Q_t	0.067 (33.10)	0.067 (33.10)	$ln(Q_t)$	0.497 (37.92)	0.012 (31.96)
$W_t.FINDEV / K_{t-1}$	-0.009 (-1.11)	-0.009 (-1.11)	$ln(W_t/K_{t-1}).FINDEV$	0.088 (6.00)	-0.012 (-1.14)
Observations	40,868	40,868	Observations	37,712	37,712
Adj. R^2	0.163	0.160	Adj. R^2	0.199	0.192

3. RZ's Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.324 (9.76)	0.324 (9.76)	$ln\ (W_t/K_{t-1})$	0.118 (2.09)	0.379 (9.26)
Q_t	0.061 (20.91)	0.061 (20.91)	$ln(Q_t)$	0.477 (25.88)	0.011 (20.95)
$W_t.FINDEV/K_{t-1}$	-0.002 (-4.23)	-0.002 (-4.23)	$ln(W_t/K_{t-1}).FINDEV$	0.003 (3.48)	-0.002 (-2.89)
Observations	24,599	24,599	Observations	22,837	22,837
Adj. R^2	0. 189	0.188	Adj. R^2	0.220	0.216

4. CIFAR Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.287 (7.14)	0.287 (7.14)	$ln(W_t/K_{t-1})$	0.001 (0.01)	0.362 (7.17)
Q_t	0.067 (33.32)	0.067 (33.32)	$ln(Q_t)$	0.503 (38.37)	0.012 (32.17)
$W_t.FINDEV/K_{t-1}$	-0.002 (-3.41)	-0.002 (-3.41)	$ln(W_t/K_{t-1}).FINDEV$	0.004 (4.17)	-0.002 (-2.77)
Observations	40,683	40,683	Observations	37,530	37,530
Adj. R^2	0. 165	0. 165	Adj. R^2	0.184	0.194

5. Equity Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t/K_{t-1}	0.163 (24.85)	0.163 (24.85)	$ln(W_t/K_{t-1})$	0.234 (21.19)	0.237 (29.06)
Q_t	0.067 (33.15)	0.067 (33.15)	$ln(Q_t)$	0.497 (37.87)	0.012 (32.00)
$W_t.FINDEV/K_{t-1}$	-0.016 (-2.02)	-0.016 (-2.02)	$ln(W_t/K_{t-1}).FINDEV$	0.070 (5.31)	-0.018 (-1.92)
Observations	40,868	40,868	Observations	37,712	37,712
Adj. R^2	0.163	0.162	Adj. R^2	0.199	0.192

6. Combined Measure of FINDEV:

	Specification I-A	Specification I-B		Specification II-A	Specification II-B
W_t / K_{t-1}	0.194 (12.40)	0.194 (12.40)	$ln(W_t / K_{t-1})$	0.150 (5.68)	0.270 (14.00)
Q_t	0.067 (33.20)	0.067 (33.20)	$ln(Q_t)$	0.497 (37.93)	0.012 (32.02)
$W_t.FINDEV / K_{t-1}$	-0.066 (-2.80)	-0.066 (-2.80)	$ln(W_t / K_{t-1}).FINDEV$	0.209 (5.25)	-0.072 (-2.49)
Observations	40,868	40,868	Observations	37,712	37,712
Adj. R^2	0.163	0.163	Adj. R^2	0.199	0.192

CHAPTER VII

CONCLUSIONS

Recent research has extended the investment-cash flow sensitivity puzzle from a domestic to an international context. Fazzari, Hubbard, and Petersen (1988) had argued that in the presence of imperfect capital markets, where firms faced a cost differential between external and internal sources of funds, the financially constrained firm would have higher investment-cash flow sensitivity. This result has been repeatedly confirmed by a large body of literature that has developed since then. On the other hand, Kaplan and Zingales (1997) and Cleary (1999) have provided opposing evidence using data on US firms, and Kadapakkam et al (1998) and Cleary (2001) using international data.

