Credit Market Disruption and Corporate Innovation: An Empirical Analysis

By
Vu Diem Hang Pham

A Major Research Report Submitted to
Saint Mary's University, Halifax, Nova Scotia
in Partial Fulfillment of the Requirements for
the Degree of Master of Business Administration

August, 2014, Halifax, Nova Scotia

Approved: Dr. Mohammad M. Rahaman
Supervisor

Approved: Dr. Margaret C. McKee
Examiner

Date: August 28, 2014

Credit Market Disruption and Corporate Innovation: An Empirical Analysis

By
Vu Diem Hang Pham

A Major Research Report Submitted to
Saint Mary's University, Halifax, Nova Scotia
in Partial Fulfillment of the Requirements for
the Degree of Master of Business Administration

August, 2014, Halifax, Nova Scotia

Approved: _____
Dr. Mohammad M. Rahaman
Supervisor

Approved: _____
Dr. Margaret C. McKee
Examiner

Date: August 28, 2014

Acknowledgement

There are many people to whom I am grateful for their assistance in the completion of this Master Research Project. I would like to thank Dr. Mohammad Rahaman, my supervisor, for the freedom given in developing the topic, the access to the database, and for the guidance provided during the conduct of this research. My gratitude also extends to all professors in the MBA program at the Sobey School of Business, especially the professors in the Department of Finance, Information Systems, and Management Science. The support they provided was invaluable. I also appreciate the kind support of Ms. Maureen Woodhouse, Ms. Yi Xie and Ms. Emily Anderson from the International Activities Office for providing me with the access to the latest statistical software version and other research materials. Finally, to my families and friends who have provided endless support and encouragement throughout the year- undoubtedly, you have all contributed to the completion of this research.

Credit Market Disruption and Corporate Innovation: An Empirical Analysis

By
Vu Diem Hang Pham

Abstract:

This paper investigates the effects of systemic banking crises on the quantity (amount of investment) and quality (efficiency of investment) of innovation in the corporate landscape. Using the 2007-2008 financial crises as a setting for heightened credit-market friction, we find that firms reduce investment in innovation activities during periods of elevated credit-market friction. However, the decline in innovation spending is disproportionately less for high-tech firms compared to low-tech firms. We show that this is due to the R&D expenditure smoothing by technologically-intensive firms. Despite the across-the-board reduction in innovation spending, we find that indeed innovation quality improves during periods of credit-market disruption. Our results show that a tighter financial constraint induced by credit contraction significantly enhances the efficiency of innovation, particularly for technologically-intensive firms. These results suggest that credit-market conditions are important determinants in understanding the extensive (quantity) and intensive (efficiency) margins of innovation in the business sector.

August 28, 2014

1. Introduction

Corporate innovation is a central issue in firm dynamics. The extent of innovation activities by firms significantly determines their productivity growth, competitive strength and ultimately their survival (Schumpeter, 1939). Despite this conventional wisdom, economists debate sharply about the best possible ways of financing innovation activities in the business sector. On the one hand, some researchers argue that, given the uncertainty, information asymmetry, and the ensuing agency problems associated with corporate innovations, such activities are best-financed using internal resources because the cost of external financing is unduly high for innovative firms. On the other hand, some researchers argue that external debt financing can mitigate agency problems associated with innovation activities and, given the specialness of some financial institutions such as banks in terms of information production about firm activities via relationship lending, debt financing could be an equally important source of innovation financing. In this paper, we investigate whether and to what extent external debt financing affects the extensive (quantity of innovation spending) and intensive (efficiency of innovation activities) margins of innovation in the business sector.

The key innovation in our paper is the use of an exogenous disruption in the credit market to identify how the changes in credit-market conditions affect firm-level innovation activities. To this end, we use the 2007-2008 financial crises as our setting for heightened credit-market disruption and find that indeed firms reduce investment in innovation activities during periods of elevated credit-market friction, but the decline is

disproportionately less for high-tech firms compared to low-tech firms. We find evidence of innovation-expenditure smoothing by technologically intensive firms. Furthermore, we show that a tighter financial constraint induced by credit contraction significantly enhances the efficiency of innovation, particularly for technologically intensive firms.

The natural question that arises is: Do credit market conditions matter for corporate innovation? There are two diametrically opposed views on this question in the literature. Some researchers argue that credit market conditions matter little for corporate innovation. Hall (1992) argues that innovation activities are different from other types of investment due to uncertainty, moral hazard, and agency problems associated with innovation and that these special features of innovation activities make them less reliant on credit market. Garnsey (1995) argues that R&D and other intangible activities are considered riskier, and thus, firms with intensive R&D face a higher cost of capital owing to the problem of undervaluation of collaterals that are primarily intangible assets, leading to a reduction in the amount of capital debt raised. Hall and Lerner (2009) argue that R&D investing is also subject to asymmetric information and moral hazard problems, as a result, high-tech firms tend to prefer internal financing sources over external sources to finance for their R&D projects. The rationale behind this tendency is that external investors often require higher return on uncertainty and informationally opaque projects (Baark, Antonio, Lau, Lo & Sharifl, 2011; Paananen, 2012; Mina, Lahr & Hughes, 2013). The aforementioned studies cast doubt on the important of external debt market in financing innovation activities in the business sector.

There is also a well-developed literature suggesting that credit market conditions significantly affect real activities by firms, including innovation activities. Holmstrom and Tirole (1997) argue that negative shocks to credit market lead to liquidity squeeze among financial intermediaries significantly raising the external financing premia of firms, thereby reducing real activities in the industrial sector. Kashyap and Stein (1997, 2000) and Bernanke and Gerler (1995) also find similar results that the effects of credit shocks on firms' investment are transmitted and amplified through the liquidity squeeze in the market for intermediated external capital. Aivazian, Rahaman and Sun (2014) build on Holmstrom and Tirole (1997) and show the importance of external financial dependence on the level of investment by firms during systemic banking crises. Fruest (1992) and Khwaja and Mian (2008) also study the real consequences of credit market shocks and highlight that these impacts are unevenly distributed among firms, depending on their sizes and the level of dependence on external financing sources.

In sum, existing studies identify negative impacts of credit market shock on firm-level investment in general, but evidence on the effects on innovation-related investment remains modest. The unique nature of innovation activities raises a question of whether the effects of financial shocks vary across different types of investments (innovation-related versus other types) as well as across different types of firms (high-tech versus low-tech). Corporate innovation during extreme financial conditions such as systemic

banking crises, therefore, is a relevant issue and deserves to be a stand-alone research topic.

To this end, we use the 2007-2008 financial crises as exogenous shocks to credit markets to identify the effects of credit market conditions on corporate innovation. By comparing the differences in innovation-related activities such as R&D expenditure during the crisis and non-crisis periods, we find that credit squeeze can lead to a decline in R&D investment. It is true for both high-tech and low-tech firms. Next, we create two sub-samples, one includes high-tech firms and the other contains low-tech firms, and compare the changes in R&D expenditure of both groups during the crisis and non-crisis periods. The empirical results show that high-tech firms reduce their R&D spending disproportionately less compared to low-tech firms. This suggests that technologically-intensive firm smooth their R&D expenditure over time as suggested by Hall (1992, 2001, and 2009).

We also address the issue of innovative efficiency of firms during financial crisis instead of merely focusing on the level of investment in innovation. After constructing multiple measures of innovative efficiency based on the ratio of innovation output over input, we compare the changes in innovation efficiency between the crisis and the non-crisis periods as well as between high-tech and low-tech firms. In contrast to conventional wisdom, we find that innovative efficiency is actually improved when firms face capital constraints. These results are consistent with the conclusions of Almeida, Hsu, and Li (2013).

Further, we also investigate the feedback effects between credit market conditions and firm-level financial constraint and how their interaction affects firm-level innovation activities. A few studies on corporate innovation show that financial constraint entails negative consequences for innovation by reducing a firm's R&D expenditure, thereby lowering the firm's future growth and probability (Aghion, Angeletos, Banerjee & Manova, 2010; Li, 2011; Brown, Martinsson & Petersen, 2012). Substantial empirical evidence, however, suggests that abundance of finance resources, i.e., financial slack, does not always lead to more or better innovation (Jensen, 1993; Jaffe, 2000; and Munos, 2009). Furthermore, financial constraint induced agency problems associated with innovation activities, on the one hand, can enhance innovation efficiency (Kumar & Langberg, 2009; Hall & Lerner, 2010) and, on the other hand, can dampen innovation output productivity (Aboody & Lev, 2000). Therefore, whether and to what extent credit market conditions affect innovation activities in the presence of financial constraint remains an open question. We find that financially constrained firms reduce innovation investment during credit contraction, but a tighter financial constraint also makes innovation-related activities more efficient, particularly for high-tech firms.

Finally, we test the superiority of high-tech firms over low-tech firms in surviving a banking crisis by comparing their performance (sales and profitability) between the crisis and non-crisis periods. We find that technologically-intensive firms are better able to

withstand the detrimental impact of the crisis compared to low-tech firms. Our results are robust with respect to alternative measures of outcome and independent variables and to out of sample tests.

Our paper adds to the existing literature on the effects of credit market conditions on firm-level innovation activities. While existing studies focus on the level of investment in general, we focus on a specific type of investment, i.e., innovation, to show that indeed credit market conditions have significant bearings on corporate innovation. Our paper fills a gap in the literature by providing empirical evidence on the difference between high-tech and low-tech firms in terms of how they finance innovation and ultimately perform during financial crises in the presence of severe financial constraints.

The rest of the paper continues as follows. Section 2 presents our five hypotheses and the theoretical background underpinning these hypotheses. Section 3 describes the sources of data and defines the variables used in our empirical models. Section 4 discusses the empirical results and the implications in relation to our study. Section 5 concludes the paper.

2. Theoretical Background and Empirical Hypotheses

Why and how does credit market disruption affect innovation activities in the business sector? The effects of credit market friction on firm-level activities have been studied extensively in the literature. Over time a consensus has emerged that the impacts of financial shocks on firm-level activities are transmitted either through a bank-lending channel (bank-balance sheet channel) or via a financial accelerator channel (borrower balance sheet channel). Holmstrom and Tirole (1997) argue that negative shocks to the economy, typical during periods of heightened credit market friction, create capital constraint conditions for financial intermediaries impairing their balance sheets and engendering liquidity shortage (Bernanke & Gertler, 1995). As a result, financial intermediaries tighten lending policies, thereby inducing a reduction in real activities by firms relying on intermediary financing (Fruest, 1992; Rajan & Zingales, 1998; Khwaja & Mian, 2008; Aivazia et al., 2014). This mechanism of credit-market friction induced firm activities is known as the bank-lending channel or bank balance sheet channel. By contrast, the financial accelerator channel (Bernanke, Gertler, and Gilchrist, 1996) notes that a firm's ability to borrow depends on the market value of its collateralized assets. During financial shocks firms' balance sheet deteriorate depressing the value of their collateralized assets. Such a decline in asset value in turn increases asymmetric information between lenders and borrowers resulting in a decline in loan supply from the financial to the real sector. This in turn leads to a decline in firm activities in the business sector.

Although there is ample evidence in the literature showing that overall firm-level investment decreases during credit contraction via either of the foregoing channels, there is little evidence in the literature about how a tightening of credit conditions affects innovative investment by firms during financial crises. Economists debate sharply about how credit market conditions should affect innovation activities in the business sector. On the one hand, following the logic of the bank balance sheet channel, an argument can be made that investment in innovation activities requires a large amount of capital which is unlikely to be financed by the external capital markets during periods of financial shocks. Thus, if a firm relies on the external capital market for financing its innovation activities, it is more likely to reduce such activities when the external capital market is in turmoil.

By contrast, some researchers argue that innovation activities are unique in the sense that such activities involve a high level of uncertainty and agency problems and are less likely to be financed by the external capital market. This strand of the literature suggests that the financing of innovation follows a pecking order, in which internal financing is the most favoured source, followed by equity and the least favoured form is debt (Hall, 1992; Hogan & Hutson, 2004; Margi, 2007). By this logic, credit contraction is less likely to have any impact on innovation activities in the business sector. There are, however, several studies showing that benefits of going to the debt market to finance for innovation are quite substantial for some firms. For instance, Czarnitzki and Kraft (2009) show that by increasing leverage high-tech firms can lessen the negative impact of the agency problems. Francis, Hasan, Huang, and Sharma (2012) find that firms with high

innovation capability and productivity enjoy more favourable loan spreads and loan terms. On balance, studies showing that internal financing as the most favoured financing source for innovation compared to debt financing are more prevalent and abundant in the literature. In sum, since innovation activities are less likely to be financed by debt, in other words, less reliant on intermediated capital, they are less prone to decline during periods of heightened credit market friction.

Finally, a key feature of innovative firms is that they are likely to smooth R&D expenditure over time. Such R&D smoothing effects can make innovation activities less prone to decline during credit crises. In a series of papers, Hall (1992, 2001, and 2009) shows that the value firms create through innovation activities is intangible and much of it is in the form of human capital and intangible knowledge. Such capital is idiosyncratic or employee-specific and can be taken away when employees leave the firms. Innovation investments, therefore, need to be smoothed in order to retain the human capital and intangible knowledge within the firms. This unique feature of innovation activity may force high-tech firm not to reduce their R&D spending too much, even though the firms may face financial constraints during crisis.

In sum, in light of the foregoing discussions, whether and to what extent firms reduce their innovation activities during credit contraction is still an open question in the literature. This leads to our first hypothesis as follows:

Hypothesis 1: Firm-level innovation activities decline during periods of heightened credit market friction.

While the above hypothesis focuses on the change in innovation activities between crisis and non-crisis periods, the extent of change may vary across firms depending on their technological intensity. As the foregoing discussion suggests, firms that are more technologically intensive tend to use internal financing first, followed by equity and debt financing. Such firms are also more likely to smooth their innovation spending over time to deter dilution of employee-specific human capital. These suggest that high-tech firms may be less susceptible to liquidity squeeze compared to low-tech firms. These observations give rise to our second hypothesis as follows:

Hypothesis 2: Credit contraction induced declines in innovation activities are disproportionately less for high-tech firms compared to low-tech firms.

In the foregoing hypotheses, we focus on the impact of credit market disruption on the input of innovation, i.e., innovation spending such as R&D. The output of innovation activities, and more importantly, innovative efficiency of firms (innovation output per unit of innovation input), are more relevant for firms' future growth, profitability, and competitive strength. Conventional wisdom suggests that financial constraint entails negative consequences to innovation by reducing firm-level R&D spending, thereby

lowering probability of successful future patent grant (Aghion et al., 2010; Li, 2011; Brown et al., 2012). Despite such wisdom, empirical evidence from studies of Jensen (1993), Jaffe (2000), and Munos (2009) suggests that substantial financial resources do not guarantee more and better innovation. Jensen (1986) develops the "free cash-flow argument" which states that firms with large free cash-flow are more likely to invest in unproductive projects because of agency problems. In other words, when firms have financial slack, managers may gain private benefits from wasteful investments, such as investing in an unnecessary high value project to show their power, or conducting high-profile projects to enhance their social image (Aboody & Lev, 2000). This issue is especially relevant for corporate innovation, which is more susceptible to agency problems due to its unique nature of uncertainty, moral hazard and information asymmetry (Hall, 1992). When firms are in tighter financial conditions, such agency problems are mitigated because given the limited financial resources at the disposal of managers, they have to be more careful in choosing projects to invest in and they are forced to make optimal decisions by only investing in safer high-value projects. This in turn can translate into improved innovation efficiency for firms. This observation leads to our third hypothesis as follows:

Hypothesis 3: Firm-level innovation efficiency improves when faced with a tighter aggregate credit condition.

Following the logic of Hypothesis 2, an argument could be made that high-tech firms are more subject to uncertainty, moral hazard, and agency problems due to their high involvement in innovation activities. Tightening of credit conditions can mitigate agency problems and moral hazard more for high-tech firms compared to low-tech firms. This leads to our fourth hypothesis:

Hypothesis 4: During credit market disruption, innovation efficiency of high-tech firms improves disproportionately more compared to low-tech firms.

