ESSAYS ON INNOVATION AND CAPITAL STRUCTURE

by Jiahong Zhang

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A Dissertation

Presented to the Faculty of the Graduate School

of Cornell University

In Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

by

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August 2010

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Cornell University 2010

This dissertation aims at improving the understanding of the relation between innovation investment, financial constraints and capital structure in the context of emerging economies. Since early 1930s, economists have argued that innovation is essential for firm survival, economic growth and development. An independent strand of the literature demonstrates that innovation by firms is a key driver of economic growth. Meanwhile, people also recognized that innovation investment is difficult to finance in a competitive marketplace due to various factors such as taxes, transaction costs, and especially informational asymmetries with external investors. Therefore, financing of innovation becomes an important managerial and policy challenge.

A lot of studies have focused on identifying the financial constraints related to risky R&D and innovation investments. Nevertheless, there is little research highlighting the mechanisms that different external financing sources can affect innovation activities differently. Moreover, the implications of innovation investment for future capital structure decisions have not been fully analyzed. I try to shed light on these issues using micro evidence in the context of emerging markets, where financial markets, political systems and economic systems are different than those in the industrialized economies such as the US.

Both of the chapters imply the importance of equity financing on innovation investment in developing countries especially for those young, small and private firms. The finding points to the significance of the private equity market for financing of innovation in the emerging economy context.

BIOGRAPHICAL SKETCH

Jiahong Zhang received her B.A. degree and M.A degree in Economics from Peking University in Beijing, China. She defended her doctoral dissertation at Cornell University in July 2010.

ACKNOWLEDGMENTS

I am deeply indebted to my advisor, Professor Aija E. Leiponen, for her continued support, encouragement and many years of invaluable guidance. Her enthusiasm, wisdom, patience and insights have impacted me in every aspect of my Ph.D. study. It is my great honor to have had Aija as a mentor. Many thanks also go to my two committee members. I thank Professor Hazem Daouk, for his suggestions, insightful comments and generous help, which are very important in deepening my understanding of the topic. I also owe tremendous thanks to Professor Jeffrey T. Prince. I benefit not only from his excellent instruction in applied econometrics but also from his discussion and comments on my research methodologies and the framework of my dissertation.

I am grateful to the financial support from the Graduate School, the Department of Applied Economics and Management at Cornell University and the research grant from the New York State Hatch program.

Finally, I would like to thank my parents and my sister, for their love and support over my entire life and study. I thank all my friends and colleagues, for their help and friendship.

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INTRODUCTION

This dissertation aims at improving the understanding of the relation between innovation, financial constraints and capital structure in the context of emerging economies. Since early 1930s (Schumpeter 1939), economists have argued that innovation is essential for firm survival, economic growth and development. An independent strand of the literature demonstrates that innovation by firms is a key driver of economic growth (Aghion and Howitt 2006). Meanwhile, people also recognized that innovation investment is difficult to finance in a competitive marketplace (Schumpeter 1942, Nelson 1959, Arrow 1962, Hall 2005) due to various factors such as taxes, transaction costs, and especially informational asymmetries with external investors. Therefore, financing of innovation becomes an important managerial and policy challenge.

A lot of studies have focused on identifying the financial constraints related to risky R&D and innovation investments. Nevertheless, there is little research highlighting the mechanisms that different external financing sources can affect innovation activities differently. Moreover, the implications of innovation investment for future capital structure decisions have not been analyzed. I try to shed light on these issues using micro evidence in the context of emerging markets, where financial markets, political systems and economic systems are different than those in the industrialized economies such as the US.

In Chapter 1, I investigate the relationship between firms' capital structure and innovation decisions in a large sample of firms in East Asian, South Asian, Central Asian and Eastern European emerging economies. I argue that access to external financial resources plays a critical role for financially constrained firms. My dataset enables more detailed analyses of different sources of external finance than previous studies. To resolve the causality problem, I utilize instrumental-variable methods for

identification.

The empirical analyses demonstrate that the broad set of primarily privately-held firms in my sample significantly benefit from external finance for innovation activities. Not only equity finance but also funding from family and friends are significant enablers of innovation activity, whereas I do not find a significant relationship between debt finance and innovation. I also find that the effects of external finance on innovation depend on the institutional environment in which firms operate. In particular, the quality of political institutions appears to moderate the asymmetric information problem between firms and potential investors. Policy implications point to the importance of efficient financial markets and institutions that potentially reduce information asymmetries between investors and innovators.

In Chapter 2, I study the relation between innovation investments and capital structures of firms in China. By investigating how innovation affects the leverage ratio of firms as well as the relation between profitability and capital structure, I find that innovation investment in China is significantly positively related to future leverage ratios for state-owned firms, while the impact on the capital structures of private firms is not the same. The increase of leverage ratios is less than that of state-owned firms and can even go negative. The striking difference can be explained by the Chinese state-dominated financial system inherited from the socialist centrally-planned economy. Even though the Chinese authority started to reform the system in the middle of 1990s to improve the efficiency of banks in allocating capital and allowing private firms' access to bank financing, state-owned firms are still less credit constrained because of their small default risk supported by the government bailout policies. To promote innovation of a country, in addition to a series of government technology innovation policies, one of the most important steps is to relax the credit constraint problems faced by many private firms, a key indicator of the success of the

ongoing financial system reforms in China.

Both of the chapters imply the importance of equity financing on innovation investment in developing countries especially for those young, small and private firms such as in China. The finding points to the significance of the private equity market for financing of innovation in the emerging economy context.

CHAPTER 1

CAPITAL STRUCTURE AND INNOVATION IN ASIAN EMERGING ECONOMIES

1.1 Introduction

According to the Modigliani-Miller theorem (1958), in an efficient market with perfect information and no transaction costs, firms choose optimal levels of investments to maximize their returns, which do not depend on how the firms are financed. At the margin, firms should face the same cost of capital for all types of investment. However, in reality, this theorem is often violated because of a variety of financial market distortions. Recent studies have provided evidence of an impact of financial constraints on fixed investment (Bond and Meghir 1994, Love 2003). Hall (2005) surveyed the evidence on the "funding gap" for innovation investment and summarized that the reasons for why the Modigliani-Miller theorem might fail to hold in practice could be attributed to factors such as taxes, transaction costs, and agency problems (see also Stein 2003).

In the case of investments in innovation—creation of new products and technologies—financing constraints may be even more severe because of the substantial uncertainty regarding the final output of this expensive and risky process (Lerner, Shane, and Zhao 2002; Savignac 2006). Schumpeter (1939), widely regarded as the pioneer in the economic analysis of innovation, made the study of resource allocation, especially the allocation of financial resources, central to his work on innovation (see also O'Sullivan 2006). Since then, economists have long held the view that innovative activities are difficult to finance in a competitive marketplace (Schumpeter 1942, Nelson 1959, Arrow 1962, Hall 2005).

In the emerging-market context, where the financial market is less developed than

in industrialized countries, access to external sources of finance for innovation is likely to even more significantly influence firms' ability to engage in risky new product or process development projects. Economists have argued that innovation is essential for firm survival, economic growth and development (Schumpeter 1942, Ayyagari, Demirguc-Kunt and Maksimovic 2006). Financing of innovation is thus an important managerial and policy challenge. Indeed, a large body of research argues that financial development is a significant driver of economic growth and development (see Levine, 1997, for a survey). Nevertheless, there is little research that would highlight the mechanisms through which financial development influences economic development. We argue that innovation is one such channel and examine the role of external finance in funding firms' innovation investments.

Most studies of financing of R&D focus on the link between internal finance—usually measures of cash flow—and R&D investment (e.g., Hall, 1992; Himmelberg and Petersen, 1994) to identify financing constraints for investment with uncertain output and asymmetric information. In contrast, we control for internal finance and focus on the relationship between external sources of finance and innovation activities. Whereas about eighty percent of all financing for investments, including fixed investments and industrial R&D, is done with internally generated funds (Ross et al. 1993), we argue that external financial resources are also critical for some of the most innovative firms. Even though firms facing profitable innovation opportunities would prefer to use internal funds, firms such as technology-based startups usually have little cash flow and therefore they may be dependent on external finance for innovation. However, innovating firms may be even more financially constrained in emerging economies because financial markets are less mature than in the industrialized world. As a consequence, without well-functioning financial markets, economies may experience substantially lower rates of technological change and

economic growth. Focusing on the actual external financing sources of firms, our results for Asian emerging economies particularly point to the importance of private equity and family finance for innovation.

Young firms are likely to have more limited internal sources of finance—in some cases it may take years for high tech firms to even start generating sales revenue. The fundamental reasons for the external financial constraints of small and young innovators are related to the information asymmetries between firms and their potential investors. A firm's managers will know more about their innovation investment opportunities than potential outside funders, and it is difficult to credibly exchange this information. The situation involves high transaction costs and can be characterized as a classical lemons problem (Akerlof, 1970).

In summary, compared with previous studies, our paper makes the following contributions:

a. Using a cross-country and cross-industry dataset, our study compares the effects of different sources of external financing on innovation investment decision across a diverse set of industries and regions, with generalizable results for emerging economies. Much of the previous research on capital structure focuses on large, listed corporations in the developed world, whereas more than 90 percent of our sample consists of non-listed firms. Therefore, in contrast to the great majority of previous studies, our data are not limited to publicly traded firms, or the very special case of venture-capital financed privately-held firms. This study is based on a representative sample of companies in developing countries.
b. We study which sources of external finance are the most essential in promoting innovation in these emerging economies, comparing and contrasting funding from local and foreign commercial banks, equity markets, governmental investment funds, and family and friends.

c. We also examine whether the macroeconomic factors of literacy and political institutions moderate the effects of external finance on innovation. Literacy level is one of the determinants of the overall human capital stock as well as economic development. It reflects the general innovation ability of a country and influences the demand for innovation and innovation financing, Political constraints not only capture the political risk of investment but also influence the supply of finance for a country. A country with lower political risk provides a better environment for domestic investors but also attracts more foreign investors.
d. Our attention is focused on a set of emerging economies in Eastern Asia, in Southern Asia, in Eastern Europe and Central Asia. To date, there is little research on any aspects of innovation in the emerging economy context. We include firms from nineteen countries, with eight countries from the low-income group, nine countries from the lower middle-income group and two countries from the upper middle-income group according to the World Bank categorization.

Our results suggest that the effects of external finance on innovation investments are statistically significant and the most pronounced for small firms and for firms operating in economies with medium levels of political institutions. These effects are equally large for firms engaging in product innovation and process innovation. We interpret these results through the literature on the relationship between asymmetric information conditions and external financial constraints. Under conditions where the information asymmetry between potential investors and the firm's managers is more substantial, innovating firms are more severely financially constrained. Then, firms with access to external finance will be more likely to innovate.

The rest of the paper is organized as follows. The second section reviews the relevant literatures from three different perspectives. This theoretical discussion is used to formulate a set of empirical hypotheses. The third section introduces the

dataset as well as the empirical model and methods. In the fourth section, we conduct the empirical analyses. The last section discusses the results and provides concluding remarks.

1.2 Literature Review and Theoretical Foundations

1.2.1 Investment and Financial Constraints

Previous research has examined the reasons why the Modigliani-Miller Theorem is unlikely to hold in practice. Among the most important factors are taxation that favors certain types of investments; transaction costs that vary between types of investments; and informational asymmetries and agency problems (Hall 2002 and 2005; Stein 2003). In particular, firms may find it difficult to raise external funds for financing their investments due to informational asymmetries with external investors (Myers and Majluf, 1984); in the case of innovative investments, financing constraints may be even tighter because the output of innovative projects is highly uncertain.

Innovative investments are thus particularly risky (Savignac 2006), inducing high transaction costs and financing difficulties (Williamson 1988). More specifically, it is difficult for a firm's managers to credibly communicate the quality of the innovation investment opportunity because of adverse selection and moral hazard. Even when the firm is able to describe the innovation project, it might be reluctant to do so because of the concern for information spillovers. Moreover, R&D investment does not lead to the build-up of useful collateral, further increasing transaction hazards for potential investors. As a result, flows of financial resources for innovative projects will be rationed by suppliers of capital, even if the project is promising (Jaffee and Russell 1976, Stiglitz and Weiss 1981). The separation of ownership and management thus drives a wedge between the costs of external and internal funds.

In short, from a theoretical perspective, when financial frictions exist, financing constraints are likely to arise, and the costs of internal and external financing will diverge. Firms facing high frictions are expected to be less able to engage in costly innovation investment projects. In terms of empirical testing, when financial constraints are tight, exogenous changes to the availability of external finance will significantly influence firms' likelihood of engaging in innovation activities.

1.2.2 Financial Development and Economic Growth

Dating as far back as Schumpeter (1911), a large literature emphasizes the positive influence of the development of a country's financial sector on the level and the rate of growth of its per capita income. Levine (2004) provides a comprehensive literature review regarding research on the thesis that financial development promotes long-term economic growth. By using cross-country aggregate data, King and Levine (1993) and Levine, Loaya, and Beck (2000) concluded that financial development promotes growth.

Furthermore, economists have emphasized the role of financial development in better identifying investment opportunities, reducing investment in liquid but unproductive assets, mobilizing savings, boosting technological innovation, and improving risk taking (Rajan and Zingales 1998). Love (2003) provides further evidence that financial development impacts growth by reducing financing constraints that would otherwise distort efficient allocation of investment. In addition, Rajan and Zingales (1998) found that industries requiring much external finance grow faster in more developed capital markets, suggesting that financial constraints negatively impact the growth of firms and industries.

Additional institutional factors have been found to moderate the effects of financial markets on growth. For example, both the financial and legal systems of a country are positively related to the proportion of rapidly-growing firms

(Demirguc-Kunt and Maksimovic 1998). Moreover, firm growth is more affected by self-reported financing constraints in countries with underdeveloped financial and legal systems and high corruption (Beck, Demirguc-Kunt and Maksimovic 2002). It is thus important to consider the macroeconomic and institutional environment when studying the relationship between financial development and firm performance. To summarize, the literature discussed above demonstrates that financial development has an important impact on economic growth. The starting point of our research is the assumption that firms' innovation activities are an important mechanism that channels this impact.

1.2.3 Empirical Studies

Because the theoretical literature has emphasized that investment in innovative projects is very likely to be influenced by financial constraints, empirical evidence of the existence of these financial constraints has largely been focused on the relationship between cash flow and R&D investment. This ignores the possibility that, even with the transactional hazards involved with external finance of R&D, financially constrained but innovative firms may be willing to bear the additional costs of capital in order to exploit highly profitable innovation opportunities.

