Abant Sosyal Bilimler Dergisi

Journal of Abant Social Sciences

2022, 22(2): 632 – 647, doi: 10.11616/asbi.1094934

Firm Size, Financial Constraints and Inverse Monotonicity of Investment-Cash Flow Sensitivity*

Firma Büyüklüğü, Finansal Kısıtlar ve Ters Monotonik Yatırım-Nakit Akış Duyarlılığı

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Geliş Tarihi (*Received*): 29.03.2022 **Kabul Tarihi (*Accepted*):** 26.05.2022 **Yayın Tarihi (*Published*):** 31.07.2022

Abstract: Financial constraints hypothesis states that firms that are more likely to be financially constrained should have higher investment-cash flow sensitivity. This paper aims at testing the financial constraints hypothesis in a period when access to credit is relatively easy using firm size as *a priori* criterion for access to credit. We use data of firms listed on Borsa Istanbul during the period 2006–2017 and estimate regressions with panel fixed effects. We find that investment-cash flow sensitivities monotonically increase from small firms to large firms across four groups. The findings reject the financial constraints hypothesis and imply an inverse monotonic relationship between investment-cash flow sensitivities and financial constraints. We conclude that any difference in investment-cash flow sensitivities estimated by a cash flow-augmented q investment equation can't be interpreted as an indicator of financial constraints especially when firms are not homogenous in terms of cash flow which can indicate financial distress or free cash flow problem.

Keywords: Firm Size, Financial Constraints, Investment-Cash Flow Sensitivity, Financial Distress, Free Cash Flow

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Öz: Çalışma, krediye erişimin göreceli olarak daha kolay olduğu bir dönemde krediye erişim için öncül kriter olarak firma büyüklüğünü kullanarak finansal kısıtlar hipotezini test etmeyi amaçlamaktadır. Çalışmada Borsa İstanbul'da 2006–2017 dönemi boyunca işlem gören firmaların verisi kullanılmıştır ve yatırım-nakit akış duyarlılıkları panel sabit etkiler yöntemi ile tahmin edilmiştir. Yatırım-nakit akış duyarlılıklarının küçük firmalardan büyük firmalara doğru monoton arttığı bulunmuştur. Bu bulgu finansal kısıtlar hipotezini reddetmektedir ve yatırım-nakit akış duyarlılığı ile finansal kısıtlar arasında ters monoton ilişki olduğu anlamına gelmektedir. Nakit akışı ile genişletilmiş q yatırım denklemi kullanılarak tahmin edilen yatırım-nakit akış duyarlılıkları arasındaki bir farklılığın, finansal kısıtların bir göstergesi olarak yorumlanamayacağı sonucuna varılmıştır. Nakit akışı finansal sıkıntıyı veya serbest nakit akışı problemini gösterebileceği için, bu sonuç özellikle firmalar nakit akışı açısından homojen olmadığında geçerlidir.

Anahtar Kelimeler: Firma Büyüklüğü, Finansal Kısıtlar, Yatırım-Nakit Akış Duyarlılığı, Finansal Sıkıntı, Serbest Nakit Akışı

JEL Classification Codes: G31, G32, O16

Atıf/Cite as: Çobanoğlu, C., Gümrah, Ü. (2022). Firm Size, Financial Constraints and Inverse Monotonicity of Investment-Cash Flow Sensitivity. *Abant Sosyal Bilimler Dergisi, 22(2),* 632 - 647. doi: 10.11616/asbi.1094934

İntihal-Plagiarism/Etik-Ethic: Bu makale, en az iki hakem tarafından incelenmiş ve intihal içermediği, araştırma ve yayın etiğine uyulduğu teyit edilmiştir. / This article has been reviewed by at least two referees and it has been confirmed that it is plagiarism-free and complies with research and publication ethics. https://dergipark.org.tr/tr/pub/asbi/policy

* An earlier version of this study has appeared in the proceedings of *4th International Congress of The Human and Social Science Researches (ITOBIAD) in 2021.* This expanded version is significantly improved in many aspects. It has more detailed discussion of the topic, better presentation and organization, new results and it is in a different language to reach wider scientific audience. This version elaborates on the possible causes of the inverse monotonicity and presents findings on how financial distress and free cash flow problem affect investment-cash flow sensitivities.

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1. Introduction

The positive relationship between cash flow and investment has been recognized for a long time, for example since Tinbergen (1938) and Meyer and Kuh (1955). However, it wasn't clear how to interpret this relationship because cash flow can indicate either investment opportunities or availability of low-cost source of finance both of which are positively related to investment. It is difficult to control investment opportunities because proxies for investment opportunities contain measurement errors. An important contribution to explain cash flow–investment relationship is made by Fazzari, Hubbard, and Petersen (1988) (hereafter FHP) who split a sample of firms by how likely each firm is financially constrained. They found that investment-cash flow sensitivity increases monotonically from one group of firms to another as the degree of financial constraints increases. If there is not a systematic pattern in the measurement errors, the difference across firm groups in the investment-cash flow sensitivity indicates the existence of financial constraints and cost advantage of internal finance.

A relationship between two variables is said to be direct (inverse) monotonic if one variable steadily increases (decreases) as the other variable increases. It is said to be non-monotonic if the movement of one variable reverses direction at some point as the other variable continues to increase. Accordingly, the FHP result implies a monotonic relationship between investment-cash flow sensitivity and financial constraints. However, Kaplan and Zingales (hereafter KZ) claimed that theoretical basis for monotonic relationship is not strong (Kaplan and Zingales, 1997: 170, 171) and the sufficient conditions for expecting a monotonic relationship are not specified in any theory (Kaplan and Zingales, 2000: 1). The large sample evidence of Cleary (1999) supports the conclusions of KZ. However, there are many other studies that support the financial constraints interpretation of investment-cash flow sensitivity (Gilchrist and Himmelberg, 1995; Hoshi, Kashyap and Scharfstein, 1991; Schaller, 1993).

Many alternative measures of financial constraints are proposed during 1990's such as payout ratio, size, age, banking ties, ownership concentration, bond and commercial paper ratings in order to predetermine financially constrained firms. Some indices of firm characteristics are also introduced for the same purpose (for example Kaplan and Zingales (1997), Cleary (1999), Whited and Wu (2006) and Hadlock and Pierce (2010)). Some authors analyzed the effects of financial constraints on other decision variables alternative to fixed investments such as working capital (Fazzari and Petersen, 1993), inventories (Kashyap et al., 1994), intangibles (Demmou et al., 2019), cash (Almeida et al., 2004, 2021), and some authors analyzed the interdependence of them (Gatchev et al., 2010). The literature on the financial constraints continues to develop with new variables and methods.

