The Effect of the Global Financial Crisis on Corporate Investment in Korea: From the Perspective of Costly External Finance[†]

By DAEHEE JEONG[*]

This paper examines the effect of the global financial crisis on corporate investment in Korea. Specifically, the crisis was considered to have possibly constrained firm-level investment as the negative shock to the credit supply dramatically unfolded. As Duchin et al. (2010) demonstrated, if a negative supply-side shock is evident during a crisis period, larger cash holdings before the crisis will lead to fewer constraints to corporate investment, or vice versa. In order to investigate the supply-side effect of the crisis, we use firm-level financial data, including firms listed on the Korean stock market as well as small and medium-sized enterprises. We find that corporate investment declined significantly after the crisis, even if we control for factors associated with the demand side, such as contemporaneous capital productivity and cash flow. More importantly, the decline is positively and significantly related to cash holdings before the crisis, implying the negative effect of a credit supply shock. Small and medium enterprises experienced relatively sharp investment declines compared to those of larger firms, and the relationship between pre-crisis cash amounts and the degree of investment decline is greater than that in large firms. Additionally, we examine whether the negative effect persists up to the present, finding evidence that the cash-investment relationship continues in small and medium-sized enterprises.

Key Word: Financial crisis, corporate investment, credit supply, financial constraint, cash holdings
JEL Code: G01, G31, G32

I. Introduction

Concerns about the negative effects of the credit supply shock emerged during the global financial crisis. Although a current account surplus in Korea had been maintained before the crisis, domestic banks experienced large capital inflows from 2005 to 2007, especially in short-term debt. As the negative effects of the global crisis were fully manifested, financial institutions whose headquarters were located in distressed economies stopped rolling over short-term loans to Korean banks. As a result, financial market in Korea experienced high volatility due to the sudden lack of capital inflows. The won/dollar exchange rate rose rapidly, reaching 1,513 won in late November of 2008, up 38.9% from that August. CDS premiums also skyrocketed to 692bp, reflecting the increased credit risk to domestic banks. Stock prices lost roughly 50 percent of their value from the 2008 peak, market interest rates went up sharply, escalating the credit spread between corporate (AA-, three-year maturity) and government bonds (three-year maturity) to three times the level before the crisis. More importantly, domestic banks reduced their credit supply and became more conservative with regard to lending.

Classical models of financial friction predict that a negative shock to external finance would restrict the real activities of economic agents. Consumers are expected to reduce their consumption of durable goods because the relative marginal value of durable goods to nondurable goods and services increases when facing constraints to liquidity. Firms will cut their investment expenditures because the cost of external fund increases, making the planned investment less profitable. Moreover, financial friction may increase during a crisis period when collateral loses its value (i.e., real estate prices drop). In such a case, the negative effects of the credit crunch are amplified and become more persistent.

Our paper investigates the impact of the credit crunch during the global financial crisis on corporate investment. More specifically, we focus on cash reserves on firms' balance sheets in order to identify the supply-side effects of the crisis, as in Duchin *et al.* (2010). Typically, if the external finance of a firm is constrained, its investment expenditure will be reduced on account of financial constraints. However, if the firm has enough cash reserves to accommodate the negative shock to external funding, its investment expenditures will be less affected by the negative shock. In essence, the more cash reserves a firm has, the lower its investment constraints (i.e., from a credit crunch) will be. We can use this idea to examine whether firms were negatively affected by the credit shortage during the crisis period. In particular, if the relationship between pre-crisis the cash reserve level and the degree of investment decline is significantly negative, we may conclude that a firm's investments were negatively affected by the credit supply shortage during that period.

Additionally, the magnitude of negative supply-side effects on corporate investment may differ depending on the degree of a firm's financial constraints. In order to determine how much financial constraints matter, our study adds unlisted firms to the analysis. This is relatively unexplored in the literature, and doing this will highlight the differential negative supply effects on investments between large firms and small and medium enterprises (SMEs). Because a firm's financial

constraints may also depend on factors other than its size, we also use the factors of industry (three-digit) sales growth and ownership to identify financially constrained and unconstrained firms. In addition, we investigate whether the shrinkage of the credit supply during the crisis had persistent negative effects on corporate investment. If the negative shock of external funds persistently affected corporate investment, we would observe that the relationship between pre-crisis cash levels and the investment decline is significant not only for the immediate year after the crisis but also for all years since the crisis in the sample.

Our results show that the estimated average investment decline after the global financial crisis is 1.3%p (in terms of investments to the total asset ratio) for the firms in our sample. This decline is significant even if we control for investment demand, implying that the contraction in investment expenditure cannot be explained by the reduced investment opportunity after the crisis. More importantly, we find evidence that the investment decline is caused by the negative supply-side shock (or the credit supply shortage). Specifically, as a firm has more cash reserves before the crisis, its investment decline is significantly less. When we divide our estimation sample into two groups, i.e., firms which are more financially constrained and those which are less financially constrained, we find that the negative shock to the credit supply has in general a greater effect on financially constrained firms. For instance, the investment decline caused by the supply-side effect is more evident for SMEs. Other criteria pertaining to financial constraints, such as industry sales growth and ownership, also provide results which are qualitatively identical to those determined by the classification of financial constraints based on firm size. We also find evidence that the persistent investment contraction in SMEs after the crisis is related to the negative shock to the credit supply.

Our paper is organized as follows. In the next section, we introduce related studies, especially those on the real effects of the financial crisis. In Section 3, we briefly review the financial market in Korea during the global financial crisis and provide a preliminary analysis of the relationship between firms' pre-crisis cash levels and the degrees of the decline in corporate investment. In Section 4, we discuss the manner in which we construct our estimation sample from firms' financial data, the baseline hypothesis in which we are interested, and the empirical strategy that we use in order to address the endogeneity issue and secure robustness. We then move on to present the main results, which will shed light on the negative effects of the credit crunch. In the final section, we summarize our findings and describe their implications.

II. Related Literature

Since the global financial crisis of 2008, studies on the real effects of the financial crisis, specifically in developed economies, have been active. Many attempt to quantify the magnitude of the negative effects of the crisis based on the transmission mechanism through which financial contraction affects the real economy. In this section, we discuss the findings of related studies on the financial

crisis and introduce a number of empirical works which quantify the negative effects of the global financial crisis.

Classical theory assumes the existence of financial friction[1] when analyzing the relationships between real and financial variables. According to studies related to classical theory, financial friction would not only amplify the response of real activities to negative shocks, but also make it persistent.[2] For instance, a financial crisis involves a large negative shock of the external funding to debtors, in what is termed a credit crunch, as well as a sharp depreciation of asset prices. As a result, the fall in asset prices damages the debtor's net worth (or the collateral value), which makes it more difficult for the debtor to procure additional outside funds. This is the so-called 'vicious cycle', which produces an amplification mechanism which acts on the financial friction. Moreover, in the event the debtor was highly leveraged before the crisis, this amplification mechanism makes it more difficult for them to recover their financial soundness, allowing observations of a prolonged economic contraction after the crisis.

With regard to credit supply during the global financial crisis, Ivashina and Scharfstein (2010) report that during the fourth quarter of 2008, when the uncertainty from the financial crisis started to unfold, new loans by commercial banks fell by 47% relative to the prior quarter and by 79% relative to the peak of the credit boom (the second quarter of 2007). According to their analysis, banks' over dependence on short-term financial market leads to a large drop in the credit supply during the crisis period. Meanwhile, they also show that even if the total assets of the banking sector in the U.S. grew by 100 billion dollars from September to mid-October of 2008, it was a result of credit line drawdowns and not the creation of new loans.

Related to the real effect of the credit shortage during the global crisis, Campello *et al.* (2010) find that financially constrained firms cut employment and capital expenditure more compared to unconstrained firms. Based on a survey of chief financial officers (CFOs) in the U.S., Europe, and Asia, they studied whether firms' economic activity levels differ conditional on their degree of financial constraint. They find that the average constrained firm in the U.S. reduced employment by 11% and capital expenditures by 9%, while unconstrained firms' spending cuts were insignificant. Moreover, they report that constrained firms burned through approximately 20% of their pre-crisis cash, drew more from their credit lines for fear that banks would restrict access in the future, and sold more assets to fund their activities.

Meanwhile, Duchin *et al.* (2010) find that the corporate investment decline in the U.S. was significant and that the decline was more severe for firms with fewer cash reserves or more short-term debt. In addition, they investigate whether the credit crunch has had persistent effects on corporate investment, finding that the negative supply-side effect seems to have disappeared one year after the crisis. In fact, their result shows that the demand-side effect, e.g., decreased investment opportunities,

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[1] Financial friction essentially refers to the cost of financial transactions; it can originate from information asymmetry or from moral hazard. For traditional models of financial friction, refer to Jaffee and Russell (1976), Stiglitz and Weiss (1981), and Holmstrom and Tirole (1997), among others.

