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# Asymmetric Effects of the Financial Crisis: Collateral-Based Investment-Cash Flow Sensitivity Analysis

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**Asymmetric Effects of the Financial Crisis: Collateral-Based Investment-Cash Flow Sensitivity Analysis**

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**Abstract**

This paper uses the financial crisis of 2008 as a natural experiment to demonstrate that when measuring investment-cash flow sensitivity, the value of a firm‟s assets that can be used as collateral should be taken into account. Using panel data on U.S. firms from 1990 to 2011, it was found that the share of physical capital in assets has a strong influence on investment-cash flow sensitivity, which decreased substantially after the crisis when banks changed their expectations about the value of assets on firms‟ balance sheets. This paper deepens our understanding of firms‟ investment behavior.

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## 1. INTRODUCTION

The study of investment-cash flow sensitivity plays an important role in empirical finance literature. Many papers find that investment is more sensitive to cash flow among firms that are more likely to have binding financing constraints (see Fazzari, Hubbard and Petersen, 1988; Allayannis and Mozumdar, 2004; Rousseau and Kim, 2009; Brown and Petersen, 2009; and others). Although there is a disagreement on how to interpret the findings in investment-cash flow studies (see Kaplan and Zingales, 1997; Cleary, 1999), investment-cash flow regressions continue to be an effective analysis tool in finance.

The traditional viewpoint, originally put forward by Fazzari, Hubbard and Petersen (1988), holds that firms which face tighter financing constraints must rely more heavily upon internal cash flows for investment, due to larger cost differentials between internal and external funds. The authors argue that „most constrained" firms should have investment expenditures that are more sensitive to internal cash flows and the stock of liquidity than „least constrained" firms. Their empirical tests show substantially higher sensitivity of investment to cash flow and liquidity for firms that retain nearly all of their income.

Following the approach of Fazzari, Hubbard and Petersen (1988), many empirical studies find that investment is more sensitive to changes in cash flow for firms initially identified as financially more constrained. Kaplan and Zingales (1997), however, argue that this empirical approach is not well-grounded in theory and provide evidence in apparent conflict with Fazzari, Hubbard and Petersen (1988) (see also a response by Fazzari, Hubbard and Petersen, 2000).

More recent results are controversial. The Kaplan and Zingales result finds further support from Cleary (1999), who uses more recent data (1987-1994), examines a large cross-section and measures financing constraints using a discriminant score estimated from several financial variables. Allayannis and Mozumdar (2004) find that, while Cleary‟s results can be explained by such negative cash flow observations, the Kaplan and Zingales results are driven more by a few influential observations in a small sample.

There are only a few theoretical models that give direct prediction of the connection between investment and cash flow. The most popular and straightforward model is the model by Kaplan and Zingales (1997). They show that constrained firms should be sensitive to internal cash flow, while unconstrained firms should not; but it is not necessarily true that the magnitude of the sensitivity increases in the degree of financing constraints. Cleary, Povel and Raith (2007) construct a theoretical model in which a firm's optimal investment is a U-shaped function of its internal funds. They show that when the information asymmetry between firm and investor increases, investment becomes more sensitive to changes in internal funds. Pratap (2003) shows how a dynamic model of firm investment with liquidity constraints and non-convex capital adjustment costs can explain high sensitivity of investment to cash flow, as firms need to have a certain threshold level of financial resources before they can afford to increase investment. Abel and Eberly (2011) derive a closed-form solution for Tobin‟s Q in a stochastic dynamic framework and show analytically that investment is positively related to Tobin‟s Q and cash flow, even in the absence of adjustment costs or financing frictions. They also find that cash flow delivers larger effects for smaller and faster-growing firms.

A number of recent papers criticize conventional investment-cash flow regressions, particularly in studies that do not control for the potential endogeneity of cash flow or neglect the possibility of external financing. Alti (2003) and Moyen (2004) calibrate models of firms that use debt as a substitute for internal financing. They run OLS regressions on simulated data to show that investment-cash flow sensitivities can be generated even if firms do not face financing frictions. Gatchev, Pulvino and Tarhan (2010) use a dynamic multiequation model, in which firms make financing and investment decisions simultaneously, to show that static models of financial decisions produce inconsistent coefficient estimates. Using a model that allows for the connection between lagged and current decision variables, they find that the positive relationship between investment and cash flow disappears. There are several econometric obstacles in estimating investment-cash flow regressions. Many recent papers use the GMM estimator developed by Arellano and Bond (1991) to overcome endogeneity problems (see, for example, Rousseau and Kim, 2009; Brown and Petersen, 2009; and others).

As it is hard to construct a good experiment to test investment-cash flow sensitivity, some authors use the recent financial crisis to explore the differences in firms‟ decisions. Campello, Graham and Harvey (2009) discuss the results of a survey of 1,050 CFOs in the U.S., Europe, and Asia to directly assess whether their firms were credit constrained during the global financial crisis of 2008. Their responses indicate that constrained firms experienced deeper cuts in tech spending, employment, and capital spending; constrained firms also burned through more cash, drew more heavily on lines of credit for fear that banks would restrict access in the future, and sold more assets to fund their operations. Campello, Giambonam, Graham and Harvey (2010) study how firms managed liquidity during the financial crisis of 2008. Their evidence points to an important role for internal and external liquidity in driving spending during the financial crisis. They find that the current crisis has not severely hindered ability to access lines of credit and draw down existing facilities;

constrained firms draw more heavily on their credit lines, while they are more likely to face difficulties in renewing or initiating lines of credit during the crisis.

During the financial crisis, companies were affected by a severe credit-supply shock, which changed firms‟ investment decisions and created conditions to test the investment-cash flow sensitivity more directly. This paper is an attempt to use the crisis environment to contrast the actions of firms that were financially constrained with those that were less constrained. I am looking for empirical asymmetric effects of the financial crisis on firms‟ investment decisions. I argue that the investment-cash flow sensitivity is different across industries and must be measured taking into account the expected value of a firm‟s capital that can be used as collateral. Before the crisis, with the expectation of continued real estate appreciation, banks lent money more easily to firms with higher physical capital and in construction-connected sectors as they expected the value of the firms‟ collateral to increase over time. Therefore, investment-cash flow sensitivity in these industries was less pronounced as banks took into account the growing collateral values.