Despite many work, it hasn't been clarified when to expect a monotonic relationship between investment-cash flow sensitivity and financial constraints since the discussion between FHP and KZ during the late 1990s and early 2000s. The factors that may contaminate the monotonicity are not fully explored. The literature review on firm size criteria shows that non-monotonicity of investment-cash flow sensitivity is common in studies which use firm size for the classification of firms. In fact, the relationship tends to be inverse monotonic in samples in which financial constraints are likely to be less severe. We try to answer whether investment-cash flow sensitivity increases monotonically with financial constraints when firm size is used as a proxy of loosening financial constraints in a period of increasing commercial loans in Turkey when financial constraints are expected to be less severe. We also analyze the role of financial distress or free cash flow problem on investment-cash flow sensitivities to solve the puzzle of contradictory findings related to firm size criteria.

The study consists of four sections after the introduction section. The first section explains the conceptual framework and the hypothesis of the study. It also includes a brief literature review of studies that estimate investment-cash flow sensitivities in different firm size groups. The second section describes the methodology. The third section reports the results and discusses possible factors affecting the results. The forth section concludes the study.

1. Financial Constraints and Firm Size

1.1. Conceptual Framework

FHP claimed that cash flow has a cost advantage over external funds when the capital markets are not perfect and hence availability of low-cost cash flow may affect investment spending. Moreover, the effect is greatest on financially constrained firms, which are defined as the firms that face higher costs on external finance. They used mean retention ratio to identify financially constrained firms because a financially constrained firm is expected to retain higher amount of its profit as the amount of funds needed for their investment increases. They tested the role of cash flow by augmenting an investment equation, preferably that of q theory of investment, with cash flow.

The q theory of investment has a conceptual advantage over other investment models because Tobin's q is a forward-looking measure of investment demand that incorporates market data. The q theory of investment can be derived from a firm's optimization problem assuming quadratic adjustment costs. Theoretically, q is the principal determinant of investment and all other factors can affect investment only through q. The cash flow term is added into the investment equation on ad hoc basis without theoretical derivation. If the perfect capital markets assumption of q theory of investment is valid, then cash flow term shouldn't be significant. However, Tobin's q is notorious for having measurement errors and cash flow can also be a proxy for investment demand. To the extent that Tobin's q fails to capture investment demand, the cash flow coefficient can be found to be significant positive even in perfect capital markets.

According to financial constraints view, when the cost of external funds is higher than the cost of internal funds, investment spending should increase as cash flow increases. Therefore the cash flow coefficient is expected to be significant positive for financially constrained groups. Moreover, cash flow coefficient is expected to increase monotonically as the degree of financial constraints increases. Considering the possible measurement errors in Tobin's q, the difference in the cash flow coefficients across groups is interpreted as the strongest evidence of financial constraints. The estimated coefficient of Tobin's q can be insignificant for financially constrained groups because the perfect capital markets assumption of the q theory of investment is not valid for financially constrained firms. Such firms may not respond to increases in investment demand because they can't simply use external finance when required investment finance exceeds internal finance.

Since the difference between the costs of external and internal funds is not visible in financial statements, a criterion is used to classify firms according to how likely they are financially constrained or have access to financial markets. Firm size is one of the several criteria that are commonly used in the literature. Smaller firms are more likely to be financially constrained for several reasons such as flotation costs, asymmetric information and idiosyncratic risk. (1) An important part of the flotation costs are fixed and they need to be shared among fewer securities in small firms. Thus, issuing securities is more costly in small firms. (2) Small firms are either young or unlucky about their past investments. In the first case, the stock of knowledge about a small firm is likely to be small so that potential investors can't evaluate the firm. In the second case, a small firm must try hard to convince potential investors about the profitability of its future investments. (3) Small firms may have higher idiosyncratic risk because of less diversified operations, products or customers. Thus, potential investors may require higher rates of return on the securities of small firms.

Firm size is positively related with some other criteria such as payout ratio, having bond or commercial paper rating and age. Fazzari et al. (1988: 147) showed that smaller firms have higher average retention ratio and lower percentage of new long-term debt from nonbank sources. Gertler and Gilchrist (1994: 316–317) also showed that smaller firms have lower percentage of debt from nonbank sources and they claimed that nearly in all studies financially constrained firms are smaller in average. Gilchrist and Himmelberg (1995: 553) claimed that smaller firms are typically younger. These relations support the view that smaller firms are more likely to be financially constrained. As a caveat, Gertler and Hubbard (1988: 32) claimed that firm size is a rough proxy for ability to borrow and even large firms can face market frictions. Fazzari et al. (1988: 158) also claimed that financial constraints are widespread because

their sample consist of publicly traded large firms. However, Beck et al. (2004) measured financial obstacles using survey data and confirmed that firm size is a useful criterion for classification of firms. Hadlock and Pierce (2010) also showed that firm size and age are more useful predictors of financial constraints than some other alternative measures.

1.2. Review of Previous Findings

Several studies estimated the cash flow-augmented q investment equation and reported that the coefficient of cash flow is higher in firms that are more likely to be financially constrained. However, some studies reported findings that are contrary to financial constraints view. Mixed evidence is common in studies which use firm size to classify firms according to the probability of being financially constrained. Table 1 summarizes previous studies which use firm size as a criterion for financial constraints. The studies are divided into two panels according to whether their samples are from developed markets or emerging markets. The second column of the table shows the sample of each study. The table also shows the number of groups that the sample is split into and the group which has the highest investment-cash flow sensitivity (ICFS).

Table 1: Previous Studies That Group Firms by Their Size

Notes: The table lists the previous studies which estimate investment-cash flow sensitivities for various size groups in the first column. Other columns respectively show the sample, the number of groups, the group that have the highest investment-cash flow sensitivity in the related study.

Study	Sample	Groups	Highest ICFS
Panel A: Studies that use samples from developed markets			
Devereux and Schiantarelli (1990)	UK 1969-1986	4	Large firms
Oliner and Rudebusch (1992)	US 1977-1983	2	No difference
Kadapakkam et al. (1998)	OECD 1982-1991	3	Large firms
Audretsch and Elston (2002)	Germany 1970-1986	4	Large but not the largest firms
Booth and Cleary (2006)	US 1981-1998	3	Large firms
Panel B: Studies that use samples from emerging markets			
Laeven (2003)	Developing C. 1988-1998	2	Varies by financial liberalization
Arslan et al. (2006)	Turkey 1998-2002	2	Varies by crisis status
Ismail et al. (2010)	Malaysia 1988-2005	2	Varies by estimation method
Crisóstomo et al. (2012)	Brazil 1995-2006	2	Small firms
Benligiray and Aydın (2017)	Turkey 2002-2014	2	Small firms

The first studies that group firms by size criteria focus on UK or US samples. Devereux and Schiantarelli (1990) found that larger firms have higher investment-cash flow sensitivity in the UK. Their interpretation about the finding is that large firms can have more dispersed ownership which can increase agency costs. There is a reason to doubt this interpretation because Oliner and Rudebusch (1992) found that ownership structure doesn't cause a difference in investment-cash flow sensitivities of US firms. An interesting point is that they also found that size doesn't cause a difference either. However, using a panel of US firms, Booth and Cleary (2006) found that small firms have higher investment-cash flow sensitivity. They claim that smaller firms have higher cash flow volatility and hence they keep higher amount of financial slack for potential financial constraints which reduces the sensitivity.