[2] Brunnermeier *et al.* (2012) provides an excellent survey of the role of financial friction in business cycle theory.

mainly explains the sluggish investment after the crisis.

We also find qualitatively similar results in earlier studies.[3] For instance, Arslan *et al*. (2006) find that cash reserves in Turkish firms served as a form of self-insurance during the crisis period, as firms there with enough cash could cope with the negative shock to external finance and ultimately maintain their planned investment projects. Dell'Ariccia *et al*. (2008) studied banking crises cases across countries and showed that industries with higher dependence on external funding experienced slower recovery rates and delayed growth.

Recent studies of the impact of the global financial crisis on the Korean economy focus on the adequacy of the capital of banks or cash holdings of the corporate sector, as these variables can serve to buffer the negative shock from the crisis. Hahm and Kim (2011) find that the soundness of financial institutions in emerging economies can perform as a shock absorber as well. They concluded that greater soundness of a financial institution meant a shorter spell of a crisis and a smaller negative impact as well. Kim (2011) also finds that the economic downturn of Korea accompanying the 2008 crisis was much smaller than that of the 1997 currency crisis and that the recovery was also faster after the recent crisis. According to his assessment, the corporate sector has made significant improvement in restoring their financial soundness and managing the risks from assets and liabilities denominated in foreign currencies after the 1998 crisis, leading to relatively low amounts of damage from the more recent crisis.

In this paper, we focus on the roles of financial buffers in mitigating negative external shocks to corporate investment. While previous studies of the 2008 crisis mainly examine the impact of foreign financial shocks, we contrast the impact of the negative shock to the demand side with the negative shock to the credit supply by incorporating variables which reflect investment demand. Additionally, we investigate a sample which was relatively unexplored in previous studies by including small and medium enterprises (SMEs) to determine whether the negative supply-side effect stands out in our sample. Because the funding structure of large firms differs from that of SMEs, the negative shock from external finance would also have a different impact. If this is the case, we would observe a different real impact of the crisis depending upon the firm size.

Finally, our work is also related to studies of domestic firms' cash holdings. From the negative view[4] on firms' cash holdings, large cash holdings of corporate sector are interpreted as poor corporate governance or as misallocations of resources. On the other hand, Lim and Choi (2006) find evidence that the cash holdings of firms can be considered as precautionary savings[5] in response to operational uncertainty. Lee (2005) also finds in his work on publicly traded firms that higher sales uncertainty can lead to more cash holdings. Our view on these cash reserves is in line with the above studies, indicating a positive role of this cash,

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[3]Refer to Fazzari *et al*. (1988), Hoshi *et al*. (1991) and Kaplan and Zingles (1997) among others, for more traditional studies on the negative effect of credit shrink to financially constrained firms.

[4]Classical literature on excess cash holdings by firms report that poor governance can create management incentives to accumulate cash assets, leading to misappropriations and excessive cash holdings (see, e.g., Dittmar *et al*. (2007), Harford *et al*. (2008) and Pinkowitz *et al*. (2006)).

[5]Regarding the precautionary saving motive by firms, refer to Opler *et al*. (1999), Almeida *et al*. (2004), and Bates *et al*. (2009), among others.

i.e., if firms hold enough cash reserves, they can mitigate negative shocks to the supply side.

III. The Relationship between Pre-Crisis Cash Reserves and Investment Decline: An Episode of the 2008 Global Financial Crisis

A. *A Foreign Liquidity Crisis May Lead to a Credit Crunch*

The global financial crisis can be symbolized as a global event which was accompanied by a world-wide credit shock. The crisis emerged from the massive defaults of U.S. subprime mortgages, and eventually unfolded to full scale in September of 2008, when Lehman Brothers filed for bankruptcy. Subprime mortgages, which were real-estate-backed loans to households with relatively poor credit ratings, had been growing at a fast pace due to the prolonged accommodative monetary policy and the appreciation of house prices. Newly underwritten subprime mortgage loans accounted for nearly 8.6% of all mortgage lending in 2001, but they increased rapidly to 20.1% by 2006. However, after the middle of 2006, mortgage interest rates increased as the Federal Reserve increased rates, driving up the delinquency rate of subprime mortgage borrowers. As a result, the prices of financial derivatives related to the subprime loans, such as mortgage-backed securities (or MBS) and collateralized debt obligations (or CDOs) fell drastically. Financial institutions which had considerable exposure to these assets experienced massive losses, and the credit worthiness of Monoline, a U.S. CDO guarantor, was seriously downgraded. In March of 2008, the U.S. investment bank Bear Sterns declared bankruptcy, and the government sponsored entities Fannie Mae and Freddie Mac, which reinforced the credit of mortgage-backed securities, saw their stock prices plunge. Eventually, in September of 2008, Lehman Brothers, one of the largest investment banks in the U.S., filed for bankruptcy protection.

The Lehman bankruptcy alerted against counterparty risk, and the preference for risky assets evaporated quickly. Many financial institutions had difficulty securing liquidity, and the liquidity problem quickly spread from one institution to the others. Banks in emerging economies, which usually serve as intermediaries for funds from banks in developed countries to domestic firms and consumers, were at this point in peril because they borrowed short-term foreign currency while lending in long-term domestic currency. As a result, many emerging-market banks experienced their own foreign liquidity crises when their counterparties in developing countries stopped lending (or rolling over the loans). Korean banks were not an exception to this turmoil.

In the Korean domestic financial market, the volatility in exchange rates, stock prices and interest rates increased sharply (see Figure 1). As foreign bank branches stopped supplying short-term foreign currency loans (or rolling over these loans), domestic banks faced extreme foreign liquidity problems. As their demand for foreign liquidity skyrocketed, banks took large long positions in the FX spot market. As a result, won/dollar exchange rate soared. The exchange rate started to rise at a steep pace in September of 2008, reaching 1,513 won in November of 2008, thus marking a rise of nearly 38.9% in only two months. During this process,

a vicious cycle emerged: as spot prices increased, the banks' ability to repay the foreign-currency-denominated debt weakened and the creditworthiness of domestic banks was hampered, making the foreign banks even more hesitant to supply
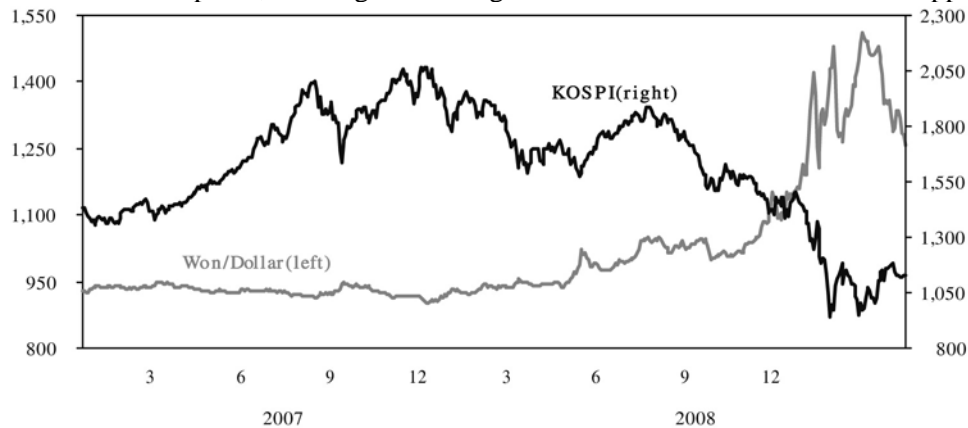

FIGURE 1. KOREA STOCK PRICE INDEX (KOSPI) AND THE WON/DOLLAR EXCHANGE RATE

Source: Bank of Korea

foreign currency loans to domestic banks. This caused the domestic bank's demand for foreign currency to increase even more. Although the Korean economy had maintained a current account surplus before the crisis, many factors pushed the exchange rate surprisingly upwardly. Together with the foreign liquidity problem of domestic banks, we also observed a large counterparty risk premium to emerging countries and a sudden draw of short-term portfolio capital as one of the driving forces behind the exploding exchange rates. Meanwhile, the KOSPI index was at 938.75p in October of 2008, the lowest level of the year and marking a 50.3% decline compared to the highest level of 1,888.88p in May of 2008. Market interest rates also showed steep increases before the effect of the policy rate cut by the Bank of Korea was reflected. For instance, the corporate bond rate (AA-, three-year maturity) soared from 6.64% in January of 2008 to 8.56% in November of 2008.