There are various ways to study the existence as well as the effect of financial constraints on investment. In empirical literature, the existence of financial constraints for innovative firms is most frequently identified by examining the sensitivity of R&D investment to financial factors. One approach is based on the Q theory of investment suggested by Tobin (1969) that has been widely used in the financial literature after the influential paper of Fazzari et al. (1988). The second approach examines the sensitivity of investments to financial factors through estimating the Euler equation for the capital stock (Claessens and Tzioumis 2006). While a number of studies find significant cash-flow effect on R&D investments by firms (Himmelberg and Petersen

1994), which means that a large and significant relationship between R&D and internal finance exists, whether this cash-flow sensitivity of investment can be interpreted as revealing the existence of financial obstacles is still debatable (Kaplan and Zingales 1997, Alti 2003 and Gomes 2001).

An alternative strand in the literature examines factors that affect firms' propensity to innovate. By conventionally controlling for country and industry dummies, these empirical models usually include firm characteristics, such as firms' size and the market power, or environmental factors linked to the market or to technological opportunities (Savignac 2006). However, few studies consider financial constraints when they explore the propensity to innovate (but see Crepon et al. 1998, Mohnen and Therrien 2002). Savignac (2006) also examines the impact of financial constraints on innovation for French firms and finds that financial constraints significantly reduce the probability that a firm undertakes innovative projects, whereas Hyytinen and Toivanen (2005) implicitly identify financial constraints through the effects of government R&D support and suggest that government subsidies may alleviate the effects of capital market imperfections on innovation investments.

In a study conceptually closest to ours, Brown, Fazzari and Peterson (2009) identify financial factors for young high-tech firms that explain a significant portion of the dramatic 1990s boom, and the subsequent decline, in R&D investments in the United States. They argue that if young high-tech firms face binding financing constraints, then exogenous changes in the supply of either internal or external equity finance should lead to changes in R&D. Furthermore, if such firms undertake a large fraction of aggregate R&D, then changes in the availability of finance may have macroeconomic significance. By analyzing microeconomic data of the US firms, they highlight a key mechanism that connects finance and growth: firms' innovation investments.

The literature on financial constraints that employs econometric modeling of publicly-traded firms' financial statements provides a rigorous method for empirical investigation. However, it is of little use in the context of emerging economies since the majority of private sector activity originates from SMEs for which financial data is limited. In addition, in transition and developing economies, financial statements are not as reliable as those in developed countries (Claessens and Tzioumis 2006). Therefore, our goal is to develop an alternative empirical approach that circumvents these data problems related to analyzing financing of innovation in emerging economy settings.

1.2.4 Empirical Hypotheses

Building on the literature described above, we acknowledge the importance of (and we empirically control for) internal financing of innovation for firms, but we also argue that external finance is critical for a substantial range of innovative firms. In particular, small, young, and privately-held firms are more likely to be financially constrained, because they may have limited internal funds, but at the same time, they may experience a particularly high cost of external capital due to asymmetric information. Similarly, product innovating firms are likely to be more affected by information asymmetries with outside investors than are firms engaged in process innovation or technology adoption. We therefore expect to find a stronger relationship between external finance and innovation activities for these firms, as articulated in the first hypothesis:

H1 *Innovating firms that are financially constrained and facing conditions of more substantial asymmetric information are likely to more strongly respond to exogenous variation in access to external finance.*

We also examine the contribution to innovation of different sources of external finance. Although the extant literature on the financing of R&D has largely focused on

sensitivity of R&D investments on internal financing (although see MacKie-Mason, 1989), we suggest that different sources of external finance have different implications for innovation. In our dataset we can distinguish external sources such as banks, equity, family and friends, and investment funds. Most previous studies have analyzed publicly-traded firms, for which equity financing is available through public equity markets. In our dataset, in contrast, only 6% of firms are listed in a stock exchange. This means that we can assess the innovation impact of funding from the private equity market.[1] Much recent research has examined innovation by and funding of venture-capital financed firms (e.g., Lerner, 1994; Lerner, Shane and Tsai, 2003). We argue that this is a relatively small and quite special subset of privately-held firms. Our analyses highlight the impact of all types of private equity funding on innovation.

The early "pecking order theory" by Myers and Majlof (1984) suggested that, because of the various transaction costs associated with different types of external finance, firms will first try to finance investments internally, then issue debt, and only as a last resort, raise new equity. Although this approximation may apply to mature firms in traditional industries, Hall (2002) concludes that, compared to non-R&D intensive firms, the capital structure of R&D intensive firms tends to exhibit significantly less leverage, i.e., be less oriented to debt as a source of external finance. For R&D intensive firms the advantages of equity over debt financing include that there are no collateral requirements and that the risk of financial distress and ultimately bankruptcy is not increased by the funding (Brown, Fazzari, and Petersen, 2009: 157). We thus expect that external funds obtained from equity markets for innovation—public or private—will be more relevant for financing innovation than funds obtained from commercial credit markets.

[1] Note that we are simply referring to private transactions with equity, as opposed to using a stock exchange to trade shares publicly, rather than the specific notion of "private equity."

H2 *Equity financing is more conducive than debt financing to innovation activities.*

Because of the bias in empirical research on the financing of innovation investments toward publicly-traded firms, an important type of external finance has been entirely ignored in the scholarly literature to date. Much very early-stage venturing is financed through the private sources of family and friends (and possibly "fools," to complete the "FFF" framework). This is consistent with the implications of asymmetric information, because these types of individuals are likely to have a trusting relationship with the entrepreneur, thereby greatly mitigating the lemons problem. Financing from family and friends could be either in the form of debt or equity, and we cannot distinguish between the two. Although the practitioner-oriented literature frequently discusses this type of financing, research explicitly focused on entrepreneurial finance has barely begun to analyze this type of funding (see e.g., Cowling et al. 2009). We hypothesize that the availability of family financing is most likely to be driving innovation of the smallest and youngest firms. These firms are the most constrained and facing the highest degrees if asymmetric information, but their financing need is also likely to be more modest than their larger counterparts so that individuals may have sufficient funds to make a difference.

H3 *Financial resources from family and friends are the most likely to drive innovation by small and young firms.*

Finally, our dataset of firms in emerging economies allows us to examine how the macroeconomic environment moderates the hypothesized effects of external finance on firms' innovation activities. We focus on the effects of two factors that influence the conditions of asymmetric information and investment risk faced by firms: literacy and political constraints. Literacy is an indicator of the general level of human capital in the country, and as such, it is correlated with the difficulty of communicating

technological innovation projects to potential investors. Political constraints measure the degree to which the institutional environment of a country contains checks and balances for political decision makers. This indicator is related with the number of political players with veto power. The more political players with veto power, i.e. the more political constraints for the political leader, the more difficult for them to implement their preferences without consensus and coordination with other players. Checks and balances influence political and financial risks (Henisz 2005). Political constraints are thus a general measure of political risk and correlated with transactional hazards that influence investment decisions. When political institutions are poor, external finance is likely to be particularly costly for innovating firms. We expect both of these macroeconomic factors to moderate the impact of external finance on innovation. In particular, we expect family financing to be the most useful in less developed macroeconomic environments, where political institutions and human capital are the least developed, and asymmetric information and other transaction costs are especially high.

H4 *The macroeconomic environment measured by levels of human capital and political risk accentuates the effects of asymmetric information and other transactional frictions on innovation investments.*

1.3 Econometric Analysis

1.3.1 The Dataset

Our analysis is based on the micro data from the Enterprise Survey conducted by the World Bank. “The purpose of this survey is to better understand conditions in the local investment climate and how they affect firm-level productivity.”(World Bank’s Enterprise Survey 2007). The first part of the survey deals with the characteristics of

firms' business and the investment climate. In addition to general information about firms, this part contains a series of questions on firms' infrastructure and services, sales and supplies, degrees of competition, crime, land, business-government relations and investment climate constraints. The second part of the survey contains questions on production costs, investment flows, balance sheet information, and workforce statistics.

The surveys used here were conducted between 2003 and 2005, and the samples were designed to be representative of the populations of firms according in each industry and each country. Our dataset includes Asian developing countries and some East European and Central Asian transition countries, where innovation activities have not been studied as much as in the industrialized world. Due to the availability of our key innovation variables and information about the details of external financing sources, we utilize data from nineteen countries, of which five are in East Asia and twelve are in Central Asia and East Europe. The full sample consists of nearly 12,000 firms and covers key manufacturing and service sectors including agriculture, food, leather, textiles, electronics, and telecommunications. Because of item non-response, our estimation sample consists of 6940 firms with full answers to the questions used to construct our empirical variables.

Table 1.1 summarizes the observations and the key variables in each of the 19 countries and 25 industries. The numbers of firms in the country samples vary considerably with the size of the economy. We can see that China and India, two of the largest emerging economies, constitute around 40% of the sample. About 37% is from East Asian and Pacific countries, 43% from Eastern Europe and Central Asia (former Soviet republics), and 20% from South Asia.

In light of our research questions, the information available in the survey has several advantages over alternatives for analyzing the relationship between financing

Table 1. 1 Innovation, external finance, and observations by country and by industry

Panel A

Country	Innovation	Share of external finance	Observations
Armenia	0.772	29.919	307
Azerbaijan	0.816	2.336	304
Belarus	0.858	17.592	211
Cambodia	0.975	73.511	487
China	0.537	38.674	1333
Georgia	0.699	25.959	73
India	0.711	39.711	1365
Indonesia	0.759	35.412	291
Kazakhstan	0.721	17.786	308
Kyrgyzstan	0.813	12.086	139
Moldova	0.816	19.644	239
Mongolia	0.774	38.459	146
Philippines	0.833	28.029	174
Russia	0.701	7.854	431
Tajikistan	0.814	5.294	102
Turkey	0.579	40.145	330
Ukraine	0.814	22.600	430
Uzbekistan	0.614	4.658	114
Vietnam	0.910	62.126	156

Table 1.1 (Continued)
Panel B

Industry	Innovation	Share of external finance	Observations
Accounting and finance	0.269	33.194	67
Advertising and marketing	0.509	24.843	159
Agroindustry	0.921	66.629	89
Auto and auto components	0.730	39.183	371
Beverages	0.850	25.267	446
Chemicals and pharmaceuticals	0.709	43.098	302
Construction	0.774	21.059	376
Electronics	0.747	34.458	491
Food	0.746	37.942	398
Garments	0.677	35.908	728
Hotels and restaurants	0.766	32.189	201
IT services	0.711	38.497	187
Leather	0.866	34.478	67
Metals and machinery	0.751	30.327	676
Mining and quarrying	0.741	27.586	58
Non-metallic and plastic materials	0.676	39.444	216
Other manufacturing	0.887	33.943	53
Other services	0.660	38.288	462
Other transport equipment	0.889	17.222	9
Paper	0.716	26.800	95
Real estate and rental services	0.586	17.471	87
Retail and wholesale trade	0.650	23.256	738
Telecommunications	0.938	11.563	32
Textiles	0.824	44.508	313
Transport	0.798	24.438	178
Wood and furniture	0.723	26.217	141
Total	0.724	32.684	**6940**

and technological innovations in emerging economies. First, it is based on a standardized questionnaire and a uniform sampling methodology across a large set of countries. As a result, it yields comparable information of firm-level variables and facilitates industry and country comparisons. Second, the survey allows us to analyze both product and process innovation activities (Ayyagari Demirguc-Kunt and Maksimovic 2006, Almeida and Fernandes 2006). Third, the survey collects detailed information about the major channels used by firms to acquire financing for their investments and working capital, which makes the study on the relation between external finance and innovation possible. Finally, the survey contains information about many other relevant firm characteristics which need to be accounted for when assessing the relationship between external finance and innovation. These variables include new technology adoption, ownership structure, in-house training, firm age, size, and participation in international trade.

1.3.2 Empirical Analysis

1.3.2.1 Basic Model

The goal of the following empirical analysis is to identify the relationship between firms' access to external finance and innovation, controlling for relevant firm-, industry-, and country-level factors that also influence firms' decisions to engage in innovation.

The data do not provide a specific variable for innovation investment activity. Therefore, our measure of innovation investment activity derives from six innovation-related responses from the survey. Following Ayyagari Demirguc-Kunt and Maksimovic (2006), we use a broad definition of innovation activities. In addition to the core innovation activity of developing new products and processes, a set of

organizational innovations are included. As long as the firm indicated that it engages in any of the following activities, we will define it has innovation investment activity: 1) Developed a major new product line, 2) Upgraded an existing product line, 3) Introduced new technology that has substantially changed the way that the main product is produced, 4) Opened a new plant, 5) Obtained a new licensing agreement, 6) Brought in-house a major production activity that was previously outsourced. The resulting variable is thus a binary indicator for innovative investment decision with the value 0 and 1. For one set of analyses comparing product and process innovation, we define product innovation as a positive answer to the first type of innovation activity which is specific to new product innovation, and process innovation as a positive answer to the third element, which is about improving the current production process.

Firm-level control variables include firm size, age, export activity, government ownership, foreign ownership, and in-house training for employees. The survey categorized the size of firms into three groups: small firms are defined as those with fewer than 20 employees, medium-sized firms have 20 to 99 employees, and large firms have more than 99 employees. In our estimation sample, small firms amount to 36.95%, medium-sized firms make up 33.11%, and large firms constitute 29.94% of the sample. The expected benefit from innovation depends on the size of the firm because of economies of scale in R&D. As a firm gets larger, it can amortize the sunk costs of innovation investments over a larger volume of sales. Firm age ranges from 0 to 149 years. More than half of the firms in our sample were less than 10 years old when the surveys were conducted and about 80% firms in our sample were less than 20 years old. As size and age are likely to be correlated with information costs, they are taken as proxies for firms' financial constraints (Hubbard 1998).

Foreign ownership refers to the nationality of the primary shareholders. In an earlier study by Almeida and Fernandes (2006), majority foreign-owned firms were

found to be significantly less likely to engage in technological innovations than minority foreign-owned firms or domestic firms. Moreover, these authors found that joint ventures between foreign- and domestic-owned firms are more fruitful than fully-owned foreign subsidiaries because they are associated with a greater degree of technology transfer. However, evidence is inconclusive regarding whether technology transfers from parent firms to fully-owned subsidiaries are higher than those to minority-owned subsidiaries. Nevertheless, extant research suggests that foreign ownership may influence the incentives for innovation, and, hence, it is an important firm characteristic to control. In our sample, about 14% of the firms have foreign ownership.