The results of other samples from developed markets are similar to the results of UK and US samples. For example, Kadapakkam et al. (1998) used a sample of six OECD countries and used various measures of firm size. They found that investment-cash flow sensitivity of large firms is higher than that of small firms. They postulate that there are two reasons for the result. First, large firms are more flexible to delay their investments until enough amount of cash flow is available. Second, large firms face greater agency

problems because of more dispersed ownership that can result in expanding firm size using free cash flow. Using a sample of firms in Germany which is among the OECD countries, Audretsch and Elston (2002) found similar result except that investment-cash flow sensitivity suddenly drops to a negative value in the largest firms. Their interpretation is that Germany has a bank-based financial system in which firms have close long-term relations with banks and this kind of institutional structure alleviates financial constraints in small firms.

The first studies on emerging markets appeared in the 2000s. Laeven (2003), examined the effect of size and financial liberalization on investment-cash flow sensitivity for 13 developing countries. He found that investment-cash flow sensitivity is higher for small firms at the beginning of financial liberalization and higher for large firms as financial liberalization advances. Another contingent finding is reported by Arslan et al. (2006) who used Turkish firm data. They found that investment-cash flow sensitivity is higher for large firms in the pre-crisis period and higher for small firms in the crisis period. Using Malaysian firm data, Ismail et al. (2010) found that the group with the highest cash flow coefficient varies according to the estimation method but the coefficients of cash flow are close to each other. Crisóstomo et al. (2012) found that small firms have higher investment-cash flow sensitivity in Brazil. Their finding is the first in our literature review that supports the financial constraints hypothesis. Similarly, Benligiray and Aydın (2017) estimated higher cash flow coefficient for small firms but it is significant only at the 0.10 level.

1.3. Hypotheses of the Study

According to the literature review, the studies on developed markets generally report that large firms have higher investment-cash flow sensitivity. On the contrary, the studies on emerging markets report that small firms have higher investment-cash flow sensitivity or the results are mixed. In fact, as the financial markets develop, financial liberalization advances, and there is not any crisis, it is the larger companies that tend to have higher investment-cash flow sensitivities. In the opposite case, when the financial markets are poorly-developed and there is an economic downturn, it is the smaller companies that tend to have higher investment-cash flow sensitivities. Although the evidence on financial constraints looks mixed, it doesn't mean that capital markets are perfect. A better explanation is that market imperfections have conflicting effects on investment-cash flow sensitivities. Besides, when financial constraints are relaxed or not much binding, the effects that reverse the monotonicity of investment-cash flow sensitivity are more pronounced.

There are some factors that can reduce the difference in the degree of financial constraints between small and large firms when the financial markets develop, financial liberalization advances, or the economy avoids any crisis. On the one hand, some kind of market imperfections can be ameliorated in well-developed financial markets which provide more effective financial arrangements. On the other hand, banks can play a similar role in poorly-developed financial markets. Smaller firms are more likely to face higher costs on external finance due to flotation costs, asymmetric information and idiosyncratic risk as explained beforehand. Banks can mitigate the effect of each market imperfection by reducing transaction costs, acquiring more information from close relationships and diversifying risk. However, banks can ration credit especially during economic downturns when the loans are less likely to return. Banks can reject granting loan at higher rates because of adverse selection. Since smaller firms are more dependent upon banks, they face higher financial constraints in an economic downturn in poorly-developed financial markets. Therefore, unless the financial markets are poorly-developed or there is an economic downturn, the difference in the degree of financial constraints between small and large firms can be low and the effects that reverse the monotonicity can be more pronounced.

Two factors can reverse any weak evidence on financial constraints by affecting investment-cash flow sensitivities of small firms or large firms. The first factor is financial distress, a situation in which a firm has difficulties in paying its financial obligations due to insufficient cash flows and liquidity problems. Allayannis and Mozumdar (2004: 902) claimed that investment of a financially constrained firm can't respond to cash flow if the firm is dragged into financial distress. Some authors tried to remove financially distressed firms from their sample (Gilchrist and Himmelberg, 1995: 552) but some others kept

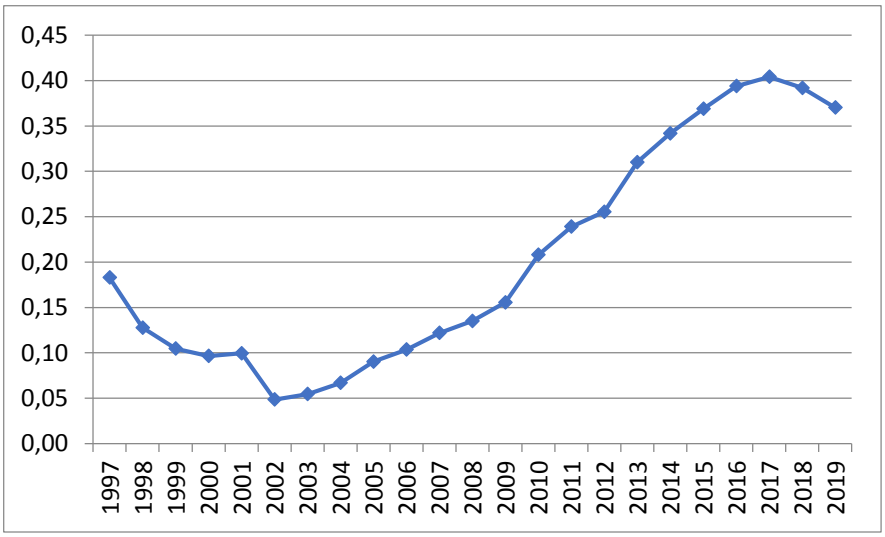
them (Cleary, 1999; Kaplan and Zingales, 1997). The second factor is free cash flow, i.e. cash flow that is left after funding all positive net present value projects. Jensen (1986: 323) remarked that managers have incentives to invest even in low-return projects instead of paying free cash flow to shareholders. Richardson (2006: 159) and Schiantarelli (1996: 78) noted that this kind of agency problem may cause a relation between cash flow and investment independent of the effect of financial constraints.

