Aspects of Globalization:

Financial Markets Liberalization, Technological Innovation, Accounting Harmonization and Corporate Finance

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This thesis investigates several aspects of globalization which are relevant to international finance. We first examine the impacts of financial market liberalization on technological innovation. We find that financial market liberalization motivates innovation, and such motivation is stronger among industries which are more dependent on external finance, have higher growth opportunities, are younger, and are high-tech intensive. High country-level institutional quality is found to strengthen this positive impact of financial liberalization on innovation. We then study how adoption of International Financial Reporting Standards (IFRS) influences technological innovation. Empirical evidence shows that mandatory IFRS adopters outperformed firms that follow local Generally Accepted Accounting Principles (GAAP), in terms of technological innovation. Likewise, high country-level institutional quality facilitates such positive influences. We also find evidence that reduced cost of capital and increased institutional investors' holdings are two possible underlying channels through which mandatory IFRS adoption motivates innovation. Finally, we examine the negative correlation between dividend payout policy and future cash-flow uncertainty in an international context. Employing country-level and firm-level analysis frameworks, the results suggest country-level institutional quality reinforces this negative relationship. Firms with higher future cash-flow uncertainty appear to be more conservative in paying dividends in countries with a more transparent information environment, better protection for investors, more efficient legal and political institutions, and stronger control of corruption. Our finding continues to hold during the recent Global Financial Crisis (GFC) of 2008.

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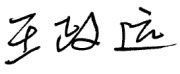
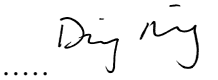


…… ……  ……. ……30/May/2015……

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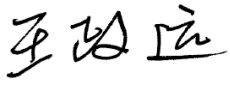
Signed: 

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Abstract

This thesis investigates several aspects of globalization which are relevant to international finance. We first examine the impacts of financial market liberalization on technological innovation. We find that financial market liberalization motivates innovation, and such motivation is stronger among industries which are more dependent on external finance, have higher growth opportunities, are younger, and are high-tech intensive. High country-level institutional quality is found to strengthen this positive impact of financial liberalization on innovation. We then study how adoption of International Financial Reporting Standards (IFRS) influences technological innovation. Empirical evidence shows that mandatory IFRS adopters outperformed firms that follow local Generally Accepted Accounting Principles (GAAP), in terms of technological innovation. Likewise, high country-level institutional quality facilitates such positive influences. We also find evidence that reduced cost of capital and increased institutional investors' holdings are two possible underlying channels through which mandatory IFRS adoption motivates innovation. Finally, we examine the negative correlation between dividend payout policy and future cash-flow uncertainty in an international context. Employing country-level and firm-level analysis frameworks, the results suggest country-level institutional quality reinforces this negative relationship. Firms with higher future cash-flow uncertainty appear to be more conservative in paying dividends in countries with a more transparent information environment, better protection for investors, more efficient legal and political institutions, and stronger control of corruption. Our finding continues to hold during the recent Global Financial Crisis (GFC) of 2008.

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Chapter 1.

Introduction

"Globalization is a historical process, the result of human innovation and technological progress. It refers to the increasing integration of economies around the world, particularly through the movement of goods, services and capital across borders. The term sometimes also refers to the movement of people (labor) and knowledge (technology) across international borders. There are also broader cultural, political and environmental dimensions of globalization" (International Monetary Fund, 2008). The total global export of goods and services in 2012 has exceeded $US22 trillion, which accounted for one-third of total global GDP in that year (data from the World Bank Database). Although this number merely measures the volume of international trade, it has highlights the significant importance of globalization to the global economy in nowadays.

There are more examples of globalization closer to people's daily life, making everyone inevitably, more or less, affected by globalization. For instance, people may wear clothes made in India, Vietnam or Philippines, use iPhones designed in the US and assembled in China, and drive cars made in Japan, Germany or South Korea. The money people borrow for their residential mortgage may be ultimately sourced from Japan or the US because the interest rates there are low. Superannuation is invested overseas in order to diversify risk or to achieve higher returns. However, globalization has negative impacts. The most recent Global Financial Crisis (GFC) in 2008 first started in the US but quickly swept the whole world and triggered sovereign debt crisis in Europe and caused economic difficulties in many other regions. Other unpleasant consequences of globalization may include loss of jobs, increased competition, deepening income inequality and changes in global climate, among many others (World Economic Forum, 2014). These facts remind us that globalization may be beneficiary or disastrous to people's lives, depending on how we manage this irreversible trend.

Certainly, it is important to first understand globalization before we can manage it. There have been many books, articles and essays discussing the causes, the processes and the consequences of globalization. Due to the richness of the concept, it is impossible to address all aspects of "globalization" in a single thesis. So this thesis tries to enrich people's understanding of globalization from a perspective of finance.

The recent Initial Public Offering (IPO) of Alibaba Group provides an excellent example demonstrating the importance of globalization to finance. Headquartered in China, Alibaba Group is an e-commerce company providing internet platforms of on-line shopping and international business. Alibaba Group launched its IPO in the New York Stock Exchange (NYSE) in the US, instead of Chinese domestic stock exchanges. The reason is that NYSE, as developed stock markets, allows unconventional ownership structure, meaning different levels of voting rights can be attached to shares. Interestingly, the biggest shareholder of Alibaba Group is not the founder of Alibaba, but is a Korean-Japanese businessman, Masayoshi Son, and his Japan-based SoftBank, with 34% of total shares. Alibaba's IPO successfully attracted capital from all over the world. By the close of its first public trading day on 19 November 2014, Alibaba's share price was $US93.89, a 38% increase from its IPO price. At this price, Alibaba was ranked as the third largest technology company in the world following Google and Microsoft and even ahead of Facebook. At the same time, this Chinese company had earned the title of biggest IPO in the US history. To some extent, globalization is the cornerstone of Alibaba: if it is not globalization, Alibaba would not be even created in the first place. Globalized capital markets further nourish the success of Alibaba. The increasingly sophisticated global financial markets also shape many other firms, like Alibaba. Therefore, it is important to carefully examine globalization from a perspective of finance.

The main body of this thesis comprises three stand-alone essays, with each one addressing one aspect of globalization relevant to the discipline of finance. The structure of this thesis is as follows: in Chapter 2, we first examine the impact of financial market liberalization on technological innovation. This study is inspired by the fact that many countries liberalized their financial markets to allow foreign investors to participate in their domestic stock markets during the 1980s and 1990s. Many countries have also loosened restrictions on capital accounts allowing cross-border flow of capital. This process is definitely part of globalization by accelerating the integration of domestic financial markets into the world market. More importantly, technological innovation is generally considered as a critical driver of long-term economic growth (Solow, 1957; Romer, 1986). Utilizing a large sample of financial and patent data across 34 countries over a period of 1980-2009, we find that financial market liberalization motivates technological innovation. Such positive effect is disproportionately more prominent among industries which are more dependent on external finance, have higher future growth opportunities, are younger and are high-tech intensive. Furthermore, we find that country-level institution quality strengthens the positive relationship. Our finding remains valid under various robustness tests.

Next in Chapter 3, we focus on a special type of globalization – the harmonization of accounting rules around the world represented by the introduction of International Financial Reporting Standards (IFRS). Similarly, we employ a unique perspective of technological innovation by examining whether mandatory IFRS adoption exhibits impacts on technological innovation. Facilitated by the mandatory IFRS adoption by the European Union (EU) in 2005, we empirically show that mandatory IFRS adoption firms outperformed firms following local Generally Accepted Accounting Principles (GAAP) in other non-EU countries, in terms of innovation, after

2005. Our finding is robust to a range of checks, and we also find country-level institutions are important to this positive relationship between mandatory IFRS adoption and innovation. We further investigate two possible channels, reduced cost of capital and increased institutional investor holdings, through which mandatory IFRS adoption could motivate innovation, and we provide relevant empirical evidence.

In Chapter 4, we study a traditional topic of corporate finance, dividend policy, in an international context. More specifically, we extend Chay and Suh (2009) to examine how country-level institutional quality affects the negative relationship between dividend payout and future cash-flow risk. Based on a large sample of 52 countries between 1994 and 2011, we find that the negative relationship is more prominent in countries with higher information quality and transparency, with better investor protection, with efficient legal and political institutions, and with stronger corruption controls. We implement country-level and firm-level analysis frameworks and find consistent results. Our finding is robust to alternative measures of dividend payouts. We also find that the negative relationship between dividend policy and cash-flow uncertainty persists during the recent Global Financial Crisis, while its strength and its interaction with country-level institutions was not intensified by the GFC in 2008.

Finally, we conclude in Chapter 5.

Chapter 2.

Financial Liberalization and Technological Innovation

2.1. Introduction

Throughout the last two decades of the 20th century, we have witnessed the liberalization of financial markets in many countries. The governments of these countries allowed foreign investors to participate in their domestic stock markets and loosened restrictions on cross-border capital transactions. Financial liberalization has inevitably caused substantial impacts on the economy. For example, according to Bekaert, Harvey, and Lundblad (2005), financial liberalization leads to a 1% increase in annual real economic growth. This positive effect of financial liberalization on economic growth is subsequently confirmed in other studies both at the industry-level (Gupta and Yuan, 2009) and at the firm-level (Mitton, 2006). However, the underlying economic channels through which financial liberalization spurs economic growth are less well understood (Henry, 2003). In this chapter, we propose one such channel: technological innovation. Our objective is to establish a link between financial liberalization and innovation because existing literature has already shown that innovation is vital for a country's economic growth (Solow, 1957; Romer, 1986). For example, Rosenberg (2004) argues 85% of economic growth could be attributable to technological innovation. Based on an international sample of patents across 59 countries between 1980 and 2005, Chang et al. (2013) find that a one standard deviation increase in patent stock per capita portends a 0.85% increase in GDP growth.

We propose and empirically examine four plausible mechanisms to study whether financial liberalization affects innovation, motivated by extant literature: relaxation of financial constraints, growth opportunities, industry maturity and exposure to high technology. To begin with, we consider the most important consequence of financial liberalization: the relaxation of financial constraints. Financial liberalization lowers the cost of equity capital and relaxes financial constraints (Bekaert and Harvey,

2000; Henry, 2000a), because more foreign capital becomes available to domestic equity markets. Since innovative firms usually exhaust internal capital and rely heavily on external equity finance (Brown, Fazzari, and Petersen, 2009; Brown, Martinsson, and Petersen, 2012), we postulate that industry sectors of a country that are more dependent on external finance will benefit more, in terms of technological innovation, from an open stock market.

The second underlying mechanism we study is growth opportunities. Financial liberalization accelerates a domestic market's integration into the global markets and thus better aligns financial resource and growth opportunities. Bekaert et al. (2007) find that financial liberalization exacerbates the effect of a country's growth opportunities on its economic expansion. Gupta and Yuan (2009) find that industries with better growth opportunities grow faster following financial liberalization. To the extent that technological innovation is a main driver of economic growth, we hypothesize that industries with better growth potential will produce more innovation after a country liberalizes its financial markets.

The third underlying economic mechanism we propose is industry maturity. Allen and Gale's (1999) model implies that because young industries are characterized by heterogeneous technologies, more developed equity markets that are promoted by financial liberalization attract investors with heterogeneous beliefs who tend to fund new technologies in these industries. In addition, financial liberalization allows the entry of sophisticated foreign investors such as failure-tolerant venture capitalists (Tian and Wang, 2014) or other types of institutional investors (Aghion, Van Reenen, and Zingales, 2013), which facilitates better incubation of young innovators. Therefore, we postulate that younger industries benefit more in countries with liberalized equity markets.