We also control for the share of government ownership. Government ownership percentage ranges from 0 to 100 and the average is 9.45%. Government ownership is a relevant control variable because government ownership might be associated with different types of incentives for innovation and improvement than private-sector ownership.

Export activity is another firm-level control variable. If the exposure to export markets is indeed a channel promoting innovations, firms facing strong competition in export markets will be forced to more frequently improve their technological capabilities than firms exclusively oriented to the domestic market. In our sample, around 17% of firms engaged in export activities.

We also control firms' internal training that is important for developing the human resource base essential for innovation. In the survey, firms were asked whether they offered formal training (beyond "on the job") to the permanent employees. Within the whole sample, 42.5% of firms provided such formal training.

In addition to firm-level variables and industry dummies, we consider two important country-level control variables: literacy level and political constraints,

which affect the country-level innovation environment as well as the demand for and supply of innovation financing. The literacy information comes from the United Nations Human Development Report. It calculates the adult literacy rate (percentage of literate adults, 15 years and older) one year before the Enterprise Survey was collected. We expect a higher literacy rate to be more conducive to innovation by firms, thus more demand for innovative finance in countries with higher literacy rates. We use it as a measure of development instead of GDP per capita, because it not only captures economic development of the country but also the general human resource base. The two variables are highly correlated.

The country-level political environment index, POLCONIII, is constructed by W. Henisz (see Henisz and Zelner 2006). Previous studies have usually used macroeconomic accounting measures (Frankel and Rose 1996) to reflect financial market stability. However, Frankel and Rose argued that these conventional risk measures are problematic because of their lack of focus on political systems. The latter would better capture why less investment occurs in countries that managers perceive to be risky and reflect the fundamental sources of risk. We assume that stable political environments are more conducive to risky and difficult-to-appropriate investments in innovation. Moreover, the supply and terms of external finance will also be affected by the stability of the political environment. Structurally derived from a spatial model of political interaction, the measure of political constraints incorporates data on the number of independent political institutions with veto power in a given polity and data on the alignment and heterogeneity of the political actors that inhabit those institutions (Henisz 2005).

Finally, we include the industry average for the share of internal finance for working capital. This is intended to control for the impact of cash flow on innovation investment, assuming that a substantial part of cash flow is correlated among firms in

an industry. We cannot include firm-level internal finance variable because of its collinearity with the share of external finance (shares of internal and external finance sum up to 100% in our dataset).

Our main explanatory variables of interest represent firm-level external finance. In the survey, firms were asked to identify the contributions over the last year of each of the following sources of financing for new investments: internal funds, local commercial banks, foreign commercial banks, leasing arrangements, investment funds/special development financing, trade credit, credit cards, equity, family, and informal sources (e.g. money). As financing for innovation is not directly surveyed, we will use the contribution of each external financial resource for new investment as a proxy for the available financing for innovation activity. In other words, we will assume that the funding for innovation investment is positively correlated with that for other types of new investments.

Table 1.2 summarizes the contribution of each source of financial resources for new investment. Internal funds are the most important financial resource. In addition, the use of the financial resources agrees with the "pecking order theory" in terms of the overall ranking of debt vs. equity finance: The top three external sources of finance are local commercial banks, the equity market, and family or friends, although if most of family funding is in the form of equity, then the two forms of equity finance together are greater than debt finance. It should be noted that a rather small minority of firms in the sample are publicly traded (6.3% of the estimation sample). The relevant equity market for most of the firms studied here is thus the private one.

From the different sources of external finance we also construct a summary variable of external finance by adding up the contribution percentage for new investment from local commercial banks, foreign commercial banks, equity markets, and family and friends, deemed to be the most important sources of external funds. We

Table 1. 2 Descriptive Statistics

Continuous variables	Mean	Std. dev.	Min	Max
Financial variables				
Share of internal finance	51.066	42.481	0	100
Share of external finance	32.684	40.783	0	100
Share of local bank finance	16.477	30.901	0	100
Share of foreign bank finance	0.815	7.336	0	100
Share of equity finance	8.704	25.767	0	100
Share of finance from family and friends	6.688	21.299	0	100
Share of finance from investment funds	0.784	6.676	0	100
Share of informal finance	1.320	9.458	0	100
Firm-level control variables				
Government ownership	9.454	28.136	0	100
Firm age	14.721	14.337	1	149
Country-level control variables				
Political constraints	0.227	0.187	0	0.537
Literacy	87.012	14.510	73.6	100
Binary variables (0,1)	**Mean**			
Any innovation	0.724			
Product innovation	0.652			
Process innovation	0.376			
Organizational innovation	0.207			
Product or process innovation	0.704			
Publicly traded firm	0.063			
Small firm (1-19 employees)	0.369			
Medium-sized firm (20-99 employees)	0.331			
Large firm (over 99 employees)	0.299			
Age less than 10 years	0.558			
Primarily foreign ownership	0.116			
Any exports	0.169			
In-house training	0.425			

use this summary variable to analyze the general effect of the availability of external finance on innovation.

1.3.2.2 Empirical Model

Let I_{ijc} be an index variable that equals to one if a firm i in industry j and country c engages in innovation activity, zero otherwise. The probability that the firm innovates is empirically modeled using a probit model. The empirical framework considers a risk-neutral firm deciding whether to engage in innovation investment to maximize its profit.

Let Y_{ijc}^{*} be the expected profit from the innovation project of a firm i in industry j in country c. If the profit was greater than zero, the firm would invest in the innovation project. We assume that Y_{ijc}^{*} is a function of firm characteristics such as age, size, ownership status, export activities, and in-house training. Furthermore, our control variables for the country-level macroeconomic conditions include adult literacy and political constraints.

The main model assumes that

$$Y_{ijc}^{*} = \alpha EXTFIN_{ijc} + \beta X_{ijc} + \gamma Z_{c} + \delta \text{Industry dummies} + \varepsilon_{ijc} \qquad (3.1)$$

where X_{ijc} is a vector of firm characteristics and Z_c represents country-level characteristics. We also use industry dummies to control for industry effects. Since Y_{ijc}^{*} is not observable, the equation above cannot be estimated directly.

Instead, we assume that

$$I_{ijc} = \begin{cases} 1, \text{ if } Y_{ijc}^{*} > 0 \\ 0, \text{ otherwise} \end{cases} \qquad (3.2)$$

Then,

$$\Pr(I_{ijc} = 1) = \Pr(\varepsilon_{ijc} > -\alpha EXTFIN_{ijc} - \beta X_{ijc} - \gamma Z_{c} - \delta \text{Industry dummies}) \qquad (3.3)$$

Assuming that ε_{ijc} are normally distributed, we can estimate equation (3.3) by probit

maximum likelihood.

To identify the causal effect of external finance on innovation activities, we need to consider unobserved heterogeneity. Both innovation and external finance could be affected by unobservable factors, which would bias the coefficient of external finance in the probit model. On one hand, from the demand side, firms with innovation activities may be more motivated to seek external finance for their investment projects. This would make the coefficient of external finance positively biased. On the other hand, from the supply side, external investors might be reluctant to finance an innovative firm because it is more risky, which could make the coefficient negatively biased. In practice, the potential bias of the coefficient of external finance depends on whether supply factors or demand factors are dominating. Our approach is to use instrumental variable methods to identify exogenous variation in the external finance variables. Provided that our instrumental variables are valid, we can then estimate the two-step IV probit version of the basic model.

Our instruments include the firm-level observations of external auditing, country-industry level averages, excluding the focal firm, of the shares of external finance, and the concentration of commercial banks in each country. External auditing variable, which is an indicator about whether an establishment has its annual financial statement reviewed by an external auditor or not, provides information to external investors and affects the costs and benefits of providing finance. All forms of external finance are influenced by this factor because the information revealed by annual auditing affects all types of external investors. In addition, we utilize country-industry level averages, excluding the focal firm, of the shares of external finance, which represents exogenous variation in the industrial environment in terms of general availability of external finance. We also utilize the exogenous effect of the financial market structure on external finance. A highly concentrated commercial banking sector

is likely to reduce the competitive pressure to attract savings and channel them efficiently to investors (Beck, Demirguc-Kunt and Levine 1999).

1.4 Results

Table 1.3 reports the first set of results from estimating different versions of Equation (3.3). The coefficient of External finance is always positive and statistically significant, which implies that the access to a higher level of external finance for new investment is associated with a greater probability of innovation. The marginal effect of External finance is 0.00069 for the probit model. In other words, one percent increase in external financing is associated with an increase in the probability of innovation of about 0.1 percent. The effect is thus economically small but statistically very significant. The marginal effects of External finance are 0.002, 0.001 for the probit models above, respectively. In other words, one percent increase in external financing is associated with an increase in the probability of innovation investment of about 0.1 percent. The marginal effect of external finance for the IV probit model is 0.009 (third specification in Table 1.3) suggests that the probability are increased by 4% when an additional percentage point of external finance (measured as the percentage share of total finance) is obtained. Compared to the odds ratios for the coefficients from the probit models, the instrumental variable model suggests a larger impact and hence that the simple probit model provides estimates that are biased downwards. Finally, the Wald test for exogeneity (not reported) suggests external finance is indeed endogenous.

In terms of the control variables, we find in all models that younger and larger firms and those providing in-house training are significantly more innovative. We also find a better political environment and higher literacy level positively promotes firms' innovation propensities. Firms engaging in export activity are also more innovative,

Table 1. 3 The effect of external finance on innovation (N=6940)

Notes: The dependent variable for each column is any innovation. The external finance variable is instrumented in the third specification. Instruments include the firm-level survey question regarding auditing, country-industry-level averages of external finance excluding the focal firm, and country-level concentration of the financial market. *** indicates statistical significance at the 1% confidence level; ** and * indicate confidence levels of 5% and 10%, respectively.

	(1)		(2)		(3)	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Constant	-0.099	0.619	1.235 *	0.634	-2.052 **	0.832
External finance	0.002 ***	0.001	0.001 **	0.001	0.040 ***	0.004
Internal finance (industry)	0.007 ***	0.001	-0.003	0.003	0.027 ***	0.003
Gov. ownership	-0.001 **	0.001	-0.001 **	0.001	0.002 *	0.001
Age	-0.006 ***	0.001	-0.004 ***	0.014	-0.003 *	0.002
Medium-sized	0.098 **	0.042	0.198 ***	0.044	0.145 **	0.061
Large	0.313 ***	0.053	0.445 ***	0.056	0.232 ***	0.077
Foreign ownership	0.062	0.060	-0.032	0.063	0.341 ***	0.061
Exports	0.383 ***	0.055	0.321 ***	0.057	0.243 ***	0.077
Training	0.333 ***	0.043	0.483 ***	0.048	0.341 ***	0.061
Political constraints	1.266 ***	0.129			0.605 ***	0.196
Literacy	0.005 **	0.002			0.011 ***	0.003
Industry dummies	Yes		Yes		Yes	
Country dummies	No		Yes		No	
Estimation method	Probit		Probit		IV probit	
Log likelihood	-3756.92		-3487.86			
Pseudo R^2	0.0808		0.1466			
Amemiya-Lee-Newey test for overidentification					2.055	(p-value 0.3579)

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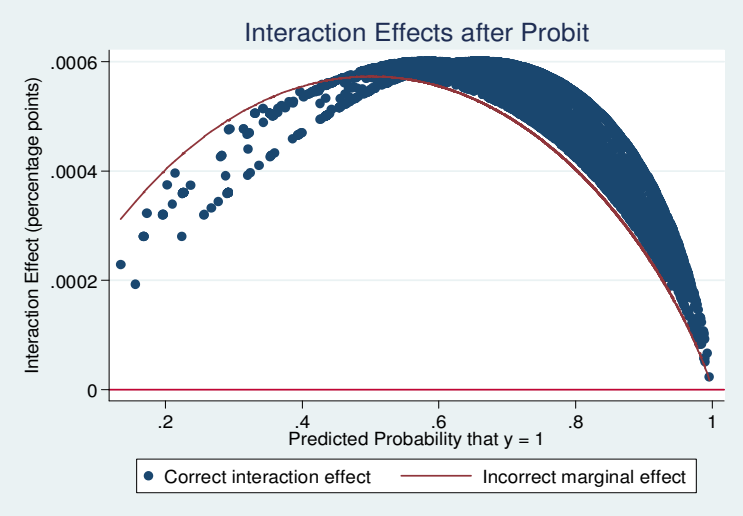
which is in accord with previous literature. Among the effects that somewhat vary between the models, industry-level internal finance has a significantly positive effect on innovation in two of the three models, whereas the effect of governmental ownership is not consistent across models.

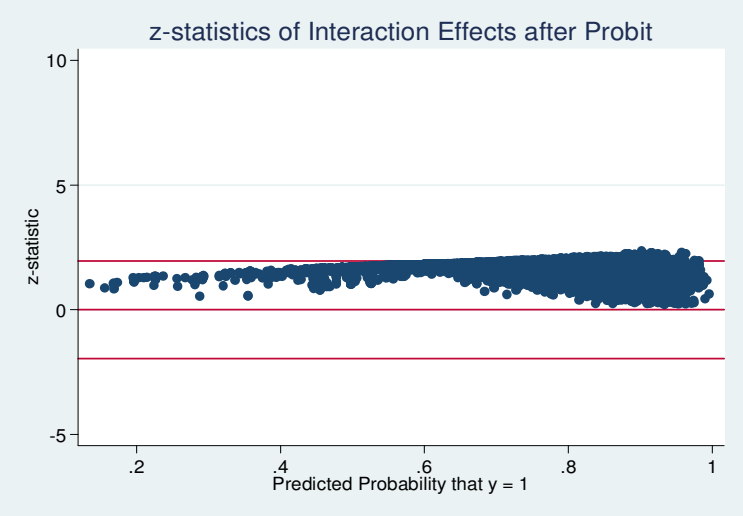
Next, we examine whether the effect of external finance depends on firms' other characteristics, such as size and age. We generate interaction terms with external finance by utilizing the dummy for firms with fewer than 20 employees and the dummy for firms younger than 10 years. The results are shown in Table 1.4. The interaction effect of small size and external finance is positive significant but the moderating effect of age on the relation between external finance and innovation is not significant. For robustness check, we also classify the firms according to their ages into different groups, including ages less than five years old and ages less than ten years old. The results are similar the interaction analysis and we did not find that age would influence the effect of external financing on innovation investment outcomes among these firms.