With regard to the impact of the global financial crisis on the real economy in Korea, we also observe that no major bankruptcy in the business sector was reported and that overall economic activity recovered in a relatively short period of time. However, this does not imply that the Korean economy did not suffer any negative influence of the liquidity shock. In fact, the following argument indicates that the credit crunch for financially constrained firms was real and affected them negatively. First, the foreign liquidity problem experienced by banks during the crisis contributed to the decrease in the credit supply to the business sector. As domestic banks found it more difficult to finance foreign currency, they sought alternative measure, such as selling their local currency assets and buying foreign currency on the spot market. As a result, households or firms found it more difficult to obtain new loans or were forced to repay their debts. Such a collapse of stock prices or asset prices can also affect the supply of credit negatively. The U.S. case can provide us valuable insight into this argument; as asset prices there

significantly declined, bank balance sheets worsened due to losses from their exposure to the troubled assets, which triggered a massive retrieval of their exposure (or sales of assets) in an effort to maintain their capital requirements. In this process, the reduction of banks' assets resulted in a decreased credit supply.

Figure 2 and Figure 3 show the results of a survey of loan officers and the net change in outstanding loans by banks, respectively. The net percentage of domestic banks tightening standards for industrial and household loans grew rapidly after mid-2008 (see Figure 2), and banks appeared to reduce their new lending during 2008, especially to SMEs (see Figure 3). This may reflect the domestic banks' weakening balance sheets and their efforts to recover their capital. Firms can also experience a negative shock to their net worth due to asset price declines and sluggish demand during crises periods. As their net worth begins to contract, their creditworthiness is also aggravated such that financial institutions will hesitate to supply loans which otherwise are available to firms.
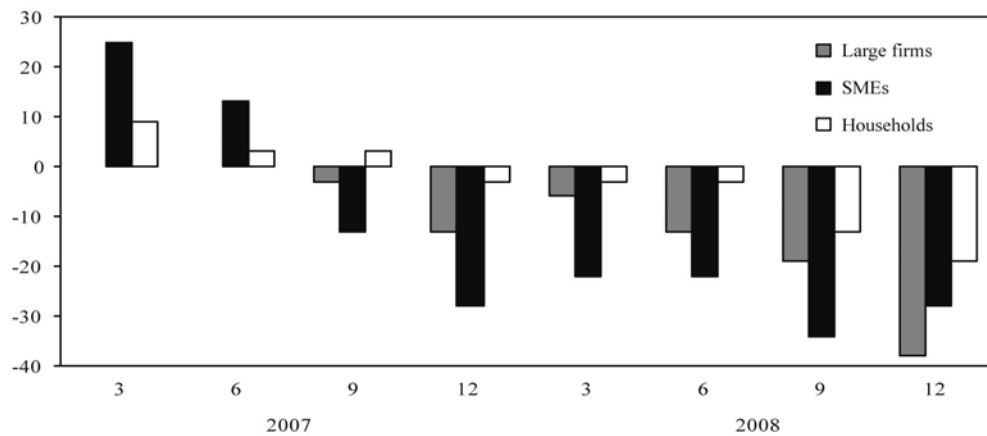

FIGURE 2. FINANCIAL INSTITUTIONS' ATTITUDES TOWARD LENDING

Notes: A positive (+) lending attitude means that there are more financial institutions with an 'easing' attitude to lending than those with a 'tightening' attitude.
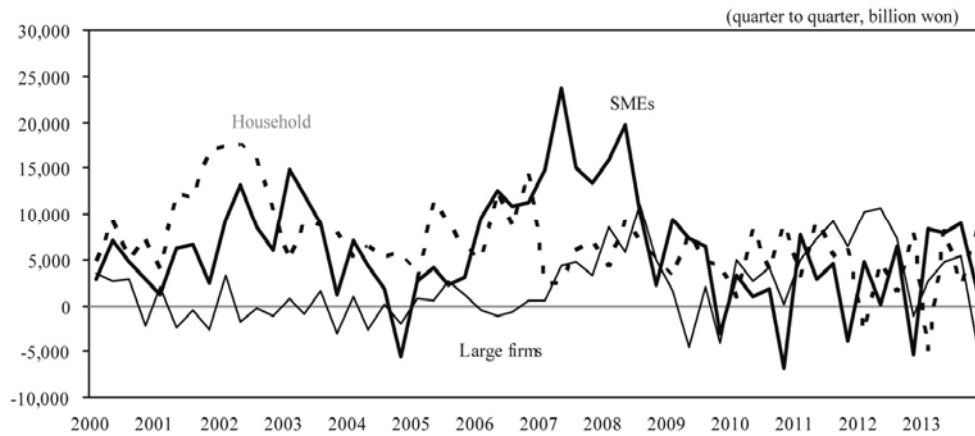
Source: Bank of Korea

FIGURE 3. CHANGES IN OUTSTANDING LOANS BY BANKS

Source: Bank of Korea

In sum, domestic banks in Korea were affected by the sudden halt in short-term debt (or the stoppage of roll-overs) during the 2008 crisis, and the magnitude of the foreign liquidity problem does not appear to be less than that of the 1997 crisis. While the Korean economy rode out the crisis relatively well and showed a rapid recovery after the crisis in an ex-post sense, it is hard to say that firms were quarantined from the negative shock to the credit supply during the crisis period. From this perspective, we investigate whether the shock to the credit supply affected economic activity, especially firm investments during the crisis period. In the following subsection, we examine the relationship between pre-crisis cash reserves and corporate investment declines in a simple analysis of negative supply-side effects.

B. *Corporate Investment during the Crisis and Pre-crisis Cash Reserves*

In order to examine the relationship between pre-crisis cash and the corporate investment decline, we categorize our sample firms[6] into three groups based on cash reserves (cash/total assets) as measured one year before the crisis year of 2008 and define low- and high-cash firms as the first and the third terciles, respectively. For both the low- and high-cash firms, we compare the sample means of corporate investment (capital expenditure/total assets) before and after the crisis and attempt to check whether high-cash firms show relatively low investment declines. Table 1 shows the differences in investments from 2007 to 2008 for both high- and low-cash firms. Before the crisis, the investment expenditure of an average firm matched 9.28% of its total assets, showing a decline by 0.99%p (10.6% relative to the pre-crisis investment level) to 8.29%, with the decline statistically significant at the 1% level. Meanwhile, when we compare the investment declines of low- and high-cash firms, the decline for low-cash firms was found to be 2.43%p, whereas it is only 0.20%p for high-cash firms, indicating that low-cash firms reduced their

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[6]For more details on the construction of our sample, refer to Section 4.1.

investments more than high-cash firms.

TABLE 1—CASH RESERVES AND POST-CRISIS INVESTMENTS: LARGE FIRMS AND SMES

		Pre-crisis Inv.	Post-crisis Inv.	Inv. decline	P-value
	Pre-crisis Cash	(A)	(B)	(B-A)	
Overall	Low	10.291	7.857	-2.435	0.000
	High	7.760	7.968	0.208	0.836
	All	9.287	8.295	-0.992	0.000
Large firms	Low	7.766	5.838	-1.928	0.000
	High	5.480	5.881	0.401	0.831
	All	6.603	6.055	-0.548	0.026
SMEs	Low	10.614	8.112	-2.502	0.000
	High	8.208	8.398	0.189	0.787
	All	9.640	8.592	-1.048	0.000

Notes: 1) 'Low' and 'High' correspond to the first and third terciles, respectively. 2) The classifications of small and medium enterprises (SMEs) and large firms are based on KIS data. 3) The p-value is for the null hypothesis of an investment decline (B-A < 0).

Because SMEs are financially more constrained (or more exposed to the information asymmetry problem), one can expect that small firms experience greater investment declines even after controlling for pre-crisis cash reserves. In order to take into account the difference in financing constraints between large firms and SMEs, we divide the sample into two groups, e.g., large firms and SMEs, and perform the same analysis. For large firms, investments by low-cash firms drop by 1.92%p, while those of high-cash firms actually increase by 0.40%p. We find a similar relationship between cash and investment declines for SMEs, though the relationship between pre-crisis cash and the investment decline appears to be somewhat stronger than it is for large firms.