The null hypothesis of the study is the financial constraints hypothesis which is the mainstream view in the financing constraints literature. It states that higher investment-cash flow sensitivities indicate higher financial constraints. Strictly speaking, there should be a direct monotonic relationship between financial constraints and investment-cash flow sensitivities. Since firm size is a useful criterion for sorting firms according to how likely they are financially constrained, investment-cash flow sensitivity should be increasing from small firms to large firms. When the financial constraints are relaxed, there shouldn't be any difference between small and large firms. The alternative hypotheses include (1) problems in the classification, (2) financial distress in small firms and (3) free cash flow in large firms.

Turkish firms provide an interesting sample to test the hypothesis of the study because they experienced periods with varying degrees of access of credit due to their dependence on banks. Banks constitute the major part of Turkish financial system (Belen and Karamelikli, 2016: 127). They play a contingent role in removing the differences in availability of credit between small and large firms. First, during a crisis, banks can cut financing for all firms which can affect small firms most. Second, during an expansion period, banks can extend credit to smaller firms as much as they extend credit to large firms because banks can mitigate flotation costs, asymmetric information and idiosyncratic risk that small firms suffer. Figure 1 shows how the ratio of commercial loans to gross domestic product changed over years in Turkey. Commercial loans to GDP was about 10% in 2000 and dropped to 5% after the banking crisis of February 2001. It reached back to 10% in 2006 and increased continuously until 2017.

Figure 1: Commercial Loans to GDP in Turkey

Notes: The size of commercial loans is measured by the end-of-year stock value of credits that are extended to non-financial companies in private sector by Turkish banks. The data is retrieved from Money and Banking Statistics of the CBRT.



The studies on Turkish stock market use data of older periods when access to credit is not easy (for example Arslan, Florackis and Ozkan (2006) and Benligiray and Aydın (2017)). They estimated higher investment-cash flow sensitivities for smaller firms, at least during 2001-2002 crisis period. However, as the economy recovers from the crisis, banks can cease rationing credit. Hence, investment-cash flow sensitivities of small firms may not remain high in later periods. The continuous increase in the size of commercial loans indicates relatively easier access to credit in the 2006–2017 period in Turkey. The data

of this period allows answering three questions. First, is financial constraints view valid in all cases? Second, can large firms have higher investment-cash flow sensitivity even in an emerging market as they are in developed markets? Third, what are the possible effects that reverse the monotonicity of the relationship between financial constraints and investment-cash flow sensitivities?

2. Empirical Methodology

2.1. Model and Variables

We test the hypotheses of the study using the cash flow-augmented q investment equation which is defined as:

$$I_{it}/K_{it-1} = \beta_1 Q_{it-1} + \beta_2 CF_{it}/K_{it-1} + u_{it} \quad (1)$$

The terms I_{it} and CF_{it} in the equation represent fixed investment spending and cash flow of i-th firm during t-th year, respectively. The terms K_{it-1} and Q_{it-1} represent replacement value of capital stock and the ratio of market value to replacement value of i-th firm at the beginning of t-th year, respectively. u_{it} is the error term. Both current investment and cash flow is divided by beginning-of-period capital stock.

Investment is measured as the change in gross property, plant and equipment net of the change in revaluation surplus. It represents gross investment because it is equal to the sum net investment which is the change in net property, plant and equipment and replacement investment which is assumed to be equal to depreciation. Cash flow is measured by net income plus depreciation and amortization charges. Tobin's q is measured as market value of total assets to replacement value of total assets. The numerator is estimated by the market value of shareholder's equity plus the book value of debt. The denominator is estimated by the replacement value of net property, plant and equipment plus the book value of other assets. Accounting and market data used in the calculation of Tobin's q is measured end-of-period. Thus lagged Tobin's q in the model represents beginning-of-period values.

Capital stock is measured as the replacement value of the property, plant and equipment. The replacement value is set to the net book value of the property, plant and equipment for the first observation of each firm. The replacement value of each later period is derived from its lagged value by revaluing with the inflation rate, depreciating with the depreciation rate and adding the investment of that period. The calculation of replacement value resembles to the calculation used by Fazzari et al. (1988: 193). The data used in the calculation dates back up to 1988 for some firms. Firm size is measured by the real value of total assets in 2017 prices which is calculated by multiplying the beginning-of-period book value of total assets with the growing factor of price index of each year up to 2017. Inflation rate is the ratio of change in the producer price index. Depreciation rate is estimated by the ratio of depreciation expense to the sum of net property, plant and equipment and depreciation expense.

Firm size is assumed to be an indirect proxy of access to external finance and reduction in financial constraints. Hence, it is used as an a priori criterion to group observations or firms according to the degree of financial constraints. A classification based on observations allows firms to switch from one size group to another depending on the changes in the degree of financial constraints. However, it can reduce degrees of freedom by separating observations of a firm into different groups. The primary classification in the study groups firms according to the average firm size. In order to check the robustness of results to the classification method, a secondary classification that groups observations is also used. While the firm-based classification uses firm averages of firm size to classify firms, the observation-based classification uses measured firm size to classify observations, where firm size is measured by the real value of beginning-of-period total assets. Descriptive statistics and some other results are presented only for the primary classification.

2.2. Data and Descriptive Statistics

The empirical analysis uses a panel data of Turkish firms over the period 2006–2017, listed on Borsa Istanbul. The period is characterized by a steadily growth in the size commercial loans to GDP as

discussed above. Accounting and market data are retrieved from Datastream and inflation data is retrieved from TURKSTAT. Financial firms and firms with low asset tangibility are excluded from the sample for two reasons. First, the source of firm value in some industries such as finance or services in general may not be the production with physical capital stock. Therefore, the return of physical capital may be lower than the return of other assets and Tobin's q of total assets may not be a good proxy for marginal q of capital stock. Second, very small values of capital stock may lead to outliers in the variables which are ratios of some monetary variables to capital stock. Asset tangibility of an observation is accepted as low if current or first lag of the ratio of net property, plant and equipment to total assets is below 0.15. Some observations are excluded from sample because they have missing value in any of the investment, cash flow and q variables and can't be used in the estimations. Variables are *winsorized* at 1-st and 99-th percentiles to prevent outliers that can divert the results. There are 2030 observations from 253 companies in the unbalanced panel data that is used in the analyses.