Finally, financial liberalization may affect innovation through an industry's exposure to high technology. An important function of equity markets is to help market participants diversify their exposure to systematic risk (King and Levine, 1993), which may ultimately nurture innovation. High-tech firms are usually engaged in the design, development and introduction of innovative manufacturing processes or new products. However, innovation with advanced and novel technological content is more idiosyncratic and riskier than routine operations (Holmstrom, 1989). Financial liberalization that removes the entry barriers to international investment imposed on foreign investors offers a richer set of risk management tools that diversify the risks inherent in high-tech industries (Obstfeld, 1994). Henry (2003) also suggests that a direct test of liberalization-based explanations of economic growth is to examine whether increased risk sharing induces firms to adopt new technologies. In addition, the entry of foreign investors following financial liberalization could bring in new knowledge, and thus consequently stimulate innovation in the domestic market. We expect such a stimulation effect to be more likely in high-tech industries. Therefore, we propose that high-tech intensive industries innovate more in markets following financial liberalization.

Although we propose these four plausible underlying economic mechanisms through which financial liberalization affects innovation, we acknowledge that these mechanisms are not necessarily mutually exclusive and could jointly contribute to the impact of financial liberalization on technological innovation.

We use a country-industry-year level panel-based fixed effects identification approach. Building on the seminal work of Rajan and Zingales (1998), we examine specific economic mechanisms through which financial liberalization affects innovation. This specification is appropriate in our setting for two reasons. First, it allows us to

control for time-varying country and industry heterogeneity and global trends that may potentially bias our estimations. Second, we include industry attributes that are exogenously designed so that they are unlikely to be affected by financial liberalization.

We collect global innovation data from the Orbis patent database sourced from the European Patent Office (EPO). Compared to the National Bureau of Economic Research (NBER) Patent Citation database compiled by the United States Patent Trademark Office (USPTO), the Orbis database has a much broader coverage. In addition to the patents filed in the US administered by the USPTO, the Orbis database covers patents filed in 93 non-US patent offices including national patent offices, and regional and international organizations such as the EPO, the African Intellectual Property Organization (AIPO), and the World Intellectual Property Organization (WIPO). Therefore, we are able to directly measure a country's innovation level using the Orbis database, instead of inferring it indirectly through the USPTO database. We obtain research and development (R&D) information from the Worldscope database, and collect official financial liberalization dates from Bekaert, Harvey, and Lundblad (2005). Our final sample includes 34 developed and emerging economies over 1980-2009.

We acknowledge that financial liberalization is a broad concept. The official liberalization dates in Bekaert, Harvey, and Lundblad (2005) mainly capture the liberalization of stock markets. However for some countries, the official liberalization dates also capture other legislation changes. For example, the market liberalization date of Argentina is 1989, because Argentina allowed free repatriation of capital and remittance of dividend and capital gains since that year. Greece liberalized its domestic equity market in 1987 and allowed foreign investor to repatriate capital gain in the same year. Therefore, we can interpret "financial liberalization" as "stock market

liberalization" in the main test of this chapter. Later in the robustness tests, we use an alternative proxy variable to represent the openness of capital account as another important dimension of financial liberalization.

Consistent with our conjectures, we find that industries that are more dependent on external finance, have higher growth opportunities, are younger, and are more high-tech intensive exhibit a disproportionally higher level of innovation following financial liberalization. For example, industries in the top quartile of external finance dependence, on average, produce 27% more patents and have patents that receive 12.4% more future citations than industries that are in the bottom quartile of external finance dependence after financial liberalization. Our findings continue to hold in a rich set of robustness checks using alternative model specifications, alternative construction of industry-level variables and alternative subsamples. We also examined capital account openness as another aspect of financial liberalization and find very similar results.

In the last part of this chapter, we further investigate how the relationship between financial liberalization and innovation varies in response to country-level institutional quality. As suggested by Bekaert, Harvey, and Lundblad (2005), financial liberalization is unlikely to have the same effect in all liberalizing countries. Even though financial liberalization is associated with the removal of explicit barriers on foreign investments, implicit constraints such as legal institutions keep global equity markets partially segmented (Stulz, 2005; Bekaert et al., 2011; Carrieri, Chaieb, and Errunza, 2013). Hence, we explore how the quality of a country's institutions alters the impact of financial liberalization on technological innovation. We find that the positive effect of financial liberalization on innovation is more pronounced in countries with lower barriers to international investment as proxied by better institutional quality.

This thesis contributes to two streams of literature. The primary contribution is

to the literature on financial openness and economic growth. There is an on-going debate on the growth effects of financial liberalization. For example, Bekaert, Harvey, and Lundblad (2005), Bekaert et al. (2011), Mitton (2006), Quinn and Toyoda (2008), and Gupta and Yuan (2009) find strong growth effects at the country-level, industry-level and firm-level, while Rodrik (1998) and Edison et al. (2004) document weak effects of financial liberalization. In a survey paper, Kose et al. (2009) summarize the collective evidence regarding the effect of financial liberalization on economic growth as "mixed"[1]. More specifically, studies show that financial liberalization leads to a decrease in systematic risk (Chari and Henry, 2004), a reduction in the cost of capital (Bekaert and Harvey, 2000), an increase in equity prices (Henry, 2000a), and an increase in private investment (Henry, 2000b). We contribute to this literature by identifying a specific economic channel – technological innovation – through which financial liberalization affects economic growth.

Another contribution of this thesis is to the literature on finance and innovation. There is a rapidly growing body of literature, both theoretical and empirical, that studies various strategies for promoting technological innovation[2]. Holmstrom (1989) highlights that innovation activities may mix poorly with routine activities in an organization. Manso (2011) suggests several ways to motivate innovation from a perspective of corporate governance, such as designing a failure tolerant managerial contract. Nanda and Rhodes-Kropf (2013) argue that financial markets drive innovation,

[1] There is another large body of literature linking finance and growth that goes back to Goldsmith (1969) and Shaw (1973). More recent research has shown that the size and depth of a country's financial system positively affects its future growth per capita, real income, employment, entrepreneurship and output (King and Levine, 1993; Jayaratne and Strahan, 1996; Rajan and Zingales, 1998; Beck and Levine, 2002; Black and Strahan, 2002).

[2] The growing literature on finance and innovation has identified a range of factors that may affect innovation, including law (Acharya and Subramanian, 2009), firm boundaries (Seru, 2014), stock liquidity (Fang, Tian, and Tice, forthcoming), financial analysts (He and Tian, 2013), banking competition (Cornaggia et al., forthcoming), labor unions (Bradley, Kim, and Tian, 2013), product market competition (Aghion et al., 2005), corporate venture capital (Chemmanur, Loutskina, and Tian, 2014), and institutional ownership (Aghion, Van Reenen, and Zingales, 2013).

and "hot" rather than "cold" financial markets help innovation. Other studies such as Brown, Martinsson, and Petersen (2013) and Hsu, Tian, and Xu (2014), show that development of domestic financial markets motivates innovation. This thesis differs from prior papers because it examines a unique aspect of financial markets within the context of globalization, that is liberalizing financial markets to foreign investors.

The rest of the chapter is organized as follows. Section 2.2 describes sample selection and reports summary statistics. Section 2.3 presents our main empirical findings. Section 2.4 discusses a variety of robustness tests for our main results. Section 2.5 investigates how country-level institutional quality alters the influence of financial liberalization on innovation. Section 2.6 concludes.

2.2. Data and Summary Statistics

In this section, we discuss the global patent database used in this study and describe the construction of key innovation variables. We also define industry-level mechanism variables and other control variables.

2.2.1. **Patent Database**

We use Bureau Van Dijk's Orbis patent database to construct our innovation variables. This database is sourced from the EPO Worldwide Patent Statistical Database (PATSTAT). Similar to the USPTO, the EPO is one of the largest and most important patent offices in the world. The Orbis patent database offers a comprehensive coverage of more than 83 million[3] patent applications worldwide since 1850. These patents are filed by both publicly-traded and privately-held firms, individuals, governments, and other organizations such as universities through 94 regional, national, and international patent offices.

[3] By the end of 2013, about 36 million out of total 83 million patent applications are granted patents.

The Orbis patent database has a much wider coverage than The National Bureau of Economic Research (NBER) USPTO patent database. Although the NBER patent data has been widely used in the innovation literature (such as Hall, Jaffe, and Trajtenberg, 2005; Aghion, Van Reenen, and Zingales, 2013), it has limitations in cross-country analyses as the NBER database only covers patents applied to and granted by the USPTO. That means patents applied to and granted by other patent offices around the world are not included. Similarly, only citations referring to US patents are kept in the NBER patent database. The limited scope of the NBER database may result in severe biases, most likely underestimation, in judging the innovative performance of non-US inventors who do not apply for US patents to the USPTO.

A simple example can illustrate the advantage of using the Orbis database. To compare the patents of the Japanese car maker Toyota and the German car maker BMW, we assume Toyota and BMW both invent and obtain 100 patents from their own domestic patent offices. However, Toyota considers the US market to be very important while BMW focuses mainly on the European market. Toyota subsequently protects 90 out of these 100 patents in the US by submitting patent applications to the USPTO. On the contrary, BMW only applies for 50 out of its 100 patents that are relevant to US market to the USPTO. So the NBER patent database will show that Toyota outperforms BMW by 40 US patents. This conclusion is obviously misleading due to the different marketing strategies adopted by the two firms. There are many other possible explanations for inventors not seeking US patents in reality. Fortunately, the EPO cooperates with other patent offices to share patent information. Although it does not administer patent granting in Japan, the EPO can retrieve information from the JPO and record Toyota's Japanese patents. Similarly, the EPO records BMW's 100 German patents. Therefore, data of the Orbis patent database shows that Toyota and BMW are

equally innovative. In this manner, we are able to measure innovative performance around the world more accurately.

An important issue when aggregating worldwide patents is that a simple total sum of patents across countries leads to overestimation, because inventors may obtain multiple patents in different countries to protect one original innovation or invention. In the example of Toyota and BMW above, the simple total count of patents for Toyota and BMW is 190 (100 Japanese patents + 90 US patents) and 150 (100 European patents + 50 US patents), respectively. This simple aggregation of domestic and US patents overestimates both firms' innovation output. To avoid overestimation, Orbis provides a variable called "priority number" commonly used in the international patent system. The priority number is "the number of the application in respect to which priority is claimed, i.e., it is the same as the application number of the claimed priority document" according to the manual of Orbis. It means that, in the example, when an inventor (such as Toyota) applies for a patent to a patent office (the JPO) and then applies for another patent based on the same invention to another patent office (such as the USPTO), the subsequent USPTO patent application will be assigned a priority number that is the same as the first application number (i.e., the application number registered in the JPO). Using the priority number, we are able to identify whether a patent is a novel invention or is a subsequent application to other patent offices. Our sample only includes patents without a priority number (i.e. novel innovation).

Another important feature of our database is the ease of identifying patent assignees (owners). The Orbis database identifies the majority of patent owners using unique firm identifiers, called BVDID. This identifier not only covers publicly-traded firms but also includes medium-sized and large-sized privately-held firms. With BVDID, we are able to identify patent owners' industry classification and financial

status by using information in the Orbis database or by merging with other databases, such as the Worldscope database. In contrast, it is not easy to obtain firm-level information about foreign firms holding US patents recorded in the NBER database.[4]

Finally, to obtain further insights about the quality of the Orbis database, we compare the number of US patents owned by publicly-traded firms included in the Orbis database with those included in the NBER patent database. Because the coverage of the NBER database extends until 2006, we plot the number of US patents between 1980 and 2006 in Figure 2.1. The numbers of US patents from two databases are quite similar. The only noticeable difference is the large decline in the number of US patents from the NBER database over the period of 2002-2006. This difference is because the lag between a patent's application year and its grant year is significant (about two years on average) and many patent applications filed during these years were still under review and had not been granted by 2006 when the NBER database ends. However, the Orbis database does not suffer from this problem because it continues to include granted patents after 2006[5]. Apart from this difference, the two lines in Figure 2.1 are very close to each other and exhibit an identical rising trend. Therefore, the quality of the Orbis database for US patents is at least as good as that of the NBER patent database.