Figure 4 shows a scatterplot of the average pre-crisis cash reserves and the differences in investments for the 100th percentile cash group of large firms and SMEs. We confirmed that the negative relationship between pre-crisis cash and investment decline is greater for SMEs. Table 2 reports a simple regression result,
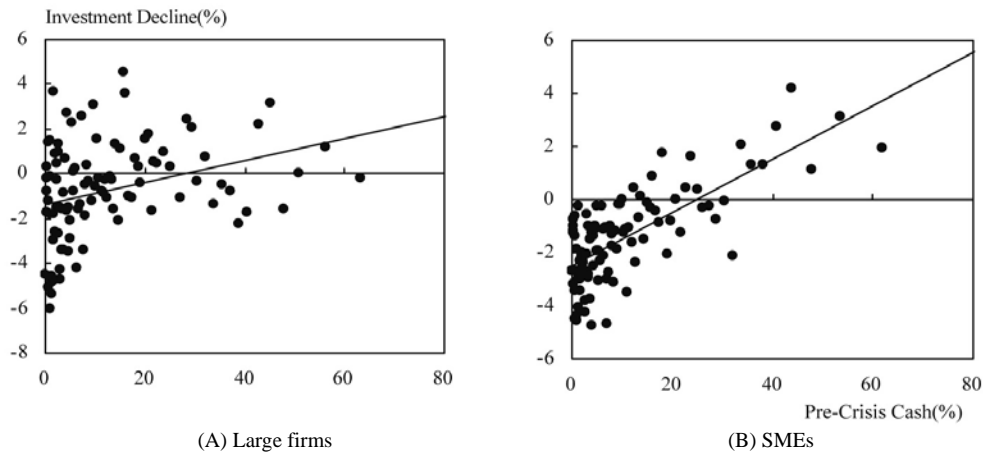

(A) Large firms   (B) SMEs

FIGURE 4. PRE-CRISIS CASH AND CORPORATE INVESTMENT DECLINES

Source: KIS data, author's calculations

TABLE 2—SIMPLE REGRESSION RESULTS FOR CORPORATE INVESTMENT DECLINES

	Overall	Large firms	SMEs
Cash	0.0947***	0.0487***	0.101***
	(0.00758)	(0.0150)	(0.00945)
Constant	-2.410***	-1.350***	-2.507***
	(0.130)	(0.284)	(0.160)
N. Obs.	100	100	100
R-squared	0.615	0.097	0.538

Notes: 1) This result is based on a simple regression of the difference in corporate investments with regard to pre-crisis cash reserves. Cash reserves are the 100th percentiles of 'cash and cash equivalents' for fiscal year 2007, and the differences in investments are calculated for the corresponding percentile group from fiscal years 2007 to 2008. 2) The classifications of small and medium enterprises (SMEs) and large firms are based on KIS data. 3) Numbers in parenthesis are the standard errors from the ordinary least squares. 4) ***, **, or * indicate that the coefficient estimate is significant at 1%, 5%, or 10% level, respectively.

showing the difference in corporate investments as the dependent variable and pre-crisis cash reserve as the independent variable. The estimated coefficients of cash for the pooled sample, for large firms, and for SMEs are all positive and statistically significant. However, the coefficient for the SMEs is more than two times greater than that of the large firms. For instance, SMEs with an additional 10%p of cash showed reduced investment drops by 1.01%p, while for large firms with 10%p more cash, this value was 0.48%p.

Overall, we find that firms with low amounts of cash before the crisis suffered more; their investment decline was greater than those of high-cash firms. Second, cash was more valuable to SMEs; their cash reserves played a greater role as an internal buffer in mitigating the negative shock to external finances as compared to those of large firms.

We will consider demand-side variables into our model, where unobservable firm-specific time-invariant effects are also considered.

IV. Empirical Analysis

A. *Data*

We use firm-level panel data on financial statements to construct our sample. The sample is extracted from the KIS VALUE database of the National Information & Credit Evaluation. In order to investigate corporate investments before and after the 2008 crisis, we use annual[7] data for firms with the fiscal year closing at the end of December.

We pay strong attention to corporate investment expenditures between fiscal years 2007 and 2008, presuming that the crisis was mainly a financial phenomenon, which is usually short-lived. Hence, we exclude data from 2009 from our main

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[7]Because we include not only publicly traded firms but also SMEs in our sample, many observations are not available at quarterly frequencies.

sample.[8] Because there may be concern over sample selection bias, we check whether the main results from our sample are robust. We find that our empirical findings stand still after adding two or three years of data to the pre- and post-crisis sample and after changing the dating of the crisis from 2008 to 2009. Our sample includes not only publicly traded firms (listed on either the KOSPI or KOSDAQ markets) but also firms with external audit requirements and general firms[9] (see Table 3). The broad coverage of our dataset is helpful for examining whether SMEs were more vulnerable to the liquidity shock during the crisis. Typically, publically traded firms, which already meet stock market listing requirements such as years in operation, business size and performance level, are less exposed to the information asymmetry problem. Thus, they appear to be less financially constrained. However, small firms (or young firms) are more financially constrained such that their investment decline due to the credit supply shock is expected to be greater.

TABLE 3—COMPOSITION OF FIRMS IN THE SAMPLE

		N. Obs.	(%)	N. Firms	(%)
KOSPI	Listed	1,020	4.80	559	4.43
	Issues for admin.	17	0.08	17	0.13
KOSDAQ	Listed	1,283	6.04	777	6.16
	Registered	1,611	7.59	930	7.37
	Issues for admin.	102	0.48	95	0.75
External audit requirement		14,808	69.75	9,236	73.22
General firm		2,362	11.13	2,016	15.98
Govt. owned corporations and others		26	0.12	20	0.16
Total		21,229	100.00	13,650	108.21

Notes: 1) The table shows the composition of the sample after excluding outliers and those with missing values. 2) 'KOSDAQ registered' refers to the status in which a firm meets certain requirements of the Securities and Exchange Act while its stock is not yet traded in the market. 3) 'Issues for administration' refers to firms which may face a delisting from the stock market. 4) Firms can be counted twice if they changed their status regarding a stock market listing, e.g., the initial public offering of an external audit firm. For reference, the total number of firms in our sample is 12,614.

By dividing our sample into large firms and SMEs, we can compare the negative supply-side effect on investment expenditures for the two different groups and find implications pertaining to the relationship between corporate investment decline and financial constraint.

With regard to the SME sample, the following issues should be noted. First, we should consider a new proxy reflecting investment demand by individual firms, as the market value of non-public firms (and Tobin's q) is unobservable in practice. In this study, we use the sales-to-capital ratio[10] as a proxy for the marginal

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[8]One may suggest using a different time span, e.g., from 2008 to 2009; however we see limitations on the use of this time span, as the negative shock to external finance may disappear quickly and may be more difficult to capture, as the government started to inject massive liquidity into the market via the emergency liquidity supply program.

[9]Here, general firms refer to corporations which do not meet the external audit criteria.

[10]Conceptually, Tobin's q is a theoretical value which is determined by summing all of the streams of present and future expected marginal productivity of capitalbased on information from management (Gilchrist and Himmelberg (1998)). Strictly speaking, one needs a theoretic model (or assumptions) on how management calculates marginal productivity and takes expectation to find the value of Tobin's q for individual firms. In our work, we calculate the marginal productivity of capital based on the assumption of the Cobb-Douglas production function, finding the expected value by presuming that productivity is dictated by an autoregressive Markov process.

productivity of capital instead of Tobin's q. Second, as Lim (2005) noted, we find that the financial statements of firms with external audit requirements or those of general corporations has many missing values about detailed items, compared to those of publicly traded firms, indicating that the credibility and usefulness of the included SME samples are relatively low.[11]

We measure corporate investment as cash outflows for items of purchase of tangible, intangible and leased asset on cash flow statements.[12] Our measurement of corporate investment has the following features. First, as Lim (2005) noted, our measure is free from distortions such as depreciation and asset revaluations compared to the alternative investment measure of the difference in tangible assets. Because the increase in tangible assets reflects investment expenditures as well as the difference in accumulated depreciation, it may undervalue a firm's investments. With regard to asset revaluations, tangible assets can increase even if there were no investment expenditures; in such a case, the alternative measure can overvalue corporate investments.

Second, our measure of corporate investment includes not only expenditures for property, plants, and equipment, which are typically termed 'capital expenditures', but also expenditures on land, buildings, and intangible assets (e.g., R&D expenditures). Hence, corporate investment in this paper is more comprehensive than capital expenditures. Practically, it is not very attractive or feasible to calculate capital expenditures in our case, as there are many missing values pertaining to expenditures for land, buildings, and intangible assets in our sample of SMEs.

Third, investment expenditures in our study did not adjust for an increase in cash due to asset sales, though Lim (2005) measures corporate investment as net cash outflows (cash outflows minus cash inflows) in items of purchases of tangible assets (excluding land and buildings). Because one of the objectives in his work was to compare corporate equipment investments as calculated from firm-level data with those from aggregate data, it appears to be reasonable to use the net cash decrease as equipment investments. However, our goal is to examine whether firms decrease investment expenditures in response to a negative credit supply shock. In this case, it is natural to focus on cash outflows.[13]

With regard to data purging, we exclude financial firms and utilities, defined as firms with Korea Standard Industry Classification (KSIC) codes 35-36 and 64-66 in the two-digit category. The financial statements of financial firms have different items and accounting standards; moreover, their investment expenditures (e.g., an increase in private loan) are not directly connected to real activities, which among the main variables of interest. Meanwhile, most utilities are accounted for in large public firms, where investment expenditures are related more to the government's plan to supply electricity, gas, water, and other such utilities, indicating that the

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[11]The number of publicly traded firms in our sample is 1,336; firms with external audit requirements number 9,236, and general corporations stand at 2,016, whereas there were a total of 1,567 publicly traded firms, 14,594 firms with external audit requirements, and 91,454 general corporations in the original KIS database. For more details on the composition of firms in our sample, refer to Table 4-1.