Because of the issues from estimating interaction effects in probit models, we also report the graphical "interaction effect" analysis (see Ai and Norton 2003; Norton et al. 2004). The size effect on the relation between external finance and innovation is shown in Figure 1.1.

Figure 1.1 (a) reports the estimated moderating effect of firm size from the probit model. The interaction effect is a function of the estimated probability of innovation. Figure 1.1(b) reports the significance levels for each observation. The moderating effect of size is positive for all observations. When a firm is in the smallest size group, the effect of external finance on probability of innovation is higher compared with medium-sized or large firms. The significance of the moderating effect exceeds conventional levels of confidence as the propensity of innovation approaches one. This



(a)



(b)

Figure 1. 1 The moderating effect of firm size

Figure 1.1 (a) reports the estimated moderating effect of firm size from the probit model, which is a function of the estimated probability of innovation. Figure 1.1 (b) reports the significance levels for each observation. The moderating effect of size is overall positive for all observations.

Table 1. 4 The moderating effects of firm size and age (N=6940)

Notes: The dependent variable is any innovation. External finance variable and its interaction terms are instrumented in specifications 2 and 4. Instruments include the firm-level survey question regarding auditing, country-industry averages of external finance excluding the focal firm and country-level average of the concentration of the financial market. *** indicates statistical significance at the 1% confidence level; ** and * indicate confidence levels of 5% and 10%, respectively.

	(1)		(2)		(3)		(4)	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Constant	-0.156	0.621	-1.932 **	0.860	-0.260	0.623	-1.173	7.941
External finance	0.002 ***	0.001	0.038 ***	0.010	0.002 **	0.001	0.187	0.279
External finance*small firm	0.001 *	0.001	0.003	0.018				
External finance*age<10					0.001	0.001	-0.194	0.365
Internal finance (industry)	0.006 ***	0.001	0.026 ***	0.003	0.006 ***	0.001	0.039	0.023
Gov. ownership	-0.001	0.001	0.002 *	0.001	-0.002 **	0.001	0.012	0.016
Age<10	0.103 **	0.036	0.061	0.052	0.115 **	0.045	6.324	11.77
Small	-0.203 ***	0.047	-0.266	0.567				
Medium-sized					0.098 **	0.042	-0.207	0.195
Large					0.313 ***	0.052	0.082	0.342
Foreign ownership	0.093	0.060	0.322 ***	0.097	0.066	0.060	0.868	1.047
Exports	0.434 ***	0.054	0.272 ***	0.082	0.392 ***	0.055	0.044	0.431
Training	0.353 ***	0.043	0.351 ***	0.060	0.331 ***	0.043	0.391 **	0.179
Political constraints	1.215	0.1	0.566 **	0.233	1.241 ***	0.129	1.531	1.832
Literacy	0.005		0.012 ***	0.003	0.004 **	0.002	0.021	0.019
Industry dummies	Yes		Yes		Yes		Yes	
Country dummies	No		No		No		No	
Estimation method	Probit		IV probit		Probit		IV	
Log likelihood	-3770.918				-3762.0			
Pseudo R^2	0.077				0.08			
Amemiya-Lee-Newey test			2.317	(p-value			0.011	(p-value
for overidentification				0.128)				0.918)

is in accordance with our first hypothesis. Small firms are facing conditions of more difficult information asymmetries than are medium-sized or large firms. Therefore, they are more financially constrained and hence likely to strongly respond to exogenous variation in access to external finance.

In contrast, the interaction term of young firms and external finance is not significant. As shown in Figure 1.2, we can see that the moderating effect of age is generally positive except when the innovation probability is close to one.

We also distinguish between product and process innovations in the dependent variable and consider differences in the impact of external finance and the results are showed in Table 1.5.We use product innovation (specific to developing a new product line) and process innovation, including introducing new technology to production and upgrading an existing product line, as dependent variables and analyze how external finance influence each of them. We find that external finance has a significant positive effect in both probit and IV probit models for both types of innovation, but the results do not suggest the effect of external finance is clearly stronger for one type of innovation or the other. The marginal effects of external finance are almost identical in the two probit models (0.000767 for process innovation and 0.000736 for product innovation).

Given the evidence that external financing is important for the probability of innovation investment, are there any differences in the impact of different sources of external finance on innovation investment decisions? This is particularly interesting from a policy perspective when governments aim to foster firms' innovation investments. The results in Table 1.6 indicate that equity finance and family finance have significantly positive effects for financially constrained innovators in emerging economies, although the effect of family finance becomes statistically insignificant in the instrumental variable model.

Table 1. 5 The effect of external finance on new product innovation and process innovation (N=6940)

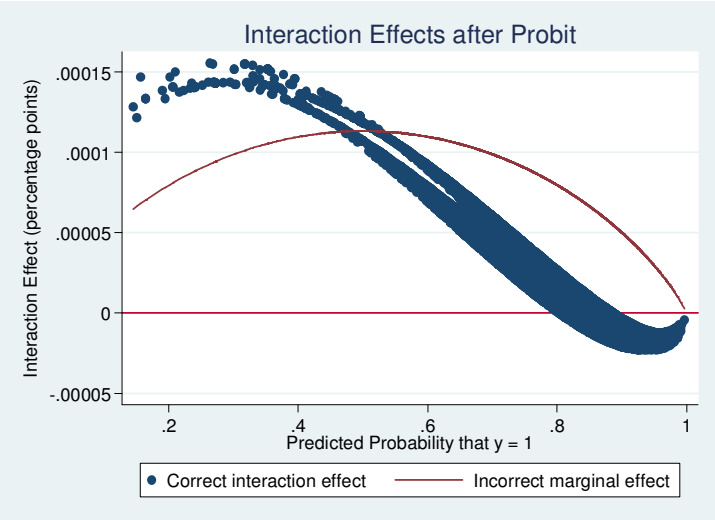
Notes: Dependent variable: New Product Innovation in (1) and (2). Process and upgrading existing product line Innovation in (3) and (4). The external finance variable is instrumented in the second and third specifications. Instruments include the firm-level survey question regarding auditing, country-industry averages of external finance excluding the focal firm and country-level concentration of the financial market. *** indicates statistical significance at the 1% confidence level; ** and * indicate confidence levels of 5% and 10%, respectively.

	(1)		(2)		(3)		(4)	
	Coeff.	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**
Constant	-0.627	0.463	-1.654***	0.560	-2.150***	0.470	-4.170***	0.730
External Finance	0.002***	0.000	0.022***	0.003	0.002***	0.000	0.040***	0.004
Internal Finance(industry)	0.006***	0.001	0.017***	0.002	0.0001	0.001	0.021***	0.002
Political constraints	0.910***	0.115	0.553***	0.144	0.525***	0.115	-0.140	0.187
Literacy	0.000	0.002	0.003	0.002	0.017***	0.002	0.024***	0.003
Gov.ownership	0.000	0.001	0.002*	0.001	-0.0003	0.001	0.003***	0.001
Age	-0.004***	0.001	-0.002	0.001	-0.004***	0.001	-0.001	0.002
Medium-sized	0.108***	0.039	0.133***	0.046	0.058	0.041	0.117**	0.061
Large	0.286***	0.048	0.237***	0.056	0.273***	0.049	0.191***	0.074
Foreign ownership	-0.012	0.052	0.113*	0.064	0.085	0.052	0.324***	0.083
Exports	0.249***	0.046	0.166***	0.055	0.224***	0.046	0.074	0.072
Training	0.211***	0.038	0.210***	0.044	0.283***	0.038	0.292***	0.058
Estimated Method	Probit		IV probit		Probit		IV probit	
Log Likelihood	-4494.95				-4298.91			
Pseudo R squre	0.0458				0.0641			
Amemiya-Lee-Newey test for			2.851	(p-value			36.684	(p-value
Over identification				0.2404)				0)

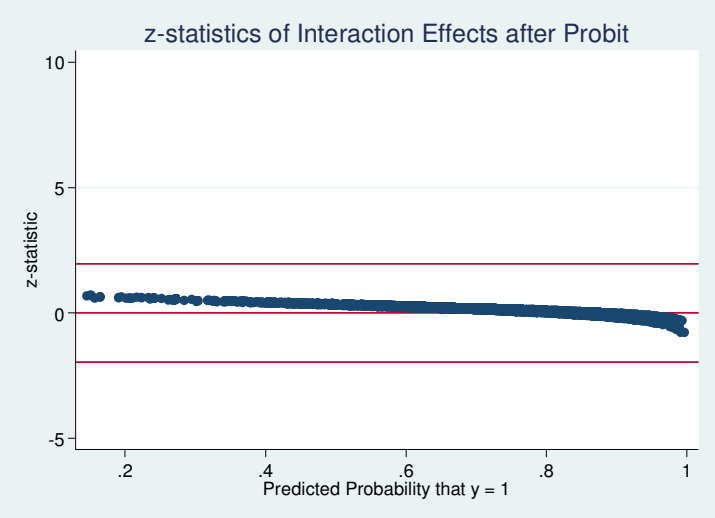
Table 1. 6 The effects of each source of external finance (N=6940)

Notes: Dependent variable: Any innovation. External finance variables and their interactions are instrumented in all but the first specification. Instruments include the firm-level survey question regarding auditing, country-industry averages of each form of external finance excluding the focal firm, and country-level concentration of the financial market. *** indicates statistical significance at the 1% confidence level; ** and * indicate confidence levels of 5% and 10%, respectively.

	(1)		(2)		(3)		(4)	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Constant	-0.123	0.622	-0.529	1.743	-7.786	4.846	-0.444	0.831
Local bank finance	0.000	0.001	0.009	0.015				
Foreign bank finance	0.004	0.003	0.350 *	0.182				
Equity finance	0.006 ***	0.001	0.035 ***	0.007			-0.016	0.030
Family finance	0.002 ***	0.001	0.009	0.039	-0.329	0.235		
Family finance*small firm					0.725 **	0.397		
Equity finance*small firm							0.088	0.058
Internal finance (industry)	0.008 ***	0.001	0.019 ***	0.006	0.002	0.015	0.016	0.002
Gov. ownership	-0.001 **	0.001	0.003 **	0.002	-0.009	0.008	-0.001	0.001
Age<10	0.108 ***	0.037	0.041	0.080	-0.206	0.255	0.116 *	0.067
Medium-sized	0.116 ***	0.042	0.164	0.109	5.874 **	3.047	0.878 **	0.465
Large	0.343 ***	0.053	0.029	0.313	4.988 **	2.325	1.122 **	0.483
Foreign ownership	0.043	0.060	-0.372	0.422	0.108	0.344	0.073	0.091
Exports	0.387 ***	0.055	0.093	0.193	0.122	0.373	0.290 ***	0.072
Training	0.345 ***	0.044	0.257	0.166	-0.351	0.614	0.460 ***	0.077
Political constraints	1.157 ***	0.130	-0.215	0.485	0.902	0.802	0.430 *	0.256
Literacy	0.003	0.002	-0.003	0.007	0.055	0.034	-0.002	0.003
Industry dummies	Yes		Yes		Yes		Yes	
Country dummies	No		No		No		No	
Estimation method	Probit		IV probit		IV probit		IV probit	
Log likelihood	-3739.844							
Amemiya-Lee-Newey test for over identification			3.992	(p-value 0.136)	NA		1.072	(p-value 0.301)



(a)



(b)

Figure 1. 2 The moderating effect of firm age

Figure 1.2 (a) reports the estimated moderating effect of firm age from the probit model, which is a function of the estimated probability of innovation. Figure 1.2 (b) reports the significance levels for each observation. The moderating effect of age is overall positive for all observations.

However, when we include an interaction effect between small firms and family finance in the third specification, the coefficient of the interaction term is positive and significant in an IV probit model. Similar estimation of the interaction effect of equity finance for small firms does not generate significant results (specification 4). This suggests that, overall both equity finance and family finance support innovation by financially constrained emerging economy firms, but family finance plays an important role mainly for small firms.

The significance of equity finance also points to the significance of the private equity market (i.e., equity transactions outside of the stock markets) for financing of innovation in the emerging economy context. Building on previous research on American high-technology firms we hypothesized that, generally for innovators, equity finance is more conducive than bank finance to innovation investment. However, the development of public stock markets may be incomplete in many of our sample countries, and as a consequence, firms may need to seek private equity funding or informal private lenders (family and friends) which are relatively less costly to them than debt financing.

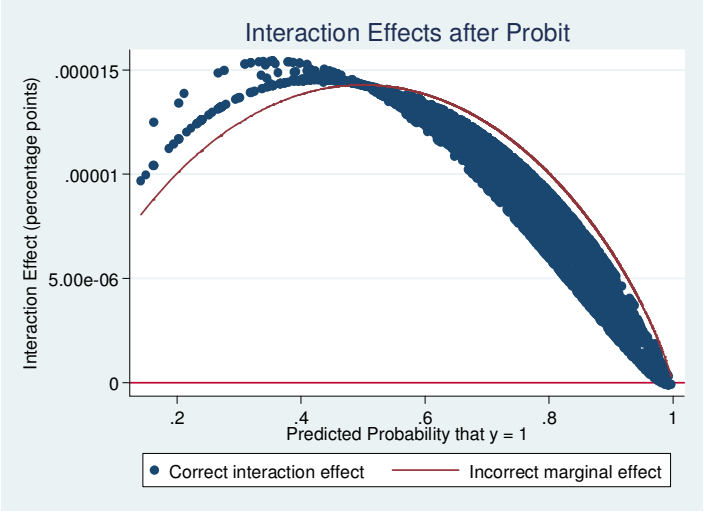
Finally, we study whether the macro environment moderates the effect of external finance availability on innovation probability. In the same way, we added interaction terms between political constraints (POLCONIII) and external finance, and between literacy level and external finance, to the original empirical model. The results in Table 1.7 show that the estimated interaction effect of literacy and external finance is not significant, and the graphical interaction effect analysis shows the moderating effect of literacy is generally positive in Figure 1.3 but not statistically significant.