The ultimate impacts of innovation activities are on firm value. Following the logic of our Hypotheses 2 and 4, one can argue that high-tech firms have more innovation input and output compared to low-tech firms during financial crisis. Indeed Acs and Audretsch (1987), Cohen and Klepper (1996), and Rogers (2004)) also suggest that high-tech firms tend to be of larger size and higher profitability compared to low-tech firms. The question arises whether high-tech firms have better performance compared to low-tech firms during periods of heightened credit market friction. This leads to our final hypothesis as follows:

Hypothesis 5: High-tech firms outperform their low-tech counterparts when faced an aggregate tightening of credit conditions.

3. Data and Variables

3.1 Data

We use a combination of three databases for our sample. First, to measure innovation activities, we collect data from the latest edition of the National Bureau of Economic Research (NBER) patent database[1] (2006 edition, Hall, Jaffe & Trajtenberg). This dataset gives information on public firms' patenting records granted by the U.S. Patent and Trademark Office (USPTO) from 1976 to 2006, including firm-year patent counts and patent citations, among other variables, are sorted and classified by patent assignee names, application year and technology class. Since the purpose of this study is to examine the impact of the financial crisis of 2007-2008 on corporate innovation, we update the rest of the patent data up to 2010 using the database from Kogan, Papanikolaou, Seru and Stoffman (2014). [2] The third dataset is the quarterly Compustat data for accounting data of U.S. public firms from 1966Q1 to 2013Q4. This includes accounting information on total assets, liabilities, sales, profit, R&D, IPO dates and other firm-level data. The data is sorted by Gvkey. These datasets are merged by historical CRSP PERMNO Link to Compustat Record and Gvkey. Since we use the 2007-2008 financial crises as the exogenous shock to firm's investment in innovation, we use a panel of firms from 2005Q1 to 2010Q4. By using the data from 2005 onwards, we can avoid

[1] The NBER patent database is available at https://sites.google.com/site/patentdataproject/Home/downloads and contains patent assignee names and Compustat-matched identifiers (if available), the number of citations received by each patent, technological class, application years, and other details.

2 "Technological Innovation, Resource Allocation, and Growth" by Leonid Kogan, Dimitris Papanikolaou, Amit Seru, and Noah Stoffman.

selection bias in the patent data because according to Hall and Ziedonis (2001) and Hall (2005) U.S. firms only began to actively patent their inventions since the 1980s.

During the data cleaning process, we exclude non-active firms, financial institutions (SIC codes 6000-6999) and utilities firms (SIC codes 49000-4999) and firms with no Gvkey. We also require non-missing data on data date, sales and R&D expenditure. Following Atanssow (2013), we set the number of patent counts and citations to zero when there is no information on patent and/or citations available. The data is winsorized at 1% and 99% to mitigate the effect of outliers. The final data set contains 4,416 firms and 61,963 observations for the sample period from 2005Q1 to 2010Q4.

3.2 Main Variables

Firm-level innovation activities: The first dependent variable in our analysis is innovation input, i.e., the level of investment in innovation activities. We use two measures to proxy for such activities. They are the c*hange in R&D spending scaled by total assets* and the c*hange in R&D spending scaled by net sales.* The level of R&D spending is a direct measure of innovation input employed by firms (Hall et al., 2001, 2005). The normalization of R&D spending by total assets and sales controls for firm-size effect as suggested by Sapra and Subramanian (2013). Specifically, the change in innovation investment is calculated as follows:

$$\Delta Inn.Investment_{it} = R\&D_t/TA_{it-1} - R\&D_{t-1}/TA_{it-2} \quad \text{(a)}$$

$$\Delta Inn.Investment_{it} = R\&D_t/Sales_{it-1} - R\&D_{t-1}/Sales_{it-2} \quad \text{(b)}$$

The time lag is 1 period to reflect that R&D spending is more subjected to Sales and Total Assets of last period compared to the current period.

Innovation efficiency: The second dependent variable in our study is innovation output, i.e., innovation efficiency. We use two measures to proxy this outcome variable. They are *patent citations scaled by R&D* and *patent counts scaled by R&D*. Previous studies show that citations can reflect the impacts of firms' inventions, therefore, they are considered as a better measure for innovation output than patent counts (Tranjtenberg, 1990; Hall, 2005). By using two different proxies for innovation output, we check the robustness of the model. We use R&D spending in the same year with the patent application year as the denominator since innovation input (R&D) is found to have a strong effect on current patent applications and weak effect on subsequent patent applications (Hausman, Hall & Griliches, 1984; Lerner & Wulf, 2007). Following Hall, Jaffe, and Trajtenberg (2001), we use application year instead of effective year for innovation measure to avoid any selection bias due to the variability of the time lag between application year and granted year. The change in innovation efficiency is measure as:

$$\Delta Inn.eff_{it} = Patent\ counts_{it}/R\&D_{it} - Patent\ counts_{it-1}/R\&D_{it-1} \quad \text{(c)}$$

$$\Delta Inn.eff_{it} = Citations_{it}/R\&D_{it} - Citations_{it-1}/R\&D_{it-1} \quad \text{(d)}$$

Firm-level innovation intensity: We divide all firms in the sample into two groups: high-tech firms and low-tech firms. We use two methods to classify them. The first method follows Kile and Phillip (2009). They classify firms based on the three-digit SIC codes[3]. To be specific, firms whose three-digit SIC codes belong to the high-tech industries (please see footnote 3) are considered technologically intensive firms and the remainder of the sample firms are classified as low-tech firms. However, this method may ignore firms that have significant R&D activities but are not in high-tech industries. For robustness purpose, we use the second method which based on the actual amount of a firm's R&D expenditure. Similar to the approach of He, Qiu, and Tang (2014), we identify high-tech firms as those that have positive R&D spending in the past five years.

Credit market disruption: The key to our identification strategy is the use of an exogenous change in the credit market condition to estimate the effects of credit market friction on firm-level innovation quantity and quality. To this end, we use 2007-2008 financing crises as our setting for exogenous credit market shocks. Campello, Graham, and Harvey (2010) and Campello, Giambona, Graham, and Harvey (2010) argue that the 2007 to 2009 financial crisis represents an ideal setting for studying the effects of corporate finance on investment because, while the crisis ultimately spilled over onto the corporate domain, the origins of the crisis was exogenous to the financial system and can be traced back to the reversal in housing prices in 2006 and the wave of subprime

[3] The U.S. Patent Office classifies patent into 421 classes by SIC codes. The three-digit SIC codes for high-tech industries are 283 Drugs; 357 Computer and Office Equipment; 366 Communication Equipment; 367 Electronic Components and Accessories; 382 Laboratory, Optic, Measure, Control Instruments; 384 Surgical, Medical, and Dental Instruments; 481 Telephone Communications; 482 Miscellaneous Communication Services; 489 Communication Services, NEC; 737 Computer Programming, Data Processing, etc; and 873 Research, Development, and Testing Services.

mortgage defaults this triggered in early 2007 (Gorton, 2008; Acharya, Philippon, Richardson & Roubini, 2009). During the early phase of the crisis (August 2007), credit spreads on both short-term and long-term financing instruments had reached historical highs and new bond issues had reached historical lows (Almeida, Campello, Laranjeira & Weisbenner, 2010). When Lehman Brothers filed for bankruptcy on September 15, 2008 and the Reserve Primary Fund fell to 97 cents the day after, equity markets plunged with the S&P500 reaching a 12-year low and the Chicago Board Options Exchange Volatility Index (VIX) reaching a record high. These extreme market conditions lead to a dramatic credit squeeze by financial intermediaries. Ivashina and Scharfstein (2010) document that new loans to large borrowers fell by 47% during the peak period of the financial crisis (2008Q4) relative to the prior quarter and by 79% relative to the peak of the credit boom (2007Q2). Following Kuppuswamy and Villalonga (2010), we divide the 2007-2008 financial crises into two phases: the early phase (from 2007Q3 to 2008Q3) and the later phase (from 2008Q4 to 2009Q1). We also construct the total phase (from 2007Q3 to 2009Q1) to characterise the total duration of the crisis. All three phases are measured using dummy variables.

Firm performance: We use Natural logarithm of Sales and Net income/Sales to proxy for the firm performance. The use of natural logarithm and normalization is to mitigate outliners and size effect.

Financial constraints: Credit market conditions are also linked with a firm's financial constraint. In other words, it is likely that there is a feedback effect between them in the

sense that during credit contraction firms relying on the credit market for financing needs are likely to face a tighter financial constraint. To control for such feedback effects, we use three different measures of financial constraints that are widely used in the literature: WW index developed by Whited and Wu (2006), the SA index developed by Hadlock and Pierce (2010), and the Z-Score developed by Altman (1968), Altman, Haldeman and Narayanan (1977) and Altman (2000).

The WW index is constructed as follow:

$$WW= -0.091*CF- 0.062*DIVPOS +0.021*TLTD- 0.044*LNTA+ 0.102*ISG- 0.035*SG.$$

Where, *CF* is the ratio of cash flow to total asset; *DIVPOS* is a dummy variable, taking value one if firms pay cash dividends and zero if otherwise; *TLTD* is long term debt scaled by total asset; *LNTA* is the natural log of total assets; *ISG* is the sales growth of the industry the firm belongs to (based on three-digit SIC code); *SG* is firm's sales growth. A higher WW index implies a higher level of financial constraint.

The SA index is calculated as following:

$$SA= -0.737*Assets +0.043*Assets^2 – 0.040*Age.$$

Where, *Assets* is the natural log of book value total assets (adjusted for inflation) and cannot exceed $4.5 billion; *Age* is the number of years since the firm is listed without missing stock price on Compusat and is capped at 37 years. A higher SA index implies a higher level of financial constraint.

The Z-Score is constructed using the following formula:

$Z = 0.012X1 + 0.014X2 + 0.033X3 + 0.006X4 + 0.999X5$

Where, *X1* is working capital scaled by total assets; *X2* is retained earnings scaled by total assets; *X3* is earnings before interest and taxes scaled by total assets; *X4* is market value equity scaled by book value of total liabilities; *X5* is sales scaled by total assets. A higher level of Z-Score implies a lower level of financial constraint.

Firm-specific controls: We use different variables to control for firm's specific characteristics, including *Size* (natural log of total assets); *Leverage* (ratio of long term debt and total assets), *Cash* (total cash scaled by total assets), *ROA* (EBITDA divided by total assets) and *Age* (the number of years form IPO date to current year). Firm's leverage is included in the model because according to previous studies, capital structure can have impacts on firm's innovation and financial conditions (Bhagat and Welch, 1995; Atanassov, Nanda & Seru, 2007). We use *ln(Sales), Cash, ROA* and *Age* as control variables for the models because firm's age, size, free cash flow and profitability can all possibly affect innovation input and output as well as firm's access to external capital market (Hogan, Teresa & Hutson, 2004; Magri, 2007).

4. Empirical Analysis

4.1 Univariate Analysis

In Table 1, we compare innovation activities (*R&D spending/Total asset, patent counts, citations, patent counts/R&D spending, and citations/R&D spending*) and firm

characteristics (*size, leverage, age, cash, and ROA*) of all firms in the crisis and non-crisis periods in different phases of the crisis. Panel A of Table 1 shows that firms slightly increase their spending on R&D in crisis; however the number of patent applications and citations received are reduced. Innovation productivity is lower than their non-crisis levels. Regarding firm characteristics, firms on average reduce their cash holding by 1% and tend to borrow more from the debt market to finance for the constraints they face in crisis. In addition, firm performance in crisis is worse than the non-crisis period, given the decrease in ROA and sales. Panel B and Panel C show similar results with different phases of the crisis.

Table 1 is about here

Table 2 compares innovation activities and firm characteristics of high-tech and low-tech firms. Panel A reports results of the mean comparison t-test between high-tech and low-tech firms when they are classified by three-digit SIC codes whereas Panel B reports the results when the firm types are classified based on the method of He et al. (2014). Panel A of Table 2 shows that technologically based firms invest more in R&D activities as their ratio of R&D spending and total assets is 7% higher than the ratio of non-innovative firms. In addition, high-tech firms have less number of patents applied but receive more citations. Regarding innovation productivity, high-tech firms on average underperform low-tech firms. The differences between the ratios of patent counts to R&D spending and the citations to R&D spending of high-tech firms and low-tech ones are 5% and 15%, respectively, and are in favor of the low-tech firms. As for firm specific characteristics,

Panel A of Table 2 shows that high-tech firms on average are of smaller size and younger age compared to low-tech firms. High-tech firms also reserve a higher percentage of their total assets as cash (40%) compared to that of low-tech firms (17%). In terms of leverage, the results are consistent with previous findings that high-tech firms are less levered than low-tech firms.

Given a different method of firm classification, the results in Panel B of Table 2 are similar to the findings of Panel A, with some exceptions. Panel B shows that technologically based firms outperform low-tech firms in all aspects. They have a higher number of patents applied, more citations cited, obtain more patent counts and citations given the same number of investment in R&D activities. Regarding firm characteristics, high-tech firms are older in age and have lower sales growth compared to low-tech firms.

Table 2 is about here

Part I of Table 3 compares characteristics and innovation activities of high-tech firms in crisis and non-crisis period using different phases of the crisis. The results in Panel A and B indicate that high-tech firms increase their investment in R&D projects in the crisis period; however, they experience a fall in the number of patent counts and citations during the crisis. Innovation efficiency, measured by *number of patent scaled by R&D spending* and *citations scaled by R&D spending*, is lower than the non-crisis level. However, Part I of Panel B shows opposite results for citations and citations scaled by R&D expenditure as it suggests that high-tech firms receive more citations in the crisis period and their innovation efficiency is improved. As for firm performance, the results

are consistent and robust across three Panels in Part I of Table 3. High-tech firms reduce their cash holding and increase their leverage in the crisis. Their sales and profitability are smaller than non-crisis levels. We conduct the same tests for low-tech firms and report the results in Part II of Table 3. We observe very similar results for low-tech firms. [4]

Table 3 is about here

4.2 Regression Analysis

The univariate analysis shows mixed results when comparing innovative activities of high-tech and low-tech firms. Since the investment in innovation and innovation efficiency may be subjected to firm characteristics, we conduct multivariate regression analysis to address that issue. Following are the tests designed for each hypothesis.

Hypothesis 1: We use the following regression model to test the Hypothesis 1

$$\Delta Inn.Investment_{it} = \propto + \beta Crisis + \gamma FC_{it-1} + \mu Crisis \times FC_{it-1} + (X'_{it-1}\lambda) + \varepsilon_{it} \quad (1)$$

where i indexes a firm and t indexes time. The dependent variable, denoted by $\Delta Inn.Investment_{it}$, is the change in firm investment in innovation according to

[4] The classification of high-tech and low-tech firms in table 3 is based on three-digit SIC codes. In unreported tests, we find similar results using the classification method of He, Qiu, and Tang (2014).

equation (a) and (b) in Section 3. Independent variables include: FC_{it} is the level of market friction, proxy by WW index; SA index and Altman's Z-score 2000; X'_{it} is a set of firm characteristics that can affect innovation activities, including *Cash* (Cash/Total Assets), *ROA* (EBITDA/Total Assets), and *Leverage* (Long-term debt/Total Assets); *Age* (the number of years since the firm is listed) and *Size* (Natural log of Total Assets); and *Crisis* is a dummy variable, taking value one if in the crisis period and zero otherwise.

Table 4 report the results from the regression model (1). As a robustness check, we run the model using different measures of financial constraints and innovation investment. Panel A of Table 4 reports the results of the early phase of the crisis (2007Q3 to 2008Q3). The coefficient of *Crisis*FC* is negative for WW index and SA index and positive for Z-score, indicating that during the crisis, tighter financial conditions lead to investment cuts in innovation. Coefficient of *Crisis* is negative, which suggests that firms reduce their investment in R&D projects in crisis period. Financial constraints; however, shows a positive relationship with the change in innovation investment. In other words, an increase in the level of financial constraints leads to an increase in innovation investment. It is noted that the coefficient of *FC* is very small; therefore the positive relationship of financial constraints and innovation investment is not strong. These results are robust when using different proxies of innovation investment and financial constraints. Panel B and Panel C of Table 3 report similar results in different phases of the crisis.

As for control variables, coefficients of *Size* (measured by ln(TA)) and *Age* are positive and significant, indicating that larger and older firms reduce investment in innovation less than smaller and younger firms do. The negative coefficient of *Leverage* suggests that firms with high leverage will be more likely to cut their investment in innovation when they face financial constraints. These finding are significant and robust across three Panels.