[4] For example, Hsu, Tian, and Xu (2014) use the industry distribution of domestic public patent owners to infer the industry distribution of non-US patent owners. This indirect approach could introduce potential biases due to at least two reasons. First, the benchmark distribution is based on US publicly-traded firms only, while foreign owners of US patents can be public, private or other types. Second, certain overseas firms may be better innovators than their US peers, although they hold fewer US patents than their US peers.

[5] Actually, the Orbis database is continuously refreshing patent information up to date.

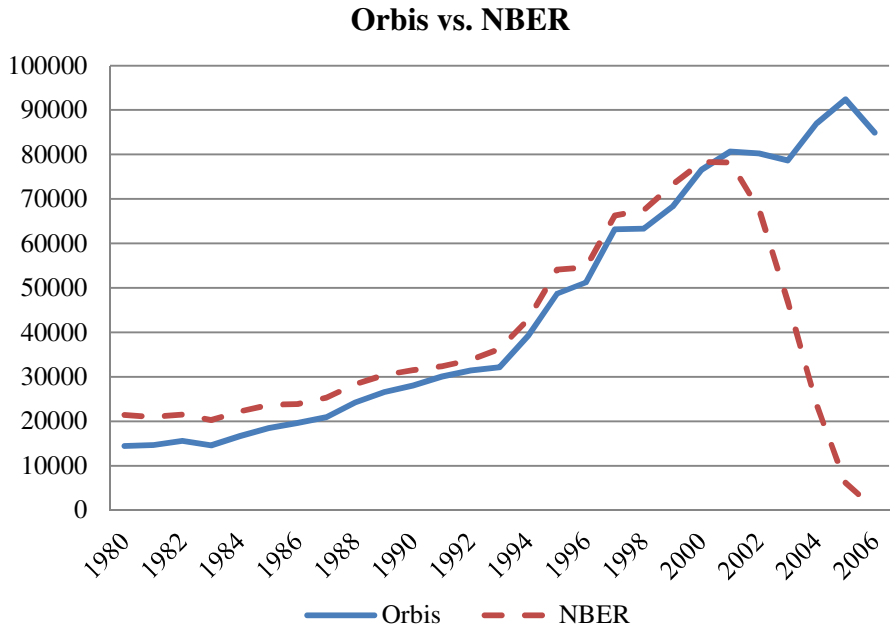

Figure 2.1: The number of US patents in the Orbis database vs. the NBER database
This figure compares the number of US patents produced by publicly-traded firms included in the Orbis database with those included in the NBER patent database between 1980 and 2006. The solid line depicts the number of patents recorded in the Orbis database and the dashed line depicts the number of patents recorded in the NBER patent database.

2.2.2. **Innovation Measures**

Following previous studies (such as Aghion, Van Reenen, and Zingales, 2013; Seru, 2014), we build the first innovation measure as the number of successful patent applications ($Patent_{i,j,t}$). The measure captures the total number of patents invented by all publicly-traded and privately-held firms in the two-digit Standard Industrial Classification (SIC) industry *j* of country *i* in year *t*. This variable is an innovation output measure based on the assumption that manufacturing firms materialize inventions in the format of patents. We evaluate all granted patents filed by both publicly-traded and privately-held firms for two reasons. First of all, financial liberalization should affect both publicly-traded and privately-held firms. In Bekaert, Harvey and Lundblad's (2005) country-level analysis, the noticeable real economic growth spurred by financial liberalization is nation-wide, meaning both public and private sectors contribute to the national economic growth. Gupta and Yuan's (2009) industry-level analysis does not separate the public and private sectors either as most of their survey-based growth variables are industry-wide aggregations. We believe that financial liberalization should have some reasonable indirect, spill-over effects on the private sector. For example, the inflow of foreign money reduces the cost of capital thus attracting some privately-held firms to go public. The participation of foreign investors may also change the intensity of market competition, which in turn affects both publicly-traded and privately-held firms. Our belief is coherent with the idea that financial liberalization most directly affects publicly-traded firms (Chari and Henry, 2008). We show later in a robustness test that our conclusion still holds for a subsample of privately-held firms only. The second reason to include both publicly-trade and privately-held firms is that many studies (such as Bena and Li, 2014; Chava et al., 2013; Cornaggia et al., forthcoming; Sevilir and Tian, 2013) recognize that privately-held

firms contribute a significant proportion of innovation activities in an economy.

We use the patent application year instead of grant year to denote the innovation date because there is a lag of a couple of years between a patent's application year and its grant year (Hall, Jaffe, and Trajtenberg, 2001). Because our download of Orbis database was in 2013, four years after the 2009 end of our sample period, and the average lag between a patent's application year and its grant year is two to three years, our patent count variable is less likely to be subject to the patent truncation problem. Nevertheless, we still follow Hall, Jaffe, and Trajtenberg's (2001) suggestion to adjust raw patent counts in the last three years of the sample (2007-2009) using the patent application-grant lag distribution of the previous three years (2004-2006) to alleviate the potential truncation problem. The raw measure is a count variable so that we transform it as the logarithm of one plus raw patent counts, following the existing innovation literature.

The second innovation measure is the number of citations received ($Citation_{i,j,t}$), meaning the total number of future citations received by all granted patents in industry *j* of country *i* in year *t*. This measure captures the quality and importance of innovation. Hall, Jaffe, and Trajtenberg (2001) point out that a patent may continue to receive citations long after the sample period ends. Therefore, we follow the standard time-technology class "fixed-effect approach" to adjust our citation measure. Again, we transfer the raw citation count to the logarithm of one plus the raw citation count in the regressions, following the existing innovation literature.

To capture more information about the fundamental nature and importance of patents, we compute two additional patent citation-based innovation measures, $Generality_{i,j,t}$ and $Originality_{i,j,t}$, which measure the average generality and originality scores of patents in industry *j* of country *i* in year *t*. Following Hall, Jaffe,

and Trajtenberg (2001), a patent's generality score is defined as one minus the Herfindahl concentration index of technological classes[6] for all the citations this patent receives. A patent with a high generality score has widespread impact on future patents from various technological classes. Likewise, a patent's originality score is defined as one minus the Herfindahl concentration index of technological classes for all prior patents that this patent cites. Therefore, a patent with a high originality score is inspired by prior inventions from a wide range of technological classes instead of only closely related technological classes, and is considered to be more original.

The last innovation measure is the total industry R&D expenditures ($R\&D_{i,j,t}$), which indicates the aggregated R&D spent by all firms in industry j from country i in year t. Following Hsu, Tian, and Xu (2014), we employ R&D expense (Worldscope item WS01201) to build this measure. Unlike the other innovation measures discussed above, R&D expenditures data is only available for publicly-traded firms in Worldscope. This measure is also subject to another concern because R&D expenditures data is not required to disclose in many countries' financial reporting standards. Thus, we treat $R\&D_{i,j,t}$ as a supplementary innovation measure and interpret the results with caution.

We start with a sample comprised of economies listed in Bekaert, Harvey, and Lundblad (2005) that either have an official market liberalization announcement date or already have open financial markets. After excluding countries with less than 50 valid patent records, we have a final sample of 34 economies from 1980 to 2009.[7] For convenience, we call economies that officially liberalized financial markets during the sample period the "liberalizing group" and other economies that had already liberalized

[6] In the Orbis patent database, technological classes are defined using the International Patent Classification (IPC) system. There are eight main classes in the IPC, as opposed to six main classes in the NBER USPTO patent database.

[7] The Worldscope database systematically reports global financial data from 1980, so our sample begins from 1980. Considering that there is usually two to three years' lag time between a patent's application and when a patent is granted (Webb et al. 2005), we end the sample period in 2009.

financial markets before the sample starts the "liberalized group". We aggregate innovation of firms by firms' two-digit SIC codes, obtained from the Orbis and Worldscope databases. Our sample includes only manufacturing industries (SIC codes 20-39) because patenting innovation is more important to these industries, while other industries may materialize innovation in other forms such as trademarks or copyright.

Panel A of Table 2.1 presents summary statistics for our innovation variables. The top half of the panel reports the liberalizing group. The column "Lib Year" reports their official liberalization years. In the bottom half of the panel, we present the liberalized group. Therefore, the "Lib Year" variable is marked as "Open Market." Panel A shows that all open market economies are developed countries, while there is a mixture of both developed and developing economies in the liberalizing group. For example, Japan, the second largest developed economy in our sample, underwent a major reform and opened its financial markets in 1983. South Africa is a developing economy that liberalized its market in 1996. Geographical diversity is another noticeable feature of the liberalizing group. This finding shows that financial liberalization occurred across geographically diverse countries in our sample over the sample period.

Table 2.1: Summary statistics

Panel A reports summary statistics of innovation variables by economies. The column entitled "Lib Year" lists the official market liberalization years. "Open Market" indicates economies with fully liberalized financial markets before our sample period starts. Market liberalization years are from Bekaert, Harvey, and Lundblad (2005). *Patent*, *Citation*, and *R&D* are time series averages of total number of patents, citations and R&D expenditures ($US millions), respectively. *Generality* and *Originality* are pooled-averages of generality and originality scores. Industry is defined by two-digit SIC codes. Our sample industries include two-digit SIC codes from 20-39. The sample period is 1980-2009.

Panel A						
Country	Lib Year	*Patent*	*Citation*	*Generality*	*Originality*	*R&D*
Argentina	1989	3.17	0.36	0.002	0.002	0.002
Brazil	1991	140.89	0.94	0.013	0.018	0.425
Chile	1992	1.67	0.85	0.002	0.002	0.008
Greece	1987	6.94	0.64	0.001	0.003	0.020
India	1992	3.13	0.63	0.000	0.006	0.421
Israel	1993	116.46	34.54	0.105	0.129	0.698
Japan	1983	18,762.07	628.65	0.233	0.233	37.525
Malaysia	1988	6.94	2.64	0.001	0.006	0.050
Mexico	1989	11.86	1.34	0.022	0.035	0.003
New Zealand	1987	22.15	0.86	0.007	0.003	0.018
Portugal	1986	9.93	0.58	0.006	0.004	0.004
South Africa	1996	32.82	0.35	0.004	0.003	0.095
South Korea	1992	3,250.43	175.67	0.064	0.070	2.001
Spain	1985	431.75	1.98	0.036	0.041	0.042
Taiwan	1991	3,148.75	398.56	0.153	0.197	3.727
Thailand	1987	6.56	3.28	0.006	0.005	0.007
Turkey	1989	67.26	1.13	0.007	0.012	0.110
Australia	Open Market	65.89	2.91	0.019	0.036	0.241
Austria	Open Market	454.21	9.41	0.084	0.071	0.171
Belgium	Open Market	266.39	7.33	0.070	0.082	1.265
Canada	Open Market	466.86	189.31	0.185	0.203	0.684
Denmark	Open Market	242.54	8.33	0.057	0.067	0.926
Finland	Open Market	514.68	34.20	0.093	0.091	1.298
France	Open Market	2,207.75	30.62	0.074	0.100	9.766
Germany	Open Market	7,650.32	430.52	0.145	0.144	14.181
Ireland	Open Market	12.86	2.30	0.027	0.033	0.195
Italy	Open Market	1,517.21	12.13	0.072	0.080	2.005
Netherlands	Open Market	568.25	52.02	0.081	0.104	3.434
Norway	Open Market	114.11	3.70	0.043	0.053	0.287
Singapore	Open Market	139.05	65.55	0.028	0.037	0.189
Sweden	Open Market	677.71	55.16	0.078	0.087	2.929
Switzerland	Open Market	728.07	26.18	0.083	0.073	4.563
United Kingdom	Open Market	1,366.93	30.65	0.126	0.136	7.980
United States	Open Market	15,425.32	9,935.48	0.306	0.311	66.696

Table 2.1: Summary statistics – continued

Panel B reports industry mechanism variables constructed based on US data. *Dependence*, *Growth*, *Maturity* and *High-tech* are medians of dependence on external finance, market-to-book ratio, firm age, and R&D expenditures scaled by sales of each industry (in percentage). Industry is defined by two-digit SIC codes, and our sample industries include two-digit SIC codes from 20-39. The sample period is 1980-2009.