The degree of financial constraints is expected to increase monotonically from small firms to large firms. Hence, firms are classified into three groups according to their average firm size using 33-th and 66-th percentiles of that variable. The groups are named as small firms, medium-sized firms and large firms. This classification will be referred as the primary classification in the rest of the paper. There are 674 or more observations in each group. Descriptive statistics of some variables for each group and for the full sample are presented in Table 2. Firm size represents real beginning-of-period total assets in thousands of Turkish liras of 2017. I/K, CF/K and DIV/K represent the ratios of investment, cash flow and dividend to beginning-of-period capital stock, respectively. Q is beginning-of-period Tobin's q of total assets. The first value represents median and the second value represents mean in each cell of the table. Variables are positively skewed because they are naturally unrestricted in the positive direction and they have a few very large values. As a result of skewness, mean values are higher than median values in all cells.

Table 2: Descriptive Statistics

Notes: Firms are classified as small, medium-sized and large according to their average firm size using 33-th and 66-th percentiles of that variable. Firm size represents real beginning-of-period total assets in thousands of Turkish liras of 2017. I/K, CF/K and DIV/K represent the ratios of investment, cash flow and dividend to beginning-of-period capital stock, respectively. Q is beginning-of-period Tobin's q of total assets. The first value represents median and the second value represents mean in each cell of the table.

	Small	Medium	Large	Full Sample
Firm	90,006	407,872	2,501,224	407,501
Size	106,854	447,623	5,633,277	2,068,993
I/K	0.0399	0.0712	0.1234	0.0798
	0.1122	0.1480	0.1831	0.1478
CF/K	0.0412	0.1758	0.2229	0.1481
	0.0578	0.2111	0.2686	0.1794
Q	1.1563	1.0366	1.1265	1.1031
	1.4897	1.3257	1.3121	1.3756
DIV/K	0.0000	0.0000	0.0157	0.0000
	0.0287	0.0682	0.0753	0.0575
N	674	677	679	2030

Both median and mean values of investment and cash flow variables increase from small firms to large firms. Investment expenses of median firms are around %4, %7 and %12 of their capital stock respectively in small, medium-sized and large firms. Cash flows of median firms are around 4%, 18% and 22% of their capital stock respectively among small, medium-sized and large firms. Descriptive statistics of both

variables increase monotonically from small firms to large firms. Median and mean values of Tobin's q change between subsamples in a non-monotonic way and they are close to but higher than the equilibrium value of one. The two points on Tobin's q don't indicate a systematic pattern in measurement errors in Tobin's q or even existence of them. Median dividend in full sample is zero implying that that half of the observations didn't pay any dividend. It is the same for small and medium-sized firms but at least half of the observations in large firms paid dividend. Mean values of dividend increase from very small firms to very large firms.

The findings on dividend, cash flow and investment show that firm size is successful as a criterion for financial constraints and support the assumption that financial constraints decline as firm size increases. First, financially constrained firms are expected to use their cash flow in investment instead of paying as dividend. Although dividend payment is at firm's choice, it is a common assumption that firms with lower payout ratio are more likely to face financial constraints because dividend is one of the first variables in the literature that is used as an indicator of financial constraints. Second, financially constrained firms are more likely to have higher interest expenses as a percentage of capital stock because they face higher costs on debt to finance capital stock. Recall that our cash flow definition doesn't add interest expense back to net income because interest payments of existing debt are not optional. Hence they have lower cash flow available for investment as a percentage of capital stock. Third, financially constrained firms are likely to invest less because external finance is costly and internal finance is generally insufficient.

3. Regression Estimates

3.1. Cash Flow Sensitivity in Various Size Groups

The general approach for testing financial constraints is a priori classification of firms or observations. While some studies classify firms (e.g. Fazzari et al. (1988)), some others classify observations (e.g. Cleary (1999)). A classification based on observations allows firms to switch from one size group to another depending on the changes in the degree of financial constraints. Hence, it can reflect the changing financial status of firms over time. However, observations of a single firm can fall into different groups in an observation-based classification. In a fixed effects model, separating the observations of a single firm to multiple groups can waste a number of degrees of freedom. The degrees of freedom simply equal to total number of observations minus the number of independent variables, firm dummies and year dummies. A firm contributes to the degrees of freedom of a fixed effects model estimated on a group by the number of its observations that lie in that group minus one because of one firm dummy. Pooling all of the observations of a firm in a single size group can increase the degrees of freedom by reducing the number of firm dummies and hence efficiency of the fixed effects model estimated on a group.

The primary classification in the study is a firm-based classification as described in the descriptive statistics but the results of an observation-based classification are also presented to check if the results are robust against ignoring the dynamic nature of financial status. The secondary classification groups observations according to the quartiles of firm size which are named as very small, medium-small, medium-large and very large. The number of groups in the observation-based classification is four instead of three because higher number of groups can reflect the shifts in the financial status of firms better while giving up the efficiency of regressions.

The regression estimates of the investment model for different groups formed by firm-based or observation-based classification are reported in Table 3. Panel A presents the results for the three groups that are formed by grouping firms. The coefficients of cash flow are -0.07 in small firms, 0.23 in medium-sized firms and 0.34 in large firms. While the cash flow coefficient is not statistically significant in small firms, it is significant at 0.01 level in medium-sized firms and large firms. Panel B presents the results for the four groups that are formed by grouping observations. The coefficients of cash flow are -0.03 in very small firms, 0.11 in medium-small firms, 0.17 in medium-large firms and 0.32 in very large firms. While

the cash flow coefficient is not statistically significant in very small and medium-small firms, it is significant at 0.10 level in medium-large firms and significant at 0.01 level in very large firms.

Table 3: Regression Estimates for Alternative Classifications

Notes: In Panel A, firms are classified as small, medium-sized and large according to their average firm size using 33-th and 66-th percentiles of that variable. In Panel B, observations are classified as very small, medium-small, medium-large and very large according to measured firm size using quartiles of that variable. Firm size is measured by real beginning-of-period total assets in thousands of Turkish liras of 2017. I/K and CF/K represent the ratios of investment and cash flow to beginning-of-period capital stock, respectively. Q is beginning-of-period Tobin's q of total assets. Regressions are estimated with fixed firm and year effects. The values in the parentheses are cluster-robust Huber/White standard errors. *, ** and *** indicate that the corresponding coefficient is significant at 0.10, 0.05 and 0.01 levels, respectively.