In this study we have specifically examined the impact of financial development on the sensitivity of firm-level investment to internal cash flow. While previous studies have looked at the cross sectional pattern of investment cash-flow sensitivities within countries, we contribute to the existing literature by documenting a cross-sectional pattern of cash-flow investment sensitivities across countries and we relate these sensitivities to the degree of development of capital markets. Our analysis provides evidence that after controlling for future investment or growth opportunities and firm size, investment-cash flow sensitivity is negatively related to the degree of financial development, thereby presenting international evidence in support of the FHP hypothesis. Firms based in less developed countries are likely to face elevated costs not only due to higher information costs but also because of the lower availability (or supply) of external capital in these markets. These costs get translated into greater degrees of financing constraints, relative to firms based in countries having more developed capital markets, and get reflected as a stronger link between investment outlays and availability of internal cash for these firms. Our results are robust to six different measures of financial development and have important policy implications, which we discuss later in our conclusions.

We also document a significant size effect across our sample of 31 international countries. Specifically, we find that after controlling for the effects of differing degrees of capital-market development across countries, larger firms display smaller investment cash flow sensitivities. This finding is consistent with the notion that larger firms have better access to external capital markets and are therefore less dependent on their internally generated funds for making their investment outlays. These results, which once again support the FHP hypothesis, are also important as they are in direct contrast to a recent finding by Kadapakkam et al (1998) that within certain OECD countries, it is the large firm that displays a greater investment cash flow sensitivity. Our speculation is that the Kadapakkam et al (1998) result is possibly due to the presence of certain large firms in their sample where managers are, most likely, entrenched and work towards the goal of 'empire-building' rather than shareholder-value maximization.

A recent paper by Wurgler (2000) has reported, using industry-level data, that investment is more sensitive to value added in countries with more developed financial markets. We connect this result with the existing investment-cash flow sensitivity literature by examining if the sensitivity to value added is indicative of investment sensitivity to profitable investment opportunities, or to current cash flow. We find that after controlling for future investment opportunities, value added, defined as the difference between sales and cost of goods sold, has similar explanatory power to internal cash in describing a firm's investment behavior. We also present evidence that the Wurgler (2000) result is very likely a consequence of the particular log specification employed in his study. Our conjecture is that due to the nature of the data in such an analysis, log operations have more of a distortionary rather than a 'smoothing' impact on the data due to the large proportion of numbers that are positive but small in magnitude.

Our contribution is also in terms of methodology. By estimating the relationship between investment-cash flow sensitivity and financial development/size in one step, we are able to avoid the errors-in-variables problems of two-step OLS estimation models that have been employed frequently in the literature. Furthermore, our evidence also supports the conclusions of Allayannis and Mozumdar (2001) with regard to the distortionary impact of negative cash flows in estimating investment-cash flow sensitivities. Researchers and future work in this area would benefit by keeping this point in mind.

The results of this study have some important policy recommendations. We have found that firms based in less developed financial markets face a greater wedge between the cost of internal and outside finance, as evident from their greater investment cash flow sensitivities. The absence of easy accessibility to external capital markets is, therefore, likely to result in greater under-investment costs in less developed nations, consequently slowing down the rate of economic growth and social development in these emerging-markets[22]. Given this scenario, our observed pattern of investment-cash flow sensitivities, particularly with respect to the CIFAR measure of *FINDEV*, assumes special significance. Recall that the CIFAR index of *FINDEV* is a measure of transparency in the accounting standards and practices of a particular country. Implications of the strong negative relationship between investment cash flow sensitivity and the CIFAR measure of *FINDEV* that we have documented in this study are very clear. Governments and policy makers in lesser-developed nations must be educated and made aware of the adverse economic impact brought about by the presence of high levels of information asymmetries in their marketplace. They should be encouraged (and perhaps influenced) to work on means of bringing about greater levels of transparency in their country's financial system by reforming existing accounting practices into standards of reporting that encourage greater disclosure of information.

Limitations and Extensions:

The following our some of the limitations imposed by the data employed in this study. First, there is the problem of using financial information from different countries that employ diverse systems of accounting for recording this information. Under ordinary circumstances, this should only throw in more noise in the data and bias our results towards less significance. We have simply assumed that this is indeed the case and that our results are likely to be stronger had the data employed been recorded under a uniform system of accounting across our sample of 31 countries.