Panel B					
Industry description	2-digit SIC	*Dependence*	*Growth*	*Maturity*	*High-tech*
Food and Kindred Products	20	-0.270	1.629	17	0.785
Tobacco Products	21	-2.894	1.439	21.5	1.435
Textile Mill Products	22	-0.049	1.045	20.5	1.650
Apparel and Other Finished Products Made from Fabrics and Similar Materials	23	-0.605	1.398	12.75	0.887
Lumber and Wood Products, Except Furniture	24	-0.157	1.431	21	0.694
Furniture and Fixtures	25	-0.443	1.436	23.25	1.274
Paper and Allied Products	26	-0.030	1.440	22	1.189
Printing, Publishing, and Allied Industries	27	-0.692	1.796	17	2.944
Chemicals and Allied Products	28	1.265	2.232	10	8.041
Petroleum Refining and Related Industries	29	-0.007	1.248	18.5	0.902
Rubber and Miscellaneous Plastics Products	30	0.158	1.461	17.5	1.269
Leather and Leather Products	31	-1.139	1.021	21.5	1.433
Stone, Clay, Glass, and Concrete Products	32	-0.207	1.162	18.75	1.046
Primary Metal Industries	33	0.033	1.144	14	0.934
Fabricated Metal Products, Except Machinery and Transportation Equipment	34	-0.111	1.370	21	1.463
Industrial and Commercial Machinery and Computer Equipment	35	0.609	1.661	13	4.582
Electronic and Other Electrical Equipment and Components, except Computer	36	0.647	1.623	11	6.740
Transportation Equipment	37	0.143	1.440	16	2.029
Measuring, Analyzing, and Controlling Instruments; Photographic, Medical and Optical	38	0.817	1.892	11	8.056
Miscellaneous Manufacturing Industries	39	0.245	1.461	12	2.468

Table 2.1: Summary statistics – continued

Panel C reports the summary statistics of industry mechanism variables (*Dependence*, *Growth*, *Maturity* and *High-tech*) based on the values of 20 industries listed in Panel B. Industry is defined by two-digit SIC codes, and our sample includes industries with two-digit SIC codes from 20-39. The sample period is 1980-2009.

Panel C	Mean	Std. Dev.	25%	Median	75%
Dependence	-0.134	0.848	-0.314	-0.039	0.180
Growth	1.466	0.291	1.339	1.439	1.624
Maturity	16.963	4.258	12.875	17.250	21.000
High-tech	2.491	2.396	1.018	1.434	2.587

Panel D reports the correlation coefficients among industry mechanism variables (*Dependence*, *Growth*, *Maturity* and *High-tech*) of 20 industries listed in Panel B. The *p*-values of Spearman correlation tests are reported in parentheses. Industry is defined by two-digit SIC codes, and our sample includes industries with two-digit SIC codes from 20-39. The sample period is 1980-2009.

Panel D	*Dependence*	*Growth*	*Maturity*	*High-tech*
Dependence	1.000	0.479	-0.682	0.526
		(0.032)	(0.001)	(0.017)
Growth		1.000	-0.553	0.550
			(0.011)	(0.012)
Maturity			1.000	-0.479
				(0.033)
High-tech				1.000

Regarding innovation activities, Japan with 18,762 patents per year and the US with 15,425 patents per year have the largest number of patents per year on average. In terms of citations, the US has the most, followed by Japan, Germany and Taiwan.[8] The US also has the highest value of *Generality*, *Originality* and *R&D*. In general, liberalized countries, such as Germany, France, the United Kingdom and Italy, have relatively high innovation output, while liberalizing countries have lower innovation output, except for a few economies such as Japan. Overall, there is a large variation in innovation performance across the sample countries.

2.2.3. **Industry-level Mechanisms**

As mentioned above, we conjecture that financial liberalization promotes innovation through four underlying mechanisms: external finance dependence, growth opportunities, industry maturity, and high-tech intensiveness. Accordingly, we construct industry-level variables to proxy for each of these mechanisms. These industry-level mechanism variables are calculated based on US industry peers following Rajan and Zingales (1998). The US market is generally considered relatively frictionless; hence Rajan and Zingales (1998) use US data to measure external finance dependence among industries.[9] More importantly, using US data that is exogenous to other economies helps alleviate the concern that a country's industry characteristics are driven by its financial liberalization or its innovation activities. Using US data also resolves the reverse

[8] The substantially large number of US citations compared to other countries is due to the different practices employed by various patent offices. Webb et al. (2005) point out that it is a legal requirement for applicants to the USPTO to supply a full list of references. Therefore, applicants may provide more references than necessary and USPTO examiners cannot always check the entire list. However, in many other patent offices (e.g., the EPO), the patent examiners decide what references are valid, and they usually validate the most relevant references only.

[9] Rajan and Zingales (1998) suggest that there are some technological reasons causing different levels of dependence on external finance among industries. They believe such differences also hold in other countries as well. We follow and extend their reasoning to construct other industry-level mechanism variables using US data. The US equity market has a long history and is open to global investors, so we believe that the US data reflects fundamental industry attributes, such as growth opportunities, maturity and high-tech intensiveness.

causality concern that innovation activities lead to financial liberalization. This method has been widely used in the cross-country innovation literature, such as Brown, Martinsson, and Petersen (2013) and Hsu, Tian, and Xu (2014).

The first industry-level mechanism variable is industry dependence on external finance, $Dependence_j$. We collect annual financial data on US publicly-traded firms in the Compustat (North America) database. Following Hsu, Tian, and Xu (2014), we define dependence on external finance as capital expenditures (#128) plus R&D expenses (#46) minus cash flow from operations then divide by capital expenditures and R&D expenses. We derive cash flow from operations as funds from operations (#110) plus decreases in inventories (#3), decreases in receivables (#2), and increases in payables (#70) if the cash flow statement format code is 1, 2 or 3. If the cash flow statement format code is 7, we replace funds from operations (#110) with the sum of items #123, #125, #126, #106, #213 and #217. We compute industry-year medians of dependence on external finance for every two-digit SIC industry in each year between 1980 and 2009. We then take the time series median value to proxy for an industry *j*'s dependence on external finance ($Dependence_j$). A higher value of *Dependence* means a greater level of dependence on external finance.

The second industry-level mechanism variable we construct is a proxy for growth opportunities – the market-to-book ratio. It is a widely used proxy to capture both firm and industry growth opportunities (Allayannis, Brown, and Klapper, 2003; Booth et al. 2001). We calculate the market-to-book ratio for US firms listed in three major stock exchanges (NYSE, NASDAQ and AMEX) and define it as year-end stock price multiplied by the number of shares outstanding, both items from CRSP, divided by total common equity (Compustat #60). The industry-year median values of firms' market-to-book ratios are derived first, then we use the time series median value

($Growth_j$) as a proxy for the growth opportunity of industry j. A higher market-to-book ratio implies better growth opportunities.

The third mechanism variable used to evaluate industry maturity is industry median firm age. In a mature industry, incumbent firms are more likely to have longer histories and there should be fewer young entrants. However, births and deaths of firms are more frequent in the early stage of an industry's life cycle, which is associated with a lower industry median firm age. We use the Datastream/Worldscope database to compute this variable. For a US firm, we use the date of foundation or incorporation as the firm's birth date if information is available. In the absence of such information, we use the Datastream base date (the date from when Datastream starts to maintain a firm's information) as the proxy for a firm's birth date. Firm age is calculated as the current year minus the firm birth year. To prevent overestimating the age after firm "death," we cease computing ages for delisted firms in the next period.[10] Similar to the above two variables, we first take the annual median firm age for each industry, and then use the time series median ($Maturity_j$) to measure industry j's maturity.

High-tech intensiveness is our last industry-level mechanism variable. We compute annual R&D expenditures scaled by sales revenue for US firms in the Compustat. We take the annual median R&D intensiveness ratio for each industry, and then use the time series median ($high\text{-}tech_j$) as the high-tech intensiveness of industry j. An industry is more high-tech intensive if it has a larger value of high-tech intensiveness.

We report industry-level mechanism variables in Panel B of Table 2.1, and cross-industry summary statistics (mean, standard deviation and quartiles) of these mechanism variables in Panel C. The results suggest a significant heterogeneity across

[10] We use the delisting date as a feasible and reasonable proxy for the death of firms because the real termination dates are not available in the database.

industries. For instance, Industry 28 (Chemicals and Allied Products) is the industry most dependent on external finance (*Dependence* = 1.265). A *Dependence* value greater than one means that chemical firms on average have net operating cash outflows, thus they heavily rely on external capital to finance their capital expenditures. On the other side of the spectrum, Industry 21 (Tobacco Products) has the lowest value of *Dependence*, -2.894. The negative number means tobacco firms on average generate more cash flow than their investment needs. For some industries that are usually considered high-tech and innovative, their *Dependence* value is relatively high. For example, *Dependence* is 0.609 for Industry 35 (Industrial and Commercial Machinery and Computer Equipment) and 0.647 for Industry 36 (Electronic and Other Electrical Equipment and Components), suggesting over 60% of their capital expenditures are funded by external finance.

Regarding growth opportunities, the variation in the market-to-book ratio is within a range between 1.021 and 2.232. Among all industries, Industry 28 (Chemicals and Allied Products) and Industry 31 (Leather and Leather Products) possess the highest and lowest market-to-book ratios, respectively. High-tech industries such as Industry 35 (Industrial and Commercial Machinery and Computer Equipment), Industry 36 (Electronic and Other Electrical Equipment and Components), and Industry 38 (Measuring, Analyzing, and Controlling Instruments; Photographic, Medical and Optical) have market-to-book ratios above the 75th percentile. Industry 22 (Textile Mill Products), Industry 32 (Stone, Clay, Glass and Concrete Products), and Industry 33 (Primary Metal Industries) are examples of industries with market-to-book ratios below the 25th percentile.

The maturity of Industry 25 (Furniture and Fixtures), Industry 31 (Leather and Leather Products) and Industry 21 (Tobacco Products) is above the 75th percentile,

indicating median firm ages of more than 21 years. This observation implies that these industries have many old firms. On the other hand, the median firm age of innovative industries (such as Industries 28, 35, 36 and 38) is just above 10 years, suggesting a greater number of young firms in these sectors. Finally, in terms of high-tech intensiveness, Industries 38, 28, 36 and 35 are ranked the highest. Firms in these industries spend more than 4.5% of annual revenue on R&D, while those in the rest of industries spend less than 1% of annual revenue on innovative activities. For instance, Industry 24 (Lumber and Wood Products) is the least high-tech intensive by spending only 0.69% sales revenue on R&D.

Panel D of Table 2.1 reports the coefficients of correlation among these industry mechanism variables. *Dependence* and *Growth* are positively correlated with the Spearman correlation coefficient being 0.479, significant at the 5% level. *Maturity* is negatively correlated with other variables, meaning that mature industries are more likely to have lower dependence on external finance, lower growth opportunities, and are less high-tech intensive. Furthermore, *High-tech* exhibits a positive correlation with *Dependence* at the 5% level, which suggests that firms in high-tech industries are more likely to be external finance dependent. *High-tech* is also positively correlated with *Growth* at the 5% level.