In contrast, the interaction between political constraints and external finance obtains a positive and significant coefficient in the probit model. To characterize the effect in a clear way, we interact innovation with a zero political veto power indicator

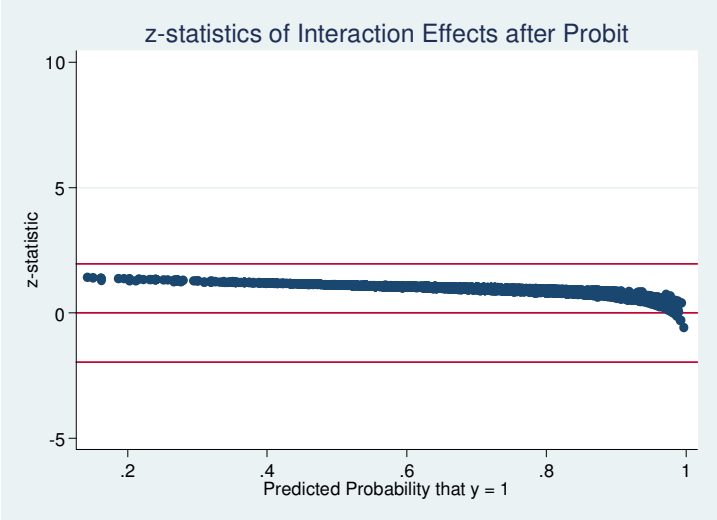
Table 1. 7 The moderating effects of literacy and political constraints (N=6940)

Notes: Dependent variable: Any innovation. The external finance variable and the interaction term are instrumented in the second and the fourth specifications. Instruments include the firm-level survey question regarding auditing, country-industry averages of external finance excluding the focal firm, and country-level concentration of the financial market. *** indicates statistical significance at the 1% confidence level; ** and * indicate confidence levels of 5% and 10%, respectively.

	(1)		(2)		(3)		(4)	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Constant	-0.148	0.632	0.975	2.909	-0.390	0.626	-2.116 *	0.886
External finance	-0.001	0.002	-0.042	0.072	-0.001	0.001	0.038	0.025
External finance*literacy	0.00004	0.000	0.001	0.001				
External finance*political constraints					0.013 ***	0.002	-0.496	0.885
Internal finance (industry)	0.007 ***	0.001	0.034 ***	0.007	0.006 ***	0.001	0.041	0.007
Gov. ownership	-0.002 **	0.001	0.003 **	0.002	-0.002 **	0.001	0.026 ***	0.009
Age<10	0.125 ***	0.037	0.085	0.062	0.122 ***	0.037	0.074	0.054
Medium-sized	0.097 **	0.042	0.126 *	0.071	0.106 **	0.042	0.152 *	0.082
Large	0.313 ***	0.052	0.212 **	0.087	0.326 ***	0.053	0.149 **	0.062
Foreign ownership	0.694	0.060	0.454 ***	0.152	0.048	0.060	0.544 ***	0.155
Exports	0.390 ***	0.054	0.172	0.110	0.386 ***	0.055	0.318 *	0.172
Training	0.331 ***	0.043	0.348 ***	0.068	0.349 ***	0.047	0.341 ***	0.083
Political constraints	1.241 ***	1.241	0.385	0.288	0.962 ***	0.138	0.496	0.885
Literacy	0.003	0.002	-0.028	0.035	0.013 ***	0.002	0.011 **	0.006
Industry dummies	Yes		Yes		Yes		Yes	
Country dummies	No		No		No		No	
Estimation method	Probit		IV probit		Probit		IV	
Log likelihood	-3761.45				-3745.46			
Pseudo R^2	0.080				0.084			
Amemiya-Lee-Newey test for overidentification			0.258	(p-value 0.611)			1.802	(p-value 0.180)



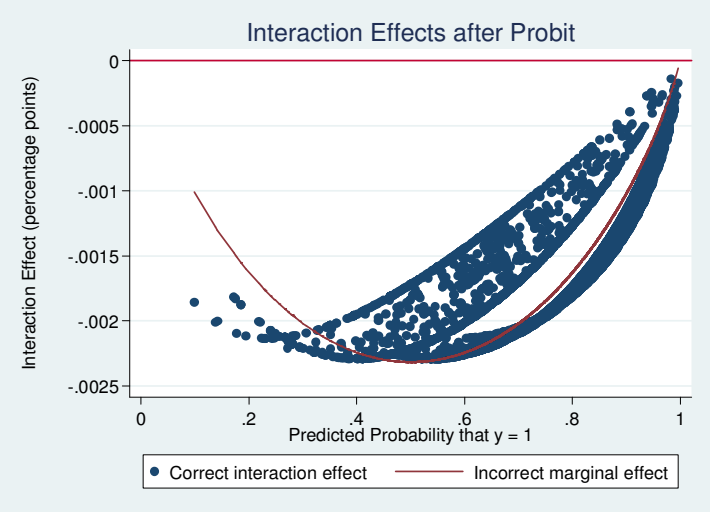
(a)



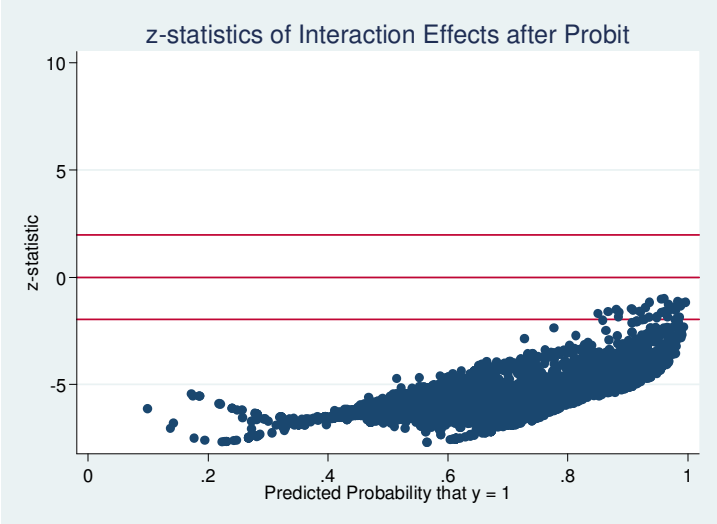
(b)

Figure 1. 3 The moderating effect of literacy

Figure 1.3 (a) reports the estimated moderating effect of literacy from the probit model, which is a function of the estimated probability of innovation. Figure 1.3 (b) reports the significance levels for each observation. The moderating effect of literacy is overall positive for all observations but the positive effect decrease when a firm has high probability of innovation.



(a)



(b)

Figure 1. 4 The moderating effect of political constraints

Figure 1.4 (a) reports the estimated moderating effect of political constraint from the probit model, which is a function of the estimated probability of innovation. Figure 1.4 (b) reports the significance levels for each observation. The moderating effect of zero political constraint is significantly negative for all observations except when a firm has high probability of innovation.

and do an interaction effect analysis in Figure 1.4，which reports the estimated interaction effect form the probit models as a function of the estimated probability of innovation in (a) and the significance levels for each observation in (b). Here, the interaction effect is negative for most of the observations. As the probability of innovation approaches one, the interaction effect is not significant any more. A speculative interpretation is that, in general, a better political environment will reduce political and financial risk, resulting in more demand for external finance because innovation investments become more attractive. Under these conditions, innovating firms are highly financially constrained, and exogenous changes in the availability of finance will generate a strong impact on innovation. In contrast, for some firms that are highly likely to innovate, the influence of the political environment is less important. In other words, when the political institutions are good, financial markets are effective at sorting innovative firms from non-innovative ones, and highly innovative firms are more likely to obtain the external funding they need.

1.5 Conclusions

This paper investigates the relationship between external financing and innovation investment of firms using the cross-sectional and cross-country World Bank Enterprise Survey. We focus on firms in Asian and Central European emerging economies and find that external financing significantly influences the propensity of innovation both in simple probit models and in instrumental variable models. Secondly, we study the effects of different sources of external financing on the probability of innovation investment. In some contrast to previous research that has mainly emphasized internal finance and also found that R&D intensive firms tend to have lower leverage than other firms, we find that both equity and family finance have significant and positive effects on innovation. As the great majority of the sampled emerging-economy firms

are privately held, this result suggests that the development of the private equity markets and other informal financing channels (family and friends) are important in emerging economy contexts. We suggest that a closer analysis of private-equity funding for innovation investments, apart from the special case of venture capital, might be a promising research avenue.

Last but not least, we investigate the moderating effects of firm age and size, orientation toward product or process innovation, and country-level political constraints and literacy. We find that smaller firms experience stronger financial constraints and are more likely to benefit from finance from family or friends for their innovation activities. The evidence of firm age and product vs. process innovation is inconclusive—both product and process innovation activities appear to benefit from availability of external finance. Furthermore, the effects of external finance significantly depend on the institutional environment.

Whereas earlier research has primarily studied publicly-traded companies from the United States, our study highlights that the results for different types of samples may diverge, and our understanding of the fundamental drivers of innovation investments would benefit from explicit attention to the institutional settings in which firms are embedded. Our results emphasize the importance of transparent and efficient financial markets and institutions that reduce information asymmetries between innovators and potential investors. It also provides managerial insights regarding the financial challenges of innovation and building growth-oriented companies in emerging economies. Innovators are generally better off developing relationships that provide access to private equity investors rather than seeking investment funding from the commercial banking sector.

In summary, we have shed new light on the effect of external finance on innovation investment decisions in Asian and Eastern European emerging economies.

We find that external financing, especially funding from equity markets and from friends and family provide significant financial resources for firms' innovation investments. Whereas the public equity markets are not mature in most of the analyzed economies, private equity financing still has a significant positive effect on innovation investment. We argue that financial development is a critical enabler of innovation in a broad set of service and manufacturing firms. Although there may be a "pecking order" in which firms actually choose the sources of finance for their innovation activities, equity, as well as family and friends play important roles in different stages of firm growth and innovation.

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CHAPTER 2

DOES INNOVATION AFFECT CAPITAL STRUCTURE DECISIONS? - EVIDENCE FROM CHINA

2.1 Introduction

The first paper of my dissertation studied the effects of external finance sources on innovation investment outcomes in Asian emerging economies. Under the hypothesis that investment of firms are subject to financial constraints, especially for the risky R&D and innovation investments, we focused on how each of the financing sources including financing from banks, equity market, friends and family and other informal sources affect the innovation investment outcome. We found that by controlling internal finance, equity finance is significantly more important for promoting innovation than debt finance across a set of emerging economies in Asia. In addition, we find that for small-size and young firms the effect of equity is especially stronger than that of banks. A particularly interesting finding in our conclusion is that the effect of external finance on innovation is stronger for a country under a democratic system, i.e. with political players who have veto power in the system. We are among the first to study the detailed relations between innovation outcome and financing sources beyond debt and equity.

Given that R&D and innovation investment are risky with uncertain outcomes and are financially constrained, a natural extension is to examine how innovation affects future capital structure decisions. Is the impact on firms' capital structure the same for all types of firms?

In this paper, in order to complete the picture of the relation between innovation

and finance and understand how the two important engines for firms' growth and development evolve, we are going to explore the questions above and focus on the People's Republic of China, the biggest emerging economy in the world which has been undergoing rapid economic growth and reforms since 1970s.

With a panel data based on the Investment Climate Survey from the World Bank including 2400 firms across 18 cities in China from 2000 to 2002, we focus on whether innovation, which is important for promoting the economic growth of firm and which involves great information asymmetry problem for financing, can exacerbate the capital constraints and influence the future capital structure decisions.

To my knowledge, this paper is among the first to study the effects of innovation on capital structure decisions and the first to do so with data from China. The remainder of the paper is organized as follows. Section 2.2 reviews the literature and the theoretical framework of innovation's impact on capital structures. The section ends with testable empirical hypotheses. Section 2.3 discusses the data. Section 2.4 introduces the empirical model. Section 2.5 discusses the regression results. Section 2.6 concludes.

2.2 Literature Review

2.2.1 The Innovation Environment in China

Technological innovation has played an important role in business success and has frequently been considered as crucial to organizational competitiveness and success in a dynamic and turbulent market environment (Maurer, 1999; Qi, Wu, & Zhang, 2000; Schumpeter, 1975). Following the call of "Technology is the first productivity" in the by the political leader and reformer, Deng Xiaoping, the Chinese government has put forth various policies in promoting national technological innovation capabilities. Since then, China's technological innovation policies have experienced complicated

and diverse changes, which have significantly strengthened China's international competitiveness. From 1985 to 2003, there were more than 200 technological innovation policies issued in China (Chen et.al 2006).

In the meantime, China has achieved a spectacularly high rate of economic growth over a sustained period of more than two decades. Nevertheless, today China faces the challenge of making the transition from sustained to sustainable growth from social, economical, ecological and environmental points of view. Innovation has been identified as a major engine for the new growth model, which plays an important role in promoting economic and social development. The Chinese government has launched a national strategy to build an innovation-driven economy and society by 2020 (OECD 2008).

Extant research shows that the Chinese government is directly and indirectly involved in innovation development through policy tools (Roessner 1988; Rothwell & Zegveld 1981) of three major types: supply-oriented, demand-oriented, and indirect (environment-oriented) innovation policy (Rothwell & Zegveld 1988). Government supply-side innovation policies provide funds, human resources, and technical infrastructure to encourage firm innovation. In many defense-related innovations, the government also carries out demand-oriented innovation policies through government procurement. Supply-oriented innovation policies seem to be the most popular form and include the provision of an intellectual infrastructure, skilled and educated workforce, risk capital, base capital, and technical assistance to new businesses (Goldsmith 1990).

While the macro environment and government policies have a positive influence on innovation, whether it can be translated into firm-level productivity is not clear. One of the important reasons is that innovation is a type of risky investment which could be facing the financing constraints problem.

2.2.2 Theoretical Background

A fundamental challenge for corporate finance lies in understanding the determinants of capital structure heterogeneity (Lemmon Roberts and Zender 2006). Earlier research has examined the dynamic behavior of leverage ratios in order to distinguish among competing explanations. Several studies have focused on how firms respond to various shocks affecting capital structure (Alti 2005, Flannery and Rangan 2005, Leary and Roberts 2005a, and Strebulaev 2004), while others have focused on how historical factors affect current capital structure (e.g. Baker and Wurgler 2002, Welch 2004), and Kayhan and Titman (2004).

While the majority of the research results have been derived from developed economies that have many institutional similarities, little work has been done to further the knowledge of capital structure within developing countries that have different institutional structures. Previous findings (Booth et al. 2001) suggest that although some of the insights from modern finance theories are applicable across countries, much remains to be done to understand the impact of different institutional features on capital structure choices.