The second problem in our sample is the unbalanced representation of firms from less developed countries. Although we have imposed restrictions such as availability of at least 100 firm-year

[22] This notion is also consistent with the conclusions of Rajan & Zingales (1998) who find that financial development promotes economic growth.

observations for a country to be included in our sample, the possibility of inadequate cross-sectional coverage of firms from less developed countries remains. Countries such as India, Indonesia and Thailand have, on average, 4 or less number of observations per firm in our dataset which spans 11 years. If these small number of observations all happen to fall either at the beginning or the end of this 11 year period, and since we have controlled for fixed effects in the form of firm and year dummies, there is albeit the likelihood that in this extreme example year dummies could possibly capture firm-specific effects, perhaps causing spurious observed relationships. We have assumed that this is not the case and that the clustering of few observations, if at all present, is not a significant source of bias in our reported results.

Finally, as with the standard practice in this literature, we too have ignored issues of non-linearity and estimated our models assuming a linear relationship between investment, growth opportunities, and internal cash flows. Although preliminary tests using non-linear models support our main results reported here, we still feel this to be a possible limitation regarding the generality of our findings. More extensive analysis using non-linear models could be worthwhile extensions.

The present study can be extended in several other directions. One such direction could be to investigate the evolution of investment cash flow sensitivities *within* firms. The existing evidence on investment cash flow sensitivity in the literature is based almost entirely on investigations based on comparisons of investment cash flow sensitivities *across* groups of firms that are *a priori* assumed to face different degrees of information asymmetry, difficulty in accessing external capital markets, or both. It would be interesting to investigate how corporate events that reduce information asymmetry or facilitate access to external capital markets affect the investment cash flow sensitivities within firms. These could be events such as acquisitions by a multinational corporation, international cross-listings of shares or issuance of ADR's / GDR's. We leave these issues for future research.

REFERENCES

Akerlof, G. A., The Market for "Lemons": Quality Uncertainty and the Market Mechanism, *Quarterly Journal of Economics*, (August) 1970, 488-500.

Allayannis, G., Mozumdar, A., Investment, Cash Flow, and Hedging, *Working Paper*, 2001, Virginia Tech

Allayannis, G., Mozumdar, A., The Investment-Cash Flow Sensitivity Puzzle: Can Negative Cash Flow Observations Explain It? *Working Paper*, 2001, Virginia Tech.

Bhattacharya,S., Imperfect Information, Dividend Policy and the 'Bird in Hand' Fallacy, *Bell Journal Of Economics and Management Science,* (Spring) 1979, 259-70.

Calem, P.S., Rizzo, J.A., Financing Constraints and Investment: New Evidence from Hospital Industry Data, *Journal of Money, Credit, and Banking,* 1995, Vol. 27, No. 4, 1002-1014.

Calomiris, C. W., Hubbard, R. G., Firm Heterogeneity, Internal Finance and Credit Rationing, *Economic Journal*, (March) 1990, 90-104.

Cleary, S., The Relationship Between Firm Investment and Financial Status, *Journal of Finance*, 1999, Vol. 54, No. 2, 673-692.

Cleary, S., International Corporate Investment and the Role of Financial Constraints, *Working Paper*, 2001, York University.

Devereux, M. P., Schiantarelli, F., Investment, Financial Factors and Cash Flow: Evidence from U.K. Panel Data, *Mimeograph*, Institute for Fiscal Studies, London, 1990.

Fazzari, S. M., Hubbard, R.G., Petersen, B.C., Financing Constraints and Corporate Investment. *Brookings Papers on Economic Activity*, 1988, 141-195.

Fazzari, S., Hubbard, G., And Petersen, B., Investment-Cash Flow Sensitivities are Useful: A Comment on Kaplan and Zingales, *Quarterly Journal of Economics*, 2000, 695-705.

Froot, K. A., Scharfstein, D. S., Stein, J. C., Risk Management: Coordinating Corporate Investment and Financing Policies, *Journal of Finance*, Vol. 48 (5), 1993, 1629-1658.

Geczy, C., Minton, B. A. , Schrand, C., Why Firms Use Currency Derivatives, *Journal of Finance,* Sept, 52 (4), 1997, 1323-1354.