2.2.4. **Control Variables**

In this section, we discuss the construction of other control variables. Following Aghion et al. (2005), we control for firm size, industry concentration and its squared term, leverage and profitability. Using the Worldscope database, we compute industry-year medians for each country in our sample. We use logarithm transformed sales (Worldscope item WC01001) as a proxy for firm size (*Ln*(*Sales*)). The Herfindahl index (*Herf*) is computed for two-digit SIC industries based on sales figures and it indicates

industry concentration. Acs and Audretsch (1988) find that innovation is negatively related to industry concentration. Similarly, Ayyagari, Demirgüç-Kunt, and Maksimovic (2012) argue that competition spurs innovation. We follow the literature to hypothesize that high industry concentration would impede innovation. To capture the non-linear effects of industry concentration on innovation suggested by Aghion et al. (2005), we also include the squared Herfindahl index ($Herf^2$) as a control variable. Leverage is defined as total debt (Worldscope item WC03255) divided by total assets (Worldscope item WC02999) (*Leverage*). Finally, we use return on assets (ROA) (Worldscope item WC08326) as a proxy for profitability (*ROA*).

2.3. Empirical Results

In this section, we first describe regression model specifications, then report and discuss empirical results on how financial liberalization affects innovation through the four underlying mechanisms.

2.3.1. Model Specifications

Building on Rajan and Zingales (1998), we adopt a country-industry-year level panel-based fixed effects identification model to evaluate how financial liberalization affects technological innovation across countries and the heterogeneity of the impact across industries.[11] Specifically, we estimate the following model:

$$\boldsymbol{Innovation_{i,j,t+n} = \alpha + \beta Industry_j \times Lib_{i,t} + \gamma' X_{i,j,t} + \mu_{i,t} + \omega_{j,t} + \varepsilon_{i,j,t}} \quad (2.1)$$

The dependent variable, $Innovation_{i,j,t+n}$, is one of the innovation measures for industry *j* in country *i* and in year $t + n$ discussed in the previous section. We let $n = 2$ in the main specification when the dependent variable is *Patent*, *Citation*, *Generality* or *Originality* due to the long-term nature of the innovation output generation process.

[11] This model is based on Rajan and Zingales' (1998) work, which examines whether industries that are more dependent on external finance grow faster in more developed finance markets.

Following Aghion et al. (2004) and Hsu, Tian, and Xu (2014), we use contemporaneous R&D expenditures (i.e., n = 0) as the dependent variable in Equation (2.1) because current period innovation input, R&D expenditures, is more responsive to policy changes. $Industry_j$ is one of the four industry-level mechanism variables (*Dependence*, *Growth*, *Maturity* and *High-tech*) of industry j using the US data. $Lib_{i,t}$ is a dummy variable that equals one when a country's financial market is liberalized, and zero otherwise. Therefore during the sample period, $Lib_{i,t}$ always equals one for the liberalized group. We obtain the official financial liberalization years from the chronology of Bekaert, Harvey, and Lundblad (2005). $X_{i,j,t}$ is a vector of control variables including *Ln*(*Sales*), *Herf*, $Herf^2$, *Leverage*, and *ROA* of industry j from country i in year t. Please note that the individual terms of $Lib_{i,t}$ and $Industry_j$ are absorbed by the industry and country-year fixed effects, hence they are not explicitly expressed in the model.

Our model controls for country-year ($\mu_{i,t}$) fixed effects and industry-year ($\omega_{j,t}$) fixed effects. The country-year fixed effect absorbs time-varying country-specific characteristics, such as economic development, the size of financial markets, international transactions, and merger and acquisitions activities. Industry-year fixed effects help absorb time-varying industry-level characteristics, including the industry-level mechanism variables. This specification helps to alleviate omitted variable problems, making the interaction term $Industry_j \times Lib_{i,t}$ the key variable of interest that captures the causal effect of financial liberalization on innovation. We are interested in the coefficient estimate on the interaction term β when interpreting the results. We cluster standard errors by both country and year following Petersen (2009). All US observations are excluded from the regressions because they serve as the benchmarks in generating the industry-level mechanism variables.

2.3.2. **Dependence on External Finance**

We first examine how external finance dependence affects an industry's innovation performance after financial liberalization. Industries with a higher level of dependence on external finance need more outside capital to finance investment in innovation. Table 2.2 reports the regression results estimating Equation (2.1) using $Dependence_j$ as the mechanism variable.

In Table 2.2, the coefficient estimate of *Dependence* × *Lib* is 0.548 and is significant at the 1% level in Column (1). The economic significance is sizable. Using the statistics in Panel C of Table 2.1, our result shows that an industry with *Dependence* at the 75th percentile produces 27% (= 0.548 × (0.18-(-0.314))) more patents than an industry at the 25th percentile after financial liberalization. Next, in Column (2) the coefficient estimate of the interaction term in which patent citations are examined is 0.252, and it is significant at the 5% level. The economic magnitude is also sizable. An industry with a value of *Dependence* at the 75th percentile produces patents that receive 12.4% (= 0.252 × (0.18-(-0.314))) more citations than an industry at the 25th percentile after financial liberalization.

As shown in Table 2.2, our results also support the hypothesis regarding the fundamental importance of innovation, *Generality* and *Originality*, as the coefficient estimates of the interaction term (0.052 and 0.036) are positive and significant at the 1% level in both Columns (3) and (4). Industries more dependent on external finance produce patents with higher *Generality* and *Originality* scores after financial liberalization. Finally, the coefficient estimate of *Dependence* × *Lib* when innovation input, R&D expenditures, is used as the dependent variable is 0.402, but it is not significant. Please note that although the coefficient of R&D expenditure is not

significant in this table, it does not necessarily mean firms do not produce more innovation after financial liberalization because other more direct patent-based innovation measures exhibit consistent and strong results. As we have explained above that the coverage of R&D expenditure is limited in international data, R&D expenditure is only a supplementary proxy variable for innovation. The evidence presented in Table 2.2 suggests a sizable, disproportionate impact of financial liberalization on innovation in industries that are more dependent on external finance. Consistent with our hypothesis that financial liberalization lowers the cost of capital and relaxes capital constraints, we find that external finance dependent industries exhibit better innovation performance.

Table 2.2: The interaction of dependence on external finance and financial liberalization

This table reports OLS regressions estimating $Innovation_{i,j,t+2} = \alpha + \beta Industry_j \times Lib_{i,t} + \gamma X_{i,j,t} + \mu_{i,t} + \omega_{j,t} + \varepsilon_{i,j,t}$ using dependence on external finance as the industry mechanism variable; *i*, *j*, and *t* are country, industry, and year indices, respectively. Innovation measures are total number of patents ($Patent$), total number of citations ($Citation$), generality (*Generality*) and originality (*Originality*) scores, and total R&D expenditures ($R\&D$). Contemporaneous $R\&D$ (in year *t*) is used as the dependent variable while other innovation measures in year *t*+2 are used. $Dependence$ is the industry median dependence on external finance. Lib is a dummy variable taking a value one when a country's financial market is liberalized, and zero otherwise. Control variables are logarithm of industry median sales (*Ln(Sales)*), sales based industry concentration (*Herf*), squared concentration ($Herf^2$), industry median leverage (*Leverage*), and industry median return on assets (*ROA*). Industry is defined by two-digit SIC codes and our sample includes industries with two-digit SIC codes between 20 and 39. The sample period is 1980-2009. All regressions are estimated with country-year and industry-year fixed effects. Robust standard errors in parentheses are clustered by country and year. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Variable	*Patent*	*Citation*	*Generality*	*Originality*	*R&D*
	(1)	(2)	(3)	(4)	(5)
Dependence × *Lib*	0.548***	0.252**	0.052***	0.036***	0.402
	(0.123)	(0.126)	(0.012)	(0.011)	(0.343)
Ln(Sales)	0.031	0.013	-0.000	0.001	0.576***
	(0.029)	(0.024)	(0.003)	(0.002)	(0.091)
$Herf$	-2.682***	-2.187***	-0.100**	-0.117**	-2.443**
	(0.719)	(0.777)	(0.050)	(0.047)	(1.046)
$Herf^2$	1.524***	1.519**	0.061	0.063*	1.415
	(0.547)	(0.598)	(0.038)	(0.036)	(0.882)
Leverage	-0.129	-0.151	-0.007	-0.004	-0.733
	(0.158)	(0.110)	(0.016)	(0.015)	(0.534)
ROA	0.017	0.257	-0.013	-0.013	-1.394
	(0.230)	(0.189)	(0.017)	(0.027)	(1.011)
Constant	2.159***	0.865**	0.130***	0.108***	1.933
	(0.478)	(0.356)	(0.045)	(0.032)	(1.483)
Country-year FE	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes
Obs.	11,694	11,694	11,694	11,694	7,094
Adj. R^2	0.807	0.594	0.314	0.298	0.658

Regarding the control variables, the coefficient estimates of *Ln*(*Sales*) are positive but insignificant in all columns in Table 2.2 except the last one. There is also a non-linear relationship between industry concentration and innovation. *Leverage* coefficients are generally negative but insignificant. Finally, *ROA* does not exhibit a clear pattern of association with innovation.

In summary, we find supporting evidence that financial liberalization facilitates innovation growth in industries that are more dependent on external finance.

2.3.3. **Growth Opportunities**

Next, we test the conjecture that financial liberalization promotes innovation in industries with higher growth opportunities. Table 2.3 reports the results estimating Equation (2.1) when $Industry$ is replaced with *Growth*. The coefficient estimate of *Growth* × *Lib* is 0.960 in Column (1), and is significant at the 5% level. The result suggests a large economic impact from financial liberalization. An industry with *Growth* at the 75th percentile produces 27.4% (= 0.960 × (1.624-1.339)) more patents compared with an industry at the 25th percentile of the *Growth* distribution, following financial liberalization. In the second column where *Citation* is the dependent variable, the coefficient estimate of *Growth* × *Lib* is 0.412 and is significant at the 1% level. It shows that an industry with *Growth* at the 75th percentile generates patents that receive 11.7% (= 0.412 × (1.624-1.339)) more citations compared with an industry at the 25th percentile of *Growth* distribution, following financial liberalization.

Table 2.3: The interaction of growth opportunities and financial liberalization

This table reports OLS regressions estimating $Innovation_{i,j,t+2} = \alpha + \beta Industry_j \times Lib_{i,t} + \gamma X_{i,j,t} + \mu_{i,t} + \omega_{j,t} + \varepsilon_{i,j,t}$ using growth opportunities as the industry mechanism variable. *i*, *j*, and *t* are country, industry and year indices, respectively. Innovation measures are total number of patents (*Patent*), total number of citations (*Citation*), generality (*Generality*) and originality (*Originality*) scores, and total R&D expenditures (*R&D*). Contemporaneous R&D (in year *t*) is used as the dependent variable while other innovation measures in year *t*+2 are used. *Growth* is the industry median market-to-book ratio. *Lib* is a dummy variable taking a value one when a country's financial market is liberalized, and zero otherwise. Control variables are logarithm of industry median sales (*Ln(Sales)*), sales based industry concentration (*Herf*), squared concentration ($Herf^2$), industry median leverage (*Leverage*), and industry median return on assets (*ROA*). Industry is defined by two-digit SIC codes and our sample includes industries with two-digit SIC codes between 20 and 39. The sample period is 1980-2009. All regressions are estimated with country-year and industry-year fixed effects. Robust standard errors in parentheses are clustered by country and year. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Variable	*Patent*	*Citation*	*Generality*	*Originality*	*R&D*
	(1)	(2)	(3)	(4)	(5)
Growth × *Lib*	0.960**	0.412***	0.105***	0.062***	1.135**
	(0.396)	(0.156)	(0.023)	(0.017)	(0.498)
Ln(Sales)	0.031	0.013	-0.000	0.001	0.575***
	(0.029)	(0.024)	(0.003)	(0.002)	(0.091)
$Herf$	-2.684***	-2.189***	-0.100**	-0.118**	-2.448**
	(0.719)	(0.778)	(0.050)	(0.047)	(1.044)
$Herf^2$	1.526***	1.520**	0.061	0.063*	1.419
	(0.546)	(0.599)	(0.038)	(0.036)	(0.881)
Leverage	-0.127	-0.150	-0.007	-0.004	-0.734
	(0.158)	(0.109)	(0.016)	(0.015)	(0.534)
ROA	0.032	0.263	-0.011	-0.012	-1.381
	(0.225)	(0.186)	(0.017)	(0.026)	(1.011)
Constant	0.134	-0.002	-0.065*	-0.014	0.290
	(0.655)	(0.421)	(0.038)	(0.040)	(1.522)
Country-year FE	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes
Obs.	11,694	11,694	11,694	11,694	7,094
Adj. R^2	0.806	0.594	0.314	0.297	0.658

In Columns (3) and (4) of Table 2.3, we replace the dependent variables with patent generality and originality scores. The coefficient estimates of the interaction terms are both positive and significant at the 1% level, which suggests that industries with better growth opportunities generate more general and more original patents after financial liberalization, compared with those of industries with poorer growth opportunities. In Column (5), we examine how financial liberalization affects R&D expense through industry growth opportunities. The coefficient estimate of the interaction term is positive and statistically significant at the 5% level, suggesting that industries with higher growth opportunities invest more in innovation input after financial liberalization.