Panel A: Firm-Based Classification

I/K	Small	Medium	Large
Q	0.0568***	0.0206	0.0968**
	(0.02)	(0.02)	(0.04)
CF/K	-0.0743	0.2310***	0.3355***
	(0.06)	(0.09)	(0.11)
N. Obs.	674	677	679
N. Firms	103	78	72
Adjusted R^2	0.0294	0.0487	0.1775

Panel B: Observation-Based Classification

I/K	Very Small	Medium-Small	Medium-Large	Very Large
Q	0.0592**	0.1190*	0.0003	0.0576
	(0.03)	(0.05)	(0.02)	(0.04)
CF/K	-0.0294	0.1053	0.1684*	0.3165***
	(0.09)	(0.10)	(0.10)	(0.12)
N. Obs.	508	507	508	507
N. Firms	94	100	84	67
Adjusted R^2	0.0706	0.0672	0.2617	0.1407

The cash flow coefficients in Panel A imply that when there is a unit of increase in the cash flow but other variables remain constant, it is expected that the investment of a small firm doesn't change or the change can be attributed to chance but the investment of a medium-sized firm increases by 0.24 units and the investment of a large firm increases by 0.34 units. The cash flow coefficient of large firms is not only statistically but also economically significant. As shown in the descriptive statistics, median investment is 0.12 and median cash flow is 0.22 for large firms. If the median large firm doubles its cash flow, there will be 0.22 units increase in its cash flow and as a result there will be 0.34 × 0.22 = 0.07 units increase in its investment. The increase is 0.07 / 0.12 = 58% of the investment prior to the positive cash flow shock. It is quite high for a firm that is supposed to be financially unconstrained because theoretical value of investment-cash flow sensitivity is zero for a financially unconstrained firm. It can't be attributed to measurement errors in Tobin's q because measurement errors would bias the q coefficients towards zero. However the q coefficient in large firms is significant at 0.05 level and sufficiently high compared to much of the findings of the previous studies.

In both panels of the table, the t-values and the significance of the cash flow coefficients depend more on the magnitudes than the standard errors of the cash flow coefficients. The standard errors of the cash flow coefficients don't change much between the firm groups owing to similarity in the number of observations. However, the change in the magnitude of the cash flow coefficients from one group to another is large. For example in Panel A, the standard errors remain in the 0.06 – 0.11 margin but the magnitude of cash flow coefficients changes from negative values to 0.34. Similarly in Panel B, the standard errors remain in the 0.09 – 0.12 margin but the magnitude of cash flow coefficients changes from negative values to 0.32. Hence, any difference in the significance of cash flow coefficients is a result of the change in the cash flow coefficients and can't be attributed to any difference in the standard errors.

When compared to Panel A, the cash flow coefficients in Panel B is less significant because the magnitudes of cash flow coefficients are closer to zero but their standard errors are higher. Specifically, the absolute value of the cash flow coefficient of small firms in Panel A is greater than that of very small firms in Panel B. The coefficient of medium-sized firms in Panel A is greater than that of medium-small firms and medium-large firms in Panel B. The cash flow coefficient of large firms in Panel A is greater than that of very large firms in Panel B. On the other hand, the standard errors of cash flow coefficients of leftmost, middle and rightmost groups in Panel B are greater than their counterparts in Panel A. Lower magnitudes and higher standard errors of the cash flow coefficients in Panel B are due to smaller number of observations in each group and inefficient handling of firm dummies.

The most interesting result in Table 3 is that the cash flow coefficient increases from smaller firms to larger firms. The relationship between investment-cash flow sensitivity and financial constraints is not even non-monotonic but inverse monotonic. The result is in straight contrast to what the financial constraints hypothesis suggest. It is robust against ignoring the dynamic nature of financial status or choosing a classification that reduces the efficiency of regression. As to authors' best knowledge, no previous study reported such an inverse monotonic relationship that holds even when the number of groups is four as in Panel B. In Panel B, the largest changes in the cash flow coefficients come out with two extreme groups, from medium-small firms to very small firms and from medium-large firms to very large firms. The cash flow coefficients of the two medium groups are close to each other. It suggests that there are two factors which mostly affect extreme groups: one suppresses the cash flow sensitivity of very small firms and the other boosts the cash flow sensitivity of very large firms. The possible candidates are financial distress and free cash flow that are discussed below.

3.2. Financial Distress and Free Cash Flow

While the financial constraints hypothesis states that higher investment-cash flow sensitivities indicate higher financial constraints, the findings on size groups reject it. The rejection is robust to alternative classifications of firms by their size. However, the findings suggest that there are some factors that can affect the results. Previous studies put forward some factors that can affect investment-cash flow sensitivities. One of them is financial distress which can suppress the investment-cash flow sensitivity. If a firm is financially distressed, its investment can't respond to cash flow because the firm uses all available cash for paying financial obligations to avoid default. The firm doesn't invest because the payback of a new investment is in the future but the financial obligations are due. Another factor is the free cash flow problem which can boost the investment-cash flow sensitivity. Free cash flow is the cash flow that is left after capital expenditures and the firm is free to pay out to investors of the firm. Managers have incentives to invest in low-return projects instead of paying free cash flow as dividend. This kind of agency problem may introduce a relationship between cash flow and investment.

Financial distress and free cash flow problem have opposite effects on investment-cash flow sensitivities but the target of that factors are very different. While financial distress is more likely to be present in firms that have lower cash flows, free cash flow problem is more likely to be present in firms that have higher cash flows. Because of the asymmetry in the targets of financial distress and free cash flow problem, they can amplify, break or reverse the monotonicity of the relationship between financial constraints and investment-cash flow sensitivities. The result of the two factors depends on how low-cash flow firms and high-cash flow firms are distributed into groups that are assumed to differ only by

financial constraints. As long as observations with extreme cash flows are not evenly distributed among groups, one must be cautious in interpreting differences in cash flow sensitivities as an evidence of financial constraints. A simple way to see if the two factors are in effect is to check how excluding observations with very low or very high flows changes cash flow sensitivities.

According to the descriptive statistics of the study, cash flow as a percentage of capital stock increases from 4% in small firms to 12% in large firms so that reversing effects of financial distress and free cash flow problem is possible. It is interesting to check whether filtering observations with extreme cash flows changes estimates. Table 4 reports the regression results under alternative filtering schemes for the groups formed by the primary classification described in the descriptive statistics. Panel A presents the same estimates without any filtering as they were in Table 3. Panel B, Panel C, Panel D respectively presents the estimates excluding (1) low-cash flow, (2) high-cash-flow, and (3) both low-cash flow and high-cash-flow observations from each group. The cash flows below -0.10 are assumed to be low and the cash flows above 0.60 are assumed to be high for filtering the observations.