Gilchrist, S., Himmelberg, C.P., Evidence on the Role of Cash Flow for Investment, *Journal of Monetary Economics,* 36, 1995, 541-572.

Greenwald, B., Stiglitz, J.E., Weiss, A., Information Imperfections in the Capital Market and Macroeconomic Fluctuations. *American Economic Review,* 74, 1984, 194-199.

Gujarati, D. N., Basic Econometrics, 2nd Edition, McGraw Hill, 1988.

Hoshi, T., Kashyap, A., Scharfstein, D., Corporate Structure Liquidity and Investment : Evidence from Japanese Panel Data. *Quarterly Journal of Economics* 106, 1991, 33-60.

Houston, J.F., James, C. M., Do Relationships Have Limits? Banking Relationships, Financial Constraints, and Investment, *Journal of Business,* 2001, Vol. 74, No. 3, 347-373.

Hubbard, R. Glenn, Capital-Market Imperfections and Investment. *Journal Of Economic Literature,* 36, 1998, 193-225.

Hubbard, R.G., Kashyap, A.K., Whited, T.M., Internal Finance and Firm Investment. *Journal Of Money, Credit and Banking* 27 (3), 1995, 683-701.

Jaffee, D. M., Russell, T., Imperfect Information, Uncertainty, and Credit Rationing, *Quarterly Journal of Economics,* (November) 1976, 651-66.

Jensen, M. C., Agency Costs of Free Cash Flow, Corporate Finance and Takeovers, *American Economic Review*, (May) 1986, 323-29.

Kadapakkam, P., Kumar, P.C., Riddick, L.A., The Impact of Cash Flows and Firm Size on Investment: The International Evidence, *Journal of Banking and Finance*, 1998, 298-320.

Kaplan, S., Zingales, L., Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints? *The Quarterly Journal of Economics,* 112, 1997, 169-215.

Kaplan, S., Zingales, L., Investment-Cash Flow Sensitivities are not Valid Measures of Financing Constraints, *The Quarterly Journal of Economics*, 2000, 707-712.

Kedia, S., Mozumdar A., Foreign Currency Denominated Debt: An Empirical Examination, 2001, *Journal of Business,* Forthcoming.

Lamont, O., Cash Flow and Investment: Evidence from Internal Capital Markets. *Journal of Finance* 52 (1), 1997, 83-109.

La Porta, R., Lopez-De-Silanes, F., Shleifer, A., Vishny, R., Legal Determinants of External Finance, *Journal of Finance* 52, 1997, 1131-1150.

Leland, H. E., Pyle D. H., Information Asymmetries, Financial Structure, and Financial Intermediation, *Journal of Finance*, (May) 1977, 371-87.

Love, I., Financial Development and Financing Constraints: International Evidence from the Structural Investment Model, *Working Paper*, 2001, Columbia University.

Mackinnon, J., White, H., Davidson, R., Tests for Model Specification in the Presence of Alternative Hypotheses; Some Further Results, 1983, *Journal of Econometrics*, 21, 53-70.

Meyer, J. R., Kuh, E., The Investment Decision, (1957) Cambridge: Harvard University Press

Miller, M. H., Rock, K., Dividend Policy Under Asymmetric Information, *Journal of Finance,* 50*,* 1985, 1031-1050.

Modigliani, F., Miller, M. H., The Cost of Capital, Corporation Finance and the Theory of Investment, *American Economic Review,* 48, 1958, 261-297.

Myers, S. C., Majluf, N. S., Corporate Financing and Investment Decisions when Firms have Information that Investors do not have, *Journal of Financial Economics*, (June) 1984, 187-221.

Pindyck, R. S., Rubinfeld, D. L., Econometric Models and Economic Forecasts, 1998, 4th Edition, Irwin McGraw Hill.

Rajan, R. G., Zingales, L., Financial Dependence and Growth. *American Economic Review*, 88 (3), 1998, 559-586.

Schaller, H., Asymmetric Information, Liquidity Constraints, and Canadian Investment. *Canadian Journal of Economics* 36 (3), 1993, 552-574.