Table 4 is about here

Hypothesis 2: In order to test the difference between high-tech and low-tech firms, we introduce dummy variable[5] $Innovative_i$, which takes value one if the firm is high-tech and zero otherwise into the model (1).

$$\Delta Inn.Investment = \propto + \beta Crisis + \vartheta Innovative + \gamma FC_{it-1} + \mu Crisis \times FC_{it-1} +$$
$$+\theta Crisis \times Innovative + Innovative \times FC_{it-1} + (X'_{it-1}\lambda) + \varepsilon_{it} \qquad (2)$$

Table 5 reports the results from the regression model of Hypothesis 2. Similar to Hypothesis 1, we conduct different tests for a robustness check. We observe mixed results for the coefficients of *Crisis*Innovative* across different models; however, the majority of the models show a negative coefficient for this interaction term; especially when firms are classified by the method of He et al. (2014). The results show that during the crisis period, high-tech firms reduce their investment in innovation. The coefficient of *FC*Innovative* in general is significant and consistently positive for WW index and SA

[5] The classifications of high-tech and low-tech firms are described in Section 3.

index and consistently negative for Z-score across different estimations, suggesting that during financial constraints, high-tech firms increase their investment in innovation. This finding supports the R&D smoothing argument. The negative coefficient of *Innovative*, together with the sign of coefficient of *FC*Innovative*, indicates that the change in innovation investment of high-tech firms is less than low-tech firms. The impact of firm types (high-tech or low-tech) and financial constraints on the change in innovation investment is slightly stronger in the later phase of the crisis (2008Q4 to 2009Q1) as the coefficients of *FC*, *Innovative* and the interaction terms are larger in Panel B.

Table 5 is about here

Hypothesis 3: The model used to test hypothesis 3 has similar explanatory variables as those in model (1); however we use the dependent variable is $Inn.Efficiency_{it}$ (Innovation efficiency) instead of $Inn.Investment_{it}$. Innovation efficiency, as described in equation (c) and (d) in Section 2, is proxied by *Citations/ R&D* and *Patent Counts/R&D*.

$$\Delta Inn.Efficiency_{it} = \propto + \beta Crisis + \gamma FC_{it-1} + \mu Crisis \times FC_{it-1} + (X'_{it-1}\lambda) + \varepsilon_{it} \quad (3)$$

Table 6 reports the regression estimates from model (3). We observe that using different proxies for innovation efficiency gives similar results; however *Citation* is a better proxy than *Patent* as its results are more significant. This is consistent with previous studies which state that citation is a better proxy for innovation output as it can reflect the importance and impact of firm inventions. Across different models, the coefficients of *FC*

and *Crisis*FC* are positive for WW index and SA index; and negative for Z-score. This suggests that an increase in the level of financial constraints in the crisis period leads to an increase in innovation efficiency.

Table 6 is about here

Hypothesis 4: We replace the dependent variable $\Delta Inn.Investment_{it}$ in model (2) by $\Delta Inn.Efficiency_{it}$ and leave the rest of model (2) unchanged to get the regression model for Hypothesis 4:

$$\Delta Inn.Efficiency_{it} = \propto + \beta Crisis + \vartheta Innovative + \gamma FC_{it-1} + \mu Crisis \times FC_{it-1} + \\ + \theta Crisis \times Innovative + Innovative \times FC_{it-1} + (X'_{it-1}\lambda) + \varepsilon_{it} \quad (4)$$

Table 7 shows the results from the regression estimation of model (4) across different proxies and classification methods. Similar to Table 5, we notice that the results from the models that use citation as a proxy for innovation efficiency are more significant than those using patent. To investigate the change in innovation efficiency of high-tech firms in crisis period, we look at the coefficient of *Crisis*Innovative.* Results of this coefficient from Part I of Table 7 (where high-tech and low-tech firms are classified based on three-digit SIC codes) are mixed but results from Part II (using the method of He et al., 2014) are consistently positive. A positive coefficient on *Crisis*Innovative* suggests that innovation efficiency of innovative firms is improved during the crisis period. We observe a similar trend in the coefficient of *FC*Innovative,* where more robust results are found in Part II and the results support the argument that financial constraints improve innovation efficiency of high-tech firms.

Table 7 is about here

Hypothesis 5: We replace the dependent variable $\Delta Inn.Investment_{it}$ in model (2) by $Performance_{it}$ and leave the rest of model (2) unchanged to get the regression model for Hypothesis 5:

$$\Delta Performance_{it} = \propto + \beta Crisis + \vartheta Innovative + \gamma FC_{it-1} + \mu Crisis \times FC_{it-1} +$$

$$+\theta Crisis \times Innovative + Innovative \times FC_{it-1} + (X'_{it-1}\lambda) + \varepsilon_{it} \quad (5)$$

Table 8 reports the regression results of model (5). We observe that the coefficient of *Innovative* is positive across different Parts and Panels, indicating that high-tech firms in general have a higher sales volume and profitability than low-tech firms.

Regarding performance of innovative firms in the crisis period, the coefficient of *Crisis*Innovative* is positive and the results are robust across different estimations. This suggests that during crisis, firms that are more technologically intensive have better performance in terms of sales and profitability. The coefficient of *FC*Innovative* is positive for WW index and SA index; and negative for Z-score, showing that performance of high-tech firms are improved when they face financial constraint conditions.

Table 8 is about here

5. Conclusion

This paper examines the impact of credit market disruption on firm-level innovation activities and whether the effects vary across high-tech and low-tech firms. The results show that a tightening of credit conditions reduce innovation investment, but that the decline in innovation spending is disproportionately less for high-tech firms compared to

low-tech firms. Further, credit contraction is also significantly related to improvement in innovation efficiency, particularly for high-tech firms. The innovation-efficiency enhancing effect of a credit contraction is amplified in the presence of financial constraint suggesting that a liquidity squeeze can mitigate agency and moral hazard problems within innovative firms, particularly for high-tech firms.

While existing studies focus on the level of investment in general, this paper adds to the existing literature by focusing on a specific type of investment, i.e., innovation, and by showing that indeed credit market conditions have significant bearings on corporate innovation. Furthermore, this paper fills a gap in the literature by providing empirical evidence on the difference between high-tech and low-tech firms in terms of how they finance innovation and ultimately perform during financial crises in the presence of severe financial constraints. A natural extension of this research would be to examine how policy makers, such as government and central banks, should respond to mitigate the detrimental effects of financial crises on the level of innovation activities while preserving the efficiency enhancing role of credit contraction in relation to corporate innovation.

References

Aboody, D. and B. Lev. (2000). Information Asymmetry, R&D, and Insider Gains. *The Journal of Finance*, *55*(6), 2747-2766. Doi: 10.1111/0022-1082.00305

Acharya, Viral V. and Xu, Zhaoxia. (2014). Financial Dependence and Innovation: The Case of Public versus Private Firms. *European Corporate Governance Institute (ECGI) - Finance Working Paper* No. 400/2014. Available at SSRN: http://ssrn.com/abstract=236183.

Acharya, Viral V., Thomas Philippon, Matthew Richardson, and Nouriel Roubini, 2009, The financial crisis of 2007-2009: Causes and remedies. In Viral Acharya and Matthew Richardson , eds., *Restoring Financial Stability: How To Repair a Failed System*. Wiley, New Jersey.

Acs Z., J. and David B. Audretsch. (1987). Innovation, Market Structure, and Firm Size. *The Review of Economics and Statistics*, 69(4), 567-574.

Aghion, P., G.-M. Angeletos, A. Banerjee, K. Manova. (2010). Volatility and growth: Credit constraints and the composition of investment. *Journal of Monetary Economics*, 57, 246-265.

Aghion, P., J. Van Reenen, and L. Zingales. (2013). Innovation and institutional ownership. *American Economic Review*, 103, 277–304.

Aivazian, Varouj, Mohammad, Rahaman, and Ling , Sun. (2014). Financial shocks and firm performance: A cross-country analysis. Working paper, Version Jan, 2014.

Almeida, Heitor, Murillo Campello, Bruno Larajeire and Scott Weisbenner, 2010, Corporate debt maturity and the real effects of 2007 credit crisis, NBER Working Paper.

Almeida, Heitor and Hsu, Po-Hsuan and Li, Dongmei. (2013). Less is More: Financial Constraints and Innovative Efficiency. *SSRN Working Paper*. Available at SSRN: http://ssrn.com/abstract=1831786.

Altman, E. I. (1968). Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *Journal of Finance*, 23, 589–609.

Altman, E. I. (2000). Predicting Financial Distress of Companies: Revisiting the Z-score and Delta® Model. *Revisited and Update Paper* from E. Altman, "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy," *Journal of Finance*, September 1968; and E. Altman, R. Haldeman and P. Narayanan, "Zeta Analysis: A New Model to Identify Bankruptcy Risk of Corporations," *Journal of Banking & Finance*, 1, 1977.

Altman, E. I. (1968). Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy. *Journal of Finance*.

Altman, E., R. Haldeman, and P. Narayanan. (1977). ZETA Analysis: A New Model to Identify Bankruptcy Risk of Corporations. *Journal of Banking and Finance*.

Atanassov, J. (2012), Do hostile takeovers stifle innovation? Evidence from antitakeover legislation and corporate patenting. *Journal of Financing*, forthcoming.

Atanssow, J. (2013), Do hostile takeovers stifle innovation? Evidence from antitakeover legislation and corporate patenting, *Journal of Finance*, forthcoming.

Atanassov, J., V. Nanda, and A. Seru. (2007). Finance and innovation: The case of publicly traded firms. *Working paper*, University of Oregon, Georgia institute of Technology, and University of Chicago.

Atanassov, Julian and Nanda, Vikram K. and Seru, Amit. (2007). Finance and Innovation: The Case of Publicly Traded Firms. *Ross School of Business Paper* No. 970; AFA 2007 Chicago Meetings Paper; EFA 2006 Zurich Meetings Paper. Available at SSRN: http://ssrn.com/abstract=740045.

Baark, Erik, Antonio, K.W. Lau, William Lo, Naubahar Sharif. (2011). Innovation Sources, Capabilities and Competitiveness: Evidence from Hong Kong Firms. Paper presented at the DIME Final Conference, 6-8 April 2011, Maastricht.

Bartoli, Francesca and Ferri, Giovanni and Murro, Pierluigi and Rotondi, Zeno. (2012). Bank-Firm Relations and the Role of Mutual Guarantee Institutions at the Peak of the Crisis. *Journal of Financial Stability*, 9(1), 90-104. Available at SSRN: http://ssrn.com/abstract=1729655.

Bergemann, Dirk and Hege, Ulrich. (2004). The Financing of Innovation: Learning and Stopping. *Cowles Foundation Discussion Paper* No. 1292R. Available at SSRN: http://ssrn.com/abstract=481043

Bernanke, B.S., Gerler, M. (1995). Inside the Black Box: The credit Channel of Monetary Policy Transmission. *Journal of Economic Perspective, 9*, 27-48.

Bernanke, B.S. (2007). The Financial Accelerator and the Credit Channel. Federal Reserve Board, Washington, D.C.

Bhagat, S., and I. Welch. (1995). Corporate research & development investments international comparisons. *Journal of Accounting and Economics*, 19, 443–470.

Brown, James R. & Martinsson, Gustav & Petersen, Bruce C. (2012). Do financing constraints matter for R&D. *European Economic Review*, Elsevier, 56(8), 1512-1529.

Brown, James R. & Petersen, Bruce C. (2009). Why has the investment-cash flow sensitivity declined so sharply? Rising R&D and equity market developments. *Journal of Banking & Finance*, Elsevier, 33(5), 971-984.

Brown, James R. & Petersen, Bruce C. (2011). Cash holdings and R&D smoothing. *Journal of Corporate Finance*, Elsevier, 17(3), 694-709.

James R. Brown & Steven M. Fazzari & Bruce C. Petersen. (2009). Financing Innovation and Growth: Cash Flow, External Equity, and the 1990s R&D Boom. *Journal of Finance*, American Finance Association, 64(1), 151-185, 02.

Campello, Murillo, Erasmo Giambona, John R. Graham, and Campbell R. Harvey, 2010, Liquidity management and corporate investment during a financial crisis. NBER Working Paper.

Campello, Murillo, John R. Graham, and R. Campbell Harvey, 2010, The real effects of financial constraints: Evidence from a financial crisis, Journal of Financial Economics 97, 470–487.

Cockburn, Iain M. and Hall, Bronwyn H. and Trajtenberg, Manuel. (2007). National Bureau of Economic Research Patent Database: Data Overview (November 2, 2007). 2007 Kauffman Symposium on Entrepreneurship and Innovation Data. Available at SSRN: http://ssrn.com/abstract=1022165.

Cohen ,Wesley M. and Steven Klepper. (1996). Firm Size and the Nature of Innovation within Industries: The Case of Process and Product R&D. *The Review of Economics and Statistics, 78*(2), 232-243.

Dirk, Czarnitzki and Kornelius Kraft. (2009). Capital control, debt financing and innovative activity. *Journal of Economic Behavior & Organization, 71*, 372–383.

Francis,Bill, Iftekhar Hasan, Ying Huang, and Zenu Sharma. (2012). Do Banks Value Innovation? Evidence from US Firms. *Financial Management, 41*(1), 159–185.

Fruest, T.S. (1992). Liquidity, Loanable Funds, and Real Activity. *Journal of Monetary Economics, 29*, 3-24.

Garnsey, E. (1995). High Technology Renewal and the UK Investment Problem, *Journal of General Management, 20*(4), 1-22.

Gorton, Gary, 2008, The Panic of 2007, NBER Working Paper.

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

Hall, B. H. (1992). Research and Development at the Firm Level: Does the source of financing matter? *NBER Working Paper* No. 4096.

Hall, B., A. Jaffe, and M. Trajtenberg. (2001). The NBER Patent Citation Data File: Lessons, Insights and Methodological Tools. *NBER Working Paper* 8498.

Hall, B. H., and R. H. Ziedonis. (2001). The patent paradox revisited: An empirical study of patenting in the US semiconductor industry, 1979-1995. RAND Journal of Economics, 32, 101–128.

Hall, B. H. (2005). Exploring the patent explosion. *Journal of Technology Transfer*, 30, 35-48.

Hall, B. H. (2009). The Financing of Innovative Firms. *EIB papers, 14*(2), 8-28.

Hall, B. H. & Josh Lerner. (2009). The Financing of R&D and Innovation. *NBER Working Papers* No. 15325, National Bureau of Economic Research, Inc.

Hall, B.H., and J. Lerner. (2010). The Financing of R&D and Innovation. In: Hall, B.H., Rosenberg, N. (Eds.), *Handbook of the Economics of Innovation*. Elsevier, Amsterdam, Netherlands, pp. 610–638.

Hausman, J., B. H. Hall, and Z. Griliches. (1984). Econometric models for count data with an application to the patents-R&D relationship. *Econometrica*, 52, 909–938.

He, Zhongzhi Lawrence and Qiu, Jiaping and Tang, Tingfeng. (2014). Hedge Fund Activism and Corporate Innovation. *SSRN Working paper*. Available at SSRN: http://ssrn.com/abstract=2411739.

Hogan, Teresa and Hutson, Elaine. (2004). Capital structure in new technology-based firms : Evidence from the Irish software sector. *Centre for Financial Markets working paper series*; WP-04-19. University College Dublin. School of Business. Centre for Financial Markets

Holmstrom, B., Tirole, J. (1997). Financial Intermediation, Loanable Funds, and the Real Sector. *Quarterly Journal of Economics, 112*, 35-52.

Houston, Joel and James, Christopher. (2001). Do Relationships have Limits? Banking Relationships, Financial Constraints, and Investment. *Journal of Business*, 74, 347-374.

Ivashina, Victoria, and David S.Scharfstein, 2010, Bank Lending During the financial Crisis of 2008, *Journal of Financial Economics* 97, 319-338.

Jaffe, A. B. (2000). The U.S. patent system in transition: policy innovation and the innovation process. *Research Policy*, 29, 531–557.

Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *American Economic Review*, 78, 323–329.

Jensen, M. C., (1993). The modern industrial revolution, exit, and the failure of internal control systems. *Journal of Finance*, 48, 831–880.

Khwaja, A.J., Mian, A. (2008). Tracing the Impact of Bank Liquidity Shocks. *American Economic Review*, *98*, 1413-1442.