Table 4: Regression Estimates for Alternative Classifications

Notes: Variables, notations and estimation method are as explained in Table 3.The groups in Panel A are exactly the same as the groups in Panel A of Table 3. Panel B, Panel C, Panel D respectively presents the estimates excluding from each group the observations that have (1) low, (2) high, and (3) either low or high cash flows. The cash flows below -0.10 are assumed to be low and the cash flows above 0.60 are assumed to be high for filtering the observations.

Panel A: Without any filtering

I/K	Small	Medium	Large
Q	0.0568***	0.0206	0.0968**
	(0.02)	(0.02)	(0.04)
CF/K	-0.0743	0.2310***	0.3355***
	(0.06)	(0.09)	(0.11)
N	674	677	679
Adjusted R^2	0.0294	0.0487	0.1775

Panel B: Excluding low-cash flow observations

I/K	Small	Medium	Large
Q	0.0744***	0.0034	0.0867**
	(0.02)	(0.02)	(0.04)
CF/K	0.1314	0.4113***	0.3957***
	(0.10)	(0.10)	(0.12)
N	528	616	649
Adjusted R^2	0.0584	0.1318	0.1988

Panel C: Excluding high-cash flow observations

I/K	Small	Medium	Large
Q	0.0650***	0.0083	0.1777***
	(0.02)	(0.02)	(0.06)
CF/K	-0.0920	0.0202	0.1772
	(0.10)	(0.13)	(0.12)
N	637	614	613
Adjusted R^2	0.0481	0.0207	0.1455

Panel D: Excluding both low-cash flow and high-cash flow observations

I/K	Small	Medium	Large
Q	0.0818***	-0.0059	0.1725***
	(0.02)	(0.01)	(0.06)
CF/K	0.4018**	0.2962**	0.2228
	(0.18)	(0.14)	(0.16)
N	491	553	583
Adjusted R^2	0.0997	0.0762	0.1641

The effects of financial distress and free cash flow problem can be examined by comparing the cash flow coefficients of the same size groups in different panels. First, comparing Panel A and Panel B, the cash flow coefficients of each group are greater in Panel B where low-cash flow observations are excluded. The difference is 0.21 for small firms, 0.18 for medium firms and 0.06 for large firms. Therefore, financial distress reduces investment-cash flow sensitivities but the reduction is higher in small firms and medium firms. Second, comparing Panel A and Panel C, the cash flow coefficients of each group are smaller in Panel C where high-cash flow observations are excluded. The difference is 0.02 for small firms, 0.21 for medium firms and 0.16 for large firms. Therefore, free cash flow problem increases investment-cash flow sensitivities but the increase is higher in medium firms and large firms.

In Panel D where both low-cash flow and high-cash flow observations are excluded, the cash flow coefficient is 0.40 for small firms, 0.30 for medium firms and 0.22 for large firms. It is significant at 0.05 level for small and medium firms but insignificant for large firms. In contrast to Panel A, investment-cash flow sensitivities are in descending order from small firms to large firms which supports the financial constraints view. However, filtering out observations from both sides of the cash flow distribution causes a notable reduction in the number of observations and an increase in the standard errors. Therefore, the standard errors of cash flow coefficients in Panel D are higher than the standard errors of the cash flow coefficients in Panel A. For example, comparing Panel A and Panel D, the number of observations reduces from 674 to 491 and the standard error of cash flow coefficient increases from 0.06 to 0.18 for small firms.

Recall that in comparison to unfiltered sample estimations, excluding only low-cash flow observations gives greater cash flow coefficients but excluding only high-cash flow observations gives smaller cash flow coefficients. Hence, one would expect that excluding both low-cash flow and high-cash flow observations would give estimations that are between the cash flow coefficients in Panel B and in Panel C. The cash flow coefficients in Panel D support this expectation for medium and large firms but reject for small firms because the cash flow coefficient in Panel D is remarkably high for small firms (i.e. $0.41 \gg x \mid x \in [0.13, -0.09]$). The unexpectedly high cash flow coefficient for small firms helps investment-cash flow sensitivities to be in descending order and compatible with financial constraints view. According to the results that are not reported, when the critical values for accepting cash flows as low or high are changed from {-0.10, 0.60} to a more strict one such as {0, 0.50}, the cash flow coefficients for small firms reaches to up to 0.51 and the cash flow coefficients for large firms reduces down to 0.08. Although the spread between the cash flow coefficients of small and large firms become larger and more supportive of the financial constraints view, the standard errors become higher too which makes the coefficients insignificant.

4. Conclusion

The study present three main findings that reject the standard financial constraints hypothesis and show that investment-cash flow sensitivity in a cash flow-augmented q investment can't be interpreted as a direct evidence of the difference between the costs of internal finance and external finance. First, investment of small firms is not sensitive to cash flow. Second, investment of large firms is highly sensitive to cash flow. Third, investment-cash flow sensitivity increase from small firms to large firms in such a way that it is inverse monotonic with financial constraints. The findings are based on data for

Turkish firms over the 2006 to 2017 period when the domestic credit volume to non-financial companies as a percentage of GDP increased continuously. The sample selection is on purpose because the literature review shows that when access to credit is relatively easy due to development of financial markets, financial liberalization or recovery from any crisis, larger firms tend to have higher investment-cash flow sensitivity.

It is puzzling that the firms with higher investment-cash flow sensitivity are the ones that are supposed to be financially less constrained. The key to the mystery is that the classification by firm size not only sorts firms according to the degree of financial constraints they face but also their cash flows. Low cash flow is associated with financial distress and high cash flow is associated with free cash flow problem. The two factors have opposite effects on investment-cash flow sensitivities. Hence they can reverse the monotonicity of investment-cash flow sensitivities, while the standard financial constraints hypothesis predicts a monotonic increase in investment-cash flow sensitivities as financial constraints increase. Findings show that the investment-cash flow sensitivities become direct monotonic but statistically insignificant when observations with very low and very high cash flows are filtered out.

The contribution of the study can be summarized in three points. First, it shows that the size of investment-cash flow sensitivity does not only depend on the financial constraints but also the level of cash flow because of financial distress and free cash flow problem. Second, it reconciles the seemingly contradictory findings in the previous studies that classify firms according to firm size to test the financial constraints hypothesis. The order of investment-cash flow sensitivities of different groups depend on the net effect of financial constraints on one side and cash flow effects on the other side. Third, it presents a curious case in which investment-cash flow sensitivity increases while financial constraints reduce through three and even four groups. As to the authors' best knowledge, no previous study reported an inverse monotonic relationship between investment-cash flow sensitivity and financial constraints that holds even when the number of groups is four. Further research can focus on the methods that can control the effects of cash flow on investment-cash flow sensitivity on larger samples.

References

Allayannis, G. and Mozumdar, A. (2004), The impact of negative cash flow and influential observations on investment–cash flow sensitivity estimates, *Journal of Banking & Finance*, *28(5)*, p.901–930.