Shin, H., Park, Y., Financing Constraints and Internal Capital Markets: Evidence from Korean Chaebols, *Working Paper*, 1998, California Polytechnic State University.

Spanos, A., Statistical Foundations of Econometric Modelling, 1986, Cambridge University Press.

Spitzer, J. J., Variance Estimates in Models with the Box-Cox Transformation: Implications for Estimation and Hypothesis Testing, *Review of Economics and Statistics*, 66, 1984, 645-652.

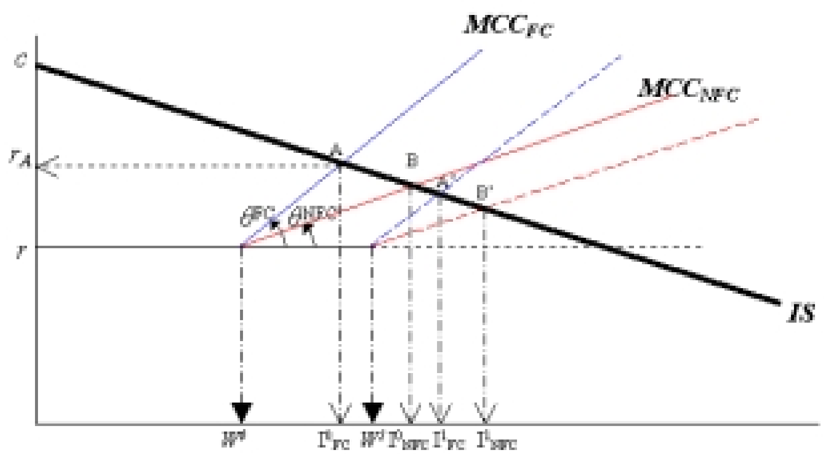
Stiglitz, J. E., Weiss, A., Credit Rationing in Markets with Imperfect Information, *American Economic Review*, (June) 1981, 393-410.

Wurgler, J., Financial Markets and the Allocation of Capital, *Journal of Financial Economics,* 2000, 187-214.

APPENDIX

A simple investment-cash flow model:

The intuition behind the relationship between investment cash flow sensitivity and degree of financing constraint can be explained by means of a simplistic firm investment model as shown below:



The downward sloping line, *IS*, is the investment schedule that the firm faces and describes the marginal return on each additional dollar invested by the firm. As the firm invests more capital, the marginal return on investment declines and the optimal level of investment is the point where the marginal return on capital equals the marginal cost of the additional dollar invested.

Let the Investment Schedule, *IS*, be described by the line:

$$R = -\alpha K + c$$

where R is the marginal rate of return on the additional dollar invested beyond K and $\alpha, c > 0$. Improvements in the investment opportunities facing the firm can be described either by a parallel movement in the *IS* to the right (i.e. and increase in c), a counter clockwise twist (i.e. a decrease in α), or both.

Now suppose two firms that face the same *IS*, have the same level of internal wealth, W^0, but face different costs for external funds. Let the firm facing a relatively higher cost of external finance be denoted by the subscript *FC* (Financially Constrained) and the other firm by the subscript *NFC* (Not Financially Constrained). Note that the marginal cost of external capital for *either* firm is *greater* than the (risk adjusted) cost of internal funds, *r,* but the marginal cost curve, *MCC*, for the *FC* firm is steeper than the marginal cost curve for the *NFC* firm, i.e. $\theta^{FC} > \theta^{NFC}$. The relative difference in marginal costs for the two firms may be on account of several factors: information asymmetry costs, transaction and floatation costs, or agency costs. What we are interested in analyzing is *given* the differences in the costs of external financing (or given the differences in the degree of financing constraint), and after controlling for growth opportunities, what is the relationship between each firm's investment decision and its level of internally generated cash or wealth.

For $\theta^{FC} > \theta^{NFC}$ and the same level of initial wealth, W^0, the optimal levels of capital that the two firms should invest are I^0_{FC} and I^0_{NFC} as shown in the figure above.