2.2.2.1 Capital structure determinants

The pecking order theory of capital structure is among the most influential theories of corporate leverage. Myers and Majluf (1984) predicts that information asymmetry between managers and investors creates a preference ranking over financing sources, beginning with internal funds, followed by debt and equity. Since then, a great amount of research within finance on capital structure has been inspired. While this model explains many observed patterns in corporate financing, Leary and Roberts (2007) reviewed the contradictory empirical evidence of pecking order of recent studies and

there is no clear agreement regarding whether the pecking order accurately describes observed financing behaviors.

Comparing with the above tension present in existing empirical evidences, a number of papers (e.g. Titman and Wessels 1988, Fama and French 2002) tested the negative correlation between leverage and profitability as evidence and supported for the pecking order's prediction that managers prefer to use internal funds before turning to debt.

Alternatively, there have been many empirical studies based on the trade-off theory and signaling models of capital structure. The development of agency theory in the 1980s has lead to the current mainstream view that corporations act as if there is a unique, optimal capital structure for individual firms that results from a trade-off between the tax benefits of increasing leverage and the increasing agency and bankruptcy costs higher debt entails. Signaling models, which were also derived from asymmetric information problems, suggest that managers use leverage to signal firm prospects to poorly informed outside investors who believe these signals because they are prohibitively costly for weak firms to mimic (Ross, 1977). Most of the work has been to identify the determinants of capital structure, attempting to test the explanatory power of capital structure models on corporate behavior in developed countries, particularly in the U.S setting. The main determinants tested include profitability, size, growth opportunity, asset tangibility, etc.

2.2.2.2 Innovation and capital structure choices

Implied by the pecking order theory, the firm will fund all projects using retained earnings if possible. If there is an inadequate amount of retained earnings, then debt financing will be used. However, when a firm has invested in R&D or innovation projects with uncertain results and risks, will this investment behavior influence this

financing order?

Previous literature analyzed the above question in two different ways. First, there have been extensive studies about the existence of financing constraints of R&D and innovation investments. R&D investments that are characterized by a high degree of risk and opaqueness are associated with lower leverage (Vincente-Lorente 2001), i.e. the asymmetry of information between shareholders, creditors and firm managers, together with the limited liability financial structure, impacts the investment decisions of firms (Maurer 1999). The argument of the negative correlation between R&D spending and leverage ratio lies in that investments in R&D creating intangible assets will likely suffer from market failure (i.e. they cannot be efficiently traded on the open market) and hence they cannot serve as effective collateral to support a high level of debt (Simerly and Li 2000, Vincente-Lorente 2001).

Recent empirical work has extended the determinants of leverage and implicated innovation as a determinant of leverage. Since the seminal paper by Jensen and Mecking (1976), the possibility for the investment and financing decisions to interact is acknowledged by researchers and a series of studies have been initiated to investigate how competitive strategies can influence capital structure. Jordan, Lowe, and Taylor (1998) investigated the relationship between capital structure and innovation and found that a strategy based on innovation was associated with the lowest level of debt, while firms pursuing a cost-leadership strategy had the highest level of debt. The strand of literature on corporate strategy generally assumes that firms operate in a market economy, where property rights are well defined and protected. Since the emerging economy context appears to be substantially different from those in developed economies, theories and research developed in those settings may have limited applicability to the transitional economy context such as in China. As these economies move to market-based, improved knowledge about managerial

decision-making including the choices of innovation clearly becomes more and more important for theory development and practice (Tan 2001).

2.2.3 Empirical Hypotheses

The Chinese Banking structure has been inherited from the socialist planned economy. While it has deprived emerging private enterprises from accessing external funding, the Chinese banking sector has traditionally been considered by the authorities as a substitute for state financing in order to ensure continued funding to preserve jobs in its many inefficient but massive state-owned enterprises.

Up until 1998, the four state-owned commercial banks including Bank of China, China Construction Bank, the Industrial and Commercial Bank of China and the Agriculture Bank of China were instructed to lend to state-owned enterprises. During the mid-1990s, Chinese authorities took the steps to reform the financial system through recapitalization and transferring non-performing loans to asset management companies. The system was liberalized at the end of 1990s, when the Chinese constitution acknowledged the private sector to be an integral part of the economy.

However, despite the fact that China has a very large and deep pool of financial capital - an estimated US$4.5 trillion of assets (McKinsey Global Institute[2]) - relatively few firms in China have access to formal finance (Hallward-Driemeier et al. 2003). Based on the World Business Environment Survey (WBES) on investment climate conduced in 80 countries during 1999-2000, 80% of private firms in China cited financing constraints as a major obstacle. This figure - twice the median figure of the sample (38.5%) - ranks China as the most financially constrained country ahead of Haiti (74.4%) and Kyrgyz Republic (66.7%). Approximately a quarter of the 2,200 domestic firms interviewed in the World Bank investment climate survey (2003) have neither a bank loan nor a loan from any other financial institutions, and on average

[2] http://www.mckinsey.com/aboutus/mckinseynews/financialreform.asp

only about 25% of firms' working capital comes from bank loans. Some research suggests that the financial intermediation and the banking reform are far from efficient in the mid-1990s (Park and Sehrt 2001). Theoretically, lending quota, the maximum amount of loan for firms, no longer exists. However, in practice, banks still consider private enterprises to be riskier than their public peers, either due to the short credit history or smaller chances of being bailed out by the government. The ability of the Chinese financial system to allocate capital more efficiently and to guarantee non-distortionary financial access to all companies, including private firms, is therefore a key indicator of the success of the ongoing reforms.

The predictions on profitability are ambiguous. In tradeoff theory, the profitable firms should be more highly levered to offset corporate taxes. In many asymmetric information models, such as Ross (1977), profitable firms are predicted to have higher leverage. However, Titman and Wessels (1988) and Fama and French (2002) show that this is not a common finding. Instead, the literature finds profits and leverage to be negatively correlated, which is consistent with the pecking order theory. The negative relation can be interpreted beyond the pecking order theory (Frank and Goyal 2003). One perspective is that firms may face fixed costs of adjustment. When a firm earns profit, debt gets paid off and leverage falls automatically. When it comes to China, I expect to find a negative relation between profitability and leverage. Compared with private firms, I especially expect that the relation will be more prominent for the state-owned firms for the following two reasons. On one hand, firms in China prefer to use internal finance first because external financing is not easily and widely accessible for firms because of the under developed economic and financial system. On the other hand, when a firm deplete its internal finance, it would be easier for a state-owned firm to get finance than that of a private firm, which implies a stronger relationship between profitability and leverage for the former one. What's more, for private firms,

because of their limited credit history and potential higher default risk, the effect of profitability on leverage could be positive if the bank or other financing sources use the profitability as an indicator of the quality of the firms according to the signal theory.

Hypothesis 1 Firms in China are credit constrained. The leverage ratio is negatively related with the profitability of a firm. But the relation between profitability and leverage ratio is weaker for private firms than for state-owned firms in China.

According to the investment literature, R&D and innovation are investments with high uncertainty and risk. They are sensitive to the internal finance and profit of a firm. When a firm has innovation investments, the demand of external financing including debt financing will increase. However, the supply of loans will be different for different types of firms in China. A state-owned firm, no matter conducting innovative projects or not, is assumed to have less default risk because of the potential bail out from the government. Therefore, it will be easier for state-owned firms to get loans from banks than for private firms. Furthermore, considering the tradition of the economic system in China, it would be easier for state-owned firms to get other external finance in general. Therefore, I expect that the ultimate equilibrium leverage ratio will increase for state-owned firms. For private firms, there could be two outcomes regarding the impact of innovation investment on future leverage ratio. The future leverage ratio can either increase or decrease, depending on whether firms can get loans or not.

Hypothesis 2 Innovation investment is positively related to future leverage ratio for state-owned firms in China. The impact of innovation investment on leverage ratio for

private firms could be positive but not as large as state-owned firms.

The first hypothesis analyzed the relation between profitability and corporate leverage in China. The most important assumption that firms are constrained by external finance and prefer to use internal finance first is derived from China's traditional economics system. When a firm has innovation investments in the current stage, compared with the situation without such investments, it will use more retained earnings to support the innovation projects, ceteris paribus. Accordingly, the demand for external financing will increase and the firm needs more external debt financing according to the pecking order theory.

Hypothesis 3 Innovation investment can affect the relation between profitability and leverage. The negative relation between profitability and leverage will be strengthened when a firm has innovation investment.

2.3 Data

The variables in the study are from the firm-level Investment Climate Survey conducted in 2003 by the World Bank in collaboration with the Chinese National Bureau of Statistics. The population primarily encompasses non-listed companies in China, including a small percentage of state-owned firms.

Accountants and personnel managers from a total of 2400 firms were interviewed in 18 Chinese cities in 15 provinces: Benxi(Liaoning), Changchun(Jilin), Changsha(Hunan), Chongqing(Chongqing), Dalian(Liaoning), Guiyang(Guizhou), Ha'erbin(Heilongjiang), Hangzhou(Zhejiang), Jiangmen(Guangdong), Kunming(Yunnan), Lanzhou(Gansu), Nanchang(Jiangxi), Nanning(Guangxi), Shenzhen(Guangdong), Wenzhou(Zhejiang), Wuhan(Hubei),Xi'an(Shanxi),

Zhengzhou(Henan). The locations of the cities range from the northeast to the southwest part of China.

None of the firms entered or exited within the observation period. The ages of firms range from 3 to 53. In addition, the non-listing criteria also ensures that the capital structure was not distorted by the effects of a recent official listing. The data include annual accounting information on sales, inputs, labor, capital stock, investment and several other expenditures from 1999 to 2002; information about broad firm characteristics is also included, such as the ownership structure, labor force characteristics, relations with competitors, clients and suppliers, innovation, market environment and investment climate. While the survey was conducted in 2003, finance and accounting information regarding sales, expenses on operation, management and interests, profit, liabilities, and investments are available annually; other information such as the ownership structure and innovation activities are measured only once between 1999 to 2002.

Among the 2,400 firms, around 1,800 of them correspond to 14 different 3-digit level industries in the manufacturing sector, including garment and leather products, electronic equipment, electronic part-making, household electronics, auto and auto-parts, information technology, food processing, chemical products and medicine, biotech products and Chinese medicine, metallurgical products and Transportation equipment. The other 600 firms are in the service sector, including accounting and non-banking financial services, advertising and marketing, and business services.

By eliminating firms that are undergoing bankruptcy, we keep firms with positive values of total sales and assets. In addition, we eliminate firms with negative debt, interest payments and investment, whose information can not be reasonably interpreted in the balance sheet. The final sample, after considering any missing data, consists of around 1,900 firms.

2.4 Empirical Model

2.4.1 The Model

Since the sample contains data across firms and over time, the basic regression model explaining firms' leverage can be specified as follows:

$$LEV_{it} = \alpha + X'_{it-1}\beta + Z'_i\gamma + u_{it}$$

Where *i* denotes the cross-section dimension and *t* indicates the time dimension, X'_{it-1} is a $1\times k$ vector of observations on *k* explanatory variables for the *i*th firm in the *t-1*th period, Z'_i represents firm level time-invariant variables (including state-owned firm indicator and innovation variable), β is a $k\times 1$ vector parameters, u_{it} is a disturbance term defined as $u_{it} = \mu_i + \upsilon_{it}$ where μ_i denotes the unobservable individual effect and υ_{it} denotes the remainder disturbance.

2.4.2 Variables

2.4.2.1 Dependent Variable

The dependent variable used to test the hypothesis is firm-level leverage ratio (*LEV*), which is computed through dividing the book value of total liability by the total assets of the firm. The total liability contains both long-term and short-term liabilities. Although the strict notion of capital structure refers exclusively to long-term leverage, we decide to include short-term liability mainly because Chinese firms use either very-little or no long-term capital. In our sample, the mean value of overall leverage is 0.54. The long-term leverage ratio is only 0.06, a much lower value.

2.4.2.2 Independent Variables

The estimation model includes dummies by city and sector to control the unobservable characteristics at the city and sector level. It is expected that most variance in financial development and institutional characteristics will be captured by the dummies.

In this survey, firms were asked to answer the types of innovation they had introduced since 1999. The five types of innovation are 1) Introduced new products in existing business; 2) Entered new business line; 3) New Process improvement; 4) New Management techniques; 5) New quality controls in production. The variable *INNOVATION* is the total of innovation investment types at the firm level, ranging from 0 and 5 to represent the innovation intensity of the firms.

The primary independent variable of interest is total innovation investment categories, which is used to proxy the real innovation investment extent of a firm. As the level of investment in innovation is unobservable, the key assumption for this variable is that the more innovation investment categories a firm has, the more finance will go into innovation investment.

For an alternative innovation variable, I use a binary indicator for innovation to study the effect of innovation on leverage ratio, which shows similar result to the innovation category variable.