Kashyap, A.K., Stein, J.C. (1997). The Role of Banks in Monetary Policy: A survey with Implication for the European Monetary Union. *Federal Reserve Bank of Chicago Economic Perspective, 21*, 2-18.

Kashyap, A.K., Stein, J.C. (2000). What do a Million Observations on Banks Say about the Transmission of Monetary Policy? *American Economic Review, 90*, 407-428.

Kile, C. O., and M. E. Phillips. (2009). Using Industry Classification Codes to Sample High-Technology firms: Analysis and Recommendations. *Journal of Accounting, Auditing & Finance, 24* (1), 35-58.

Kogan, Leonid and Papanikolaou, Dimitris and Seru, Amit and Stoffman, Noah. (2012). Technological Innovation, Resource Allocation, and Growth (July 11, 2012). Available at SSRN: http://ssrn.com/abstract=2193068 orhttp://dx.doi.org/10.2139/ssrn.2193068

Kumar, P., and N. Langberg, (2009). Corporate fraud and investment distortions in efficient capital markets. *RAND Journal of Economics* 40, 144–172.

Kuppuswamy, V., Villalonga, B., (2010). Does diversification create value in the presence of the external financing constraints? Evidence from the 2007-2009 financial crisis. HBS Working Paper Number: 10-101.

Laeven, L., Valencia,F. (2008). Systemic Banking Crisis: A new database. *Working Paper No. 08224*, International Monetary Fund.

Lerner, J., J. Wulf. (2007). Innovation and incentives: Evidence from corporate R&D. *Review of Economics and Statistics*, 89, 634–644.

Li, D. (2011). Financial constraints, R&D investment, and stock returns. *Review of Financial Studies*, 24, 2974–3007.

Silvia Magri (2007). The Financing of Small Innovative Firms: The Italian Case. Bank of Italy Temi di Discussione, *Working Paper* No. 640

Andrea Mina, Henry Lahr, and Alan Hughesy. (2013). The demand and supply of external finance for innovative firms. *Industrial and Corporate Change, 22(4)*, 869-901. doi:10.1093/icc/dtt020

Munos, B. (2009). Lessons from 60 years of pharmaceutical innovation, *Nature Reviews*, 8, 959–968.

Mikko Paananen. (2012). On innovative search: The use of internal and external sources of innovation among Finnish innovators. Thesis for the degree of Doctor of Science (Economics and Business Administration), University of Technology, Lappeenranta, Finland, December, 2012.

Rajan, Raghuram G., and Luigi Zingales (1998). Financal Development and growth. *American Economic Review*, 88, 393-410.

Mark Rogers. (2004). Networks, Firm Size and Innovation. *Small Business Economics*, *22*(2), 141-153. Kluwer Academic Publishers. DOI: 10.1023/B:SBEJ.0000014451.99047.69

Sapra, H., A. Subramanian, and K. Subramanian. (2013). Corporate governance and innovation: Theory and evidence. *Journal of Financial and Quantitative Analysis*, forthcoming.

Schumpeter, J.A., 1939. *Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*, New York: McGraw-Hill.

Chava, Sudheer and Nanda, Vikram K. and Xiao, Steven Chong. (2013). Lending to Innovative Firms: The Role of Lender Expertise and Control Rights. Available at SSRN: http://ssrn.com/abstract=2327910.

Hogan, Teresa; Hutson, Elaine. (2004). Capital structure in new technology-based firms: Evidence from the Irish software sector. *Centre for Financial Markets Working paper series*; WP-04-19; Publisher University College Dublin. School of Business. Centre for Financial Markets

Trajtenberg, M. (1990). A penny for your quotes: Patent citations and the value of innovations. *RAND Journal of Economics*, 21, 172–187.

Ivashina, Victoria and Scharfstein, David S. (2009). Bank Lending During the Financial Crisis of 2008. *EFA 2009 Bergen Meetings Paper*. Available at SSRN: http://ssrn.com/abstract=1297337.

Whited, T. M. (1992). Debt, liquidity constraints, and corporate investment: Evidence from panel data. *Journal of Finance*, 47, 1425–1460.

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

Zoltan J. Acs and David B. Audretsch. (1987). Innovation, Market Structure, and Firm Size. *The Review of Economics and Statistics, 69*(4), 567-574.

Zoltan J. Acs and David B. Audretsch. (1988). Innovation in Large and Small Firms: An Empirical Analysis. *The American Economic Review*, *78*(4), 678-690.

Table 1: Firm Characteristics and Innovation Activities in Crisis and Non-crisis Periods

This table compares the means of firm characteristic variables in the *Non-crisis* and *Crisis* periods. Panel A reports results from the early phases of the crisis (2007Q3 to 2008Q3) while Panel B shows results from the later phase (2008Q4 to 2009Q1); and Panel C is from the total phase (2007Q3 to 2009Q1). *R&D* is R&D spending scaled to sales. *Patent* is the number of patent applied by a firm in a given year. *Citations* are citations cited per patent in the same year. *Patent/R&D* is the number of patent applied scaled by R&D spending and *Citations/R&D* is citations cited and scaled by R&D spending. *Cash* is total cash scaled by total assets. *ROA* is the ratio of EBITDA and total assets *Leverage* is ratio of long term debt and total assets. *Age* is the number of years form IPO date to current year and *Size* is natural log of total assets. *Diff* is the difference in means of firms in *Non-crisis* period and *Crisis* period from the *t-test* and *t-stat* is test statistics of the t-test. The data is winsorized at 1% and 99% to mitigate the effect of outliers.

	R&D	Patent	Citations	Patent /R&D	Citations /R&D	Cash	ROA	Leverage	Age	Size
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Crisis= 2007Q3 to 2008Q4										
Non-Crisis (a)	0.06	1.98	4.49	0.11	0.27	0.31	-0.10	0.15	15.93	4.65
Crisis (b)	0.09	1.43	4.13	0.08	0.20	0.30	-0.10	0.15	15.89	4.71
Diff (c)= (a)-(b)	-0.03	0.55	0.36	0.03	0.07	0.00	0.00	0.00	0.04	0.07
t-stat	-1.73	2.48	0.89	2.25	1.65	0.90	0.38	-1.58	0.55	-2.53
Panel B: Crisis= 2008Q4 to 2009Q1										
Non-Crisis (a)	0.62	2.03	4.39	0.12	0.26	0.31	-0.10	0.15	15.98	4.66
Crisis (b)	0.10	0.61	4.64	0.03	0.23	0.28	-0.13	0.16	15.43	4.70
Diff (c)= (a)-(b)	-0.04	1.42	-0.25	0.08	0.03	0.03	0.03	-0.01	0.55	-0.05
t-stat	-1.99	5.04	-0.49	5.00	0.58	7.10	7.89	12.20	5.59	-1.47
Panel C: Crisis=2007Q3 to 2009Q1										
Non-Crisis (a)	0.06	2.15	4.45	0.12	0.28	0.31	-0.10	0.15	15.99	4.64
Crisis (b)	0.08	1.17	4.34	0.07	0.22	0.30	-0.11	0.16	15.74	4.72
Diff (c)= (a)-(b)	-0.01	0.98	0.11	0.06	0.06	0.01	0.01	-0.01	0.25	-0.08
t-stat	-1.09	4.94	0.30	4.69	1.58	5.33	5.26	-3.70	3.53	-3.60

Table 2: Firm Characteristics and Innovation Activities of High-tech and Low-tech Firms

This table compares the means of characteristic variables of *Low-tech* and *High-tech* firms based on two different classifications. Panel A reports the comparison of means when firms are classified as high-tech and low-tech based on their three-digit SIC codes while Panel B reports the results when the classification follows the method of He et al. (2014). The sample consists of 4416 firms, in which Panel A has 2419 high-tech and 1997 low-tech firms while Panel B includes 2140 high-tech and 2276 low-tech firms. *R&D* is R&D spending scaled to sales. *Patent* is the number of patent applied by a firm in a given year. *Citations* are citations cited per patent in the same year. *Patent/R&D* is the number of patent applied scaled by R&D spending and *Citations/R&D* is citations cited and scaled by R&D spending. *Cash* is total cash scaled by total assets. *ROA* is the ratio of EBITDA and total assets *Leverage* is ratio of long term debt and total assets. *Age* is the number of years form IPO date to current year and *Size* is natural log of total assets. *Diff* is the difference in means of low-tech firms and high-tech firms from the *t-test* and *t-stat* is test statistics of the t-test. The data is winsorized at 1% and 99% to mitigate the effect of outliers.

.

	R&D	Patent	Citations	Patent /R&D	Citations /R&D	Cash	ROA	Leverage	Age	Size
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Three-digit SIC classification										
Low-tech (a)	0.02	1.06	2.26	0.14	0.37	0.17	-0.07	0.19	16.95	5.20
High-tech (b)	0.09	2.40	5.82	0.09	0.22	0.40	-0.12	0.12	15.38	4.30
Diff (c)= (a)-(b)	-0.07	-1.34	-3.56	0.05	0.15	-0.23	0.05	0.07	1.57	0.90
t-stat	-5.67	-7.29	-10.62	4.11	3.92	-0.01	20.33	33.06	24.01	42.86
Panel B: He et al. (2014) classification										
Low-tech (a)	0.06	0.47	0.64	0.09	0.16	0.26	-0.11	0.17	12.66	4.71
High-tech (b)	0.07	2.61	6.41	0.11	0.29	0.34	-0.10	0.14	17.88	4.62
Diff (c)= (a)-(b)	-0.01	-2.14	-5.77	0.02	-0.13	-0.08	-0.01	0.03	-5.22	0.09
t-stat	0.56	-11.34	-16.83	-0.73	-3.04	-25.01	-5.77	18.06	-8.89	4.03

Table 3: Firm Characteristics and Innovation Activities of High-tech and Low-tech firms in Crisis and Non-crisis Period

Part I of this table compares the means of characteristic variables of high-tech firms in *Crisis* and *Non-crisis* period while Part II of the table shows results for low-tech firms. Firms are classified as low-tech or high-tech based on their three-digit SIC codes. Each Panel of the Table shows the results at different Crisis phases. *R&D* is R&D spending scaled to sales. *Patent* is the number of patent applied by a firm in a given year. *Citations* are citations cited per patent in the same year. *Patent/R&D* is the number of patent applied scaled by R&D spending and *Citations/R&D* is citations cited and scaled by R&D spending. *Cash* is total cash scaled by total assets. *ROA* is the ratio of EBITDA and total assets *Leverage* is ratio of long term debt and total assets. *Age* is the number of years form IPO date to current year and *Size* is natural log of total assets. *Diff* is the difference in means of low-tech and high-tech firms from the *t-test* and *t-stat* is test statistics of the t-test. The data is winsorized at 1% and 99% to mitigate the effect of outliers.

PART I: HIGH-TECH FIRMS

	R&D	Patent	Citations	Patent /R&D	Citations /R&D	Cash	ROA	Leverage	Age	Size
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Crisis= 2007Q3to 2008Q4										
Non-Crisis (a)	0.09	2.56	5.94	0.10	0.23	0.40	-0.12	0.12	15.38	4.28
Crisis (b)	0.12	1.78	5.33	0.07	0.18	0.39	-0.12	0.13	15.38	4.38
Diff (c)= (a)-(b)	-0.03	0.78	0.61	0.03	0.04	0.01	0.00	-0.01	0.00	-0.11
t-stat	-1.46	2.23	0.95	4.05	2.91	1.03	-0.02	-3.91	0.04	-3.36
Panel B: Crisis= 2008Q4 to 2009Q1										
Non-Crisis (a)	0.09	2.61	5.77	0.10	0.22	0.40	-0.12	0.12	15.44	4.29
Crisis (b)	0.15	0.76	6.13	0.04	0.23	0.37	-0.16	0.14	14.94	4.34
Diff (c)= (a)-(b)	-0.07	1.85	-0.36	0.06	-0.02	0.03	0.04	-0.02	0.49	-0.05
t-stat	-2.23	4.15	-0.44	7.03	-0.9029	6.03	7.74	-4.32	4.10	-1.16
Panel C: Crisis=2007Q3to 2009Q1										
Non-Crisis (a)	0.09	2.77	5.87	0.11	0.22	0.40	-0.12	0.12	15.44	4.27
Crisis (b)	0.11	1.46	5.68	0.06	0.20	0.39	-0.14	0.13	15.24	4.37
Diff (c)= (a)-(b)	-0.02	1.31	0.20	0.05	0.02	0.01	0.02	-0.02	0.20	-0.09
t-stat	-1.02	4.18	0.34	7.47	1.69	4.10	5.14	-5.58	2.37	-3.32

PART II: LOW-TECH FIRMS

Panel A: Crisis= 2007Q3to 2008Q4										
Non-Crisis (a)	0.02	1.10	1.30	0.15	0.40	0.17	-0.07	0.19	16.97	5.19
Crisis (b)	0.03	0.87	1.26	0.12	0.26	0.16	-0.07	0.18	16.87	5.23
Diff (c)= (a)-(b)	-0.01	0.24	0.03	0.03	0.14	0.01	0.00	0.01	0.09	-0.03
t-stat	-2.45	1.46	0.58	0.68	0.90	2.35	0.32	1.73	0.71	-0.79
Panel B: Crisis= 2008Q4 to 2009Q1										
Non-Crisis (a)	0.03	1.14	1.29	0.16	0.39	0.17	-0.07	0.19	17.03	5.20
Crisis (b)	0.02	0.38	1.32	0.02	0.23	0.15	-0.09	0.19	16.36	5.24
Diff (c)= (a)-(b)	0.01	0.77	-0.03	0.14	0.16	0.02	0.02	0.00	0.66	-0.05
t-stat	2.23	3.76	-0.42	2.43	0.86	4.72	2.90	0.70	4.01	-0.85
Panel C: Crisis=2007Q3to 2009Q1										
Non-Crisis (a)	0.02	1.19	1.29	0.16	0.42	0.17	-0.07	0.19	17.04	5.18
Crisis (b)	0.03	0.71	1.29	0.09	0.26	0.16	-0.08	0.19	16.71	5.25
Diff (c)= (a)-(b)	-0.01	0.48	0.00	0.08	0.16	0.01	0.01	0.00	0.34	-0.07
t-stat	-0.83	3.35	-0.02	1.91	1.20	4.94	1.84	0.78	2.86	-1.93

Table 4: Regression estimation of Innovation Investment and Credit Market Friction (Hypothesis 1)

The table reports the regression model to estimate the impact of credit market friction on firm's innovation investment. The regression model is as follows:

$$\Delta Inn.Investment_{it} = \propto + \beta Crisis + \gamma FC_{it-1} + \mu Crisis \times FC_{it-1} + (X'_{it-1}\lambda) + \varepsilon_{it}$$

where *i* indexes a firm and *t* indexes time. $\Delta Inn.Investment_{it}$ is the change in firm investment in innovation according to equation (a) and (b) in Section 3. FC_{it} is the level of market friction, proxy by WW index; SA index and Altman's *Z*-score 2000; *Crisis* is a dummy variable, taking value one if in Crisis and zero otherwise. X'_{it} is a set of firm characteristics that can affect innovation activities, including *Cash* (Cash/Total Assets), *ROA* (EBITDA/Total Assets), and *Leverage* (Long-term debt/Total Assets), *Age* (the number of years since the firm is listed) and *Size* (Natural log of total assets). Panel A reports results from the early phase of the crisis (2007Q3 to 2008Q3) while Panel B shows results from the later phase (2008Q4 to 2009Q1); and Panel C is from the total phase (2007Q3 to 2009Q1). All variables, except for dummy variables, are winsorized at 1% and 99% to mitigate the effect of outliers. *, **, *** indicate significance at 0.10, 0.05 and 0.01 level, respectively.