Considering these empirical observations, I argue that the investment-cash flow sensitivity must be measured taking into account the value of a firms‟ capital that can be used as collateral and is different across industries. To support this idea I construct a simple theoretical model to show that the tightness of financial constraints depends on the value of a firm‟s capital and should be different for firms in different sectors. To test this hypothesis I use the financial crisis of 2008 as an experiment that changed the value of firms‟ assets. I use quarterly data for U.S. firms from 1990 to 2011 from COMPUSTAT to estimate changes in the investment-cash flow sensitivity. I find empirical support for asymmetric effects of the crisis on investment-cash flow sensitivities in U.S. industries. Investment is negatively dependent on the share of capital in assets; firms with relatively higher level of capital have higher investment-cash flow sensitivity during the pre-crisis period, while after the crisis, firms with higher amounts of capital experienced less financial constraints and, therefore, became less sensitive to cash flow when they decided to invest. Also, the financial crisis of 2008 increased liquidity constraints among firms and nearly doubled the sensitivity of investment to cash flow. I argue that this asymmetry is due to the different collateral-intensity dependence.

The paper is structured as follows. In Section 2 a simple theoretical model is constructed to show that the tightness of financial constraints depends on the value of a firm"s collateral. A data discussion is presented in Section 3. Empirical results are presented in Section 4. Concluding remarks and findings are summarized in the final section.

## 2. MODEL

I follow Kaplan and Zingales (1997) and construct a simple one period model of a representative firm that maximizes profits from investment. The firm uses internal and external financing, the latter is associated with additional cost. The crucial difference of this model from the standard model is that firms differ in the level of assets (physical capital) that can be used as collateral. I can consider this as the market value of non-tradable assets like land, machinery, or housing. Higher amounts of these assets make financing easier. I do not specify precisely what this factor is in real life, but in the empirical part I use capital-to-assets ratio as a proxy. In different sectors firms use different amounts of physical capital as a share of total assets. In this framework the tightness of financial constraints depends on the value of a firm"s collateral. The higher the amount of these assets, the higher the value of the collateral a firm has and the lower the cost of external financing.

Consider a firm that chooses the level of investment to maximize profits. The return on an investment (*I*) and the amount of assets (capital) that can be used as collateral ($L$) is given by the production function *F(I,L)*. The standard assumptions are $F_1 > 0, F_{11} < 0, F_2 > 0, F_{22} < 0,\ F_{21} > 0$. A firm chooses *I* and takes $L$ as a given parameter that varies across industries.

Investment can be financed either with internal funds (*W*) or external funds (*E*), such that $I$=$W$+$E$ . Following the standard approach, I assume external financing to be associated with additional costs, due to agency problems, transaction costs, and incomplete financial markets. The amount of $L$ decreases these costs as a firm can more easily obtain financing. I represent these additional costs of external funds with the function $C(E, k, \rho L)$, where $k$ is a measure of a firm"s wedge between the internal and the external costs of funds and $\rho$ is a measure of sectoral cost reduction. The standard assumption is that the cost of external funds rises with the amount of external financing ($C_1 > 0$), rises with the extent of information problems ($C_2 > 0$), and falls with the value of assets that can used as collateral ($C_3 < 0$). The marginal cost of external financing is a decreasing function of $L$ ($C_{31} < 0$).

Each firm chooses *I* to maximize:

$$F(I, L) - C(E, k, \rho L) - I \qquad (1)$$

*s.t.*

$$I = W + E \qquad (2)$$

The first order conditions are, therefore:

$$F_1(I, L) = C_1(I - W, k, \rho L) + 1 \qquad (3)$$

where $C_1()$ represents the partial derivative of *C* with respect to its first argument and $F_1()$ is the first derivative of *F* with respect to its first argument. I assume $C_{11} > 0$ to guarantee that the above problem is well-defined.

The effects of the availability of internal finance on investment can be obtained by implicit differentiation of the equation (3) with respect to *W*:

$$F_{11}\frac{\partial I}{\partial W} = -C_{11} + C_{11}\frac{\partial I}{\partial W} \tag{4}$$

$$\frac{\partial I}{\partial W} = \frac{C_{11}}{C_{11} - F_{11}} > 0 \tag{5}$$

which is positive, as expected. Higher levels of internal funds increase investment as external financing is connected with additional cost.

The effects of the assets (that can be used as collateral) on investment can be obtained by implicit differentiation of the equation (3) with respect to *L*:

$$F_{11}\frac{\partial I}{\partial L} + F_{12} = C_{11}\frac{\partial I}{\partial L} + \rho C_{13} \tag{6}$$

$$\frac{\partial I}{\partial L} = \frac{\rho C_{13} - F_{12}}{F_{11} - C_{11}} \tag{7}$$

which is positive as $F_{11} - C_{11} < 0$ and $\rho C_{13} - F_{12} < 0$. As the higher value of $L$ decreases the cost of external financing, investment is positively related to the level of these assets. Therefore, this can explain why firms in construction-related industries were growing faster than those in other sectors in the U.S. in the past few decades.

The effects of the assets (that can be used as collateral) on sensitivity of investments to internal funds can be obtained by implicit differentiation of the equation (5) with respect to *L*:

$$\frac{\partial^2 I}{\partial W \partial L} = \frac{\partial\left[\frac{C_{11}(I-W,k,\rho L)}{C_{11}(I-W,k,\rho L) - F_{11}(I,L)}\right]}{\partial L} =$$

$$\frac{(C_{111} + \rho C_{113})(C_{11} - F_{11}) - C_{11}(C_{111} + \rho C_{113} - F_{111} - F_{112})}{(C_{11} - F_{11})^2} \tag{8}$$

While the sign of $\frac{\partial^2 I}{\partial W \partial L}$ in the equation (8) is undetermined in general as it depends of the signs of the third derivatives of the cost and the production functions, under some assumption it can be shown that $\frac{\partial^2 I}{\partial W \partial L} \geq 0$.

Taking into account the signs of the derivatives $F_{11} < 0,\ C_{11} > 0$ and the fact that the marginal cost of external financing is convex $(C_{111} \geq 0)$, imposing the assumption that $F_{111} \geq 0$ on the production function, and assuming the other third order cross partial derivatives are zero ($F_{112} = 0, C_{113} = 0$ ), one can show:

$$\frac{\partial^2 I}{\partial W \partial L} = \frac{-C_{111}F_{11} + C_{11}F_{111}}{(C_{11} - F_{11})^2} \geq 0 \qquad (9)$$

The key implication of this result is that investment is more sensitive to internal funds when the value of assets (that can be used as collateral) is higher. The higher collateral value decreases the cost of external financing and, therefore, increases the relative cost of internal financing, leading to a higher sensitivity of investment to cash flow. As the cost of external financing $C(E, k, \rho L)$ is a function of $\rho L$, the marginal change in sensitivity varies across sectors depending on the value of capital. In sum, in a one-period model with assets (capital) that can be used as collateral investment-cash flow sensitivities differ across industries. The tightness of financial constraints depends on the expected value of firms‟ collateral and is different across sectors.