[12]All variables used in our study were calculated from stand-alone financial statements.

[13]Alternatively, when we calculate corporate investments based on net cash outflows, we find qualitatively similar results, although the data coverage is reduced as the values on cash inflow from the sales of assets are largely missing or small.

exclusion of these firms provides more accuracy in our empirical analysis. We also handle outliers in investments, cash reserves,[14] and sales-to-fixed capital ratios by excluding extremely large or small firm-year observations[15] compared to the empirical distribution of those variables in the largest sample from 1993 to 2011.[16] For instance, we exclude observations with investments greater than the 99th percentile or smaller than the 1st percentile in all observations. Before calculating the percentile values, we exclude observations with variables which are nearly or precisely have a zero bound.[17]

Table 4 shows the summary statistics for of corporate investment, pre-crisis cash reserves, capital productivity, and cash flow amounts for the constructed sample. Except for the cash reserves, all of the variables are for the firm-year observations from 2007 to 2008. Large firms' investment expenditures amount to is 6.33% of over total assets, which is less smaller than the value of 9.12% of SMEs' investments.

TABLE 4—SUMMARY STATISTICS

		Mean	Std.	N. Obs.
Investment	Large firms	6.33	7.01	2,477
(%)	SMEs	9.12	9.86	18,752
	All	8.79	9.62	21,229
Cash	Large firms	12.75	13.53	1,136
(%)	SMEs	11.37	12.64	7,397
	All	11.55	12.77	8,533
Capital productivity	Large firms	9.33	15.29	2,477
(%)	SMEs	8.09	13.50	18,752
	All	8.23	13.72	21,229
Cash flow	Large firms	9.71	11.52	2,477
(%)	SMEs	8.57	13.35	18,752
	All	8.71	13.15	21,229

Notes: 1) 'Investment' denotes cash outflows due to the purchase of tangible, intangible and leased assets to the total assets ratio, 'Cash' is cash and cash equivalents over total assets during fiscal year 2004, 'Capital productivity' is the ratio of sales to tangible and intangible assets, and 'Cash flow' denotes operating income before depreciation and amortization over total assets. 2) The classifications of small and medium enterprises (SMEs) and large firms are based on KIS data.

The average cash position of large firms is 12.75% of total assets, while that of SMEs was found to be 11.37%. Capital productivity, which is measured in terms of sales over tangible and intangible assets, is also shown to be greater in large firms. The average capital productivity of large firms is 9.33%, while that of SMEs is 8.09%. The average yearly cash flows are 9.71% and 8.53% (of total assets) for large firms and SMEs, respectively.

B. *Methodology*

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[14]Cash reserve is defined as cash and cash equivalents in balance sheet.

[15]Due to the exclusion of firm-year observations, our panel is unbalanced.

[16]Due to the reported lag of financial statements, we only observe a small number of firms for fiscal year 2012; therefore, we did not use the observations made in 2012.

[17]This arises because the raw distribution of our main variables is too skewed towards zero to find reasonable cut-off values for handling outliers. Though we arbitrarily exclude observations which have values which are very close or equal to zero, this clearly contributes to reducing unnecessary miscalculations from handling and comparing extremely small values.

Mainly, we follow the empirical strategy in Duchin *et al*. (2010). One of the key identifying assumptions in their approach is that the significantly positive relationship between the corporate investment decline and pre-crisis cash reserves will reflect the negative supply-side effect during the crisis period. Before digging further into the details, we introduce the main features of their method here. The specifications of Duchin *et al*. (2010) are designed to test whether the decline in the credit supply during the financial crisis had a negative effect on corporate investments. Intuitively, the method is similar to the difference in differences method, in which mainly the treatment effect of pre-crisis cash reserves is examined. If the negative supply-side effect actually matters, the larger a firm's cash holdings are, the smaller the constraint to investment would be, as cash holdings prior to a crisis can serve as an alternative funding source for investments. Hence, the regression model of investments by firms will exhibit a significantly positive coefficient of the interaction term between the crisis dummy and pre-crisis cash reserves, as far as the null hypothesis of the supply-side effect is evident.

Meanwhile, it appears to be necessary to include variables which reflect investment demand by firms, as corporate investment expenditures can also be affected individual firms' investment opportunities. After including variables regarding the investment opportunities of each firm, we can decompose how much of the investment decline is affected by financial and fundamental factors while also check the robustness of the results with regard to the specification for investment demand. The significantly positive relationship between investment and cash reserves will only be observed in firms which experienced a negative external funding shock due to the decline in the credit supply or a loss of their net worth during the crisis period. Also, if corporate investment declines are mainly driven by demand-side effects, then the significantly positive relationship will disappear after including variables pertaining to investment opportunities. The baseline model of Duchin *et al*. (2010) can be described as follows:

(1) $$y_{i,t} = c + \alpha D_t + \beta D_t Cash_{i,\tau} + \gamma' X_{i,t} + v_i + \varepsilon_{i,t},$$

Here, the subscripts i, t and τ are the firm, the year, and a fixed pre-crisis year, $y_{i,t}$ denotes investment expenditure over total assets, D_t is a crisis dummy, $Cash_{i,\tau}$ denotes pre-crisis cash reserves over total assets, $X_{i,t}$ represents variables which reflect investment opportunities, and v_i indicates unobservable firm-specific fixed effects.

Though the methodology is simple and straightforward, the use of pre-crisis cash reserves in identifying supply-side effects requires much caution due to endogeneity and identification problem. Following Duchin *et al*. (2010), we provide a rationale for our selection of this instrument by comparing the estimation results. We also conduct various robustness checks of our baseline results. Specifically, the empirical strategy used here is as described below.

First, in order to address the possible endogeneity issue, we include lagged cash reserves of individual firms in our baseline specification. Our baseline specification can be expressed as follows:

(2) $y_{i,t} = c + \alpha D_t + \beta_0 D_t Cash_{i,\tau} + \sum_{k=1}^{K} \beta_k Cash_{i,t-k} + \gamma' X_{i,t} + v_i + \varepsilon_{i,t}.$

Lagged cash balances of firms are known to be related to their investment activities; therefore, this may impose the endogeneity problem (a non-zero correlation between cash reserves and unexplained investment demands) on pre-crisis cash should it be missing. For example, firms which expect greater investment opportunities in the future may retain more profits to increase corporate savings. In such a case, the investment at time t will be correlated with cash reserves at t-1; moreover, the coefficient estimate of the interaction term between pre-crisis cash and the crisis dummy will be biased due to the endogeneity problem. In order to address the issue, we add lagged cash as an additional variable reflecting investment demand.[18] Pre-crisis cash reserves represent valuable information regarding a firm's financial buffer prior to the crisis, though it is not greatly correlated with unexplained investment opportunities, i.e., after controlling for the lagged cash variables. Therefore, this will contribute to reducing the upward bias from the endogeneity problem. In order to show that our specification is in fact distant from the endogeneity issue, we compare the estimation results with a different order of lagged cash reserves. If the endogeneity problem is still evident in our specification, the results with a higher order of lagged cash will be much different.

Second, in order to deal with the possible spurious correlation between pre-crisis cash and investment decline, we run the same analysis with samples from a financially stable period. If a significantly positive coefficient of the interaction term is observed from the financially stable period, the interpretation of the significantly positive relationship between pre-crisis cash and post-crisis investment given the existence of the negative supply-side effect will be misleading.

Third, we examine whether firms which are financially more constrained experience higher investment declines, as expected from the negative supply-side effects. If the negative shock to the credit supply in fact matters during the crisis period, we would then find a greater influence (or greater sensitivity) of cash for financially constrained firms on investment. In order to do this, we mainly categorize small and medium enterprises (SMEs) as financially more constrained firms. Alternatively, we also use leverage, short-term debt, and stock market listing as alternative method of identifying firm's financial constraint.

Finally, we add recent firm-year observations to investigate whether the negative shock to external finance has any long-term effect on investment activity. Because our baseline model uses only two years (one pre- and one post-crisis observation for each firm) of observations, it is difficult to determine from our original sample whether the weak investment recovery thus far is related to supply-side effects. If the impact of the negative supply-side shock during the 2008 crisis still persists, then the estimated coefficient of interaction term between pre-crisis cash and time dummy for the recent years will also be significantly positive. On the other hand, if the negative effect is only short-lived, then the estimated coefficient of the

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[18]Duchin *et al.* (2010) did not include lagged cash in their specifications. However, they use cash reserves one year (or four quarters) prior to the crisis to address the endogeneity issue. In this case, the omission of lagged cash up to an order of three would produce downward bias, as their pre-crisis cash reserves show lags in four periods.

interaction term would be insignificant or negative.