Almeida, H., Campello, M. and Weisbach, M. S. (2004). The Cash Flow Sensitivity of Cash. *The Journal of Finance*, *59*(4), 1777-1804.

Almeida, H., Campello, M. and Weisbach, M. S. (2021). The Cash Flow Sensitivity of Cash: Replication, Extension, and Robustness (Working Paper No. 2021-03-002). Fisher College of Business.

Arslan, Ö., Florackis, C. and Ozkan, A. (2006), The Role of Cash Holdings in Reducing Investment–Cash Flow Sensitivity: Evidence from a Financial Crisis Period in an Emerging Market, *Emerging Markets Review, 7(4)*, p.320–338.

Audretsch, D. B. and Elston, J. A. (2002), Does Firm Size Matter? Evidence on the Impact of Liquidity Constraints on Firm Investment Behavior in Germany, *International Journal of Industrial Organization, 20(1)*, p.1–17.

Beck, T., Demirgüç-Kunt, A., Laeven, L. and Maksimovic, V. (2004), The Determinants of Financial Obstacles (Working Paper No. 3204), World Bank.

Belen, M. and Karamelikli, H. (2016), Finansal Gelişme ve Yoksulluğun Azalması Arasındaki İlişki: Ampirik Bir İnceleme, *AİBÜ Sosyal Bilimler Enstitüsü Dergisi, 16(1)*, p.125–141.

Benligiray, S. and Aydın, N. (2017), Borsa İstanbul Firmalarında Yatırımların Nakit Akışlarına Duyarlılığının İncelenmesi, *Business and Economics Research Journal, 8(4)*, p.699–714.

Booth, L. and Cleary, S. (2006), *Cash Flow Volatility, Financial Slack and Investment Decisions*, 2006 China International Conference in Finance, Xi'an.

Cleary, S. (1999), The Relationship between Firm Investment and Financial Status, *The Journal of Finance, 54(2)*, p.673–692.

Crisóstomo, V., López-Iturriaga, F. J. and Vallelado, E. (2012), Firm Size Matters for Financial Constraints: Evidence from Brazil, *Sistemas & Gestão, 7(3)*, 490–501.

Demmou, L., Stefanescu, I. and Arquie, A. (2019). Productivity Growth and Finance: The Role of Intangible Assets - A Sector Level Analysis (Working Paper No. 1547), OECD.

Devereux, M. and Schiantarelli, F. (1990). Investment, Financial Factors, and Cash Flow: Evidence from U.K. Panel Data, (Ed.: R. G. Hubbard), *Asymmetric Information, Corporate Finance, and Investment*, pp. 279–306, Chicago: University of Chicago Press.

Fazzari, S. M., Hubbard, R. G. and Petersen, B. C. (1988), Financing Constraints and Corporate Investment, *Brookings Papers on Economic Activity, 1988(1)*, p.141–206.

Gatchev, V. A., Pulvino, T. and Tarhan, V. (2010). The Interdependent and Intertemporal Nature of Financial Decisions: An Application to Cash Flow Sensitivities. *The Journal of Finance*, *65*(2), 725-763.

Gertler, M. and Gilchrist, S. (1994), Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms, *The Quarterly Journal of Economics, 109(2)*, p.309–340.

Fazzari, S. M. and Petersen, B. C. (1993). Working Capital and Fixed Investment: New Evidence on Financing Constraints. *The RAND Journal of Economics*, *24(3),* p.328–342.

Gertler, M. and Hubbard, R. G. (1988), *Financial Factors in Business Fluctuations*, A Symposium Sponsored by the Federal Reserve Bank of Kansas City, Federal Reserve Bank of Kansas City, Wyoming.

Gilchrist, S. and Himmelberg, C. P. (1995), Evidence on the role of cash flow for investment, *Journal of Monetary Economics, 36(3)*, p.541–572.

Hadlock, C. J. and Pierce, J. R. (2010). New evidence on measuring financial constraints: Moving beyond the KZ index. *The Review of Financial Studies, 23(5)*, p.1909–1940.

Hoshi, T., Kashyap, A. and Scharfstein, D. (1991), Corporate Structure, Liquidity, and Investment: Evidence from Japanese Industrial Groups, *The Quarterly Journal of Economics, 106(1)*, p.33–60.

Ismail, M. A., Ibrahim, M. H., Yusoff, M. and Zainal, M.-P. (2010), Does Firm Size Matter for the Financial Constraints?, *Jurnal Ekonomi Malaysia, 44(1)*, p.73–81.

Jensen, M. C. (1986), Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers, *The American Economic Review, 76(2)*, p.323–329.

Kadapakkam, P. R., Kumar, P. C. and Riddick, L. A. (1998), The Impact of Cash Flows and Firm Size on Investment: The International Evidence, *Journal of Banking & Finance, 22(3),* p.293–320.

Kaplan, S. N. and Zingales, L. (1997), Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints?, *The Quarterly Journal of Economics, 112(1),* p.169–215.

Kaplan, S. N. and Zingales, L. (2000), Investment-Cash Flow Sensitivities are not Valid Measures of Financing Constraints (Working Paper No. 7659), NBER.

Kashyap, A. K., Lamont, O. A. and Stein, J. C. (1994). Credit Conditions and the Cyclical Behavior of Inventories. *The Quarterly Journal of Economics*, *109*(3), 565-592.

Laeven, L. (2003), Does Financial Liberalization Reduce Financing Constraints?, *Financial Management, 32(1)*, p.5–34.

Meyer, J. and Kuh, E. (1955), Acceleration and Related Theories of Investment: An Empirical Inquiry, *The Review of Economics and Statistics, 37(3)*, p.217–230.

Oliner, S. D. and Rudebusch, G. D. (1992), Sources of the Financing Hierarchy for Business Investment, *The Review of Economics and Statistics, 74(4),* p.643–654.

Richardson, S. (2006), Over-investment of free cash flow, *Review of Accounting Studies, 11(2–3)*, p.159–189.

Schaller, H. (1993), Asymmetric Information, Liquidity Constraints, and Canadian Investment, *The Canadian Journal of Economics, 26(3),* p.552-574.

Schiantarelli, F. (1996), Financial Constraints and Investment: Methodological Issues and International Evidence, *Oxford Review of Economic Policy, 12(2)*, p.70–89.

Tinbergen, J. (1938), Statistical Evidence on the Acceleration Principle, *Economica, 5(18)*, p.164–176.

Whited, T. M. and Wu, G. (2006). Financial constraints risk. *The Review of Financial Studies, 19(2)*, p.531–559.