## 3. EMPIRICAL APPROACH

To test the above model empirically, I use the 2008 financial crisis as a shock, which changed the expected value of firms‟ collateral, defined as $L$ in the model. After the financial crisis banks changed their expectations about the value of capital and assets that were on firms balance sheets. Lending conditions changed as banks were ready to accept firms" assets as collateral with a higher discount. Therefore, for this purposes, the financial crisis played the role of a natural experiment that allows us to estimate the real investment-cash flow sensitivity in the absence of overinflated asset prices.

This simple model predicts asymmetric responses of firms with different levels of collateral. I empirically test the predictions of the model along two dimensions. First, I include the physical capital-to-assets ratio in investment-cash flow sensitivity regressions. It allows us to understand the importance of capital for investment-cash flow sensitivity. Second, I decompose investment-cash flow sensitivity by firms" assets and look at industry-specific effects of the financial crisis.

To estimate the sensitivity of investment to cash flow, I use quarterly data for U.S. firms from 1990 to 2011 from COMPUSTAT. I exclude firms in *Finance, Insurance, and Real Estate and Public Administration* divisions from all regressions[1]. Among the COMPUSTAT universe of firms, I consider only firms that existed for at least five subsequent quarters after the beginning of the crisis (since the end of 2008). As I want to track the performance of firms that existed before and after the crisis, some companies were excluded from regressions as they no longer existed after the crisis. In order to test the potential survivorship bias, I compared first and second moments of the variables of interest before the crisis for two populations of firms (the first that survived the crisis, the second that did not). The fact that I did not find significant differences in the main statistical moments of these variables can be explain by the observation that all COMPUSTAT firms are public and relatively large and, therefore, most of them did not go bankrupt even if they incurred

[1] Due to the absence of physical capital that is used in the production process.

substantial losses during the crisis. In the baseline panel regression the total number of firms is 3,071 with 67,811 firm-quarter observations.

I follow Fazzari, Hubbard and Petersen (1988) and Kaplan and Zingales (1997) and measure investment as capital expenditures and cash flow as the sum of earnings before extraordinary items and depreciation. A proxy for the Tobin‟s Q is constructed as the ratio of market to book value of a firm‟s financial obligations. All balance sheet items other than capital are expressed as ratios to the firm‟s capital at the beginning of the period. I use the share of capital in assets as a proxy variable for assets that can be used as the firm‟s collateral (capital is measured as “Property, Plant, and Equipment-Total” from firms‟ balance sheets). The summary statistics of the variables are presented in Table I. The distribution of firms‟ assets is presented in Table II.

TABLE I. Dynamics of the main variables. U.S. firms, 1990Q1-2011Q2.

| | *Mean* | | | | | Average ratio | | | |
|---|---|---|---|---|---|---|---|---|---|
| | CF ($m) | Investment ($m) | Capital ($m) | Total Assets ($m) | Q | CF/ Capital | Investment/ Capital | Capital/ Assets | Obs |
| 1990 | 66.6 | 102.0 | 1191.8 | 2154.0 | 1.9 | 5.59% | 8.56% | 55.33% | 2175 |
| 1991 | 40.5 | 72.6 | 1192.3 | 2044.4 | 2.2 | 3.40% | 6.09% | 58.32% | 3779 |
| 1992 | 42.2 | 63.5 | 1165.7 | 2043.2 | 2.2 | 3.62% | 5.44% | 57.05% | 4063 |
| 1993 | 38.1 | 58.7 | 1119.1 | 2155.4 | 2.4 | 3.40% | 5.24% | 51.92% | 4361 |
| 1994 | 52.8 | 59.7 | 1135.6 | 2189.7 | 2.1 | 4.65% | 5.25% | 51.86% | 4684 |
| 1995 | 65.0 | 70.6 | 1264.7 | 2212.7 | 2.4 | 5.14% | 5.58% | 57.16% | 5250 |
| 1996 | 61.7 | 64.5 | 1027.8 | 2036.4 | 3.0 | 6.00% | 6.28% | 50.47% | 6932 |
| 1997 | 59.3 | 65.4 | 963.0 | 2048.8 | 3.0 | 6.15% | 6.79% | 47.00% | 7959 |
| 1998 | 61.3 | 76.4 | 1060.2 | 2345.8 | 3.2 | 5.78% | 7.21% | 45.20% | 8574 |
| 1999 | 64.0 | 74.1 | 1095.5 | 2414.0 | 3.9 | 5.84% | 6.77% | 45.38% | 9245 |
| 2000 | 73.2 | 81.4 | 1188.7 | 2732.5 | 4.7 | 6.15% | 6.85% | 43.50% | 10039 |
| 2001 | 67.5 | 106.6 | 1987.2 | 3837.7 | 3.8 | 3.39% | 5.36% | 51.78% | 7853 |
| 2002 | 66.6 | 88.6 | 2170.5 | 4317.8 | 4.5 | 3.07% | 4.08% | 50.27% | 8304 |
| 2003 | 95.4 | 85.4 | 2323.9 | 4675.4 | 4.9 | 4.11% | 3.67% | 49.70% | 8729 |
| 2004 | 116.5 | 97.0 | 2540.6 | 5070.1 | 5.9 | 4.59% | 3.82% | 50.11% | 9297 |
| 2005 | 121.0 | 106.5 | 2440.0 | 4980.7 | 5.4 | 4.96% | 4.36% | 48.99% | 10283 |
| 2006 | 149.1 | 128.4 | 2530.3 | 4942.4 | 5.4 | 5.89% | 5.07% | 51.20% | 11317 |
| 2007 | 135.9 | 140.6 | 2521.9 | 5675.5 | 5.1 | 5.39% | 5.57% | 44.43% | 12650 |
| 2008 | 92.8 | 155.7 | 2666.7 | 5733.3 | 4.0 | 3.48% | 5.84% | 46.51% | 13795 |
| 2009 | 86.2 | 120.4 | 2709.3 | 5161.4 | 4.7 | 3.18% | 4.44% | 52.49% | 14346 |
| 2010 | 144.5 | 123.7 | 2988.7 | 5559.9 | 4.3 | 4.83% | 4.14% | 53.76% | 13359 |
| 2011* | 76.4 | 23.7 | 965.1 | 4595.9 | 5.0 | 7.92% | 2.46% | 21.00% | 1050 |

* The number of observations is small as data for 2011 is available for at most two quarters.