Table 2.1 lists the main financial variables I am using in the empirical analysis. All variables in this table are calculated on an annual basis. The mean values of innovation categories, binary innovation indicator, overall leverage and short-term leverage ratios are summarized by cities and sectors in Panel A and Panel B of Table 2.2. Hangzhou, located in the Yangtze River Delta, an area with the highest economic growth rate in China, has the highest mean value both in innovation categories and innovation binary indication, 3.145 and 0.895 respectively. In contrast, Benxi, a medium-sized city in Liaoning province, northeastern part of China, has the lowest mean value of innovation in this sample. Figure 2.1 and 2.2 show the average innovation level in each of the city and sector. The table also indicates that innovation categories are highly correlated with the binary innovation indicator. What's more, we can also find that the overall leverage ratios are much higher than the long-term

Table 2. 1 Measurement of financial variables

Main financial variable	Measurements
Dependent variables	
Overall Leverage (LEV)	Ratio of book value of total debt to total assets
Long-term Leverage(LLEV)	Ratio of book value of long term debt to total assets
Independent variables	
Profitability	Ratio of operating income before interest, tax and depreciation to total assets
Size	Logarithm of total assets
Tangibility(Asset Structure)	Ratio of tangible assets(the sum of inventory and fixed assets)to total assets
Capital intensity	Ratio of book value of total assets to total sale

Table 2. 2 Panel A: Mean value of Innovation and Leverage ratio in China by sector

Sector	Innovation Categories	Any Innovation	Overall Leverage	Long-term Leverage	N
Garment & leather products	1.870	0.667	0.564	0.056	259
Electronic equipment	2.946	0.885	0.521	0.039	146
Electronic parts making	2.573	0.802	0.570	0.056	223
Household electronic	3.021	0.830	0.547	0.024	49
Auto & auto parts	2.666	0.809	0.596	0.081	290
Information technology	2.119	0.726	0.451	0.031	161
Accounting &non-banking financial service	1.150	0.480	0.496	0.139	120
Advertisement & marketing	1.294	0.580	0.484	0.032	113
Business services	1.350	0.573	0.483	0.115	207
Food processing	2.462	0.731	0.555	0.076	56
Chemical products &medicine	2.250	0.769	0.626	0.108	50
Biotech products & Chinese medicine	2.893	0.857	0.562	0.059	30
Metallurgical products	1.784	0.696	0.595	0.058	119
Transportation equipments	1.415	0.561	0.453	0.047	40
Total	2.097	0.710	0.539	0.068	1863

Table 2.2 Panel B:Mean value of Innovation and Leverage ratio in China by city

City	Innovation Categories	Any Innovation	Overall Leverage	Long-term Leverage	Obs.
Benxi	1.315	0.534	0.561	0.063	73
Changchun	2.303	0.770	0.554	0.081	122
Changsha	2.435	0.800	0.549	0.067	108
Chongqing	2.752	0.816	0.584	0.094	125
Dalian	2.014	0.704	0.500	0.072	71
Guiyang	2.196	0.696	0.576	0.094	98
Haerbin	2.155	0.691	0.520	0.067	110
Hangzhou	3.145	0.895	0.577	0.051	76
Jiangmen	1.962	0.722	0.532	0.062	79
Kunming	1.813	0.667	0.534	0.075	123
Lanzhou	1.303	0.580	0.554	0.057	114
Nanchang	2.135	0.698	0.501	0.073	123
Nanning	1.839	0.634	0.527	0.068	108
Shenzhen	2.141	0.679	0.495	0.022	78
Wenzhou	2.115	0.701	0.473	0.035	83
Wuhan	2.341	0.770	0.520	0.091	126
Xian	2.198	0.754	0.571	0.064	122
Zhengzhou	1.589	0.645	0.540	0.054	124
Total	2.097	0.710	0.539	0.068	1863

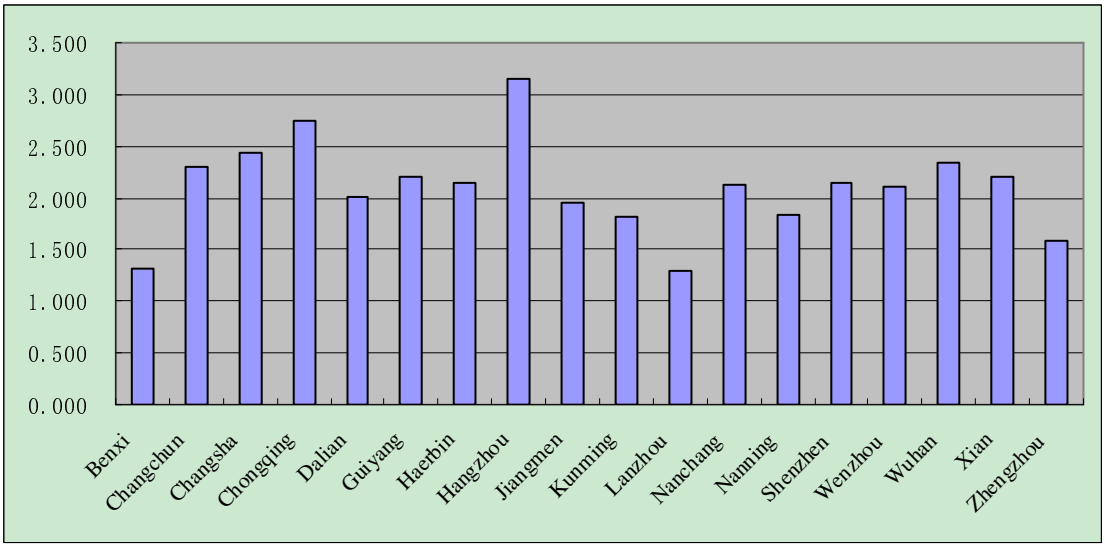

Figure 2. 1 Innovation by city

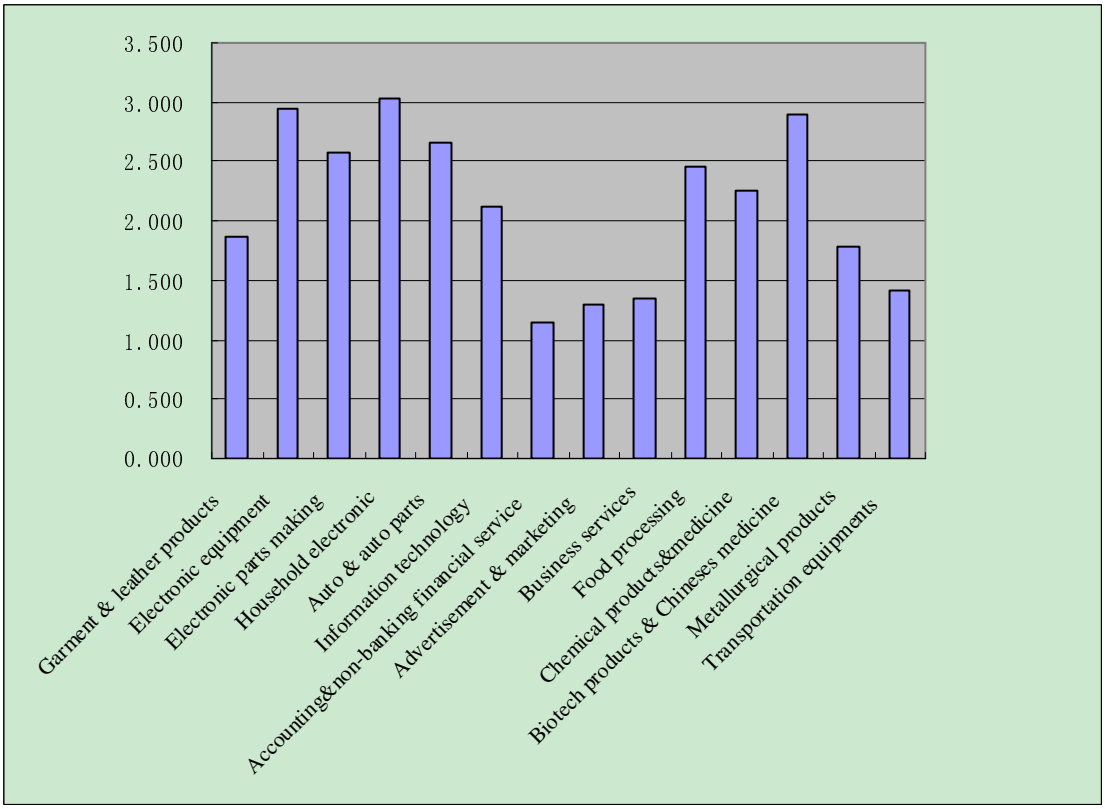

Figure 2. 2 Innovation by sector

Table 2. 3 Descriptive Statistics

Notes: Table 2.3 reports the summary statistics of the innovation variables and key financial variables in line with the capital structure literature.

Variable	Mean	Std. Dev.	Min	Max
Innovation	2.097149	1.789168	0	5
Binary Innovation	0.7101373	0.4537284	0	1
Profit	5979.969	98666.86	-2708410	5413730
Asset	214070.2	1280547	4.8	5.98E+07
Sale	119403.3	706375.9	0	3.03E+07
Leverage	0.5390241	0.2556683	0	0.9997931
Profitability	0.0454041	1.210024	-19.2428	72.13071
Capital Intensity	8.39605	145.5392	0.0001563	7099.595
Tangibility	1.068224	12.27065	0.0007214	564.2918
Size	9.153769	2.228569	-0.2231435	17.22603
Government ownership	20.76164	39.24695	0	100

leverage ratios.

Table 2.3 summarizes the key variables used in the empirical capital structure determinants model.

2.5 Econometric Analysis

As the dataset contains multiple observations per firm, I will attempt to account for unobserved heterogeneity using panel data methods. Two of the most common approaches for modeling this type of panel data are: (a) random-effects (RE) models; (b) fixed-effects (FE) models. Although a fixed-effects model would be preferred to a random-effects design, it has a critical shortcoming regarding the present study because the innovation variable is time-invariant. Because the firm fixed effects capture all factors that are constant within a firm over time, the fixed effects models cannot produce stable estimates for variables that are either invariant or display little change within a firm over the time.

Alternatively, we first analyze the data using the pooled OLS and random effects model to estimate the main regression function. Both pooled OLS and the RE estimator make use of the between and the within variation, while the RE estimator does so in an efficient way. Since leverage changes very slowly, and it may take some time for actual leverage ratios to approach the 'optimum' level in response to shift in the optimum, all independent variables were lagged 1 year for the leverage models. A proper interpretation of this model is that a change in an independent variable at time t-1 will be associated with a change in leverage between time t-1 and time t.

Since the Pooled OLS relies on a between comparison, the estimate for the coefficient of innovation variable can be biased because of the unobserved heterogeneity. Actually, even if the analysis could be conducted with fixed effect regression, the problem can not be resolved completely. Therefore, for further analysis,

we use IV estimation method. The city-sector level of innovation excluding the focal firm is highly correlated with the firm-level innovation variable, but not the error term. Neither will it affect the firm leverage ration directly according to the assumption of the IV method.

2.5.1 Profitability and Leverage

In order to estimate the effect of the independent variables on the overall leverage, we first consider the Pooled OLS econometric approach to estimate the model. Under the hypothesis that there is no group or individual effects among the firms in the sample, I estimate the models with full sample. The results of the OLS regression and random effects used to test Hypothesis 1 are reported in Table 2.4.

By controlling the key variables, profitability, size (log of assets), tangibility and capital intensity, which are conventionally in line with the literature studying capital structure determinants, the four models test the first empirical hypothesis and the table summarizes the results by using Pooled OLS and random effects regressions. Hypothesis 1 predicts that firms in China are financially constrained. The negative relationship between profitability and the leverage ratio implies that retained profit is the quickest and easiest source of finance for most companies. The result of the negative coefficient of profit also supports the Pecking Order model hypothesis.

In terms of tangibility, there are two different perspectives in interpreting the sign of the coefficient. The common idea is based on the hypothesis that collateral supports debt, and tangible assets are easy to collateralize in both developed and developing countries. Therefore, the usual prediction for the coefficient of tangibility is positive. However, one might expect that firms with few tangible assets would have greater asymmetric information problems, which makes firms with few tangible assets accumulate more debt over time and become more highly levered (Harris and Raviv

Table 2. 4 Determinants of capital structure in China with Full Sample

Notes: Table 2.4 reports regression of the capital structure determinants including innovation with full sample. The dependent variable for each column is firm-level leverage ratio. Standard errors in parentheses; ***, **,* denote significance at 1%. 5% and 10% levels respectively.

Dependent Variable: Leverage	**(1)**	**(2)**	**(3)**	**(4)**
Independent Variables	**Pooled OLS**	**Pooled OLS**	**Random Effects**	**Random Effects**
Innovation	-0.0044*	-0.0098***	-0.0022	-0.0079**
	(0.0026)	(0.0026)	(0.0034)	(0.0035)
Profitability	-0.0102**	-0.0091**	-0.0013	-0.0012
	(0.0047)	(0.0046)	(0.0019)	(0.0019)
Capital Intensity	0.0001***	0.0001***	0.0001**	0.0001**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tangibility	-0.0001	0.0003	-0.0001	0.0001
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Size	0.0107***	0.0115***	0.0056**	0.0053*
	(0.0022)	(0.0024)	(0.0025)	(0.0027)
State_Owned	0.0036	0.0229**	0.0087	0.0277*
	(0.0099)	(0.0105)	(0.0134)	(0.0142)
_cons	0.4508***	0.4953***	0.4911***	0.5413***
	(0.0189)	(0.0312)	(0.0226)	(0.0404)
Sector Dummies		Yes		Yes
City Dummies		Yes		Yes
N	3577	3577	3577	3577
F	5.8433	6.1583		

1991). In the regressions of this paper, we do not find a significant result for the coefficient. In addition, the positive effect of size is also consistent with previous literature (Rajan and Zingales 1995, Hovakimian et al., 2000). Capital intensity is usually included in the capital structure determinants model to control a firm's efficiency in deployment of its assets, which indicates how much money is invested to produce one dollar of sales revenue. In our analysis, we find that capital intensity consistantly has significant positive effect on leverage ratio for private firms in China, which implies that the efficiency of private firms is important for getting finance from banks while the relation is not clear for state-owned firms.

In Table 2.4, we find that being a state-owned company has a positive effect on the leverage ratio of firms in China. To test for the different ownership effects, I split the sample into private and state-owned companies, the results of which are reported in Table 2.5. One of the most significant differences between state-owned firms and private firms is the relation between profitability and leverage ratios. The negative marginal effect of profitability on leverage is stronger for state-owned firms than for private firms.

As introduced at the beginning of this paper, state-owned firms were protected by the government and had easier access to external funding from the Chinese banking sector before the reform of the financial system in mid-1990s. Even though the current financial system allocates capital more efficiently and guarantees more financial access to all companies, including private firms, the Chinese financial environment still maintains some features of a centrally planned economy. If the government does not change its controlling behavior towards state-owned enterprises, those firms are less likely to run into financial crisis compared with their private sectors counterparts. The implication of the weaker negative relation between profitability and leverage ratio for private firms is that the pecking order phenomenon, i.e. the negative relation

Table 2. 5 Determinants of Capital Structure in China: State-owned V.S. Private Firms

Notes: Table 2.5 compares investigation of determinants of capital structure for firms in China for state-owned firms and private firms. The dependent variable for each column is firm-level leverage ratio. Standard errors in parentheses;***, **,* denote significance at 1%. 5% and 10% levels respectively.