	Innovation Investment = R&D/Sales			Innovation Investment = R&D/TA		
	FC = WW index	FC = SA index	FC =Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Crisis= 2007Q3 to 2008Q3						
Crisis	-0.0007	-0.0321*	-0.0005	-1.3512***	-0.1699	-0.0763
	(-1.00)	(-1.65)	(-0.71)	(-14.93)	(-0.73)	(-0.97)
FC	0.0002	0.0066***	-0.0001	0.0151***	0.0576	0.0008
	(0.39)	(6.97)	(-1.31)	(2.52)	(1.60)	(1.01)
Crisis*FC	-0.0013	-0.009**	0.0002*	-5.5528***	-0.0353*	0.0004
	(-0.77)	(-1.98)	(1.67)	(25.29)	(-1.68)	(0.75)
Cash	-0.0013	-0.0011	-0.0024**	-0.0962	-0.1853	-0.1779
	(-1.35)	(-1.01)	(-2.27)	(-0.75)	(-1.44)	(-1.35)
ROA	-0.0206***	-0.0188***	-0.0225***	-0.5987***	-0.6662***	-0.7779***
	(-14.73)	(-12.46)	(-15.73)	(-3.26)	(-3.66)	(-4.06)
Leverage	-0.0021*	-0.0039***	-0.0037***	-0.3179**	-0.3388***	-0.3459**
	(-1.90)	(-3.18)	(-2.89)	(-2.21)	(-2.36)	(-2.29)
Age	0.0011*	0.0051***	0.0024***	0.1078	0.1796**	0.1290
	(1.77)	(6.10)	(3.25)	(1.35)	(2.08)	(1.47)
Size	0.0008***	0.0033***	0.0012***	0.0931***	0.0503***	0.0284
	(5.70)	(9.61)	(7.70)	(5.14)	(2.30)	(1.53)
No. of obs	27902	30784	29728	27978	29661	27910
No. of firms	2044	2150	2095	2045	2143	2015
R-square	0.80%	1.06%	0.92%	2.34%	0.90%	0.90%
Adj R-Sq	0.78%	1.04%	0.89%	2.31%	0.60%	0.60%

	Innovation Investment = R&D/Sales			Innovation Investment = R&D/TA		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Crisis= 2008Q4 to 2009Q1						
Crisis	-0.0014	-0.0019*	-0.0002	-1.911***	-0.4329	-0.1122
	(-1.40)	(-1.65)	(-0.26)	(-13.93)	(-1.62)	(-1.14)
FC	0.0002	0.0064***	-0.0001	0.0177***	0.0667*	0.0005*
	(1.35)	(6.76)	(-0.38)	(2.93)	(1.85)	(1.70)
Crisis*FC	-0.0078***	-0.0007	0.0002***	-8.9475***	-0.1032	0.0002*
	(-2.41)	(-0.71)	(2.32)	(-20.52)	(-1.24)	(1.71)
Cash	-0.0013	-0.0011	-0.0024**	-0.1141	-0.1968	-0.1871
	(-1.32)	(-1.00)	(-2.23)	(-1.05)	(-1.52)	(-1.42)
ROA	-0.0199***	-0.0187***	-0.0223***	-0.5984***	-0.6925***	-0.7813***
	(-14.65)	(-12.39)	(-15.55)	(-3.24)	(-3.80)	(-4.07)
Leverage	-0.0021*	-0.0039***	-0.0037***	-0.3181**	-0.3389***	-0.3475**
	(-1.92)	(-3.17)	(-2.94)	(-2.20)	(-2.36)	(-2.31)
Age	0.0011*	0.0051***	0.0024***	0.1256	0.1681**	0.1210
	(1.80)	(6.15)	(3.26)	(1.56)	(1.95)	(1.38)
Size	0.0008***	0.0033***	0.0012***	0.0888***	0.0485**	0.0293
	(6.14)	(9.66)	(7.73)	(4.87)	(2.21)	(1.58)
No. of obs	27902	30784	29728	27978	29661	27910
No. of firms	2044	2150	2095	2045	2143	2015
R-square	0.80%	1.06%	0.93%	1.58%	0.90%	0.09%
Adj R-Sq	0.77%	1.03%	0.90%	1.56%	0.70%	0.06%
Panel C: Crisis=2007Q3 to 2009Q1						
Crisis	-0.0003	-0.0005*	-0.0044*	-1.38***	-0.0296	-0.0244
	(-0.86)	(-1.73)	(-1.74)	(-16.63)	(-0.75)	(-0.94)
FC	0.0001	0.0064***	-0.0001	0.0147***	0.0584*	0.0006*
	(0.97)	(6.71)	(-1.48)	(2.45)	(1.69)	(1.66)
Crisis*FC	-0.0069*	-0.0002	0.0001**	-5.9469***	-0.0074**	0.0010*
	(-1.74)	(-0.17)	(2.07)	(-28.37)	(-2.12)	(1.71)
Cash	-0.0013	-0.0011	-0.0024**	-0.0875	-0.1873	-0.1798
	(-1.36)	(-1.03)	(-2.28)	(-0.69)	(-1.45)	(-1.36)
ROA	-0.0201***	-0.0187***	-0.0224***	-0.0565***	-0.6713***	-0.7773***
	(-14.73)	(-12.42)	(-15.66)	(-3.08)	(-3.69)	(-4.05)
Leverage	-0.0021**	-0.004***	-0.0037***	-0.3189**	-0.3384***	-0.3471**
	(-1.91)	(-3.17)	(-2.92)	(-2.22)	(-2.35)	(-2.30)
Age	0.0011*	0.0051***	0.0024***	0.1169	0.1769**	0.1278
	(1.75)	(6.11)	(3.23)	(1.46)	(2.05)	(1.46)
Size	0.0008***	0.0033***	0.0012***	0.1221***	0.049**	0.02855
	(5.85)	(9.63)	(7.73)	(6.72)	(2.25)	(1.53)
No. of obs	27902	30784	29728	27978	29661	27910
No. of firms	2044	2150	2095	2045	2143	2015
R-square	0.80%	1.06%	0.92%	2.89%	0.08%	0.08%
Adj R-Sq	0.78%	1.03%	0.90%	2.87%	0.06%	0.06%

Table 5: Regression Estimation of Innovation Investment of High-tech and Low-tech firms (Hypothesis 2)

The table reports the regression model to estimate the change in innovation investment of high-tech and low-tech firms. The regression model is estimated as:

$$\Delta Inn.Investment = \propto + \beta Crisis + \vartheta Innovative + \gamma FC_{it-1} + \mu Crisis \times FC_{it-1} + \\ + \theta Crisis \times Innovative + Innovative \times FC_{it-1} + (X'_{it-1}\lambda) + \varepsilon_{it}$$

where *i* indexes a firm and *t* indexes time. $\Delta Inn.Investment_{it}$, is the change in firm investment in innovation according to equation (a) and (b) in Section 3. $Innovative_i$ is a dummy variable, taking value one if firms are high-tech and zero otherwise. There are two methods to classify high-tech and low-tech firms, once based on the three-digit SIC code and the other follows the approach of He et al. (2014) and the table reports results of both methods. FC_{it} is the level of market friction, proxy by WW index; SA index and Altman's Z-score 2000; *Crisis* is a dummy variable, taking value one if in Crisis and zero otherwise. X'_{it} is a set of firm characteristics that can affect innovation activities, including *Cash* (Cash/Total Assets), *ROA* (EBITDA/Total Assets), and *Leverage* (Long-term debt/Total Assets), *Age* (the number of years since the firm is listed) and *Size* (Natural log of total assets). Panel A reports results from the early phase of the crisis (2007Q3 to 2008Q3) while Panel B shows results from the later phase (2008Q4 to 2009Q1); and Panel C is from the total phase (2007Q3 to 2009Q1). All variables, except for dummy variables, are winsorized at 1% and 99% to mitigate the effect of outliers. *, **, *** indicate significance at 0.10, 0.05 and 0.01 level, respectively.

PART I: INNOVATIVE = THREE-DIGIT SIC CLASSIFICATION

	Innovation Investment = R&D/Sales			Innovation Investment = R&D/TA		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Crisis= 2007Q3 to 2008Q3						
Crisis	-0.0008	-0.0036	-0.0006	-0.8975***	-0.1771	-0.0652
	(-0.74)	(-1.32)	(-0.49)	(-6.44)	(-0.65)	(-0.48)
FC	0.0001	0.0059***	-0.0002***	0.0039	0.0422	-0.0012*
	(0.07)	(5.77)	(-4.17)	(0.65)	(0.82)	(-1.70)
Innovative	0.0008	0.0038*	0.0003	0.4945***	0.0329	0.0499
	(1.19)	(1.81)	(0.44)	(5.92)	(0.18)	(0.58)
Crisis*FC	-0.0039**	-0.0095	0.0001	-3.397***	-0.0364	0.0007
	(-2.26)	(-1.22)	(1.25)	(-14.76)	(-0.49)	(0.47)
Crisis*Innovative	-0.0007	-0.0043	0.0012	-0.0553	-0.0049	0.0179
	(-0.64)	(-0.31)	(0.08)	(-0.35)	(-1.03)	(0.11)
FC*Innovative	0.0031***	0.0013**	-0.0003***	2.3895***	0.0228	-0.0012
	(4.69)	(1.96)	(-4.79)	(28.05)	(0.42)	(-0.85)
Cash	-0.0012	-0.0009	-0.0021*	0.0026	-0.0156	-0.1372
	(-1.11)	(-0.76)	(-1.78)	(0.12)	(-1.11)	(-0.95)
ROA	-0.0201***	-0.0186***	-0.2296***	-0.5929***	-0.6660***	-0.7706***
	(-14.73)	(-12.32)	(-16.03)	(-3.27)	(-3.66)	(-4.01)
Leverage	-0.0022**	-0.0041***	-0.0036***	-0.4118***	-0.3424***	-0.3551***
	(-2.01)	(-3.27)	(-2.85)	(-2.90)	(-2.38)	(-2.35)
Age	0.0011*	0.0052***	0.0024***	0.0965	0.1781**	0.1282
	(1.73)	(6.17)	(3.19)	(1.22)	(2.08)	(1.46)
Size	0.008***	0.0033***	0.0012***	0.1365***	0.0494**	0.0286
	(6.07)	(9.63)	(7.59)	(7.59)	(2.26)	(1.53)
No. of obs	27902	30784	29728	27978	29661	27910
No. of firms	2044	2150	2095	2045	2143	2015
R-square	0.0088	0.0108	0.0099	0.0502	0.0009	0.0009
Adj R-Sq	0.0085	0.0104	0.0096	0.0498	0.0005	0.0005

	Innovation Investment = R&D/Sales			Innovation Investment = R&D/TA		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Crisis= 2008Q4 to 2009Q1						
Crisis	0.0005	0.0005	0.0013	1.8913***	0.2964**	0.0051
	(0.33)	(1.14)	(0.93)	(9.87)	(-1.96)	(0.13)
FC	0.0001	0.0057***	-0.0001***	0.0036	0.0529	-0.0010
	(0.70)	(5.59)	(-4.01)	(0.61)	(1.03)	(-1.12)
Innovative	0.0003	0.0037*	0.0005	0.6033***	0.0453	0.0200
	(0.51)	(1.76)	(0.78)	(7.58)	(0.25)	(0.24)
Crisis*FC	0.0063*	0.0006	-0.0000***	7.5646***	-0.0947	0.0028*
	(1.92)	(0.62)	(-3.18)	(17.52)	(-1.13)	(1.64)
Crisis*Innovative	0.0009	0.0018	-0.0017	0.4615**	0.1703	-0.1769
	(0.61)	(1.01)	(-0.97)	(2.34)	(0.84)	(-0.85)
FC*Innovative	0.0024***	0.0013**	-0.0000***	2.6654***	0.0192	-0.0020
	(3.95)	(1.97)	(-5.33)	(33.09)	(0.36)	(-1.37)
Cash	-0.0011	-0.0009	-0.0020*	0.0034	-0.1705	-0.1442
	(-1.06)	(-0.74)	(-1.71)	(0.82)	(-1.21)	(-1.00)
ROA	-0.0199***	-0.0185***	-0.0227***	-0.5793***	-0.6937***	-0.7620***
	(-14.62)	(-12.23)	(-15.86)	(-3.19)	(-3.81)	(-3.95)
Leverage	-0.0022**	-0.0041***	-0.0037***	-0.4233***	-0.3419***	-0.3612***
	(-2.01)	(-3.26)	(-2.92)	(-2.98)	(-2.38)	(-2.39)
Age	0.0022*	0.0052***	0.0024***	0.1095	0.1676*	0.1191
	(1.77)	(6.23)	(3.20)	(1.39)	(1.94)	(1.36)
Size	0.0009***	0.0034***	0.0012***	0.1543***	0.0470**	0.0304
	(6.50)	(9.70)	(7.61)	(8.56)	(2.16)	(1.63)
No. of obs	27902	30784	29728	27978	29661	27910
No. of firms	2044	2150	2095	2045	2143	2015
R-square	0.0088	0.0107	0.0102	0.0532	0.0014	0.0010
Adj R-Sq	0.0084	0.0104	0.0099	0.0528	0.0011	0.0006

	Innovation Investment = R&D/Sales			Innovation Investment = R&D/TA		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel C: Crisis=2007Q3 to 2009Q1						
Crisis	-0.0008	-0.0009*	-0.0010	-1.0573***	-0.1003*	-0.0655
	(-0.85)	(-1.83)	(-1.32)	(-8.39)	(-1.94)	(-1.54)
FC	0.0003	0.0057***	-0.0024***	0.0037*	0.0429	-0.0009
	(1.18)	(5.55)	(-3.67)	(1.66)	(0.82)	(-1.00)
Innovative	0.0005*	0.0036*	-0.0006	0.5158***	0.0552	-0.0248
	(1.77)	(1.70)	(-0.99)	(5.88)	(1.30)	(-0.97)
Crisis*FC	0.0016**	0.0001	-0.0016***	4.0244***	0.0125	-0.0014
	(1.97)	(0.89)	(-2.55)	(18.36)	(1.02)	(-0.96)
Crisis*Innovative	0.0002	0.0010	-0.0009*	0.1812	0.0842	-0.0616
	(0.23)	(0.76)	(-1.68)	(1.28)	(0.58)	(-0.41)
FC*Innovative	0.0028***	0.0013**	-0.0036***	2.3045***	0.0214	-0.0014
	(4.27)	(1.96)	(-5.10)	(27.21)	(0.94)	(-1.00)
Cash	-0.0012	-0.0009	-0.0021*	0.0111	-0.1588	-0.1394
	(-1.12)	(-0.77)	(-1.80)	(0.18)	(-1.13)	(-0.97)
ROA	-0.0201***	-0.0185***	-0.0229***	-0.5716***	-0.6724***	-0.7690***
	(-14.72)	(-12.27)	(-15.97)	(-3.15)	(-3.69)	(-4.00)
Leverage	-0.0022**	-0.0041***	-0.0037***	-0.4087***	-0.3410***	-0.3570***
	(-2.00)	(-3.26)	(-2.90)	(-2.88)	(-2.37)	(-2.36)
Age	0.0011*	0.0052***	0.0024***	0.1020	0.1761**	0.1261
	(1.72)	(6.19)	(3.18)	(1.29)	(2.04)	(1.44)
Size	0.0008***	0.0034***	0.0012***	0.1575***	0.0483**	0.0290
	(6.12)	(9.66)	(7.61)	(8.73)	(2.21)	(1.55)
No. of obs	27902	30784	29728	27978	29661	27910
No. of firms	2044	2150	2095	2045	2143	2015
R-square	0.0087	0.0107	0.0110	0.0641	0.0090	0.0090
Adj R-Sq	0.0083	0.0104	0.0098	0.0638	0.0060	0.0060