Overall, Table 2.3 provides evidence that is consistent with our second hypothesized underlying economic mechanism through which financial liberalization affects technological innovation: financial liberalization promotes technological innovation in industries with better growth opportunities.

2.3.4. **Industry Maturity**

We examine the third underlying economic mechanism by analyzing whether industries with different maturity levels exhibit disproportionately different responses to financial liberalization in terms of innovation output and input. Table 2.4 reports the results using the industry median firm age as a proxy for industry maturity. Mature industries typically have a greater number of old firms, while industries in the early stage of their life cycles generally have more young firms.

In Table 2.4, the coefficient estimates of *Maturity* × *Lib* are -0.090 and -0.034 in the first two columns in which patent counts and citations are the dependent variables. The coefficient estimates are significant at the 1% and 5% level, respectively. An industry with maturity at the 75th percentile (a more mature industry) produces 73% (=

0.09 × (21-12.875)) fewer patents and its patents receive 27.6% = (0.034 × (21-12.875)) fewer citations as opposed to an industry at the 25th percentile (a younger industry) after financial liberalization. The noticeable difference underlines the economic significance of our results.

In Columns (3) and (4), we replace the dependent variable with patent generality and originality scores to examine how financial liberalization affects the fundamental nature of innovation differently across industry maturity. The coefficient estimates of the interaction term are negative and significant at the 1% level in both columns with a magnitude of -0.008 and -0.005, respectively. This finding suggests that firms in younger industries produce more general and more original patents compared with those in mature industries after financial liberalization. In Column (5), R&D expense is the dependent variable. The coefficient estimate of the interaction term is -0.112 and is significant at the 10% level, which suggests that a mature industry spends significantly less on R&D compared with a young industry after financial liberalization.

In general, the results reported in Table 2.4 are consistent with our hypothesis that younger industries develop more innovation after financial liberalization. This finding is consistent with previous studies such as Chava et al. (2013) that highlight the importance of young innovators.

Table 2.4: The interaction of industry maturity and financial liberalization

This table reports OLS regressions estimating $\boldsymbol{Innovation_{i,j,t+2} = \alpha + \beta Industry_j \times Lib_{i,t} + \gamma X_{i,j,t} + \mu_{i,t} + \omega_{j,t} + \varepsilon_{i,j,t}}$ using maturity as the industry mechanism variable. *i*, *j*, and *t* are country, industry and year indices, respectively. Innovation measures are total number of patents (*Patent*), total number of citations (*Citation*), generality (*Generality*) and originality (*Originality*) scores, and total R&D expenditures (*R&D*). Contemporaneous R&D (in year *t*) is used as the dependent variable while other innovation measures in year *t*+2 are used. *Maturity* is the industry median firm age. *Lib* is a dummy variable taking a value one when a country's financial market is liberalized, and zero otherwise. Control variables are logarithm of industry median sales (*Ln(Sales)*), sales based industry concentration (*Herf*), squared concentration ($\boldsymbol{Herf^2}$), industry median leverage (*Leverage*), and industry median return on assets (*ROA*). Industry is defined by two-digit SIC codes and our sample includes industries with two-digit SIC codes between 20 and 39. The sample period is 1980-2009. All regressions are estimated with country-year and industry-year fixed effects. Robust standard errors in parentheses are clustered by country and year. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Variable	*Patent*	*Citation*	*Generality*	*Originality*	*R&D*
	(1)	(2)	(3)	(4)	(5)
Maturity × *Lib*	-0.090***	-0.034**	-0.008***	-0.005***	-0.112*
	(0.027)	(0.017)	(0.002)	(0.001)	(0.062)
Ln(Sales)	0.029	0.013	-0.000	0.001	0.574***
	(0.029)	(0.024)	(0.003)	(0.002)	(0.090)
$Herf$	-2.656***	-2.179***	-0.097*	-0.116**	-2.444**
	(0.717)	(0.776)	(0.050)	(0.047)	(1.049)
$Herf^2$	1.501***	1.511**	0.059	0.062*	1.412
	(0.545)	(0.598)	(0.038)	(0.036)	(0.885)
Leverage	-0.122	-0.148	-0.006	-0.004	-0.724
	(0.157)	(0.109)	(0.016)	(0.014)	(0.533)
ROA	0.025	0.260	-0.012	-0.012	-1.376
	(0.225)	(0.187)	(0.017)	(0.027)	(1.010)
Constant	2.975***	1.138**	0.214***	0.158***	4.050**
	(0.711)	(0.464)	(0.059)	(0.041)	(1.833)
Country-year FE	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes
Obs.	11,694	11,694	11,694	11,694	7,094
Adj. R^2	0.807	0.594	0.314	0.297	0.658

2.3.5. **High-Tech Intensiveness**

The last underlying economic mechanism we evaluate is high-tech intensiveness. Table 2.5 reports the results related to high-tech intensiveness using the industry median R&D-to-sales ratio as the proxy variable.

In Column (1) of Table 2.5, the coefficient estimate of *High-tech* × *Lib* is positive with a magnitude of 0.112 and significant at the 5% level. This finding suggests that an industry with *High-tech* at the 75th percentile (a more high-tech intensive industry) generates 17.6% (= 0.112 × (2.587-1.018)) more patents than an industry at the 25th percentile (a less high-tech intensive industry) after financial liberalization. In Column (2), we replace the dependent variable with patent citations. The coefficient estimate of *High-tech* × *Lib* is 0.053 and significant at the 10% level. The magnitude of the coefficient estimate suggests that an industry with high-tech intensiveness at the 75th percentile produces patents that receive 21.3% more citations compared to an industry at the 25th percentile of *High-tech* distribution after financial liberalization. The economic significance of financial liberalization on patent counts and citations is sizable.

In Columns (3) and (4) in Table 2.5, the dependent variables are *Generality* and *Originality*. The coefficient estimates of the interaction term are both positive and significant at the 1% and 5% level, respectively. This observation suggests that high-tech industries generate fundamentally more important patents, patents with higher generality and originality scores, than non-high-tech industries after financial liberalization. Finally, in Column (5), we examine the effect of financial liberalization on R&D spending through the high-tech intensiveness mechanism. The coefficient estimate of the interaction term is positive but statistically insignificant.

In summary, the empirical results in Table 2.5 suggest that financial liberalization promotes innovation better in high-tech industries.

Table 2.5: The interaction of high-tech intensiveness and financial liberalization

This table reports OLS regressions estimating $Innovation_{i,j,t+2} = \alpha + \beta Industry_j \times Lib_{i,t} + \gamma X_{i,j,t} + \mu_{i,t} + \omega_{j,t} + \varepsilon_{i,j,t}$ using high-tech intensiveness as the industry mechanism variable; *i*, *j*, and *t* are country, industry, and year indices, respectively. Innovation measures are total number of patents (*Patent*), total number of citations (*Citation*), generality (*Generality*), and originality (*Originality*) scores, and total R&D expenditures (*R&D*). Contemporaneous R&D (in year *t*) is used as the dependent variable while other innovation measures in year *t*+2 are used. *High-tech* is the industry median R&D expenditures scaled by sales revenue. *Lib* is a dummy variable taking a value of one when a country's financial market is liberalized, and zero otherwise. Control variables are logarithms of industry median sales (*Ln*(*Sales*)), sales based industry concentration (*Herf*), squared concentration ($Herf^2$), industry median leverage (*Leverage*), and industry median return on assets (*ROA*). Industry is defined by two-digit SIC codes and our sample includes industries with two-digit SIC codes between 20 and 39. The sample period is 1980-2009. All regressions are estimated with country-year and industry-year fixed effects. Robust standard errors in parentheses are clustered by country and year. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Variable	*Patent*	*Citation*	*Generality*	*Originality*	*R&D*
	(1)	(2)	(3)	(4)	(5)
High-tech × *Lib*	0.112**	0.053*	0.012***	0.007**	0.090
	(0.049)	(0.030)	(0.003)	(0.003)	(0.077)
Ln(Sales)	0.030	0.013	-0.000	0.001	0.575***
	(0.029)	(0.024)	(0.003)	(0.002)	(0.091)
$Herf$	-2.710***	-2.200***	-0.102**	-0.119**	-2.449**
	(0.723)	(0.777)	(0.050)	(0.047)	(1.046)
$Herf^2$	1.546***	1.529**	0.063	0.065*	1.421
	(0.550)	(0.598)	(0.039)	(0.037)	(0.881)
Leverage	-0.131	-0.151	-0.007	-0.004	-0.735
	(0.157)	(0.109)	(0.016)	(0.014)	(0.535)
ROA	0.025	0.261	-0.012	-0.012	-1.381
	(0.225)	(0.186)	(0.017)	(0.027)	(1.009)
Constant	1.063**	0.401	0.035	0.046	1.480
	(0.484)	(0.353)	(0.036)	(0.034)	(1.423)
Country-year FE	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes
Obs.	11,694	11,694	11,694	11,694	7,094
Adj. R^2	0.806	0.594	0.314	0.297	0.658

2.4. Robustness Tests

We conduct a rich set of robustness tests to check the robustness of our main findings. In Section 2.4.1, we first examine whether alternative model specifications affect our inferences by clustering standard errors at the country level only and by examining a different length of the gap in years between the financial liberalization year and the innovation measurement year. Second, we study whether our results are robust to alternative constructions of industry-level mechanism variables in Section 2.4.2. Then in Section 2.4.3, we examine whether the results are robust to alternative subsamples. In this subsection, we suppress the coefficients of all control variables and only report the coefficient estimates of the key variable of interest in tables for brevity. Finally in Section 2.4.4, we employ alternative proxies for financial liberalization. Instead of the binary variable of liberalization used in the above main tests, we use a continuous variable depicting the degree of openness of stock markets to foreign investors. We also examine the liberalization of capital account as another aspect of financial liberalization.

2.4.1. **Alternative Model Specifications**

Our main analysis clusters standard errors in two dimensions, by both country and year, following Petersen (2009). Although two-way standard error clustering avoids misleading statistical inferences, it may introduce excessive variance compromising the inference power of the results. We conduct a set of robustness tests by clustering standard errors by country only given that financial liberalization occurs at the country-level. We repeat the above analyses and report condensed results in Table 2.6.