C. *Results*

1. *Corporate investment and pre-crisis cash reserve*

Table 5 presents the estimates of our baseline specification for cash reserves and corporate investment. We select the order of lagged cash reserves (or K in Equation (2)) as two years based on the information criteria[19] and use cash reserves one year[20] before the crisis (or 2007 cash) as pre-crisis cash. We also use capital productivity and cash flow as proxies for investment opportunities.

The results in Table 5 show that yearly investment expenditures decreased significantly after the global financial crisis. The coefficient estimate in the regression of corporate investment on the crisis dummy (see column (1)) shows a significantly negative value, and it remains close to this significantly negative value even if controlling for investment opportunities (see columns (2) to (6)).

TABLE 5—BASELINE RESULTS

	(1)	(2)	(3)	(4)	(5)	(6)
After	-1.760***	-2.993***	-1.847***	-1.286***	-1.251***	-1.304***
	(0.110)	(0.151)	(0.153)	(0.161)	(0.159)	(0.158)
After x Cash		0.107***	0.0590***	0.0375***	0.0386***	0.0372***
		(0.00771)	(0.00855)	(0.00914)	(0.00905)	(0.00898)
Cash (t-1)			0.144***	0.165***	0.161***	0.156***
			(0.0156)	(0.0174)	(0.0173)	(0.0170)
Cash (t-2)				0.0318**	0.0368**	0.0316**
				(0.0162)	(0.0161)	(0.0160)
Capital productivity					0.235***	0.253***
					(0.0243)	(0.0245)
Cash flow						-0.0729***
						(0.0121)
Constant	9.670***	9.484***	7.078***	5.784***	4.128***	4.814***
	(0.0550)	(0.0489)	(0.193)	(0.323)	(0.368)	(0.377)
N. Obs.	21,229	19,274	16,852	13,529	13,529	13,529
R-squared	0.029	0.046	0.051	0.047	0.074	0.083
N. Firms	12,614	10,659	9,897	7,796	7,796	7,796

Notes: 1) 'After' is a dummy variable which is one for fiscal year 2008 and zero otherwise, 'Cash' is cash and cash equivalents over total assets during fiscal year 2004, 'Capital productivity' is the ratio of sales to tangible and intangible assets, and 'Cash flow' denotes operating income before depreciation and amortization over total assets. 2) The numbers in parenthesis are the Huber-White standard errors clustered at the firm level. 3) ***, **, or * indicate that the coefficient estimate is significant at 1%, 5%, or 10% level, respectively.

This implies that the investment decline after the crisis is significant even after we control for demand-side effects, such as the decline in investment opportunities. The results in column (6) show that the yearly corporate investment expenditure of

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[19]The Akaike and Bayesian information criteria were calculated from the baseline specifications to obtain the optimal lag length. We also run an alternative specification without the crisis dummy or pre-crisis cash for a stable period (from 2004 to 2007) and find that the BIC will give the same lag length.

[20]The selection of pre-crisis cash does not change the estimation results when $\tau \geq$ crisis year $- K - 1$ due to the two-stage least-squares argument; the residuals from the regression of $D_t Cash_{i,\tau}$ of the lagged cash are unchanged.

assets on average for firms declined[21] by 1.30%p following the global crisis period. This decline is 14.0% relative to the pre-crisis unconditional mean level of yearly investment expenditures of 9.28% (see Table 1).

More importantly, we find evidence that the negative supply-side effect is significant on post-crisis investments. The coefficient of the interaction term between the crisis dummy and cash reserves is estimated to be significantly positive with regard to the regression of corporate investments on the crisis dummy and the interaction term (column (2)); it also retains a significantly positive value even after we control for investment opportunities (columns (5) and (6)). This result coincides with our prediction that the investment decline will be positively correlated with pre-crisis cash if the negative credit supply shock matters during the crisis period. For example, as the supply of credit was reduced significantly following the onset of the crisis, firms with large amounts of cash could cope with the negative credit supply shock using their internal funds, resulting in less of an investment decline (or a positive relationship between pre-crisis cash and post-crisis investment). The empirical results show that the positive relationship between pre-crisis cash and investment remained even after controlling for investment demand, offering evidence that a significant portion of the investment decline was caused by the negative credit supply shock. From the result in column (6), a zero-cash firm suffered an investment decline of 1.30%p following the crisis, while for a mean-level (11.55%, see Table 4) cash firm, this value was 0.87%p; firms one standard deviation (12.77%) higher than the mean level cash firms saw an investment decline of only 0.39%p. A one-standard deviation increase in the cash balance softens the investment decline by 36.9% compared to the case of a zero-cash firm. Furthermore, cash reserves of 34.95% relative to total assets helped to eliminate the investment decline after the crisis, meaning that those who had the required cash balance to cancel out the investment decline perfectly was less than 5% of all firms.

2. *Higher order lagged cash and financially stable periods*

In order to investigate the endogeneity issue, we also additionally provide the estimation results from the specification with lagged cash up to order four (K=4). If the endogeneity problem resides in our baseline specification, a change in of unexplained investment opportunities will show a strong have large correlation with the pre-crisis cash variable. In this case, not only will the estimate be is very different from our earlier results, but it will also it will vary in its magnitude and sign depending upon the lag length.

The first four columns in Table 6 present the estimation results from the specification with a higher order of lagged cash reserves. First, it is important to note that the estimated coefficients of capital productivity and cash flow are very stable with regard to the choice of the lag length, implying that they are free from

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[21]Since we measure the corporate investment as the investment expenditure to total assets, the investment expenditure may increase in its level after the crisis which can be observed in non-financial firms' fixed asset formation from national accounts.

TABLE 6—HIGHER ORDER LAGGED CASH AND CASH RESERVES THREE AND FIVE YEARS PRIOR

	Higher order lagged cash				τ=2005	τ=2003
After	-1.832***	-1.304***	-1.209***	-1.173***	-1.304***	-1.154***
	(0.150)	(0.158)	(0.170)	(0.182)	(0.158)	(0.141)
After x Cash	0.0587***	0.0372***	0.0386***	0.0397***	0.0372***	0.0341***
	(0.00842)	(0.00898)	(0.00969)	(0.0106)	(0.00898)	(0.00894)
Cash (t-1)	0.134***	0.156***	0.154***	0.153***	0.193***	0.182***
	(0.0153)	(0.0170)	(0.0191)	(0.0222)	(0.0161)	(0.0158)
Cash (t-2)		0.0316**	0.0235	0.0150	0.0689***	0.0516***
		(0.0160)	(0.0181)	(0.0210)	(0.0161)	(0.0154)
Cash (t-3)			0.00808	0.00457		
			(0.0159)	(0.0193)		
Cash (t-4)				-0.0188		
				(0.0167)		
Capital productivity	0.264***	0.253***	0.231***	0.228***	0.253***	0.250***
	(0.0217)	(0.0245)	(0.0300)	(0.0340)	(0.0245)	(0.0244)
Cash flow	-0.0769***	-0.0729***	-0.0590***	-0.0597***	-0.0729***	-0.0728***
	(0.0111)	(0.0121)	(0.0133)	(0.0141)	(0.0121)	(0.0120)
Constant	5.970***	4.814***	4.590***	4.790***	3.931***	4.285***
	(0.255)	(0.377)	(0.527)	(0.722)	(0.360)	(0.350)
N. Obs.	16,852	13,529	11,186	9,502	13,529	13,529
R-squared	0.089	0.083	0.073	0.070	0.083	0.082
N. Firms	9,897	7,796	6,344	5,310	7,796	7,796

Notes: 1) 'After' is a dummy variable which is one for the fiscal year 2008 and zero otherwise, 'Cash' is cash and cash equivalents over total assets for fiscal years 2003 (5-yr), 2004 (4-yr), 2005 (3-yr), 2006 (2-yr), and 2007 (1-yr), 'Capital productivity' is the ratio of sales to tangible and intangible assets, 'Cash flow' denotes operating income before depreciation and amortization over total assets, and 'Cash (t-1)' is one-period lagged cash and cash equivalents over total assets. 2) The numbers in parenthesis are the Huber-White standard errors clustered at the firm level. 3) ***, **, or * indicate that the coefficient estimate is significant at 1%, 5%, or 10% level, respectively. 4) The classifications of small and medium enterprises (SMEs) and large firms are based on KIS data.

the endogeneity issue. The estimates for the interaction term are approximately 0.04 with lagged cash reserves of two years or more, and these values are all statistically significant. Specifically, they are not very different from the estimates with one and two years of lagged cash, as shown in Table 4-3, indicating that our baseline specification is not likely to be affected by the endogeneity problem caused by omitting the lagged cash variable. We also report the results from pre-crisis cash reserves measured during fiscal years 2005 and 2003. On the same token, the estimation results will be very different if our proxy for pre-crisis cash is contaminated by the endogeneity problem. However, we note that the estimates of both the crisis dummy and the interaction term are very stable. This implies that the inclusion of lagged cash effectively removes any possible endogenous changes in cash reserves from pre-crisis cash.