PART II: INNOVATIVE= HE ET AL. (2014) CLASSIFICATION

	Innovation Investment = R&D/Sales			Innovation Investment = R&D/TA		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Crisis= 2007Q3 to 2008Q3						
Crisis	-0.0002	-0.0017*	-0.0013	-1.2079***	-0.1592	0.1218*
	(-0.99)	(-1.65)	(-1.12)	(-8.90)	(-1.63)	(1.89)
FC	0.0001	0.0059***	-0.0000	0.0053*	0.0496	-0.0002
	(0.97)	(5.51)	(-1.20)	(1.91)	(1.36)	(-1.09)
Innovative	0.0013*	0.0046**	0.0020***	1.3668***	0.4593*	0.1030
	(1.91)	(2.05)	(2.60)	(15.49)	(1.94)	(1.15)
Crisis*FC	0.0017	0.0009	-0.0001*	4.4939***	0.0287	-0.0003
	(1.00)	(1.19)	(-1.68)	(20.95)	(0.93)	(-0.92)
Crisis*Innovative	-0.0008	-0.0024*	0.0026*	-0.1580	-0.0120	-0.0663
	(-0.71)	(-1.68)	(1.83)	(-1.02)	(-1.07)	(-1.04)
FC*Innovative	0.0022**	0.0010	-0.0000	5.4311***	0.1239*	0.0006
	(2.22)	(1.44)	(-1.43)	(42.42)	(1.73)	(1.22)
Cash	-0.0015	-0.0014	-0.0030***	-0.0095	-0.1986	-0.2205
	(-1.55)	(-1.27)	(-2.70)	(-0.87)	(-1.46)	(-1.60)
ROA	-0.0201***	-0.0189***	-0.0225***	-0.5966***	-0.6214***	-0.7763***
	(-14.73)	(-12.58)	(-15.73)	(-3.35)	(-3.38)	(-4.04)
Leverage	-0.0021*	-0.0040***	-0.0036***	-0.4367***	-0.3458***	-0.3413**
	(-1.90)	(-3.19)	(-2.85)	(-3.13)	(-2.40)	(-2.26)
Age	0.0008	0.0045****	0.0018**	0.0660	0.1462	0.0839
	(1.15)	(4.87)	(2.14)	(0.76)	(1.54)	(0.86)
Size	0.0009***	0.0033***	0.0012***	0.2670***	0.0766***	0.0299
	(6.13)	(9.65)	(7.84)	(14.79)	(2.92)	(1.60)
No. of obs	27902	30784	29728	27978	29661	27910
No. of firms	2044	2150	2095	2045	2143	2015
R-square	0.0083	0.0109	0.0095	0.0825	0.0010	0.0090
Adj R-Sq	0.0079	0.0105	0.0091	0.0821	0.0006	0.0050

	Innovation Investment = R&D/Sales			Innovation Investment = R&D/TA		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Crisis= 2008Q4 to 2009Q1						
Crisis	0.0024*	0.0032	0.0014	1.0414***	-0.4240	-0.0651
	(1.64)	(1.01)	(0.94)	(5.47)	(-1.47)	(-1.38)
FC	0.0010	0.0057***	-0.0010	0.0077	0.0586	-0.0001
	(1.27)	(5.31)	(-1.06)	(1.31)	(1.61)	(-1.04)
Innovative	0.0012*	0.0043*	0.0017**	1.3441***	0.4779**	0.0978
	(1.85)	(1.92)	(2.30)	(15.81)	(2.02)	(1.15)
Crisis*FC	0.0068**	0.0007*	-0.0000***	4.8005***	-0.1122	0.0018
	(2.02)	(1.71)	(-2.21)	(11.02)	(-1.34)	(1.17)
Crisis*Innovative	-0.0018	-0.0021	-0.0024	-0.0873	-0.0548	-0.0729
	(-1.22)	(-1.16)	(-1.36)	(-1.44)	(-0.27)	(-1.35)
FC*Innovative	0.0016	0.0010	0.0000	5.4097***	0.1277*	0.0004
	(1.58)	(1.43)	(1.01)	(41.16)	(1.78)	(0.97)
Cash	-0.0015	-0.0014	-0.0029***	-0.0376	-0.2107	-0.2301*
	(-1.53)	(-1.25)	(-2.65)	(-1.29)	(-1.56)	(-1.67)
ROA	-0.0200***	-0.0188***	-0.0223***	-0.6217***	-0.6466***	-0.7817***
	(-14.67)	(-12.45)	(-15.55)	(-3.46)	(-3.52)	(-4.06)
Leverage	-0.0021*	-0.0040***	-0.0037***	-0.4347***	-0.3461***	-0.3428**
	(-1.91)	(-3.17)	(-2.89)	(-3.10)	(-2.40)	(-2.27)
Age	0.0008	0.0045***	0.0017**	0.0683	0.1339	0.0755
	(1.18)	(4.89)	(2.12)	(0.98)	(1.41)	(0.78)
Size	0.0009***	0.0034***	0.0012***	0.2485***	0.0752***	0.0308*
	(6.41)	(9.69)	(7.85)	(13.69)	(2.88)	(1.65)
No. of obs	27902	30784	29728	27978	29661	27910
No. of firms	2044	2150	2095	2045	2143	2015
R-square	0.0084	0.0110	0.0095	0.0721	0.0110	0.0110
Adj R-Sq	0.0080	0.0109	0.0091	0.0717	0.0007	0.0007

	Innovation Investment = R&D/Sales			Innovation Investment = R&D/TA		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel C: Crisis=2007Q3 to 2009Q1						
Crisis	0.0005	0.0015*	0.0015	1.1775***	0.0138	0.0693
	(0.96)	(1.67)	(1.38)	(9.51)	(1.07)	(0.96)
FC	0.0012	0.0057***	-0.0001	0.0053*	0.0505	0.0002
	(1.27)	(5.31)	(-1.35)	(1.90)	(1.36)	(1.06)
Innovative	0.0015**	0.0047**	0.0023***	1.3423***	0.4594**	0.1086
	(2.13)	(2.11)	(2.83)	(14.56)	(1.93)	(1.15)
Crisis*FC	0.0003	0.0001	0.0000**	4.6693****	0.0016	0.0009
	(1.17)	(1.17)	(2.10)	(22.66)	(1.03)	(0.76)
Crisis*Innovative	-0.0014	-0.0024*	-0.0028***	-0.1405	0.0001	-0.0659
	(-1.28)	(-1.89)	(-2.18)	(-1.01)	(0.78)	(-1.04)
FC*Innovative	0.0021**	0.0010	0.0000	5.3061***	0.1250*	0.0005
	(2.06)	(1.41)	(1.30)	(41.31)	(1.74)	(0.96)
Cash	-0.0016	-0.0014	-0.0030***	-0.0047	-0.1999	-0.2223*
	(-1.56)	(-1.29)	(-2.72)	(-1.04)	(-1.48)	(-1.67)
ROA	-0.0201***	-0.0189***	-0.0224***	-0.5746***	-0.6260***	-0.7771***
	(-14.74)	(-12.50)	(-15.66)	(-3.22)	(-3.40)	(-4.04)
Leverage	-0.0021*	-0.0040***	-0.0036***	-0.4347***	-0.3456***	-0.3421**
	(-1.90)	(-3.17)	(-2.88)	(-3.12)	(-2.40)	(-2.27)
Age	0.0008	0.0045***	0.0018**	0.0754	0.1437	0.0837
	(1.16)	(4.89)	(2.15)	(0.87)	(1.51)	(0.86)
Size	0.0009***	0.0033***	0.0012***	0.2841***	0.0756***	0.0300
	(6.24)	(9.67)	(7.87)	(15.69)	(2.88)	(1.61)
No. of obs	27902	30784	29728	27978	29661	27910
No. of firms	2044	2150	2095	2045	2143	2015
R-square	0.0083	0.0108	0.0096	0.0848	0.001	0.0091
Adj R-Sq	0.0079	0.0105	0.0092	0.0845	0.0006	0.0085

Table 6: Regression Estimation of Innovation Efficiency and Credit Market Friction (Hypothesis 3)

The table reports the regression model to estimate the impact of credit market friction on firm's innovation efficiency. The regression model is estimated as:

$$\Delta Inn.Efficiency_{it} = \propto + \beta Crisis + \gamma FC_{it-1} + \mu Crisis \times FC_{it-1} + (X'_{it-1}\lambda) + \varepsilon_{it}$$

where *i* indexes a firm and *t* indexes time. $\Delta Inn.Efficiency_{it}$ is the change in firm innovation efficiency according to equation (c) and (d) in Section 3. FC_{it} is the level of market friction, proxy by WW index; SA index and Altman's Z-score 2000; *Crisis* is a dummy variable, taking value one if in Crisis and zero otherwise. X'_{it} is a set of firm characteristics that can affect innovation activities, including *Cash* (Cash/Total Assets), *ROA* (EBITDA/Total Assets), and *Leverage* (Long-term debt/Total Assets), *Age* (the number of years since the firm is listed) and *Size* (Natural log of total assets). Panel A reports results from the early phase of the crisis (2007Q3 to 2008Q3) while Panel B shows results from the later phase (2008Q4 to 2009Q1); and Panel C is from the total phase (2007Q3 to 2009Q1). All variables, except for dummy variables, are winsorized at 1% and 99% to mitigate the effect of outliers. *, **, *** indicate significance at 0.10, 0.05 and 0.01 level, respectively.

	Innovation Efficiency = Patent/Sales			Innovation Efficiency = Citations/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Crisis= 2007Q3 to 2008Q3						
Crisis	0.0013	0.0258	0.0008	0.0223*	0.1024	0.0267*
	(0.02)	(0.15)	(0.02)	(1.92)	(1.58)	(1.80)
FC	0.0019	0.0329	-0.0006	0.0032	0.0101**	-0.0003
	(0.06)	(0.61)	(-0.43)	(1.11)	(2.18)	(-1.22)
Crisis*FC	0.0030	0.0082	-0.0002	0.0303	0.0265	-0.0022*
	(0.02)	(0.16)	(-1.06)	(1.18)	(1.49)	(-1.76)
Cash	0.0525	0.0548	0.0568	-0.0064**	-0.0047	-0.0068**
	(0.92)	(1.07)	(1.09)	(-2.11)	(-1.09)	(-2.12)
ROA	-0.0584	-0.0383	-0.0396	-0.0653*	-0.0294**	-0.0332
	(-0.49)	(-0.37)	(-0.38)	(-1.73)	(-2.27)	(-1.30)
Leverage	-0.1075	-0.0973	-0.1040	0.0237	0.0284	0.0313
	(-1.47)	(-1.45)	(-1.51)	(1.31)	(1.40)	(0.43)
Age	0.0005	0.0151	0.0004	-0.0133	-0.0070	-0.0082
	(0.01)	(0.36)	(0.01)	(-0.37)	(-0.16)	(-0.24)
Size	0.0093	0.0163	0.0083	-0.0019	0.0006	-0.0005
	(1.01)	(0.99)	(0.97)	(-1.02)	(1.03)	(-1.06)
No. of obs	19303	20951	20672	19303	20951	20672
No. of firms	1461	1514	1508	1461	1514	1508
R-square	0.02%	0.02%	0.02%	0.01%	0.01%	0.01%
Adj R-Sq	-0.02%	-0.02%	-0.02%	-0.04%	-0.01%	-0.03%

	Innovation Efficiency = Patent/Sales			Innovation Efficiency = Citations/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC =Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Crisis= 2008Q4 to 2009Q1						
Crisis	0.0095	0.0048	0.0129	0.0299*	0.0305	0.0303*
	(1.16)	(1.02)	(0.33)	(1.65)	(1.14)	(1.73)
FC	0.0020	0.0322	-0.0004	0.0030	0.0028**	-0.0001**
	(1.07)	(0.60)	(-0.33)	(1.10)	(2.05)	(-2.10)
Crisis*FC	0.0078	0.0019	-0.0023	0.0234**	0.0185	-0.0009
	(0.05)	(0.03)	(-0.47)	(2.13)	(1.27)	(-1.17)
Cash	0.0532	0.0556	0.0573*	-0.0081**	-0.0069	-0.0090**
	(0.93)	(1.08)	(1.91)	(-2.14)	(-1.13)	(-2.16)
ROA	-0.0559	-0.0348	-0.0337	-0.0718	-0.0344	-0.0408
	(-0.47)	(-1.33)	(-0.32)	(-0.58)	(-0.31)	(-0.36)
Leverage	-0.1078	-0.0973	-0.1050	0.0234	0.0278	0.0303
	(-1.47)	(-1.45)	(-1.53)	(0.31)	(0.39)	(0.42)
Age	0.0009	0.0161	0.0007	-0.0138	-0.0063	-0.0092
	(0.03)	(0.38)	(0.02)	(-0.38)	(-0.14)	(-0.27)
Size	0.0093	0.0164	0.0084	-0.0016	0.0009	-0.0006
	(1.01)	(0.99)	(0.97)	(-0.17)	(0.05)	(-0.01)
No. of obs	19303	20951	20672	19303	20951	20672
No. of firms	1461	1514	1508	1461	1514	1508
R-square	0.02%	0.02%	0.02%	0.01%	0.01%	0.01%
Adj R-Sq	-0.02%	-0.02%	-0.02%	-0.04%	-0.03%	-0.03%
Panel C: Crisis=2007Q3 to 2009Q1						
Crisis	0.0012	0.0268	0.0015	0.0108**	0.0603*	0.0163
	(0.03)	(0.18)	(0.05)	(2.23)	(1.68)	(0.54)
FC	0.0019	0.0337	-0.0006	0.0030	0.0084**	-0.0003
	(0.06)	(0.62)	(-0.40)	(1.10)	(2.15)	(-0.18)
Crisis*FC	0.0025	0.0094	-0.0001	0.0171	0.0157	-0.0016
	(0.02)	(0.2)	(-0.02)	(1.11)	(0.32)	(-0.60)
Cash	0.0526	0.0550	0.0569	-0.0066**	-0.0055	-0.0076**
	(0.92)	(1.07)	(1.09)	(-2.11)	(-1.01)	(-2.14)
ROA	-0.0581	-0.0378	-0.0392	-0.0664	-0.0316	-0.0375
	(-0.49)	(-0.36)	(-0.37)	(-0.54)	(-0.29)	(-0.34)
Leverage	-0.1077	-0.0975	-0.1041	0.0234	0.0280	0.0312
	(-1.47)	(-1.45)	(-1.51)	(0.31)	(0.40)	(0.43)
Age	0.0006	0.0150	0.0005	-0.0132	-0.0074	-0.0084
	(0.02)	(0.36)	(0.02)	(-0.36)	(-0.1)	(-0.25)
Size	0.0093	0.0162	0.0083	-0.0018	0.0004	-0.0006
	(1.00)	(0.98)	(0.97)	(-0.19)	(0.02)	(-0.06)
No. of obs	19303	20951	20672	19303	20951	20672
No. of firms	1461	1514	1508	1461	1514	1508
R-square	0.02%	0.02%	0.02%	0.01%	0.01%	0.01%
Adj R-Sq	-0.02%	-0.02%	-0.02%	-0.04%	-0.04%	-0.03%

Table 7: Regression Estimation of Innovation Efficiency of High-tech and Low-tech Firms (Hypothesis 4)

The table reports the regression model to estimate the change in innovation investment of high-tech and low-tech firms. The regression model is estimated as:

$$\Delta Inn.Efficiency_{it} = \propto + \beta Crisis + \vartheta Innovative + \gamma FC_{it-1} + \mu Crisis \times FC_{it-1} + \\ + \theta Crisis \times Innovative + Innovative \times FC_{it-1} + (X'_{it-1}\lambda) + \varepsilon_{it}$$

where *i* indexes a firm and *t* indexes time. $\Delta Inn.Efficiency_{it}$, is the change in firm innovation efficiency according to equation (c) and (d) in Section 3. $Innovative_i$ is a dummy variable, taking value one if firms are high-tech and zero otherwise. There are two methods to classify high-tech and low-tech firms, once based on the three-digit SIC code and the other follows the approach of He et al. (2014) and the table reports results of both methods. FC_{it} is the level of market friction, proxy by WW index; SA index and Altman's Z-score 2000; *Crisis* is a dummy variable, taking value one if in Crisis and zero otherwise. X'_{it} is a set of firm characteristics that can affect innovation activities, including *Cash* (Cash/Total Assets), *ROA* (EBITDA/Total Assets), and *Leverage* (Long-term debt/Total Assets), *Age* (the number of years since the firm is listed) and *Size* (Natural log of total assets). Panel A reports results from the early phase of the crisis (2007Q3 to 2008Q3) while Panel B shows results from the later phase (2008Q4 to 2009Q1); and Panel C is from the total phase (2007Q3 to 2009Q1). All variables, except for dummy variables, are winsorized at 1% and 99% to mitigate the effect of outliers. *, **, *** indicate significance at 0.10, 0.05 and 0.01 level, respectively.