TABLE II. Distribution of U.S. firms by assets, 1990-2011

| Percentiles | 1% | 5% | 10% | 25% | 50% | 75% | 90% | 95% |
|---|---|---|---|---|---|---|---|---|
| Assets ($m) | .32 | 2.6 | 6.6 | 29.9 | 189.56 | 1139 | 5251 | 13586 |

## 4. ESTIMATION RESULTS

The standard approach to empirical evaluation of the investment-cash flow sensitivity is to run a regression of investment on cash flow, controlling for Tobin"s Q:

$$I_{ti} = \beta_0 + \beta_1 CF_{ti} + \beta_2 Q_{t-1,i} + u_i + \varepsilon_{ti} \qquad (10)$$

where $I_{ti}$ is investment spending of a firm *i* in period *t*, $CF_{ti}$ is cash flow, $Q_{ti}$ is Tobin"s Q, $u_i$ is firm-specific individual effect, and $\varepsilon_{ti}$ is a firm"s specific error term. The variables are usually scaled by the amount of capital at the beginning of the period in order to maintain a common scale factor. In this simple framework, $\beta_1$ is the sensitivity of investment to cash flow, and $\beta_2$ is a measure of the influence of Q on investment.

In order to capture the effect of collateral and capital value on firms" investment decisions, first, I analyze the sensitivity of investment to cash flow with capital; second, I estimate the asymmetric effects of the financial crisis on different U.S. industries.

### *4.1. Estimation of investment-cash flow sensitivity with capital*

The key implication of the model, discussed in Section I, is that physical capital can be used as collateral and, therefore, changes the cost of external financing and effects the connection between investment and cash flow. To evaluate empirically the investment-cash flow sensitivity with changes of collateral value, and to capture the effect of the 2008 financial crisis, I use the following model with physical capital a dummy variable for the crisis:

$$I_{ti} = \beta_0 + \beta_1 CF_{ti} + \beta_2 K_{ti} + \beta_3 CF_{ti} * K_{ti} + \beta_4 D^{crisis} CF_{ti} * K_{ti} + \beta_5 Q_{t,i} + u_i + \varepsilon_{ti} \quad (11)$$

where $I_{ti}$ is investment spending, $CF_{ti}$ is cash flow, $K_{ti}$ is the share of capital in total assets, $Q_{ti}$ is Tobin"s Q, $u_i$ is a firm-specific individual effect, and $\varepsilon_{ti}$ is a firm"s specific error term. I assign the value $D^{crisis} = 1$ for all periods starting from 2008:Q4, and 0 otherwise. I scale cash flow and investment by the amount of capital at the beginning of the period. In all regressions all variables are in logs, and, therefore, the coefficients are elasticities. I use the interaction variable of cash flow and capital to control for the effect of selling physical capital to raise cash flow, such that the product of physical capital and cash flow remains constant. In this framework, $\beta_1$ is the elasticity of investment by cash flow, $\beta_2$ is the elasticity of investment by capital, $\beta_3$ is the elasticity of investment by the product of cash flow and capital, $\beta_4$ is the marginal effect of the interaction of investment and cash flow during the financial crisis, $\beta_5$ is the elasticity of investment by Tobin"s Q.

According to the theoretical model in Section 1, I expect $\beta_1$ to be positive as firms invest more with higher levels of internal funds, $\beta_2$ to be negative as firms with higher share of capital invest less due to decreasing marginal returns on investment, $\beta_3$ to be positive as the sensitivity of investment to cash flow increases with the share of capital in total assets.

The estimation results of the equation (11) are presented in Table III. I mainly focus on the results of the IV and GMM-IV approaches with robust standard errors clustered by industry 4-digit SIC code. I also run FE and RE regressions to check the robustness[2]. I use the Baum, Schaffer and Stillman (2011) procedure to estimate the GMM-IV panel data model. Lagged values of independent variables and firms" sales are used as instruments.

[2] The results of the FE and RE models with lagged variables are similar to the model without lags and, therefore, omitted.

TABLE III. Estimation results of investment-cash flow sensitivity with the capital, 1990:Q1-2011Q1.

| **Dependent variable: log of Investment** | **IV** | **GMM-IV** | **FE** | **RE** |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Cash flow ($\beta_1$) | 0.0902** | 0.428*** | 0.448*** | 0.440*** |
| | *-0.0369* | *-0.0241* | *-0.00851* | *-0.00808* |
| Share of capital in assets ($\beta_2$) | -0.472*** | -0.475*** | 0.0409 | 0.0699** |
| | *-0.11* | *-0.0685* | *-0.036* | *-0.028* |
| Share of capital in assets * Cash flow ($\beta_3$) | 0.270*** | 0.00251 | 0.0381*** | 0.0380*** |
| | *-0.0518* | *-0.0343* | *-0.00767* | *-0.00695* |
| Crisis dummy * Share of capital in assets * Cash flow ($\beta_4$) | -1.499*** | -0.291** | -0.0748*** | -0.0729*** |
| | *-0.224* | *-0.125* | *-0.00949* | *-0.00903* |
| Q ($\beta_5$) | 0.192*** | -0.112*** | -0.00441 | 0.00749 |
| | *-0.0572* | *-0.037* | *-0.0204* | *-0.019* |
| Constant | | | -1.710*** | -1.636*** |
| | | | *-0.0411* | *-0.0407* |
| Observations | 69,811 | 60,674 | 89,644 | 89,644 |
| Number of firms | 3,071 | 2,856 | 3,718 | 3,718 |
| | | | | |
| *Elasticity of investment by share of capital in assets*cash flow during the crisis ($\beta_3+\beta_4$)* | *-1.179* | *-0.2884* | *-0.0367* | *-0.0349* |

[a]All variables but Q are in logs. The balance sheet items variables are scaled by total capital at the beginning of the period. *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors clustered by industry 4-digit SIC code are in italics.

First, I find that the elasticity of investment to cash flow is positive and statistically different from zero in all models. This observation confirms the previous findings of a positive connection between investment and cash flow. The elasticity is about 0.1 in the case of the IV model and about 0.43 in the case of GMM-IV, FE, and RE models. Second, the elasticity of investment by the share of capital in assets is negative and is about -0.47 in the GMM-IV and IV cases and close to zero in the FE and Remodels. The negative sign confirms the idea of diminishing marginal returns on investment. Firms with a higher share of capital in assets invest less, as they already accumulated the necessary stock of capital. Firms that have a low stock of capital, such as growing firms, tend to invest more.

Third, the coefficient $\beta_3$ for the interaction variable *Share of capital in assets * Cash flow* is positive during the pre-crisis period, confirming the idea that firms with substantial levels of capital have higher investment-cash flow sensitivity. This coefficient, furthermore, is positive and statistically significant in most of the models. As it was predicted by the theoretical model, investment is more sensitive to internal funds when the value of the capital is higher.