With regard to the identification problem, one may be concerned about whether the significant relationship between pre-crisis cash and investment decline is spurious or driven by a demand-side effect. If the significantly positive relationship between pre-crisis cash reserves and post-crisis investments is a general feature of the data, it would be misleading to interpret our results as evidence of the existence of a negative supply-side effect. However, if the significantly positive relationship is only observed in the sample during a financially turbulent period, not in a financially stable period, we may argue that the findings in the previous analysis imply the existence of an investment constraint due to the credit supply shock.

In order to answer this question, we examine the coefficient estimate of the interaction term between cash reserves and the crisis dummy for 2000, for 2006

with placebo crises (stable periods), and during the 1998 currency crisis (a turbulent period). During stable periods, financial markets performed well; hence, investment expenditures by firms are less likely to be affected by the credit supply, resulting in a small or insignificant coefficient estimate of the interaction term. However, during the 1998 currency crisis, domestic banks underwent massive restructuring, and post-crisis investments by firms were more than likely constrained by the credit shortage. In that case, firms were forced to fund their investment via internal funds, implying that the coefficient estimate of the interaction term is significantly positive. We also provide estimation results for SMEs and for all firms because SMEs are considered to be more financially constrained. Thus, their reliance on internal funding will be more prevalent during this crisis period.

Table 7 presents the estimation results for the financially stable and turbulent periods. First, we confirm that pre-crisis cash reserves did not affect investment expenditures during financially stable[22] periods. The interaction terms between pre-crisis cash and the time dummy are estimated to be 0.017 and 0.010 for 2000 and the 2006 placebo crisis, respectively, and they are both statistically insignificant. Although the estimates for the financially stable periods are in line with our expectations, but it is noteworthy that the estimates are small but positive, which implies that our findings are not as strong as those of Duchin *et al.* (2010).[23]

TABLE 7—FINANCIALLY STABLE VS. TURBULENT PERIOD

	Crisis = Year 2000		Crisis = Year 2006		Crisis = Year 1998	
	All	SMEs	All	SMEs	All	SMEs
After	0.379*	0.408	-0.541***	-0.553***	-2.474***	-2.285***
	(0.221)	(0.272)	(0.178)	(0.204)	(0.224)	(0.276)
After x Cash	0.0171	-0.00276	0.0104	0.00232	0.0404**	0.0438**
	(0.0170)	(0.0188)	(0.0108)	(0.0120)	(0.0162)	(0.0183)
Cash (t-1)	0.0759**	0.124***	0.158***	0.174***	0.118***	0.113***
	(0.0305)	(0.0326)	(0.0199)	(0.0223)	(0.0244)	(0.0291)
Cash (t-2)	0.0479**	0.0696***	0.0614***	0.0583***	0.0321	-0.0140
	(0.0232)	(0.0252)	(0.0182)	(0.0201)	(0.0251)	(0.0287)
Capital productivity	0.223***	0.266***	0.285***	0.311***	0.145***	0.161***
	(0.0436)	(0.0522)	(0.0293)	(0.0349)	(0.0338)	(0.0447)
Cash flow	-0.0240	-0.0348	-0.0667***	-0.0660***	-0.0384***	-0.0298
	(0.0236)	(0.0258)	(0.0141)	(0.0147)	(0.0148)	(0.0199)
Constant	4.367***	3.802***	4.489***	4.552***	4.943***	5.065***
	(0.554)	(0.635)	(0.410)	(0.457)	(0.472)	(0.588)
N. Obs.	6,058	4,406	11,997	10,021	5,900	4,249
R-squared	0.046	0.057	0.066	0.069	0.120	0.104
N. Firms	3,298	2,428	6,785	5,746	3,374	2,489

Notes: 1) 'After' is a dummy variable which is one for the fiscal year 2008 and zero otherwise, 'Cash' is cash and cash equivalents over total assets during fiscal year 2004, 'Capital productivity' is the ratio of sales to tangible and intangible assets, and 'Cash flow' denotes operating income before depreciation and amortization over total assets. 2) The numbers in parenthesis are the Huber-White standard errors clustered at the firm level. 3) ***, **, or * indicate that the coefficient estimate is significant at 1%, 5%, or 10% level, respectively. 4) The classifications of small and medium enterprises (SMEs) and large firms are based on KIS data.

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[22]Though the choice of financially stable periods (2000 and the 2006 placebo crises) is arbitrary, we find qualitatively similar results with alternative selections of placebo crises, except for the 1998 and 2008 crises.

[23]Duchin *et al.* (2010) find the estimates of the interaction term during placebo crises to be negative in general; therefore, the significantly positive estimates of the interaction term can be interpreted as strong evidence of a supply-side effect.

With regard to the results for the 1998 currency crisis, we find that the estimated coefficients of the interaction terms for both all firms and SMEs are significantly positive, indicating that they experienced a shortage of credit supply following the currency crisis. All in all, the results from financially stable and turbulent periods suggest that our baseline specification can be used to identify negative supply-side effects.

3. *Financial constraint and the supply-side effect*

Financially constrained firms may suffer more from a negative shock to the credit supply during a global financial crisis period. Essentially, a financial constraint, which usually arises from information asymmetry, is known to amplify the negative impact on constrained firms, e.g., a greater decline in investment expenditures following the crisis in our case. Though there are several ways to identify financially more constrained firms,[24] we use the classification as a small and medium enterprise (SME) for identifying financially more constrained firms. Together with the SME classification, we divide our sample into financially more and financially less constrained firms using alternative measures of financial constraint, in this case industry (three-digit) sales growth and ownership, and perform a similar analysis to test the robustness of our results.

The first two columns in Table 8 show the estimation results of our baseline specification for large firms and SMEs. The coefficient estimate of the crisis

TABLE 8—FINANCIAL CONSTRAINTS AND POST-CRISIS INVESTMENT: ALTERNATIVE CLASSIFICATION

	SME Category		Industry Sales Growth		Ownership	
	No	Yes	High	Low	Public	Private
After	-0.997***	-1.366***	-1.353***	-1.351***	-0.797***	-1.313***
	(0.264)	(0.183)	(0.315)	(0.297)	(0.295)	(0.188)
After x Cash	0.0264*	0.0415***	0.0243	0.0569***	0.0262*	0.0326***
	(0.0140)	(0.0107)	(0.0177)	(0.0185)	(0.0154)	(0.0115)
Cash (t-1)	0.0650***	0.170***	0.188***	0.136***	0.109***	0.167***
	(0.0252)	(0.0197)	(0.0384)	(0.0321)	(0.0330)	(0.0217)
Cash (t-2)	0.0435	0.0330*	0.0397	0.00998	0.0161	0.0493**
	(0.0271)	(0.0186)	(0.0313)	(0.0290)	(0.0310)	(0.0199)
Capital productivity	0.148***	0.292***	0.314***	0.267***	0.156***	0.300***
	(0.0351)	(0.0301)	(0.0500)	(0.0535)	(0.0529)	(0.0280)
Cash flow	-0.0664**	-0.0751***	-0.0850***	-0.0999***	-0.0522**	-0.0646***
	(0.0269)	(0.0127)	(0.0271)	(0.0252)	(0.0220)	(0.0152)
Constant	4.474***	4.763***	3.877***	5.702***	4.252***	4.539***
	(0.649)	(0.437)	(0.738)	(0.721)	(0.890)	(0.442)
N. Obs.	2,065	11,464	2,858	3,452	2,311	10,166
R-squared	0.068	0.089	0.103	0.079	0.052	0.088
N. Firms	1,130	6,723	1,429	1,726	1,274	6,039

Note: 1) 'Leverage' is liabilities over the capital ratio, 'Short-term Debt' is current liabilities over the total liabilities ratio, 'Stock listing' refers to KOSPI-listed or KOSDAQ-listed (or registered) firms, and 'Div. Payment' denotes firms with non-zero dividend payments. 2) 'After' is a dummy variable which is one for the fiscal year 2008 and zero otherwise, 'Cash' is cash and cash equivalents over total assets during fiscal year 2004, 'Capital productivity' is the ratio of sales to tangible and intangible assets, and 'Cash flow' denotes operating income before depreciation and amortization over total assets. 3) The numbers in parenthesis are the Huber-White standard errors clustered at the firm level. 4) ***, **, or * indicate that the coefficient estimate is significant at 1%, 5%, or 10% level, respectively.