PART I: INNOVATIVE= THREE-DIGIT SIC CLASSIFICATION

	Innovation Efficiency = Patent/Sales			Innovation Efficiency = Citations/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Crisis= 2007Q3 to 2008Q3						
Crisis	0.0050	-0.0160	0.0083	-0.0858*	-0.1967*	-0.0913***
	(0.06)	(-0.09)	(0.12)	(-1.89)	(-1.80)	(-2.26)
FC	-0.0258	0.0246	0.0001	0.0301	0.0492*	0.0015
	(-0.96)	(0.94)	(1.04)	(1.41)	(1.65)	(1.51)
Innovative	0.0514*	0.0742	0.0509	-0.0523	-0.1836*	-0.0408**
	(1.94)	(0.40)	(1.29)	(-1.12)	(-1.94)	(-1.98)
Crisis*FC	-0.0006	-0.0075	0.0001	-0.0355	-0.0352	0.0019
	(-0.91)	(-1.14)	(1.04)	(-0.21)	(-0.64)	(0.66)
Crisis*Innovative	-0.0089	-0.0095	-0.0113	-0.0784*	-0.0839*	0.0815*
	(-0.11)	(-0.13)	(-0.15)	(-1.95)	(-1.86)	(1.12)
FC*Innovative	0.0285	0.0081	-0.0008	-0.0317	-0.0405	-0.0024
	(1.36)	(0.15)	(-0.29)	(-0.39)	(-0.70)	(-0.79)
Cash	0.0334	0.0342	0.0360	0.0054**	0.0097*	0.0079
	(0.57)	(0.64)	(0.66)	(1.89)	(1.77)	(0.14)
ROA	-0.0567	-0.0372	-0.0391	-0.0662	-0.0346	-0.0268
	(-0.48)	(-1.36)	(-1.37)	(-1.54)	(-1.31)	(-0.24)
Leverage	-0.1051	-0.0944	-0.1007	0.0214**	0.0259**	0.0254
	(-1.43)	(-1.41)	(-1.46)	(2.28)	(1.97)	(1.35)
Age	0.0008	0.0147*	0.0008	-0.0128	-0.0040	-0.0083
	(1.02)	(1.75)	(1.02)	(-1.35)	(-1.09)	(-1.24)
Size	0.0095	0.0161**	0.0088	-0.0020***	0.0020*	-0.0001**
	(1.03)	(1.97)	(1.02)	(-2.41)	(1.92)	(-2.01)
No. of obs	19303	20951	20672	19303	20951	20672
No. of firms	1461	1514	1508	1461	1514	1508
R-square	0.03%	0.03%	0.03%	0.01%	0.02%	0.02%
Adj R-Sq	-0.03%	-0.02%	-0.02%	-0.04%	-0.04%	-0.04%

	Innovation Efficiency = Patent/Sales			Innovation Efficiency = Citations/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Crisis= 2008Q4 to 2009Q1						
Crisis	0.0347	0.0420	0.0432	-0.2871***	-0.3229	-0.2818***
	(0.35)	(0.18)	(0.51)	(-2.81)	(-1.31)	(-3.17)
FC	-0.0263	0.0238	0.0003	0.0312***	0.0425	0.0017*
	(-0.36)	(0.33)	(0.12)	(2.42)	(0.56)	(1.74)
Innovative	0.0535	0.0768	0.0533	-0.0775*	-0.2084	-0.0656*
	(1.24)	(0.42)	(1.41)	(-1.74)	(-1.07)	(-1.65)
Crisis*FC	0.0124	0.0015	-0.0023	0.0639	0.0152	-0.0019
	(0.07)	(0.02)	(-0.46)	(0.36)	(0.22)	(-0.37)
Crisis*Innovative	0.0306	0.0338	0.0384	0.3158***	0.3119***	0.3143***
	(0.31)	(0.36)	(0.41)	(3.10)	(3.19)	(3.19)
FC*Innovative	0.0286	0.0082	-0.0008	-0.0325	-0.0411	-0.0022
	(0.37)	(0.15)	(-0.29)	(-0.40)	(-0.71)	(-0.73)
Cash	0.0342	0.0350	0.0366	0.0037	0.0068	0.0054
	(0.58)	(0.65)	(0.67)	(0.06)	(0.12)	(0.09)
ROA	-0.0544	-0.0337	-0.0333	-0.0699	-0.0403	-0.0359
	(-0.46)	(-0.32)	(-0.31)	(-0.57)	(-0.36)	(-0.32)
Leverage	-0.1054	-0.0944	-0.1017	0.0211	0.0250	0.0251
	(-1.44)	(-1.41)	(-1.48)	(0.28)	(0.35)	(0.35)
Age	0.0013	0.0158	0.0010	-0.0137	-0.0049	-0.0092
	(0.04)	(0.38)	(0.03)	(-0.38)	(-0.11)	(-0.27)
Size	0.0096	0.0163**	0.0088	-0.0020	0.0017	-0.0002
	(1.04)	(1.98)	(1.02)	(-0.21)	(0.10)	(-0.02)
No. of obs	19303	20951	20672	19303	20951	20672
No. of firms	1461	1514	1508	1461	1514	1508
R-square	0.03%	0.03%	0.0003	0.06%	0.06%	0.06%
Adj R-Sq	-0.03%	-0.02%	-0.0002	0.01%	0.01%	0.01%

	Innovation Efficiency = Patent/Sales			Innovation Efficiency = Citations/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel C: Crisis=2007Q3 to 2009Q1						
Crisis	0.0211	0.0015	0.0248	-0.1085*	-0.1968**	-0.1122*
	(0.28)	(0.01)	(0.40)	(-1.90)	(-2.11)	(-1.73)
FC	-0.0261	0.0251	0.0002	0.0313	0.0486***	0.0015*
	(-0.36)	(0.34)	(0.06)	(1.42)	(2.63)	(1.93)
Innovative	0.0573	0.0798	0.0579	0.0733	0.2028	0.0615
	(1.21)	(0.43)	(1.38)	(1.50)	(1.04)	(1.39)
Crisis*FC	0.0050	-0.0070	-0.0001	-0.0340***	-0.0281*	0.0015
	(0.03)	(-0.15)	(-0.01)	(-2.23)	(-1.77)	(0.54)
Crisis*Innovative	0.0242	0.0263	0.0290	0.1184*	0.1222*	0.1203*
	(0.34)	(0.39)	(0.43)	(1.79)	(1.71)	(1.67)
FC*Innovative	0.0286	0.0079	-0.0009	0.0329	0.0401*	-0.0024**
	(0.37)	(0.14)	(-0.30)	(1.41)	(1.69)	(-1.97)
Cash	0.0335	0.0344	0.0361	0.0055	0.0090	0.0072
	(0.57)	(0.64)	(0.66)	(0.09)	(0.16)	(0.12)
ROA	-0.0567	-0.0368	-0.0386	-0.0659	-0.0365	-0.0305
	(-0.48)	(-0.35)	(-0.36)	(-0.54)	(-0.33)	(-0.27)
Leverage	-0.1051	-0.0944	-0.1007	0.0207	0.0251	0.0250
	(-1.43)	(-1.41)	(-1.46)	(0.27)	(0.35)	(0.34)
Age	0.0008	0.0145	0.0007	-0.0123	-0.0043	-0.0080
	(0.02)	(0.35)	(0.02)	(-0.34)	(-0.1)	(-0.23)
Size	0.0096	0.0160	0.0087	-0.0021	0.0017	-0.0001
	(1.02)	(0.96)	(1.02)	(-0.22)	(0.10)	(-0.01)
No. of obs	19303	20951	20672	19303	20951	20672
No. of firms	1461	1514	1508	1461	1514	1508
R-square	0.03%	0.03%	0.03%	0.02%	0.02%	0.02%
Adj R-Sq	-0.03%	-0.02%	-0.02%	-0.04%	-0.03%	-0.03%

PART II: INNOVATIVE= HE ET AL. (2014) CLASSIFICATION

	Innovation Efficiency = Patent/Sales			Innovation Efficiency = Citations/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Crisis= 2007Q3 to 2008Q3						
Crisis	-0.0613	-0.0402	-0.0534	-0.0200***	-0.1136*	-0.0290
	(-0.76)	(-0.24)	(-0.79)	(-2.24)	(-1.65)	(-1.41)
FC	-0.0015	0.0239	-0.0012	0.0041	0.0728*	-0.0002
	(-1.04)	(1.35)	(-0.59)	(1.11)	(1.81)	(-0.07)
Innovative	-0.0823	-0.0372	-0.0826*	-0.0140**	-0.2513	-0.0138
	(-1.57)	(-0.22)	(-1.70)	(-1.96)	(-1.39)	(-0.27)
Crisis*FC	0.0068	0.0033	0.0005	-0.0293	-0.0347	0.0022
	(0.94)	(0.96)	(1.18)	(-1.17)	(-1.61)	(0.77)
Crisis*Innovative	0.0742	0.0624	0.0630	-0.0031	-0.0197	0.0021
	(0.93)	(0.82)	(0.85)	(-1.04)	(-1.25)	(1.03)
FC*Innovative	0.0023	0.0135	0.0004	-0.0024**	-0.0814**	-0.0005
	(1.04)	(0.24)	(0.17)	(-2.04)	(-1.97)	(-0.17)
Cash	0.0586	0.0603	0.0634	-0.0052**	-0.0080	-0.0054
	(1.03)	(1.17)	(1.21)	(-1.99)	(-1.15)	(-0.90)
ROA	-0.0562	-0.0344	-0.0321	-0.0643	-0.0110	-0.0298
	(-0.47)	(-0.33)	(-0.30)	(-0.92)	(-0.71)	(-1.27)
Leverage	-0.1091	-0.0984	-0.1064	0.0235	0.0304*	0.0298
	(-1.49)	(-1.47)	(-1.54)	(1.31)	(1.93)	(0.41)
Age	0.0387**	0.0541	0.0395	-0.0046	0.0030	0.0011
	(1.86)	(1.08)	(0.94)	(-0.10)	(0.06)	(0.02)
Size	0.0095	0.0177	0.0083	-0.0020	-0.0020	-0.0004
	(1.01)	(1.06)	(0.97)	(-1.20)	(-1.11)	(-1.04)
No. of obs	19303	20951	20672	19303	20951	20672
No. of firms	1461	1514	1508	1461	1514	1508
R-square	0.03%	0.03%	0.03%	0.01%	0.01%	0.01%
Adj R-Sq	-0.02%	-0.02%	-0.02%	-0.05%	-0.04%	-0.05%

	Innovation Efficiency = Patent/Sales			Innovation Efficiency = Citations/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Crisis= 2008Q4 to 2009Q1						
Crisis	-0.0193	0.0045	-0.0110	-0.0469***	0.0159**	-0.0385*
	(-1.20)	(1.02)	(-1.13)	(-2.47)	(2.07)	(-1.74)
FC	-0.0020	0.0256	-0.0011	0.0041*	0.0617*	0.0003
	(-1.06)	(1.38)	(-0.54)	(1.91)	(1.86)	(1.14)
Innovative	0.0675	0.0261	0.0704	0.0171	0.2494	0.0137
	(1.35)	(0.15)	(1.51)	(0.33)	(1.38)	(0.28)
Crisis*FC	0.0086	0.0053	-0.0022	-0.0198***	0.0188**	-0.0010
	(1.05)	(1.08)	(-1.45)	(-2.11)	(1.96)	(-1.19)
Crisis*Innovative	0.0366	0.0294	0.0297	0.0226	0.0200**	-0.0102**
	(1.37)	(1.31)	(1.32)	(1.22)	(2.20)	(-2.10)
FC*Innovative	0.0027	0.0131	0.0006	0.0034**	0.0787***	-0.0004**
	(1.04)	(0.23)	(0.24)	(2.05)	(2.93)	(-2.13)
Cash	0.0588	0.0607	0.0632	-0.0071	-0.0102	-0.0077
	(1.03)	(1.18)	(1.21)	(-1.12)	(-1.19)	(-1.14)
ROA	-0.0524	-0.0303	-0.0264	-0.0709	-0.0168	-0.0380
	(-1.44)	(-0.29)	(-0.25)	(-1.57)	(-1.15)	(-1.34)
Leverage	-0.1089	-0.0982**	-0.1068	0.0232**	0.0294	0.0290
	(-1.49)	(-1.96)	(-1.55)	(2.31)	(1.42)	(1.40)
Age	0.0391	0.0554	0.0395*	-0.0060*	0.0022	-0.0008
	(0.87)	(1.11)	(1.94)	(-1.83)	(1.04)	(-1.02)
Size	0.0094	0.0179	0.0083**	-0.0017	-0.0016	-0.0004
	(1.00)	(1.07)	(1.96)	(-1.18)	(-1.09)	(-1.05)
No. of obs	19303	20951	20672	19303	20951	20672
No. of firms	1461	1514	1508	1461	1514	1508
R-square	0.03%	0.03%	0.03%	0.01%	0.01%	0.01%
Adj R-Sq	-0.03%	-0.02%	-0.02%	-0.05%	-0.04%	-0.05%

	Innovation Efficiency = Patent/Sales			Innovation Efficiency = Citations/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel C: Crisis=2007Q3 to 2009Q1						
Crisis	-0.0597*	-0.0413	-0.0550*	-0.0251*	-0.0764	-0.0313
	(-1.81)	(-0.27)	(-1.89)	(-1.93)	(-0.48)	(-0.48)
FC	-0.0014	0.0235	-0.0013	0.0042**	0.0697	-0.0001*
	(-0.04)	(0.34)	(-0.62)	(2.02)	(0.96)	(-1.86)
Innovative	0.0897*	0.0432***	0.0910*	0.0211***	0.2554**	-0.0194*
	(1.63)	(2.25)	(1.78)	(2.37)	(1.97)	(-1.86)
Crisis*FC	0.0064	0.0030	-0.0004	0.0139	0.0194***	0.0018
	(0.04)	(0.06)	(-0.14)	(0.09)	(2.38)	(0.64)
Crisis*Innovative	0.0748*	0.0654**	0.0675**	0.0183*	0.0050***	0.0179**
	(1.72)	(1.96)	(1.99)	(1.74)	(3.87)	(2.25)
FC*Innovative	0.0021	0.0139*	0.0005	0.0035**	0.0807*	-0.0005**
	(0.73)	(1.75)	(0.21	(1.96)	(1.66)	(-1.97)
Cash	0.0581	0.0602	0.0632	-0.0055	-0.0087	-0.0061
	(1.02)	(1.17)	(1.21)	(-0.09)	(-0.16)	(-0.11)
ROA	-0.0554	-0.0338	-0.0324	-0.0658	-0.0136	-0.0344
	(-0.46)	(-0.32)	(-0.30)	(-0.53)	(-0.12)	(-0.31)
Leverage	-0.1093**	-0.0988*	-0.1066*	0.0230	0.0298	0.0295*
	(-1.99)	(-1.87)	(-1.75)	(1.30)	(1.42)	(1.81)
Age	0.0383	0.0538	0.0391	-0.0050	0.0017	0.0004
	(0.85)	(1.08)	(0.93)	(-0.11)	(0.03)	(0.01)
Size	0.0095*	0.0177	0.0083**	-0.0019	-0.0022	-0.0004
	(1.81)	(1.06)	(1.97)	(-0.19)	(-0.13)	(-0.05)
No. of obs	19303	20951	20672	19303	20951	20672
No. of firms	1461	1514	1508	1461	1514	1508
R-square	0.03%	0.03%	0.04%	0.01%	0.01%	0.01%
Adj R-Sq	-0.02%	-0.02%	-0.02%	-0.05%	-0.04%	-0.05%

Table 8: Regression Estimation of Performance of High-tech and Low-tech Firms (Hypothesis 5)

The table reports the regression model to estimate the change in innovation investment of high-tech and low-tech firms. The regression model is estimated as:

$$\Delta Performance_{it} = \propto + \beta Crisis + \vartheta Innovative + \gamma FC_{it-1} + \mu Crisis \times FC_{it-1} + + \theta Crisis \times Innovative + Innovative \times FC_{it-1} + (X'_{it-1}\lambda) + \varepsilon_{it}$$

where *i* indexes a firm and *t* indexes time. $\Delta Performance_{it}$, is the change in firm sales (measured by ln(sales)) and profitability (measured by NI/sales). $Innovative_i$ is a dummy variable, taking value one if firms are high-tech and zero otherwise. There are two methods to classify high-tech and low-tech firms, once based on the three-digit SIC code and the other follows the approach of He, Qui, and Tang (2014) and the table reports results of both methods. FC_{it} is the level of market friction, proxy by WW index; SA index and Altman's Z-score 2000; *Crisis* is a dummy variable, taking value one if in Crisis and zero otherwise. X'_{it} is a set of firm characteristics that can affect innovation activities, including *Cash* (Cash/Total Assets), *ROA* (EBITDA/Total Assets), and *Leverage* (Long-term debt/Total Assets), *Age* (the number of years since the firm is listed) and *Size* (Natural log of total assets). Panel A reports results from the early phase of the crisis (2007Q3 to 2008Q3) while Panel B shows results from the later phase (2008Q4 to 2009Q1); and Panel C is from the total phase (2007Q3 to 2009Q1). All variables, except for dummy variables, are winsorized at 1% and 99% to mitigate the effect of outliers. *, **, *** indicate significance at 0.10, 0.05 and 0.01 level, respectively.