Fourth, the effect of the 2008 financial crisis on investment-cash flow sensitivity is presented by the coefficient $\beta_4$ for the interaction variable *Crisis dummy * Share of capital in assets * Cash flow*, which is negative and statistically significant in all regressions. After the crisis, firms with higher amounts of capital experienced less financial constraints and, therefore, became less sensitive to cash flow when they decided to invest. Therefore, the values of $\beta_4$ are substantially larger than values of $\beta_3$, meaning that the crisis had a substantial effect on investment-cash flow sensitivity. The cumulative elasticity of investment by the interaction of capital and cash flow for the crisis period is presented by the sum of $\beta_4$ and $\beta_3$ (the sum is calculated in the last raw in Table III) and is negative in all models. I explain this observation by the fact that during the financial crisis, banks changed their expectations about the value of firms‟ assets. Banks either re-evaluated downwards the values of assets or accepted them as collateral with a higher discount. Implicitly, it assumes that the expected value of capital that can be used as collateral decreased ($\partial L < 0$ in the model), leading to a negative influence on investment ($\frac{\partial^2 I}{\partial W \partial L}$ in the model).

These results are consistent with the analysis of Campello, Graham and Harvey (2009) and Campello, Giambona, Graham and Harvey (2010), who revealed evidence that constrained firms experienced deeper cuts in tech spending, capital spending, and employment during the crisis. Also, the results are similar to the findings of Gatchev, Pulvino and Tarhan (2010), who found that the positive relationship between investment and cash flow disappears in models that allow for the connection between lagged and current decision variables.

*4.2. Estimating sectoral asymmetries*

In order to capture the effect of the financial crisis and sectoral asymmetries, I run regressions (with dummy variables) of the following form:

$$I_{ti} = \beta_0 + \beta_1 CF_{ti} + \beta_2 Q_{t,i} + \sum_k \gamma_k D^k D^{crisis} CF_{ti} \quad + u_i + \varepsilon_{ti} \quad (12)$$

where $D^k = 1$ if a firm is in a sector $k$ , classified by industry 4-digit SIC code, and 0 otherwise, $D^{crisis} = 1$ for all periods after 2008:Q4 and 0 otherwise. All other variables are defined as before. In all regressions all variables are in logs, and, therefore, the coefficients are elasticities. In this framework, $\beta_1$ is the average elasticity of investment by cash flow during the pre-crisis period, $\beta_2$ is the elasticity of investment by Tobin‟s Q, $\gamma_k$ is a marginal elasticity of investment to cash flow in a sector *k* during the crisis period and measures of industry-specific effects. The main hypothesis is that the estimate of $\gamma_k$ will be positive in sectors with relatively high shares of assets that can be used as collateral and in industries where banks expected higher asset values.

The GMM-IV estimates with robust standard errors clustered by industry 4-digit SIC code are presented in Table IV. The coefficients for the elasticity of investment by cash flow for all firms are about 0.17 and statistically significant. The results suggest that an increase in cash flow by 1 percent will increase investment by 0.17 percent on average. This effect is not uniform across firms of different sizes (Table IV, columns 2-5). The elasticity of investment by cash flow is about 0.3 for small- and medium-size firms, about 0.6 for larger firms, and about 0.1 for the largest.

The financial crisis of 2008 increased liquidity constraints and the sensitivity investment to cash flow. For all sectors, $\gamma_k$ is positive and statistically significant (Table IV, column 1). The higher negative effect of the crisis in terms of higher dependence of investment on cash flow was experienced in the wholesale trade, retail trade, construction, manufacturing, and services sectors, in which the elasticity of investment by cash flow almost doubled in value. This effect is not uniform across firms of different sizes (Table IV, columns 2-5). Relatively small firms in the construction sector did not experience significantly higher dependence of investment on cash flow, but for bigger firms the sensitivity increased with the amount of assets firms accumulated. The largest firms in this sector experienced tighter financial constraints as they had more non-tradable assets. In the wholesale trade and services sectors, larger firms experienced a smaller influence of the financial crisis.

To check the robustness of the results I also run FE, RE, BE, and GMM-FD regressions (Table VI-VII and Appendix). I estimate FE and RE models using OLS panel regressions with robust standard errors clustered by industry 4-digit SIC code. The results of the regressions are presented in Table VI-VII. The estimates of the investment-cash flow sensitivity coefficient for the pre-crisis period are about 0.4-0.5 and are statistically insignificant for firms of all sizes. I note that the RE and FE models might overestimate the influence of cash flow on investment as these models do not take into account endogeneity problems.

**TABLE IV. GMM-IV ESTIMATION RESULTS**

| **Dependent variable: log of Investment** | **All firms** | **Small firms (assets less $50m)** | **Medium firms (assets $50-500m)** | **Large firms (assets $500-1000m)** | **The largest firms (assets >$1000m)** |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $CF_{ti}$ | **0.167*** ** | 0.301*** | 0.256*** | 0.601*** | 0.0926*** |
| | ***-0.016*** | *-0.0356* | *-0.0296* | *-0.0324* | *-0.0248* |
| $Q_{t,i}$ | **0.316*** ** | 0.288*** | 0.262*** | -0.107 | 0.203*** |
| | ***-0.0292*** | *-0.0643* | *-0.0577* | *-0.0835* | *-0.0463* |
| ***Industry-specific effects of the crisis*** ($\boldsymbol{\gamma_k}$)***:*** $\boldsymbol{D^k D^{crisis} CF_{ti}}$ | | | | | |
| Division A: Agriculture, Forestry, and Fishing | **0.121*** ** | -0.746*** | 0.27 | -0.0234 | 0.175*** |
| | ***-0.044*** | *-0.148* | *-0.168* | *-0.0324* | *-0.0561* |
| Division B: Mining | **0.0804*** ** | 0.0787 | 0.177*** | 0.0294 | 0.0464*** |
| | ***-0.0163*** | *-0.0664* | *-0.0302* | *-0.0606* | *-0.0152* |
| Division C: Construction | **0.153** ** | 0.734 | 0.233 | -0.127** | 0.223*** |
| | ***-0.0761*** | *-1.191* | *-0.153* | *-0.0497* | *-0.0857* |
| Division D: Manufacturing | **0.141*** ** | 0.167*** | 0.170*** | 0.144*** | 0.113*** |
| | ***-0.00922*** | *-0.0373* | *-0.0202* | *-0.0324* | *-0.0102* |
| Division E: Transportation, Communications, Electric, Gas, and Sanitary Services | **0.0440*** ** | 0.057 | 0.0373 | -0.0268 | 0.0479*** |
| | ***-0.0104*** | *-0.121* | *-0.0277* | *-0.0374* | *-0.0122* |
| Division F: Wholesale Trade | **0.205*** ** | 0.567*** | 0.730*** | 0.363*** | 0.116** |
| | ***-0.0417*** | *-0.167* | *-0.124* | *-0.106* | *-0.0475* |
| Division G: Retail Trade | **0.203*** ** | 0.00244 | 0.154*** | 0.299*** | 0.187*** |
| | ***-0.0195*** | *-0.102* | *-0.0252* | *-0.0609* | *-0.0264* |
| Division I: Services | **0.160*** ** | 0.199** | 0.214*** | 0.0650* | 0.140*** |
| | ***-0.0173*** | *-0.0859* | *-0.0442* | *-0.0344* | *-0.0227* |
| Observations | **71,096** | 10,512 | 23,638 | 8,862 | 27,772 |
| R-squared | **0.173** | 0.148 | 0.205 | 0.354 | 0.145 |
| Number of groups | **3,134** | 884 | 1,652 | 799 | 1,151 |
| | | | | | |

[a] All variables but Q are in logs. The balance sheet items variables are scaled by total capital at the beginning of the period. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are in italics.