Point A corresponds to the point where the marginal return on investment equals the marginal cost of capital for the FC firm and at A:

$$r_A = - \alpha I^0_{FC} + c \qquad (i)$$

Also, $\tan \theta^{FC} = (r_A - r) / (I^0_{FC} - W^0)$, i.e.

$$r_A = (I^0_{FC} - W^0) . \tan \theta^{FC} + r \qquad (ii)$$

Equating (i) and (ii);

$$(I^0_{FC} - W^0) . \tan \theta^{FC} + r = - \alpha I^0_{FC} + c, \text{ or}$$

$$I^0_{FC} = (W^0 . \tan \theta^{FC} - r + c) / (\tan \theta^{FC} + \alpha) \qquad (iii)$$

By a similar analysis:

$$I^0_{NFC} = (W^0 \tan \theta^{NFC} - r + c) / (\tan \theta^{NFC} + \alpha) \qquad (iv)$$

Let us now suppose that the two firms are able to generate an additional amount of internal cash, ΔW. Given this additional (internal) wealth, the optimal levels of invested capital for the two firms should now correspond to the points I^1_{FC} and I^1_{NFC} in the figure and by the same analysis as above:

$$I^1_{FC} = ((W^0 + \Delta W) . \tan \theta^{FC} - r + c) / (\tan \theta^{FC} + \alpha) \qquad (v)$$

$$I^1_{NFC} = ((W^0 + \Delta W) \,.\, \tan\theta^{NFC} - r + c) / (\tan\theta^{NFC} + \alpha) \qquad (vi)$$

Subtracting (*iii*) from (*v*) we have the change in investment for the *FC* firm (corresponding to a change in internal wealth of ΔW) as,

$$\Delta I_{FC} = I^1_{FC} - I^0_{FC} = \Delta W \,.\, \tan\theta^{FC} / (\tan\theta^{FC} + \alpha) \qquad (vii)$$

Similarly, the change in investment for the NFC firm corresponding to a change in internal wealth of ΔW is,

$$\Delta I_{NFC} = I^1_{NFC} - I^0_{NFC} = \Delta W \,.\, \tan\theta^{NFC} / (\tan\theta^{NFC} + \alpha) \qquad (viii)$$

A comparison between equations (*vii*) and (*viii*), i.e. the net change in investment outlays for the two firms (subject to the same increase in net internal finance), can now be made.

We had started with the (given) assumption that $\theta^{FC} > \theta^{NFC}$.

Therefore: $\tan\theta^{FC} > \tan\theta^{NFC}$

Multiplying by α : $\alpha \,.\, \tan\theta^{FC} > \alpha \,.\, \tan\theta^{NFC}$

Adding ($\tan\theta^{FC} . \tan\theta^{NFC}$) : $\tan\theta^{FC}.\tan\theta^{NFC} + \alpha \,.\, \tan\theta^{FC} > \tan\theta^{FC}.\tan\theta^{NFC} + \alpha \,.\, \tan\theta^{NFC}$, or

$\tan\theta^{FC}(\tan\theta^{NFC} + \alpha) > \tan\theta^{NFC}(\tan\theta^{FC} + \alpha)$

Multiplying by ΔW : $\Delta W.\tan\theta^{FC}(\tan\theta^{NFC} + \alpha) > \Delta W.\tan\theta^{NFC}(\tan\theta^{FC} + \alpha)$

Rearranging: $\Delta W.\tan\theta^{FC} / (\tan\theta^{FC} + \alpha) > \Delta W.\tan\theta^{NFC} / (\tan\theta^{NFC} + \alpha)$,

i.e. $\boldsymbol{\Delta I_{FC} > \Delta I_{NFC}}$ [from *(vii)* & *(viii)*]

Thus, for the *same* increase in the level of internally generated funds ΔW, the incremental increase in investment for the *FC* firm is greater than the incremental increase in investment by the *NFC* firm. This implies that :

$$\frac{\Delta I_{FC}}{\Delta W} > \frac{\Delta I_{NFC}}{\Delta W}, \text{ and in the limit: } \frac{dI_{FC}}{dW} > \frac{dI_{NFC}}{dW}$$

In other words, after controlling for future growth opportunities, investment cash flow sensitivity is greater for the more financially constrained firm.

VITA

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