Table 2.6: Robustness tests for standard errors clustered by country only

We repeat regressions in Table 2.2-2.5 with the same specification except for clustering standard errors by country only. All regressions are estimated with country-year and industry-year fixed effects. The key interaction terms of industry mechanism variables and liberalization indicator are tabulated in Panel A-D, respectively. Coefficients of control variables and regression statistics (i.e., the number of observation and adjusted R-squared) are not reported for simplicity. Robust standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	Patent	*Citation*	*Generality*	*Originality*	*R&D*
Panel A	(1)	(2)	(3)	(4)	(5)
Dependence × *Lib*	0.548***	0.252**	0.052***	0.036***	0.402
	(0.128)	(0.126)	(0.013)	(0.012)	(0.312)
Obs.	11,694	11,694	11,694	11,694	7,094
Adj. R^2	0.807	0.594	0.314	0.298	0.658
Panel B					
Growth × *Lib*	0.960**	0.412**	0.105***	0.062***	1.135**
	(0.404)	(0.168)	(0.025)	(0.018)	(0.428)
Obs.	11,694	11,694	11,694	11,694	7,094
Adj. R^2	0.806	0.594	0.314	0.297	0.658
Panel C					
Maturity × *Lib*	-0.090***	-0.034*	-0.008***	-0.005***	-0.112*
	(0.027)	(0.018)	(0.002)	(0.002)	(0.060)
Obs.	11,694	11,694	11,694	11,694	7,094
Adj. R^2	0.807	0.594	0.314	0.297	0.658
Panel D					
High-tech × *Lib*	0.112**	0.053*	0.012***	0.007**	0.090
	(0.050)	(0.030)	(0.003)	(0.003)	(0.073)
Obs.	11,694	11,694	11,694	11,694	7,094
Adj. R^2	0.806	0.594	0.314	0.297	0.658

Panels A-D report the results corresponding to each of the four underlying economic mechanisms we have identified and examined before. The coefficient estimates of key variables of interest continue to be statistically significant in innovation output regressions (*Patent, Citation, Generality* and *Originality*). The significance levels of key variables in innovation input regressions (*R&D*) remain unchanged compared with those in the main analysis. Overall, one-way standard error clustering does not alter our main inferences.

Next, we examine whether our main results are sensitive to the length of the gap between major policy changes and innovation output. Our main specification examines how financial liberalization affects two-year ahead innovation output ($n = 2$). In this robustness test, we vary n from 1 to 4. Since we use the contemporaneous R&D expense in year t ($n = 0$) as the dependent variable in the main analysis, this robust test does not include analyses with R&D as the dependent variable. We tabulate the results of $n = 1$ in Table 2.7 with one industry mechanism variable pretested in each panel. The coefficient estimates of the key variables continue to be statistically significant with signs consistent with those in the main analysis. Similarly, in untabulated analyses in which we set $n = 3$ and $n = 4$, our conclusion remains unchanged. Overall, the results suggest that different lengths of lag periods between the financial liberalization year and the future innovation output year do not alter our inferences.

Table 2.7: Robustness tests for lag period *n = 1*

We let $n = 1$ in Equation (2.1) and run OLS regressions estimating $Innovation_{i,j,t+1} = \alpha + \beta Industry_j \times Lib_{i,t} + \gamma' X_{i,j,t} + \mu_{i,t} + \omega_{j,t} + \varepsilon_{i,j,t}$. Dependent variables used are *Patent*, *Citation*, *Generality* and *Originality* as defined above. Note we do not repeat the analysis for dependent variable *R&D* in the robustness test, because we always use contemporaneous *R&D*. Industry mechanism variables (*Dependent*, *Growth*, *Age* and *High-tech*), liberalization indicator (*Lib*), and other control variables are the same as defined above. We only tabulate the coefficients of interaction terms for simplicity. Industry is defined by two-digit SIC codes and our sample includes industries with two-digit SIC codes between 20 and 39. The sample period is 1980-2009. All regressions are estimated with country-year and industry fixed-year effects. Robust standard errors in parentheses are clustered by country and year. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	Patent	*Citation*	*Generality*	*Originality*
Panel A	(1)	(2)	(3)	(4)
Dependence × *Lib*	0.549***	0.232**	0.049***	0.029***
	(0.121)	(0.117)	(0.011)	(0.011)
Obs.	12,027	12,027	12,027	12,027
Adj. R^2	0.805	0.594	0.310	0.298
Panel B				
Growth × *Lib*	0.954**	0.396***	0.099***	0.052***
	(0.417)	(0.142)	(0.021)	(0.018)
Obs.	12,027	12,027	12,027	12,027
Adj. R^2	0.805	0.594	0.310	0.298
Panel C				
Maturity × *Lib*	-0.089***	-0.031**	-0.007***	-0.004**
	(0.026)	(0.015)	(0.002)	(0.002)
Obs.	12,027	12,027	12,027	12,027
Adj. R^2	0.805	0.594	0.309	0.298
Panel D				
High-tech × *Lib*	0.110**	0.051*	0.011***	0.005**
	(0.050)	(0.026)	(0.003)	(0.003)
Obs.	12,027	12,027	12,027	12,027
Adj. R^2	0.805	0.594	0.309	0.298

2.4.2. **Alternative Proxies for Industry-level Mechanisms**

We identify four underlying industry-level mechanisms through which financial liberalization could promote innovation and build one industry-level proxy variable for each. Among the four mechanism proxy variables, the dependence on external finance proxy proposed by Rajan and Zingales (1998) is a widely-used measure and is used in many existing studies such as Beck and Levine (2002), Gupta and Yuan (2009) and Brown, Martinsson, and Petersen (2013). However, there is no standardized way to construct proxy variables for the other three economic mechanisms of growth opportunities, industry maturity and high-tech intensiveness. We examine whether our findings are robust to alternative constructions for these three mechanisms.

First of all, we use price-to-earnings (PE) ratio as an alternative proxy for industry growth opportunities. Bekaert et al. (2007) propose that the PE ratio is a good proxy for growth opportunities because it is a forward-looking measure that reflects the market's anticipation of future growth. We compute the industry PE ratio, weighted by annual year-end market capitalization, for each US industry.[12] Second, for industry maturity, we calculate the logarithm of the number of employees as an alternative proxy variable. The rationale is that firms in younger industries usually have relatively fewer employees compared to firms in more mature industries. Finally, we take the annual R&D expense growth rate as an alternative measure for high-tech intensiveness. We assume high-tech firms maintain a higher growth rate of R&D expense compared to non-high-tech firms. These alternative proxy variables are all based on US firms. To be consistent with the main analysis, we take the industry median for every sample year, and then take the time series median for every industry. We repeat the analysis of

[12] We also compute equally-weighted PE ratio and find both qualitatively and quantitatively similar results.

Equation (2.1) and report the results in Table 2.8.

Table 2.8: Robustness tests for alternative proxies of industry-level mechanisms

We repeat the regression analysis of Equation (2.1) with alternative proxies for industry-level mechanisms. We use price-to-earnings ratio as a proxy for growth opportunities, number of employees as a proxy for industry maturity, and R&D expenditure growth rate as a proxy for high-tech intensiveness. Similar to previous mechanism variables, new proxy variables are industry medians based on the US sample. We only tabulate the coefficients of interaction terms for simplicity. Industry is defined by two-digit SIC codes and our sample includes industries with two-digit SIC codes between 20 and 39. The sample period is 1980-2009. All regressions are estimated with country-year and industry-year fixed effects. Robust standard errors in parentheses are clustered by country and year. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	Patent	*Citation*	*Generality*	*Originality*	*R&D*
Panel A	(1)	(2)	(3)	(4)	(5)
Growth × *Lib*	0.051**	0.017	0.004***	0.003***	-0.027
	(0.022)	(0.012)	(0.001)	(0.001)	(0.051)
Obs.	11,694	11,694	11,694	11,694	7,094
Adj. R^2	0.806	0.594	0.313	0.297	0.658
Panel B					
Maturity × *Lib*	-0.309**	-0.162**	-0.036***	-0.021***	-0.380*
	(0.135)	(0.080)	(0.008)	(0.008)	(0.229)
Obs.	11,694	11,694	11,694	11,694	7,094
Adj. R^2	0.806	0.594	0.314	0.297	0.658
Panel C					
High-tech × *Lib*	0.060*	0.030	0.008***	0.003	0.091
	(0.031)	(0.021)	(0.002)	(0.002)	(0.084)
Obs.	11,694	11,694	11,694	11,694	7,094
Adj. R^2	0.806	0.594	0.313	0.297	0.658

In Panel A of Table 2.8 where we use the market capitalization-weighted PE ratio to capture industry growth opportunities, the coefficient estimates of key variables are all positive and most are significant at the 1% or 5% levels. This finding is consistent with the main analysis, which suggests that industries with high growth opportunities produce more innovation than low growth industries after financial liberalization. In Panel B in which we use the number of employees to capture industry maturity, the coefficient estimates of key variables are all negative and significant. Therefore, our conclusion that younger industries outperform older industries in terms of innovation after financial liberalization continues to hold. Finally, we find robust results in Panel C using the R&D expense growth rate as the alternative measure for high-tech intensiveness. In summary, we find that these economic mechanisms are robust when we use alternative industry-level mechanism variables.

2.4.3. **Alternative Subsamples**

Our main analysis employs a sample including both publicly-traded and privately-held firms, and we find that financial liberalization improves the overall innovation performance of both publicly-traded and privately-held firms. Chari and Henry (2008) argue that financial liberalization has a more direct impact on publicly-traded firms. Therefore, one possible concern is that our findings are mainly driven by the improved innovation performance of publicly-traded firms. To address this concern, we examine whether our results remain robust by examining the effect of financial liberalization on innovation output produced by privately-held firms only. We report the results in Table 2.9.

Table 2.9: Robustness tests for a subsample of privately-held firms

We repeat the regression analysis of Equation (2.1) on a subsample of privately-held firms. We only tabulate the coefficients of interaction terms for simplicity. Industry is defined by two-digit SIC codes and our sample includes industries with two-digit SIC codes between 20 and 39. The sample period is 1980-2009. All regressions are estimated with country-year and industry-year fixed effects. Robust standard errors in parentheses are clustered by country and year. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	Patent	*Citation*	*Generality*	*Originality*
Panel A	(1)	(2)	(3)	(4)
Dependence × *Lib*	0.593***	0.201**	0.038***	0.028***
	(0.151)	(0.085)	(0.012)	(0.009)
Obs.	11,675	11,675	11,675	11,675
Adj. R^2	0.783	0.573	0.267	0.267
Panel B				
Growth × *Lib*	0.742***	0.205***	0.050***	0.032***
	(0.134)	(0.070)	(0.012)	(0.010)
Obs.	11,675	11,675	11,675	11,675
Adj. R^2	0.783	0.572	0.267	0.267
Panel C				
Maturity × *Lib*	-0.084***	-0.029***	-0.006***	-0.005***
	(0.020)	(0.009)	(0.002)	(0.001)
Obs.	11,675	11,675	11,675	11,675
Adj. R^2	0.783	0.572	0.267	0.267
Panel D				
High-tech × *Lib*	0.140***	0.050***	0.009***	0.006**
	(0.032)	(0.018)	(0.003)	(0.003)
Obs.	11,675	11,675	11,675	11,675
Adj. R^2	0.783	0.572	0.267	0.267

Table 2.9 Panel A shows that, consistent with our main analysis, all coefficient estimates of the interaction term are positive and significant for innovation output variables. Similarly, in Panels B–D we examine the other three underlying economic mechanisms of growth opportunities, maturity and high-tech intensiveness through which financial liberalization affects innovation. The coefficient estimates exhibit signs and significance levels that are consistent with our main findings. Therefore, our main findings are robust to excluding publicly-traded firms from the sample.[13]

Next, we examine whether our main results are driven by a few dominant liberalizing countries. As illustrated early in Table 2.1 Panel A, a few large countries, in terms of innovation output and input, liberalized their financial markets during the sample period. The most noticeable example is Japan which has the highest patent counts and the second highest patent citations. South Korea is another country exhibiting very active innovation activities and it liberalized its financial markets during our sample period. So it is possible that our inferences from the main analysis are mainly driven by these dominant liberalizing countries.