**TABLE V. IV ESTIMATION RESULTS**

| **Dependent variable: log of Investment** | **All firms** | **Small firms (assets less $50m)** | **Medium firms (assets $50-500m)** | **Large firms (assets $500-1000m)** | **The largest firms (assets >$1000m)** |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $CF_{ti}$ | **0.168*** ** | 0.321*** | 0.324*** | 0.551*** | 0.126*** |
| | ***-0.016*** | *-0.0358* | *-0.0304* | *-0.0329* | *-0.0252* |
| $Q_{t,i}$ | **0.312*** ** | 0.271*** | 0.161*** | -0.107 | 0.181*** |
| | ***-0.0292*** | *-0.0644* | *-0.0586* | *-0.0835* | *-0.0464* |
| ***Industry-specific effects of the crisis ($\gamma_k$): $D^k D^{crisis} CF_{ti}$*** | | | | | |
| Division A: Agriculture, Forestry, and Fishing | **0.122*** ** | -0.733*** | 0.241 | 0.0211 | 0.169*** |
| | ***-0.044*** | *-0.148* | *-0.168* | *-0.0328* | *-0.0561* |
| Division B: Mining | **0.0801*** ** | 0.08 | 0.175*** | 0.0315 | 0.0452*** |
| | ***-0.0163*** | *-0.0664* | *-0.0302* | *-0. 606* | *-0.0152* |
| Division C: Construction | **0.150** ** | 0.678 | 0.229 | -0.115** | 0.229*** |
| | ***-0.0761*** | *-1.191* | *-0.153* | *-0.0497* | *-0.0857* |
| Division D: Manufacturing | **0.143*** ** | 0.177*** | 0.161*** | 0.136*** | 0.121*** |
| | ***-0.00923*** | *-0.0373* | *-0.0202* | *-0.0324* | *-0.0103* |
| Division E: Transportation, Communications, Electric, Gas, and Sanitary Services | **0.0442*** ** | 0.078 | 0.0466* | -0.0204 | 0.0477*** |
| | ***-0.0104*** | *-0.121* | *-0.0277* | *-0.0374* | *-0.0122* |
| Division F: Wholesale Trade | **0.191*** ** | 0.458*** | 0.275** | 0.250** | 0.108** |
| | ***-0.0417*** | *-0.168* | *-0.132* | *-0.107* | *-0.0475* |
| Division G: Retail Trade | **0.206*** ** | -0.0113 | 0.166*** | 0.294*** | 0.199*** |
| | ***-0.0195*** | *-0.102* | *-0.0252* | *-0.0609* | *-0.0265* |
| Division I: Services | **0.161*** ** | 0.215** | 0.192*** | 0.0906*** | 0.140*** |
| | ***-0.0173*** | *-0.086* | *-0.0442* | *-0.0345* | *-0.0227* |
| Observations | **71,096** | 10,512 | 23,638 | 8,862 | 27,772 |
| R-squared | **0.173** | 0.15 | 0.234 | 0.364 | 0.177 |
| Number of firms | **3,134** | 884 | 1,652 | 799 | 1,151 |
| | | | | | |

[a]All variables but Q are in logs. The balance sheet items variables are scaled by total capital at the beginning of the period. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are in italics.

**TABLE VI. FE MODEL ESTIMATION RESULTS**

| **Dependent variable: log of Investment** | **All firms** | **Small firms (assets less $50m)** | **Medium firms (assets $50-500m)** | **Large firms (assets $500-1000m)** | **The largest firms (assets >$1000m)** |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $CF_{ti}$ | **0.418*** ** | 0.353*** | 0.417*** | 0.478*** | 0.478*** |
| | ***-0.0113*** | *-0.0134* | *-0.014* | *-0.019* | *-0.0152* |
| $Q_{t,i}$ | **-0.00517** | 0.154*** | 0.016 | -0.182*** | -0.231*** |
| | ***-0.0324*** | *-0.0355* | *-0.0427* | *-0.0615* | *-0.0402* |
| ***Industry-specific effects of the crisis*** $(\boldsymbol{\gamma_k})$: $\boldsymbol{D^k D^{crisis} CF_{ti}}$ | | | | | |
| Division A: Agriculture, Forestry, and Fishing | **0.0422** | -0.265*** | 0.133** | -0.0363*** | 0.0623 |
| | ***-0.0549*** | *-0.0884* | *-0.0603* | *-0.00802* | *-0.0565* |
| Division B: Mining | **0.0592*** ** | 0.0127 | 0.125*** | 0.0467 | 0.0425*** |
| | ***-0.00939*** | *-0.0671* | *-0.0148* | *-0.0294* | *-0.0114* |
| Division C: Construction | **0.105*** ** | -0.0178 | 0.172*** | -0.0242 | 0.193*** |
| | ***-0.035*** | *-0.0534* | *-0.0648* | *-0.08* | *-0.0525* |
| Division D: Manufacturing | **0.106*** ** | 0.125*** | 0.114*** | 0.0907*** | 0.0747*** |
| | ***-0.0096*** | *-0.0244* | *-0.0113* | *-0.0213* | *-0.0151* |
| Division E: Transportation, Communications, Electric, Gas, and Sanitary Services | **0.0322*** | 0.0434 | 0.0373 | 0.0255 | 0.0306 |
| | ***-0.0187*** | *-0.0689* | *-0.0246* | *-0.0466* | *-0.0226* |
| Division F: Wholesale Trade | **0.148*** ** | 0.257*** | 0.155*** | 0.153** | 0.0904* |
| | ***-0.0356*** | *-0.0717* | *-0.0437* | *-0.0618* | *-0.0505* |
| Division G: Retail Trade | **0.181*** ** | 0.0535 | 0.151*** | 0.221*** | 0.154*** |
| | ***-0.011*** | *-0.0378* | *-0.024* | *-0.0282* | *-0.0199* |
| Division I: Services | **0.110*** ** | 0.126*** | 0.104*** | 0.0560* | 0.0985*** |
| | ***-0.012*** | *-0.0405* | *-0.0187* | *-0.0288* | *-0.0174* |
| Constant | **-1.841*** ** | -2.384*** | -1.749*** | -1.495*** | -1.508*** |
| | ***-0.0483*** | *-0.0463* | *-0.0578* | *-0.082* | *-0.0574* |
| Observations | **105,146** | 18,091 | 37,099 | 12,606 | 37,350 |
| R-squared | **0.249** | 0.163 | 0.253 | 0.32 | 0.339 |
| Number of firms | **4,745** | 1,756 | 2,737 | 1,388 | 1,739 |
| | | | | | |

[a]All variables but Q are in logs. The balance sheet items variables are scaled by total capital at the beginning of the period. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are in italics.