PART I: THREE-DIGIT SIC CLASSIFICATION

	Performance= ln(Sales)			Performance= NI/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Crisis= 2007Q3 to 2008Q3						
Crisis	0.04207***	0.0150	-0.0001	0.3928	-0.0518	0.0944
	(3.46)	(0.64)	(-0.01)	(0.87)	(-0.06)	(0.21)
FC	-0.0001	0.0147***	-0.0001	0.0002	0.0324	-0.0125***
	(-0.25)	(3.34)	(-1.22)	(0.01)	(0.19)	(-4.24)
Innovative	0.0379***	0.0405***	0.0200***	0.8092***	0.7669	0.5159*
	(5.33)	(2.63)	(2.76)	(3.07)	(1.30)	(1.85)
Crisis*FC	0.1990***	0.0045	-0.0001	2.2719***	0.0364	-0.0019
	(9.83)	(0.70)	(-0.35)	(3.02)	(0.15)	(-0.35)
Crisis*Innovative	0.0085	0.0100	0.0075	0.4449	0.5683	0.5913
	(0.62)	(0.71)	(0.52)	(0.87)	(1.06)	(1.07)
FC*Innovative	0.0710***	0.0074	-0.0001	1.7967***	0.1285	-0.0226***
	(9.75)	(1.59)	(-0.06)	(6.65)	(0.73)	(-4.61)
Cash	-0.0190	-0.0041	-0.0209*	-0.3068	-0.0214	-0.3205
	(-1.61)	(-0.35)	(-1.70)	(-0.70)	(-0.05)	(-0.68)
ROA	0.1809***	0.1744***	0.1839***	10.6709***	11.2675***	13.3405***
	(11.47)	(11.21)	(11.15)	(18.24)	(19.01)	(20.99)
Leverage	0.0162	0.0160	0.0212*	1.8239***	1.7889***	1.4556***
	(1.32)	(1.30)	(1.65)	(4.02)	(3.83)	(2.93)
Age	-0.0317***	-0.0233***	-0.0338***	-0.2820	-0.1912	-0.5130*
	(-4.63)	(-3.17)	(-4.48)	(-1.11)	(-0.68)	(-1.76)
Size	0.0005	0.0028	-0.0039***	-0.4499***	-0.5502***	-0.5516***
	(0.34)	(1.50)	(-2.45)	(-7.87)	(-7.72)	(-9.00)
No. of obs	29494	31517	29588	29526	31553	29624
No. of firms	2110	2224	2083	2110	2225	2084
R-square	1.52%	0.73%	0.56%	1.37%	1.16%	1.54%
Adj R-Sq	1.48%	0.69%	0.52%	1.34%	1.12%	1.50%

	Performance= ln(Sales)			Performance= NI/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Crisis= 2008Q4 to 2009Q1						
Crisis	0.0277*	-0.0502*	-0.0890***	3.2923***	0.5936	0.3228
	(1.65)	(-1.85)	(-6.12)	(5.27)	(0.57)	(0.58)
FC	-0.0001	0.0134***	-0.0001	-0.0003	0.0259	-0.0103***
	(-0.26)	(3.04)	(-0.77)	(-0.01)	(0.15)	(-3.57)
Innovative	0.0396***	0.0368***	0.0166***	0.7405***	0.6879	0.4013
	(5.83)	(2.41)	(2.40)	(2.93)	(1.17)	(1.50)
Crisis*FC	0.4522***	0.0111	-0.0004**	12.3869***	0.0902	-0.0187***
	(11.75)	(1.51)	(-2.16)	(8.67)	(0.32)	(-2.69)
Crisis*Innovative	0.0035	0.0180	0.0197	0.2710	0.1284	0.2093
	(0.20)	(1.02)	(1.10)	(0.42)	(0.19)	(0.30)
FC*Innovative	0.0865***	0.0073	-0.0001	1.8429***	0.1392	-0.0216***
	(12.52)	(1.59)	(-0.01)	(7.19)	(0.79)	(-4.43)
Cash	-0.0223*	-0.0082	-0.0249**	-0.2436	0.0079	-0.2761
	(-1.89)	(-0.68)	(-2.04)	(-0.56)	(0.02)	(-0.58)
ROA	0.1749***	0.1669***	0.1760***	10.8014***	11.3248***	13.3660***
	(11.1)	(10.74)	(10.67)	(18.46)	(19.09)	(21.01)
Leverage	0.0152	0.0160	0.0217*	1.7978***	1.7785***	1.4704***
	(1.24)	(1.30)	(1.69)	(3.97)	(3.81)	(2.96)
Age	-0.0328***	-0.0259***	-0.0369***	-0.2257	-0.1626	-0.4829*
	(-4.79)	(-3.53)	(-4.89)	(-0.89)	(-0.58)	(-1.66)
Size	0.0019	0.0029	-0.0035**	-0.4045***	-0.5473***	-0.5539***
	(1.20)	(1.54)	(-2.21)	(-7.05)	(-7.72)	(-9.04)
No. of obs	29494	31517	29588	29526	31553	29624
No. of firms	2110	2224	2083	2110	2225	2084
R-square	1.91%	0.96%	0.83%	1.59%	1.15%	1.55%
Adj R-Sq	1.87%	0.93%	0.79%	1.55%	1.12%	1.52%

	Performance= ln(Sales)			Performance= NI/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel C: Crisis=2007Q3 to 2009Q1						
Crisis	0.0120	-0.0130	-0.0395***	0.6389	-0.2296	0.2099
	(1.09)	(-0.66)	(-3.80)	(1.57)	(-0.30)	(0.52)
FC	-0.0001	0.0129***	0.0000	0.0001	0.0543	-0.0136***
	(-0.24)	(2.89)	(-0.49)	(0.01)	(0.32)	(-4.45)
Innovative	0.0357***	0.0388***	0.0172**	0.7658***	0.7480	0.5283
	(4.8)	(2.49)	(2.26)	(2.77)	(1.26)	(1.53)
Crisis*FC	0.2197***	0.0075	-0.0002*	2.7501***	-0.1223	0.0055**
	(11.39)	(1.39)	(-1.76)	(3.84)	(-0.60)	(2.12)
Crisis*Innovative	0.0002	0.0018	0.0054	0.2394	0.3690	0.4580*
	(0.02)	(0.15)	(0.42)	(0.53)	(0.77)	(1.93)
FC*Innovative	0.0684***	0.0075	0.0001	1.7358***	0.1265	-0.0234***
	(9.43)	(1.62)	(0.16)	(6.45)	(0.72)	(-4.74)
Cash	-0.0214*	-0.0066	-0.0232*	-0.2979	-0.0232	-0.3258
	(-1.79)	(-0.55)	(-1.90)	(-0.68)	(-0.05)	(-0.69)
ROA	0.1773***	0.1705***	0.1794***	10.6859***	11.2584***	13.34582***
	(11.24)	(10.95)	(10.87)	(18.25)	(18.97)	(20.98)
Leverage	0.0164	0.0165	0.0228*	1.8181***	1.7799***	1.4309***
	(1.35)	(1.34)	(1.77)	(4.01)	(3.81)	(2.88)
Age	-0.0329***	-0.0250***	-0.0360***	-0.2713	-0.1917	-0.5075*
	(-4.82)	(-3.40)	(-4.77)	(-1.07)	(-0.68)	(-1.74)
Size	0.0018	0.0029	-0.0037***	-0.4363***	-0.5521***	-0.5503***
	(1.15)	(1.54)	(-2.33)	(-7.59)	(-7.75)	(-8.98)
No. of obs	29494	31517	29588	29526	31553	29624
No. of firms	2110	2224	2083	2110	2225	2084
R-square	1.76%	0.83%	0.68%	1.38%	1.15%	1.53%
Adj R-Sq	1.72%	0.80%	0.64%	1.35%	1.12%	1.50%

PART II: INNOVATIVE= HE ET AL. (2014) CLASSIFICATION

	Performance= ln(Sales)			Performance= NI/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Crisis= 2007Q3 to 2008Q3						
Crisis	0.0627***	0.0111	0.0065	0.6013	-0.4678	-0.1839
	(5.22)	(0.51)	(0.55)	(1.35)	(-0.56)	(-0.40)
FC	0.0001	0.0192***	-0.0002	0.0007	0.1124	-0.0179**
	(0.22)	(6.13)	(-0.69)	(0.04)	(0.94)	(-1.97)
Innovative	0.0420***	0.0324	0.0001	1.0127***	0.5323	-0.1734
	(5.55)	(1.61)	(0.02)	(3.60)	(0.69)	(-0.60)
Crisis*FC	0.2329***	0.0027	-0.0001	3.1016***	-0.0895	-0.0017
	(12.13)	(0.42)	(-0.38)	(4.35)	(-0.37)	(-0.32)
Crisis*Innovative	0.0283**	0.0120	0.0167	0.4782	0.1709	0.1582
	(2.06)	(0.86)	(1.15)	(0.94)	(0.32)	(0.28)
FC*Innovative	0.1643***	0.0119**	-0.0003	4.1465***	0.2126	-0.0002
	(15.34)	(1.96)	(-1.10)	(10.43)	(0.91)	(-0.03)
Cash	-0.0011	0.0125	-0.0062	0.0001	0.2686	-0.0855
	(-0.09)	(1.09)	(-0.52)	(0.01)	(0.61)	(-0.19)
ROA	0.1800***	0.1769***	0.1819***	10.6647***	11.3155***	13.0729***
	(11.44)	(11.27)	(11.07)	(18.26)	(18.93)	(20.63)
Leverage	0.0131	0.0127	0.0202	1.7608***	1.7254***	1.5570***
	(1.07)	(1.03)	(1.57)	(3.89)	(3.69)	(3.14)
Age	-0.0301***	-0.0192***	-0.0314***	-0.2445	-0.1001	-0.3938
	(-3.96)	(-2.38)	(-3.76)	(-0.86)	(-0.32)	(-1.23)
Size	0.0040***	0.0049**	-0.0043***	-0.3599***	-0.5133***	-0.5857***
	(2.52)	(2.20)	(-2.73)	(-6.18)	(-6.03)	(-9.59)
No. of obs	29494	31517	29588	29526	31553	29624
No. of firms	2110	2224	2083	2110	2225	2084
R-square	1.96%	0.71%	0.54%	1.58%	1.15%	1.45%
Adj R-Sq	1.93%	0.68%	0.50%	1.55%	1.12%	1.42%

	Performance= ln(Sales)			Performance= NI/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Crisis= 2008Q4 to 2009Q1						
Crisis	0.0416***	-0.0193	-0.0511***	2.5735***	0.3519	0.0726
	(2.47)	(-0.76)	(-3.41)	(4.12)	(0.36)	(0.13)
FC	0.0001	0.0179***	0.0002	0.0023	0.1056	-0.0169*
	(0.04)	(5.71)	(0.74)	(0.12)	(0.88)	(-1.86)
Innovative	0.0400***	0.0329*	0.0020	0.7818***	0.4642	-0.2374
	(5.5)	(1.65)	(0.28)	(2.90)	(0.61)	(-0.86)
Crisis*FC	0.3856***	0.0097	-0.0004**	10.4977***	0.0730	-0.0207***
	(9.88)	(1.31)	(-2.24)	(7.24)	(0.26)	(-2.98)
Crisis*Innovative	0.0393**	0.0354**	0.0366**	0.2063**	0.1790	0.1920
	(2.27)	(1.99)	(2.00)	(2.32)	(1.26)	(1.27)
FC*Innovative	0.1549***	0.0112*	-0.0002	3.7032***	0.2106	0.0009
	(14.22)	(1.84)	(-0.97)	(9.15)	(0.91)	(0.09)
Cash	-0.0058	0.0082	-0.0102	0.0317	0.2968	-0.0394
	(-0.51)	(0.72)	(-0.87)	(0.08)	(0.68)	(-0.09)
ROA	0.1723***	0.1687***	0.1736***	10.7703***	11.3723***	13.1029***
	(10.94)	(10.75)	(10.56)	(18.42)	(19.01)	(20.66)
Leverage	0.0129	0.0128	0.0206	1.7518***	1.7223***	1.5613***
	(1.06)	(1.04)	(1.61)	(3.87)	(3.68)	(3.15)
Age	-0.0322***	-0.0223***	-0.0349***	-0.2035	-0.0761	-0.3710
	(-4.23)	(-2.76)	(-4.19)	(-0.72)	(-0.25)	(-1.15)
Size	0.0039***	0.0049**	-0.0039***	-0.3496***	-0.5104***	-0.5860***
	(2.47)	(2.19)	(-2.46)	(-6.01)	(-6.01)	(-9.60)
No. of obs	29494	31517	29588	29526	31553	29624
No. of firms	2110	2224	2083	2110	2225	2084
R-square	2.04%	0.95%	0.82%	1.69%	1.15%	1.48%
Adj R-Sq	2.01%	0.92%	0.78%	1.65%	1.12%	1.44%

	Performance= ln(Sales)			Performance= NI/Sales		
	FC = WW index	FC = SA index	FC = Z-score	FC = WW index	FC = SA index	FC = Z-score
	(1)	(2)	(3)	(4)	(5)	(6)
Panel C: Crisis=2007Q3 to 2009Q1						
Crisis	0.0403***	0.0015	-0.0185*	0.7823*	0.4687	-0.0194
	(3.69)	(0.08)	(-1.73)	(1.93)	(-0.67)	(-0.05)
FC	-0.0001	0.0178***	0.0002	0.0006	0.1345	-0.0182**
	(-0.21)	(5.55)	(0.80)	(0.03)	(1.10)	(-2.00)
Innovative	0.0452***	0.0344*	0.0041	0.9763***	0.5643	-0.1768
	(5.74)	(1.70)	(0.52)	(3.33)	(0.73)	(-0.58)
Crisis*FC	0.2419***	0.0060	-0.0002*	3.2434***	-0.1616	0.0013
	(13.12)	(1.12)	(-1.81)	(4.73)	(-0.79)	(0.26)
Crisis*Innovative	0.0351***	0.0221*	0.0255**	0.2806	0.1729	-0.0916
	(2.85)	(1.76)	(1.95)	(0.61)	(0.36)	(-0.18)
FC*Innovative	0.1588***	0.0112*	-0.0002	4.0674***	0.2170	-0.0008
	(14.79)	(1.85)	(-0.93)	(10.19)	(0.93)	(-0.08)
Cash	-0.0031	0.0102	-0.0080	0.0049	0.2662	-0.0906
	(-0.28)	(0.89)	(-0.68)	(0.01)	(0.61)	(-0.20)
ROA	0.1757***	0.1723***	0.1773***	10.6747***	11.3084***	13.0669***
	(11.17)	(10.97)	(10.78)	(18.25)	(18.90)	(20.60)
Leverage	0.0134	0.0134	0.0216***	1.7557***	1.7189***	1.5428***
	(1.10)	(1.09)	(1.68)	(3.88)	(3.67)	(3.11)
Age	-0.0312***	-0.0207***	-0.0333***	-0.2361	-0.1018	-0.3887
	(-4.09)	(-2.56)	(-3.99)	(-0.83)	(-0.33)	(-1.21)
Size	0.0051***	0.0049**	-0.0041***	-0.3485***	-0.5138***	-0.5851***
	(3.23)	(2.20)	(-2.59)	(-5.96)	(-6.04)	(-9.58)
No. of obs	29494	31517	29588	29526	31553	29624
No. of firms	2110	2224	2083	2110	2225	2084
R-square	2.18%	0.82%	0.67%	1.59%	1.15%	1.45%
Adj R-Sq	2.15%	0.79%	0.63%	1.55%	1.12%	1.41%