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[24]For more details, refer to Kaplan and Zingles (1997) and Whited and Wu (2006), among others.

dummy is significantly negative for both large firms and SMEs. However, the post-crisis investment decline is greater for SMEs. For instance, the coefficient estimate of the crisis dummy for large firms is -0.99, while the estimate for SMEs is -1.36. The coefficient estimates of the interaction term between cash and the crisis dummy are positive for both large firms and SMEs. However, we find that the estimate for large firms is less significant (with 10% level)[25] while the estimate for SMEs is much higher and significant at the 1% level. These results provide evidence that SMEs, which are more financially constrained due to information asymmetry, can experience greater investment declines following the onset of a financial crisis. Moreover, the results coincide with our previous analysis (in Section 3), which showed that pre-crisis cash has more of an impact on post-crisis investment levels for SMEs. When compared to the results for all firms, shown in Table 5, we find that the estimate of the interaction term for SMEs is 0.041, which is close to the estimate for all firms (0.037), implying that the overall estimate is largely driven by the SMEs in the sample. Compared to firms with no cash, the average cash holdings for large firms can mitigate an investment decline by 0.66%p, while the average cash holdings for SMEs can alleviate the decline by 0.89%p, implying that cash is more valuable for SMEs.

Table 7 (from column (3) to column (6)) presents the estimation results for financially more and less constrained firms by dividing the sample according to industry (three-digit) sales growth and ownership. We use industry sales growth one year prior to the crisis to capture the financial constraints and divide our sample into 'high' (above the third quantile) and 'low' (below the first quantile) groups. With regard to ownership, we classify KOSPI-listed, KOSDAQ-listed or registered firms as public firms, and others as private firms.

We find that the role of cash in mitigating the investment decline is greater for financially more constrained firms. The coefficient estimate of the interaction term for firms with low industry sales growth is 0.056, which is around twice the coefficient estimate for firms in the group showing high industry sales growth (0.024). Private firms also show greater sensitivity to of investment expenditures on cash reserves than public firms. Overall, the results imply that the corporate investment decline following the 2008 crisis is largely related to the level of financial constraint of a firm, supporting the view that negative credit supply-side effects on corporate investments were evident during the crisis period.

4. *Why do corporate investments remain sluggish?*

Related to recent investment activity in corporate sector, we observe that private fixed capital formation (in current prices) remains sluggish after showing an increase due to the base effect following the fourth quarter of 2009. In order to examine the impact of external finance shocks on recent corporate investments, we

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[25]This result is robust even when (i) we include data from two and three years before and after the crisis in the sample, (ii) we include higher order lagged cash reserves as an explanatory variable, and (iii) we use Tobin's q rather than capital productivity for listed firms.

add recent firm-year observations[26] to our original sample. Next, we include an additional year dummy variable ('further after' crisis dummy) for the years from the first to the third year following the 2008 crisis, as well as an interaction term between pre-crisis cash and the 'further after' crisis dummy. If the credit crunch during the crisis has had a negative effect on corporate investments persistently, we would observe that the interaction term (between pre-crisis cash and the 'further after' crisis dummy) is significantly positive with the coefficient estimate for the 'further after' crisis dummy being significantly negative. Meanwhile, if post-crisis investments are mainly affected by investment demand, such as depressed investment opportunities, we would find that the interaction term between the 'further after' crisis dummy and pre-crisis cash reserves loses its significance.

Table 9 shows the estimation results for our extended sample with large firms and SMEs. Interestingly, the 'further after' crisis dummy for SMEs is estimated to be significantly negative. Moreover, the estimated coefficient of the interaction term is significantly positive, implying that the more pre-crisis cash a firm has, the less its investment decreased during 2009-2011 compared to 2007. For large firms, the result is less suggestive for the supply-side effect on corporate investment; while the 'further after' crisis dummy has a negative coefficient, the estimated coefficient of the interaction term is not significant.

In summary, the investment decline of SMEs after the crisis remains significant even if we include recent firm-year observations and is related to their levels of pre-crisis cash reserves. This indicates that the additionally depressed investments

TABLE 9—LONG-TERM EFFECT OF A NEGATIVE SUPPLY SHOCK AND FINANCIAL CONSTRAINTS

	Large firms			SMEs		
After	-0.876***	-0.893***	-0.898***	-1.364***	-1.368***	-1.376***
	(0.266)	(0.264)	(0.264)	(0.179)	(0.177)	(0.177)
After x Cash	0.0270*	0.0270**	0.0262**	0.0445***	0.0486***	0.0480***
	(0.0139)	(0.0134)	(0.0133)	(0.00979)	(0.00971)	(0.00968)
Further after	-1.119***	-1.109***	-1.124***	-2.479***	-2.434***	-2.452***
	(0.281)	(0.281)	(0.282)	(0.179)	(0.178)	(0.178)
Further after x Cash	0.0155	0.0152	0.0141	0.0684***	0.0699***	0.0691***
	(0.0146)	(0.0142)	(0.0142)	(0.00965)	(0.00980)	(0.00980)
Cash (t-1)	0.0737***	0.0674***	0.0676***	0.156***	0.143***	0.143***
	(0.0163)	(0.0158)	(0.0158)	(0.00933)	(0.00920)	(0.00921)
Cash (t-2)	0.0519***	0.0522***	0.0521***	0.0559***	0.0556***	0.0549***
	(0.0140)	(0.0137)	(0.0137)	(0.00825)	(0.00825)	(0.00827)
Capital productivity		0.0983***	0.102***		0.198***	0.202***
		(0.0202)	(0.0202)		(0.0151)	(0.0155)
Cash flow			-0.0245*			-0.0155
			(0.0149)			(0.0105)
Constant	5.135***	4.412***	4.640***	6.538***	5.400***	5.542***
	(0.267)	(0.329)	(0.351)	(0.169)	(0.195)	(0.215)
N. Obs.	6,287	6,287	6,287	28,746	28,746	28,746
R-squared	0.031	0.044	0.045	0.043	0.060	0.061
N. Firms	2,335	2,335	2,335	9,270	9,270	9,270

Note: 1) 'After' is a dummy variable which is one for the fiscal year 2008 and zero otherwise, 'Cash' is cash and cash equivalents over total assets during fiscal year 2004, 'Further after' is a dummy variable which is one for fiscal years 2008-2011 and zero otherwise, 'Capital productivity' is the ratio of sales to tangible and intangible

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[26]Due to the time lag of financial statement disclosure, especially for unlisted small firms, the most recent financial statements which are up to date and which are consistent with our previous sample are for fiscal year 2011.

assets, and 'Cash flow' denotes operating income before depreciation and amortization over total assets. 2) The numbers in parenthesis are the Huber-White standard errors clustered at the firm level. 4) ***, **, or * indicate that the coefficient estimate is significant at 1%, 5%, or 10% level, respectively.

of SMEs after the crisis (from 2009 to 2011) are associated with the credit supply shock during the 2008 crisis and that the funding problem may have had a long-last negative impact on the investment activities of SMEs. However, we could not find any evidence that investment declines in large firms are related to a negative shock to their external finances, especially over the long term.

V. Conclusion

We study whether the corporate investments of domestic firms, including small and medium enterprises, are affected by the negative shock to the credit supply which arose during the global financial crisis. Following Duchin *et al*. (2010), we use pre-crisis cash reserves (or internal funds) held by firms to identify any negative supply-side effect of the crisis, as cash reserves can play an important role as a financial buffer to an external funding shock. In order to address possible the endogeneity issue, we include lagged cash reserves in our baseline specifications. As a robustness check, we compare the results from the specification with higher order lagged cash reserves as well as the results from financially stable periods. From our baseline specification, we can summarize our empirical findings as follows.

First, corporate investments (to the total asset ratio) significantly decreased following the onset of the global financial crisis, and the decline is found to be significant after controlling for investment demand. More importantly, we find that the investment decline is negatively related to pre-crisis cash reserves; the more cash a firm holds (or the greater the financial buffer), the less its post-crisis investment decline becomes in the data. The result implies that corporate investments are significantly affected by a negative shock to the external financing of a firm.

Second, large firms experienced less of an investment decline following the crisis compared to small and medium enterprises (SMEs). Because SMEs are more exposed to financial constraints, commonly driven by the problem of information asymmetry, a negative shock to the credit supply will have more of an impact on SMEs' investments than it will on those of large firms. Our results indicate that there exists a strong relationship between pre-crisis cash held by SMEs and their post-crisis investments, implying that the negative supply-side effect is mostly driven by the SMEs in the sample. When using alternative measures of financial constraints, such as industry sales growth and ownership, we find that the results are qualitatively identical; our empirical evidence is supportive of the existence of a negative supply-side effect.

Third, we find evidence that the recent investment depression from 2009 to 2011, mainly experienced by SMEs, is related to the negative shock to external funds during the crisis period.

Our empirical findings support the view that the post-crisis investment decline is

driven by the negative credit supply shock during the crisis, especially affecting more financially constrained firms such as SMEs. However, it is necessary to investigate why the negative supply-side effect on investments still matters to SMEs, even four years after the crisis ended. Possible explanations would be a change in the financing behavior of SMEs (e.g., towards more conservative capital management) or an aggravated information asymmetry problem, leading to higher financial constraints, among others. We leave the question to future studies.

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