TABLE VII. RE MODEL ESTIMATION RESULTS

| Dependent variable: log of Investment | All firms | Small firms (assets less $50m) | Medium firms (assets $50-500m) | Large firms (assets $500-1000m) | The largest firms (assets >$1000m) |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $CF_{ti}$ | **0.407*** ** | 0.339*** | 0.395*** | 0.453*** | 0.469*** |
| | ***-0.0121*** | *-0.0145* | *-0.0156* | *-0.0197* | *-0.0155* |
| $Q_{t,i}$ | **-0.00149** | 0.149*** | 0.0421 | -0.137*** | -0.228*** |
| | ***-0.0298*** | *-0.0315* | *-0.0373* | *-0.0483* | *-0.036* |
| ***Industry-specific effects of the crisis ($\gamma_k$): $D^k D^{crisis} CF_{ti}$*** | | | | | |
| Division A: Agriculture, Forestry, and Fishing | **0.0569** | -0.0329 | 0.142*** | -0.00344 | 0.066 |
| | ***-0.0611*** | *-0.25* | *-0.0437* | *-0.00922* | *-0.0535* |
| Division B: Mining | **0.0405*** ** | -0.00723 | 0.0819*** | 0.0245* | 0.0215* |
| | ***-0.00897*** | *-0.056* | *-0.0184* | *-0.0141* | *-0.0115* |
| Division C: Construction | **0.0966*** ** | -0.0588** | 0.159*** | -0.0045 | 0.185*** |
| | ***-0.0299*** | *-0.0269* | *-0.0373* | *-0.0875* | *-0.043* |
| Division D: Manufacturing | **0.108*** ** | 0.135*** | 0.121*** | 0.103*** | 0.0769*** |
| | ***-0.00958*** | *-0.0239* | *-0.0117* | *-0.0203* | *-0.0147* |
| Division E: Transportation, Communications, Electric, Gas, and Sanitary Services | **0.0330*** | 0.0337 | 0.0440* | 0.0471 | 0.0312 |
| | ***-0.018*** | *-0.0599* | *-0.0239* | *-0.0442* | *-0.0219* |
| Division F: Wholesale Trade | **0.155*** ** | 0.272*** | 0.171*** | 0.149*** | 0.102** |
| | ***-0.0355*** | *-0.0663* | *-0.0435* | *-0.0576* | *-0.0474* |
| Division G: Retail Trade | **0.176*** ** | 0.0680* | 0.145*** | 0.212*** | 0.153*** |
| | ***-0.0108*** | *-0.0411* | *-0.021* | *-0.0277* | *-0.0195* |
| Division I: Services | **0.108*** ** | 0.127*** | 0.109*** | 0.0512* | 0.0961*** |
| | ***-0.0116*** | *-0.0383* | *-0.0185* | *-0.0264* | *-0.0163* |
| Constant | **-1.934*** ** | -2.401*** | -1.823*** | -1.551*** | -1.540*** |
| | ***-0.0463*** | *-0.0583* | *-0.0618* | *-0.0715* | *-0.0468* |
| Observations | **105,146** | 18,091 | 37,099 | 12,606 | 37,350 |
| | | | | | |
| Number of firms | **4,745** | 1,756 | 2,737 | 1,388 | 1,739 |

[a]All variables but Q are in logs. The balance sheet items variables are scaled by total capital at the beginning of the period. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are in italics.

## 5. CONCLUSIONS

This paper investigates asymmetric effects of the 2008 financial crisis on investment-cash flow sensitivity among U.S. firms and shows that investment-cash flow sensitivity varies across industries, mainly due to differences in the expected value of a firm‟s capital that can be used as collateral. A simple theoretical model is constructed to demonstrate that the tightness of financial constraints depends on the value of a firm‟s collateral and differs by sector. It is shown that under general assumptions higher collateral value increases the sensitivity of investment to cash flow.

Taking the 2008 financial crisis as a natural experiment that changed the collateral value of firms, I test the hypothesis that the tightness of financial constraints depends on the value of a firm‟s collateral and differs across industries. Using quarterly data for U.S. firms from 1990 to 2011 from COMPUSTAT, I estimate the investment-cash flow sensitivity model using the IV and GMM-IV methods.

First, I evaluate the investment-cash flow sensitivity with changes in physical capital value. I find that the elasticity of investment by cash flow is about 0.1 in the case of the IV model and about 0.43 in the case of the GMM-IV, FE, and RE models. Empirical results show that the share of physical capital in assets has a strong influence on investment and investment-cash flow sensitivity. The elasticity of investment by the share of capital in assets is negative and is about -0.47 in the GMM-IV and IV cases. Investment is negatively dependent on the share of capital in assets, confirming the idea of diminishing marginal returns on investment.

According to my study, firms with higher share of physical capital in assets have higher investment-cash flow sensitivity on average. Also, firms with higher levels of capital had higher investment-cash flow sensitivity during the pre-crisis period. After the crisis, firms with higher amounts of capital experienced less financial constraints and, therefore, became less sensitive to cash flow when they decided to invest. As banks changed their expectations about the value of firms‟ assets, the cumulative elasticity of investment by the interaction of capital and cash flow for the crisis period was found to be negative in all models.

Second, I find that the effects of the crisis are not uniform across firms‟ sizes and industry-specific effects are significant. I provide a sectoral decomposition of changes in the investment-cash flow sensitivity. I find that an increase in cash flow by 1 percent increases investment by 0.17 percent on average. This effect is not uniform across firms of different sizes. The elasticity of investment by cash flow is about 0.3 for small- and medium-size firms, about 0.6 for larger firms, and about 0.1 for the largest firms during the pre-crisis period, demonstrating the bell-shaped distribution.