Dependent variable: Leverage	(1)	(2)	(3)	(4)	(5)	(6)
	State owned	Private	State owned	Private	State owned	Private
Independent variables	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Random Effects	Random Effects
Innovation	0.0009	-0.0069**	-0.0138**	-0.0096***	0.0074	-0.0074*
	(0.0057)	(0.0029)	(0.0058)	(0.0029)	(0.0077)	(0.0039)
Profitability	-0.5915***	-0.0095**	-0.5379***	-0.0090*	-0.2642***	-0.0012
	(0.1106)	(0.0047)	(0.1117)	(0.0046)	(0.0829)	(0.0020)
Capital intensity	0.0003	0.0001***	0.0003	0.0001**	0.0001	0.0001**
	(0.0002)	(0.0000)	(0.0002)	(0.0000)	(0.0001)	(0.0000)
Tangibility	-0.0705***	-0.0000	-0.0444***	0.0003	-0.0242**	0.0001
	(0.0126)	(0.0004)	(0.0130)	(0.0004)	(0.0115)	(0.0004)
Size	0.0093**	0.0124***	0.0044	0.0158***	-0.0009	0.0091***
	(0.0047)	(0.0024)	(0.0053)	(0.0027)	(0.0058)	(0.0030)
_cons	0.5010***	0.4410***	0.4366***	0.5347***	0.5591***	0.5853***
	(0.0436)	(0.0212)	(0.0721)	(0.0360)	(0.0541)	(0.0464)
Sector dummies			Yes	Yes		Yes
City dummies			Yes	Yes		Yes
R-squared	0.0754	0.0121	0.2033	0.0591		
N	759	2818	759	2818	759	2818
F	12.2870***	6.8647***	5.2708***	4.9963***		

between profit and debt financing, is more evident when an enterprise has more access to debt financing.

2.5.2 Innovation and Capital Structure

Empirically, financing constraints for risky R&D and innovation investment could be identified by testing the sensitivity of investment to internal funds because it is assumed that external finance is more costly than internal finance due to asymmetric information and agency problems. Controlling for other factors, the relation between investment and measures of internal funds is significantly positive (Himmelberg and Petersen 1994, Kaplan and Zingales 1997, Alti 2003 and Gomes 2001). Based on the results above from the literature, how will current innovation investment affect future capital structure decisions?

To investigate the relation, I include a variable INNOVATION which proxies the innovation investment of firms in the capital structure equation, both as a main effect and as interaction with the profitability variable. One of the key questions addressed in this paper is to identify whether innovation -a type of financially constrained investment- can affect the future capital structure decisions. When a firm has innovation investment, will the relation between profitability and innovation be consistent with the prediction of the pecking order hypothesis?

In the regressions with the full sample as shown in Table 2.4, the lagged innovation investment has a significant negative effect across all of the firms when we control the city level and industry level fixed effects. When we separate the firms into private and public firms, we can see that the negative effect of innovation on leverage ratio is significant for all the private firms but not state-owned firms. The effects of firm-level innovation investment on leverage ratio choice are not stable across all of the models.

To control the potential reverse causality and unobserved heterogeneity problem, I use the city-sector level of innovation excluding the focal firm as an instrument. As the main objective is to study the effect of a time invariant regressor INNOVATION on firms' leverage ratios, we performed the Hausman-Taylor IV method. It fits panel-data random-effects models in which some of the covariates are correlated with the unobserved individual-level random effect, which preserves the advantages of both estimators. The estimators were proposed by Hausman and Taylor (1981) and Amemiya and MaCurdy (1986). The identified effects of time invariant regressors are reported in Table 2.6.

From Table 2.6, we find that by controlling for the potential endogeneity of the innovation variable, the direct effect of innovation on leverage turns out to be significantly positive for state-owned firms in specifications (3) and (5) as well as in the overall regressions (1) and (2), suggesting a negative bias in the models when we do not consider the endogeneity issue. An unobserved innovation policy could generate this bias. On one hand, the policy might promote innovation within a firm; on the other hand, when too many innovative companies and projects apply for debt financing, the credit could be more difficult to approve. Under these circumstances, the interaction effect of innovation and profitability on leverage ratio is hard to predict in the regressions. Accounting for the endogeneity of innovation, the effect of innovation on leverage is significantly positive for all of the firms. In addition, the positive effect for state-owned companies is higher than for private firms by around 12%. To check whether the result is robust or not, we also analyze with 2SLS method in Table 2.7. We find that the results agree with that of the Hauseman-Taylor Approach.

Table 2. 6 Hausman-Taylor Estimations

Notes: Table 2.6 reports the results of the regressions with Hausman-Taylor Approach-The Standard errors in parentheses; ***, **,* denote significance at 1%. 5% and 10% levels respectively.

Dependent variables: Leverage	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables	All firms	All firms	State-owned	Private	State-owned	Private
Innovation	0.0568***	0.0444***	0.1683***	0.0496***	0.1629***	0.0408***
	(0.0170)	(0.0128)	(0.0413)	(0.0187)	(0.0402)	(0.0135)
Innovation*Profitability		-0.0288**			-0.0280	-0.0325**
		(0.0145)			(0.0546)	(0.0153)
Profitability	-0.0005	0.0568*	-0.1761**	-0.0006	-0.1417	0.0641**
	(0.0019)	(0.0290)	(0.0887)	(0.0020)	(0.1126)	(0.0307)
Capital intensity	0.0001*	0.0001*	-0.0001	0.0001*	-0.0001	0.0001*
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0001)	(0.0000)
Tangibility	-0.0005	-0.0004	0.0034	-0.0004	0.0031	-0.0003
	(0.0004)	(0.0004)	(0.0134)	(0.0004)	(0.0133)	(0.0004)
Size	-0.0087*	-0.0055	-0.0501***	-0.0045	-0.0484***	-0.0023
	(0.0047)	(0.0038)	(0.0131)	(0.0050)	(0.0128)	(0.0040)
State_owned	0.0234	0.0193				
	(0.0151)	(0.0145)				
_cons	0.4936***	0.4925***	0.7180***	0.4697***	0.7122***	0.4693***
	(0.0243)	(0.0239)	(0.0819)	(0.0269)	(0.0811)	(0.0265)
N	3577	3577	759	2818	759	2818
F	3.0921***	2.9387***	3.8879***	2.5821***	3.3298***	2.7140***

Table 2. 7 Two-stage IV regressions

Notes: Table 2.7 reports the results of the 2SLS regressions without panel features. To control the potential endogeneity of innovation, we use the city-sector level of innovation excluding the focal firm as instrument. The results compare investigation of determinants of capital structure for firms in China for state-owned firms and private firms. The dependent variable for each column is firm-level leverage ratio. Standard errors in parentheses; ***, **,* denote significance at 1%. 5% and 10% levels respectively.

Dependent Variable: Leverage	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables	All firms	All firms	State-owned	Private	State-owned	Private
Innovation	0.0204**	0.0209**	0.0958***	-0.0004	0.0959***	-0.0001
	(0.0091)	(0.0092)	(0.0240)	(0.0099)	(0.0241)	(0.0100)
Profitability	-0.0010	0.0372	-0.2263***	-0.0012	-0.1825	0.0265
	(0.0020)	(0.0283)	(0.0867)	(0.0020)	(0.1122)	(0.0298)
Capital intensity	0.0001**	0.0001**	-0.0000	0.0001**	-0.0000	0.0001**
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0001)	(0.0000)
Tangibility	-0.0003	-0.0003	-0.0089	-0.0001	-0.0087	-0.0001
	(0.0004)	(0.0004)	(0.0125)	(0.0004)	(0.0125)	(0.0004)
Size	0.0002	0.0003	-0.0284***	0.0067*	-0.0280***	0.0068**
	(0.0032)	(0.0032)	(0.0093)	(0.0034)	(0.0093)	(0.0034)
State owned	0.0146	0.0141				
	(0.0137)	(0.0137)				
Innovation*Profitability		-0.0191			-0.0326	-0.0139
		(0.0141)			(0.0531)	(0.0149)
Sector dummies		Yes			Yes	Yes
City dummies		Yes			Yes	Yes
_cons	0.4917***	0.4906***	0.6360***	0.4779***	0.6327***	0.4769***
	(0.0228)	(0.0228)	(0.0626)	(0.0251)	(0.0628)	(0.0251)
N	3577	3577	759	2818	759	2818

2.6 Conclusions

China is one of the biggest emerging economies undergoing reforms in its innovation policies as well as the financial system. On one hand, Chinese government has put forth various policies in promoting technological innovation capabilities; on the other hand, Chinese authorities also took the steps of reforming the financial system to increase its efficiency in allocating capital. The policies include allowing lending to private enterprises from the four state-owned commercial banks and recapitalizing non-performing loans to asset management companies. However, in my study, the results still suggest a striking difference between the debt financing patterns faced by state-owned and private firms.

With firm-level panel data across 18 Chinese cities, I study the determinants of firm capital structure for Chinese state-owned and private firms. In addition, I investigate how innovation investment activity affects the capital structure for different types of firms in China. My study sheds light on the special features of the financial systems in China.

First, I find that the relation between profitability and future leverage is significantly negative, which agrees with the pecking order hypothesis and suggest that firms are facing financial constraints because the financial market is not perfect and information is not symmetric. The negative marginal effect is stronger for state-owned firms than for private firms. The less the profit in the current stage, the higher external loan financing state-owned firms need to get from the banks. Since the data reflect the leverage ratio in equilibrium, the result suggests that state-owned firms are still less financially constrained than private firms.

Second, I investigate how innovation - a type of investment highly sensitive to internal finance with uncertainty and risk, will affect the leverage ratios. By controlling the potential endogeneity and unobserved heterogeneity with

Hausman-Taylor and 2SLS approach, both instrumental-variable regression analyses show that innovation has a positive impact on future leverage ratios especially for state-owned firms. When a firm has invested in innovation, its demand for finance will increase. However, since the state-owned firms have less default risk because of government protection and bailout policies, it will be easier for state-owned firms to receive funding from banks. Innovation will not exacerbate the financing condition for state-owned firms.

Last but not least, I study how innovation investment can impact the relation between profitability and leverage ratio. The point estimation in 2SLS and Hausman-Taylor Approach shows that innovation will strengthen the negative relation between profitability and leverage ratio.

The findings have reflected the transitional nature of the Chinese corporate environment. This is because the Chinese financial environment still maintains some features of a centrally planned economy as the state is still the principal stakeholder of firms. State-owned enterprises are less likely to run into financial problems compared with their counterparts in the private sector. Therefore, the negative relation between profitability and future leverage ratio is more prominent. While bank financing is still more costly than using retained earnings, if a state-owned firm depletes its internal finance, it will not be difficult for them to get access to external bank finance, which is not the case for private firms. On the other hand, certain firm-specific factors that affect firms' leverage in the Western countries also affect Chinese firms' leverage. Innovation, a type of risky investment facing with financial constraints, has a positive impact on future leverage ratio, particularly in Chinese state-owned firms. However, for private firms, the positive effect is not as strong as state-owned firms. The effect could be negative because a bank will be reluctant to finance a private firm without a long credit history and government protection.

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CONCLUSIONS

In summary, this dissertation reveals a full picture of the relation between innovation and capital structure in the context of emerging economies. Whereas earlier research has primarily studied publicly-traded companies from the United States, my study highlights that the results for different types of samples may diverge, and the understanding of the interaction of innovation investments and corporate financial structures would benefit from explicit attention to the institutional settings in which firms are embedded.

In the first chapter, I have shed new light on the effect of external finance on innovation investment decisions in Asian and Eastern European emerging economies. I find that external financing, especially funding from equity markets and from friends and family provide significant financial resources for firms' innovation investments. Whereas the public equity markets are not mature in most of the analyzed economies, private equity financing still has a significant positive effect on innovation investment. I argue that financial development is a critical enabler of innovation in a broad set of service and manufacturing firms. What's more, the political environment, characterized by the political constraints indicator, plays an important role in the relation between external finance and innovation. The more democratic a country, the stronger is the positive effect of finance on innovation.

In the second chapter, I show that innovation can affect the future capital structure decisions in China. The primary findings have reflected the transitional nature of the Chinese corporate environment, which still maintains some features of a centrally planned economy as the state is still the principal stakeholder of many firms. State-owned enterprises are less likely to run into financial problems compared with their counterparts in the private sector. Therefore, the negative relation between profitability and future leverage ratio is more prominent. While bank financing is still

more costly than using retained earnings, if a state-owned firm depletes its internal finance, it will not be difficult for them to get access to external bank finance, which is not the case for private firms. On the other hand, certain firm-specific factors that affect firms' leverage in the Western countries also affect Chinese firms' leverage. Innovation, a type of risky investment affected by financial constraints, has a positive impact on future leverage ratio, particularly in Chinese state-owned firms. However, for private firms, the positive effect is not as strong as for state-owned firms. The effect may even be negative because a bank will be reluctant to finance a private firm that engages in risky innovation without a long credit history and government protection.

The importance of equity financing on innovation is implied by the conclusion of Chapter 2 that the relationship between leverage and innovation is much weaker for private firms. As private firms are generally smaller and younger than state-owned firms with less potential bail out support from the government, they are facing stronger financing constraints from banks. Therefore, private firms have to seek financing support from equity markets.

Theoretically, this dissertation contributes to the literature in studying financing of innovation. It deepens our understanding of the interaction among innovation, external financing and the overall capital structure. Empirically, this study contributes to the literature with micro evidence in the emerging-economy context.

While the data based on the World Bank Enterprise Survey makes the study of the relation between innovation and finance possible, it is not without limitations. First, I do not have information on innovation year by year, which prevents me from doing a dynamic empirical analysis of the relation between innovation and finance. Second, it is hard to avoid the measurement errors in the process of conducting the surveys, which is beyond the control of the researchers. The biggest challenge in the research is

to control the endogeneity of the focal variables in the regression models. With instrumental-variable techniques, I resolve the issue in both chapters. The results are robust and mitigate the existing biases in the emerging economy context.

The policy implications of this study can be summarized from two perspectives. The results of the first chapter emphasize the importance of transparent and efficient financial markets and institutions that reduce information asymmetries between innovators and potential investors. It also provides managerial insights regarding the financial challenges of innovation and building growth-oriented companies in emerging economies. Innovators are generally better off developing relationships that provide access to private equity investors rather than seeking investment funding from the commercial banking sector. For China, as studied in the second chapter, the results reveal that the financial reform of the banking system is far from efficient in terms of providing funding to innovation investment of private firms. The government should overcome the institutional legacy of the planned economy by encouraging changes in the attitudes and methods of work of the banking system so as to allow market forces, competition and the private sector to play a greater role.

Future research can be extended to compare the difference of the effect of finance on innovation from within countries and between countries. In addition, I am also interested in institutional characteristics other than political constraint which can moderate the relation between innovation and corporate structure.