The financial crisis increased liquidity constraints and almost doubled the sensitivity of investment to cash flow. Negative effects of the crisis in terms of higher dependence of investment on cash flow were experienced most strongly in the wholesale trade, retail trade, construction, manufacturing, and services sectors, in which the elasticity of investment by cash flow almost doubled in value. At the same time, firms with higher levels of assets experienced a lower increase in investment-cash flow sensitivity in most industries.

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# Appendix

**GMM-FD MODEL ESTIMATION RESULTS**

| **Dependent variable: log of Investment** | **All firms** | **Small firms (assets less $50m)** | **Medium firms (assets $50-500m)** | **Large firms (assets $500-1000m)** | **The largest firms (assets >$1000m)** |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $CF_{ti}$ | 0.507*** | 0.894*** | -0.579 | 0.308 | 1.128*** |
| | *-0.115* | *-0.241* | *-1.08* | *-1.371* | *-0.169* |
| $Q_{t,i}$ | 5.819*** | -0.192 | 17.76 | 14.11 | -1.057 |
| | *-1.649* | *-5.071* | *-11.41* | *-22.57* | *-3.202* |
| ***Industry-specific effects of the crisis ($\gamma_k$): $D^k D^{crisis} CF_{ti}$*** | | | | | |
| Division A: Agriculture, Forestry, And Fishing | -8.884 | -0.747** | 5.301 | 0.23 | -1.371* |
| | *-21.39* | *-0.35* | *-6.349* | *-2.456* | *-0.755* |
| Division B: Mining | 0.25 | -2.428 | 1.045 | 0.0824 | -0.00923 |
| | *-0.408* | *-2.514* | *-2.592* | *-0.882* | *-0.259* |
| Division C: Construction | 3.279 | 0.263 | 20.46 | -6.062 | 2.141 |
| | *-5.399* | *-4.87* | *-41.44* | *-14.03* | *-5.156* |
| Division D: Manufacturing | 2.875* | -3.61 | 15.08 | 3.944 | 1.103 |
| | *-1.582* | *-4.62* | *-13.69* | *-9.406* | *-0.728* |
| Division E: Transportation, Communications, Electric, Gas, And Sanitary Services | 0.853*** | 0.971 | 3.632 | -10.3 | 0.577*** |
| | *-0.256* | *-2.106* | *-2.824* | *-8.913* | *-0.218* |
| Division F: Wholesale Trade | -0.585 | 0.195 | 1.194 | -0.125 | 1.105 |
| | *-0.896* | *-0.642* | *-2.381* | *-2.461* | *-1.254* |
| Division G: Retail Trade | 1.188 | 152.7 | -1.779 | 2.529 | 2.273 |
| | *-2.399* | *-100.9* | *-1.912* | *-6.754* | *-1.666* |
| Division I: Services | -1.696 | -1.347* | 3.179 | 9.902 | -24.14*** |
| | *-1.409* | *-0.789* | *-4.007* | *-14.11* | *-9.007* |
| Constant | 0.116*** | 0.185*** | 0.49 | 0.171 | -0.0526 |
| | *-0.0326* | *-0.0622* | *-0.328* | *-0.368* | *-0.0361* |
| Observations | 61,743 | 8,298 | 20,150 | 7,974 | 25,321 |
| | | | | | |
| Number of groups | 3,075 | 813 | 1,585 | 804 | 1,167 |

[a]All variables but Q are in logs. The balance sheet items variables are scaled by total capital at the beginning of the period.
*** p<0.01, ** p<0.05, * p<0.1. Standard errors are in italics.

**BETWEEN MODEL ESTIMATION RESULTS**

| **Dependent variable: log of Investment** | **All firms** | **Small firms (assets less $50m)** | **Medium firms (assets $50-500m)** | **Large firms (assets $500-1000m)** | **The largest firms (assets >$1000m)** |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $CF_{ti}$ | 0.217*** | 0.223*** | 0.171*** | 0.209*** | 0.272*** |
| | *-0.0115* | *-0.0205* | *-0.0142* | *-0.0221* | *-0.0181* |
| $Q_{t,i}$ | 0.108*** | 0.142*** | 0.292*** | 0.181*** | -0.0124 |
| | *-0.0267* | *-0.0442* | *-0.0344* | *-0.0494* | *-0.0421* |
| ***Industry-specific effects of the crisis ($\gamma_k$): $D^k D^{crisis} CF_{ti}$*** | | | | | |
| Division A: Agriculture, Forestry, And Fishing | 0.426** | 0.673*** | 0.151 | 0.349 | 0.035 |
| | *-0.201* | *-0.154* | *-0.31* | *-0.611* | *-0.304* |
| Division B: Mining | -0.167*** | -0.00687 | -0.138*** | -0.0436 | -0.205*** |
| | *-0.0252* | *-0.0587* | *-0.0325* | *-0.044* | *-0.0279* |
| Division C: Construction | -0.0378 | -0.414 | 0.0821 | 0.441* | 0.0185 |
| | *-0.115* | *-0.404* | *-0.123* | *-0.259* | *-0.127* |
| Division D: Manufacturing | 0.162*** | 0.307*** | 0.211*** | 0.225*** | 0.110*** |
| | *-0.0231* | *-0.0548* | *-0.0342* | *-0.034* | *-0.026* |
| Division E: Transportation, Communications, Electric, Gas, And Sanitary Services | 0.0972*** | -0.112 | 0.271*** | 0.239*** | 0.0720** |
| | *-0.0312* | *-0.168* | *-0.0634* | *-0.0415* | *-0.0281* |
| Division F: Wholesale Trade | 0.310*** | 0.513*** | 0.338*** | 0.0398 | 0.243*** |
| | *-0.0764* | *-0.184* | *-0.125* | *-0.112* | *-0.0681* |
| Division G: Retail Trade | -0.0131 | 0.276 | 0.117** | 0.165** | 0.108* |
| | *-0.0543* | *-0.201* | *-0.0585* | *-0.0778* | *-0.0576* |
| Division I: Services | 0.0527* | 0.136* | 0.184*** | 0.0838* | 0.0647* |
| | *-0.0312* | *-0.0744* | *-0.043* | *-0.0437* | *-0.0379* |
| Constant | -2.561*** | -2.641*** | -2.575*** | -2.438*** | -2.321*** |
| | *-0.0431* | *-0.0726* | *-0.0537* | *-0.0877* | *-0.0744* |
| Observations | 105,146 | 18,091 | 37,099 | 12,606 | 37,350 |
| R-squared | 0.14 | 0.151 | 0.149 | 0.188 | 0.198 |
| Number of groups | 4,745 | 1,756 | 2,737 | 1,388 | 1,739 |

[a]All variables but Q are in logs. The balance sheet items variables are scaled by total capital at the beginning of the period. *** p<0.01, ** p<0.05, * p<0.1. Standard errors are in italics.