We test whether our main findings continue to hold after excluding these two dominant innovation countries, Japan and South Korea, in the liberalizing group. Table 2.10 reports the results of this reduced sample. We find that the results are even stronger than our main analysis: all coefficient estimates of the interaction term exhibit signs that are consistent with the whole sample results and are significant at the 5% or 1% level. This robustness test shows that our main findings are not driven by high innovation countries that experienced financial liberalization during our sample period, such as Japan and South Korea.

[13] In untabulated analysis, we find our main results are robust to a subsample of publicly-traded firms only, too.

Table 2.10: Robustness tests for a subsample excluding Japan and South Korea

We repeat the regression analysis of Equation (2.1) after excluding Japan and South Korea from the sample. We only tabulate the coefficients of interaction terms for simplicity. Industry is defined by two-digit SIC codes and our sample includes industries with two-digit SIC codes between 20 and 39. The sample period is 1980-2009. All regressions are estimated with country-year and industry-year fixed effects. Robust standard errors in parentheses are clustered by country and year. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	Patent	*Citation*	*Generality*	*Originality*	*R&D*
Panel A	(1)	(2)	(3)	(4)	(5)
Dependence × *Lib*	0.578***	0.207**	0.041***	0.029***	0.825**
	(0.164)	(0.085)	(0.012)	(0.009)	(0.359)
Obs.	10,736	10,736	10,736	10,736	6,186
Adj. R^2	0.764	0.565	0.242	0.252	0.629
Panel B					
Growth × *Lib*	1.338***	0.367***	0.087***	0.055***	1.638**
	(0.308)	(0.124)	(0.024)	(0.016)	(0.674)
Obs.	10,736	10,736	10,736	10,736	6,186
Adj. R^2	0.764	0.565	0.242	0.252	0.629
Panel C					
Maturity × *Lib*	-0.093***	-0.029***	-0.006***	-0.005***	-0.199***
	(0.027)	(0.010)	(0.002)	(0.001)	(0.052)
Obs.	10,736	10,736	10,736	10,736	6,186
Adj. R^2	0.764	0.565	0.242	0.252	0.629
Panel D					
High-tech × *Lib*	0.163***	0.055***	0.010***	0.007***	0.207***
	(0.041)	(0.018)	(0.003)	(0.002)	(0.078)
Obs.	10,736	10,736	10,736	10,736	6,186
Adj. R^2	0.764	0.565	0.242	0.252	0.629

2.4.4. **Alternative Proxies for Financial Liberalization**

In this section, we explore alternative measures of financial liberalization. In our main analysis, we use a binary variable, $Lib_{i,t}$, to indicate the openness of stock markets. This dummy variable, though based on government announcements, may omit certain nuances during the process of financial liberalization. In reality, it is unlikely that financial markets in a country will become obstacle-free to foreign investors immediately after official announcements. Many countries liberalize their entire financial markets over time. Therefore, we examine whether our findings remain robust to alternative proxies for financial liberalization.

The first alternative proxy for financial liberalization is the ratio of market capitalization of firms in the Standard and Poor/International Finance Corporation (S&P/IFC) Investable index to those firms in the S&P/IFC Global index following Bekaert (1995) and Edison and Warnock (2003). We express this proxy variable as $Invest_{i,t}$, indicating the proportion of market capitalization available to foreign investors for country i in year t. $Invest_{i,t}$ ranges from zero meaning not accessible to foreign investors to one meaning complete liberalization. Many emerging markets gradually increase the proportion of their market capitalization that is available for investment by foreign investors following the announcement of financial liberalization. We collect the values of *Invest* for our sample economies for the 1989 to 2009 period due to the availability of IFC indices[14].

Another alternative proxy for financial liberalization is the capital account openness index (Quinn, 1997; Bekaert, Harvey, and Lundblad, 2005; Quinn and Toyoda,

[14] The S&P/IFC Investable index is for emerging markets only. Therefore, we assign *Invest* = 1 for those "Open Market" economies listed in Table 2.1. For developed economies with liberalization years, we assign *Invest* = 1 after their corresponding liberalization years. Portugal was categorised as a developed country after 1999, so *Invest* = 1 after 1999.

2008). The openness of capital account captures another dimension of financial liberalization because this measure indicates the ease of transferring capital cross-border. Quinn and Toyoda (2008) code the value of capital account openness between zero and 100, with zero indicating a closed economy and 100 indicating a fully open economy. We transform the index ($Cap_{i,t}$) to a range between zero and one by dividing the original value by 100. Due to the availability of the capital account openness index, our sample is limited to between 1980 and 1999.

We repeat the regressions estimating Equation (2.1) by replacing *Lib* with *Invest* or *Cap*, and report the results in Table 2.11. In Panels A1–D1, we use *Invest* as an alternative proxy for financial liberalization. All interaction terms between *Invest* and *Dependence*, *Growth*, *Maturity* and *High-tech* exhibit consistent signs with the main analysis, and all except two coefficient estimates remain statistically significant. Similarly, in Table 2.11 Panel A2–D2 in which we use *Cap* as an alternative proxy for financial liberalization, the impact of *Cap* on innovation variables through *Dependence*, *Growth*, *Maturity* and *High-tech* remains significant, consistent with our main test results. Overall, the evidence reported in Table 2.11 suggests that our main findings are robust to alternative proxies for financial liberalization.

Table 2.11: Robustness tests for alternative proxies of financial liberalization

We repeat the regression analysis of Equation (2.1) by replacing $Lib_{i,t}$ with $Invest_{i,t}$ or $Cap_{i,t}$. $Invest_{i,t}$ is the ratio of the market capitalization of firms in the S&P/IFC Investable index to those in the S&P/IFC Global index, and $Cap_{i,t}$ is capital account openness index. We only tabulate the coefficients of interaction terms for simplicity. Industry is defined by two-digit SIC codes and our sample includes industries with two-digit SIC codes between 20 and 39. Sample period is 1989-2008. All regressions are estimated with country-year and industry-year fixed effects. Robust standard errors in parentheses are clustered by country and year. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	Patent	*Citation*	*Generality*	*Originality*	*R&D*
Panel A1	(1)	(2)	(3)	(4)	(5)
Dependence × *Invest*	1.239***	0.615**	0.094***	0.087***	1.047***
	(0.345)	(0.298)	(0.018)	(0.019)	(0.259)
Obs.	11,169	11,169	11,169	11,169	6,988
Adj. R^2	0.815	0.597	0.316	0.299	0.661
Panel B1					
Growth × *Invest*	2.143***	1.136**	0.220***	0.169***	2.660***
	(0.688)	(0.569)	(0.042)	(0.041)	(0.701)
Obs.	11,169	11,169	11,169	11,169	6,988
Adj. R^2	0.812	0.596	0.316	0.297	0.661
Panel C1					
Maturity × *Invest*	-0.146**	-0.069	-0.015***	-0.012***	-0.155*
	(0.070)	(0.061)	(0.003)	(0.004)	(0.082)
Obs.	11,169	11,169	11,169	11,169	6,988
Adj. R^2	0.811	0.594	0.314	0.296	0.660
Panel D1					
High-tech × *Invest*	0.277**	0.142	0.028***	0.023***	0.252**
	(0.124)	(0.114)	(0.006)	(0.008)	(0.105)
Obs.	11,169	11,169	11,169	11,169	6,988
Adj. R^2	0.812	0.596	0.316	0.297	0.660

Table 2.11: Robustness tests for alternative proxies for financial liberalization – continued

	Patent	*Citation*	*Generality*	*Originality*	*R&D*
Panel A2	(1)	(2)	(3)	(4)	(5)
Dependence × *Cap*	1.381***	0.972***	0.142***	0.101***	1.352**
	(0.343)	(0.319)	(0.026)	(0.020)	(0.533)
Obs.	7,455	7,455	7,455	7,455	3,537
Adj. R^2	0.819	0.593	0.324	0.297	0.674
Panel B2					
Growth × *Cap*	3.094***	2.162***	0.344***	0.222***	3.612***
	(0.744)	(0.552)	(0.067)	(0.052)	(0.996)
Obs.	7,455	7,455	7,455	7,455	3,537
Adj. R^2	0.814	0.584	0.317	0.292	0.670
Panel C2					
Maturity × *Cap*	-0.215***	-0.143***	-0.023***	-0.015***	-0.195
	(0.050)	(0.050)	(0.004)	(0.004)	(0.129)
Obs.	7,455	7,455	7,455	7,455	3,537
Adj. R^2	0.816	0.586	0.321	0.294	0.672
Panel D2					
Risk × *Cap*	0.381***	0.296***	0.043***	0.026***	0.240
	(0.101)	(0.095)	(0.009)	(0.007)	(0.153)
Obs.	7,455	7,455	7,455	7,455	3,537
Adj. R^2	0.817	0.594	0.324	0.295	0.672

2.5. Institutional Quality, Financial Liberalization and Innovation

Country-level institutional quality could facilitate the growth effects of financial liberalization on the real economy. Bekaert, Harvey, and Lundblad (2005) observe that countries respond differently to financial liberalization. They find that liberalizing countries with better legal and regulatory quality exhibit faster economic growth following financial liberalization. Similarly, Gupta and Yuan (2009) highlight that contemporaneous reform, which lowers entry barriers and promotes competition, strengthens the growth effect of financial liberalization.

In the context of financial liberalization, the removal of a ban on foreign investments eliminates explicit barriers; however, there are still many implicit barriers that may compromise the positive effects of financial liberalization (Stulz, 2005). For instance, international investors may avoid investing in countries that have weak protection of private property. Bureaucracy and corruption also impede financial integration. Gelos and Wei (2005) find that foreign investors reduce their portfolio holdings in countries that lack information transparency. Carrieri, Chaieb, and Errunza (2013) show that better institutional quality improves financial integration. In a similar spirit, cross-country heterogeneity in institutional quality could alter the effect of financial liberalization on innovation.

Motivated by these existing findings, we explore how country-level institutional quality alters the effects of financial liberalization on innovation. We follow and modify a framework established by Bekaert, Harvey, and Lundblad (2005) by accommodating our industry-level mechanism variables and estimate the following model:

$$Innovation_{i,j,t+2} = \alpha Industry_j \times LibFull_{i,t} + \alpha_H Industry_j \times LibHigh_{i,t} + \alpha_L Industry_j \times LibLow_{i,t} + \delta IQ_{i,t} + \gamma' X_{i,j,t} + \rho' C_{i,t} + \mu_t + \varepsilon_{i,j,t} \quad (2.2)$$

where the dummy variable $LibFull_{i,t}$ equals one for the liberalized group and zero for the liberalizing group. Next, the dummy variable $LibHigh_{i,t}$ ($LibLow_{i,t}$) further divides the liberalizing group into two sub-groups, depending on whether a country's institutional quality index value is above (below) the liberalizing group's corresponding median.

We multiply these dummy variables with one of the four industry-level mechanism variables (*Dependence*, *Growth*, *Maturity* and *High-tech*) denoted as $Industry_j$. The value of institutional quality index itself ($IQ_{i,t}$) is also included. We examine three key institutional quality indices from Kaufmann, Kraay, and Mastruzzi (2009): Rule of Law, Regulatory Quality and Control of Corruption. These three indices capture the regulatory and legal environments of sample countries.[15] Equation (2.2) includes a group of industry-level control variables $X_{i,j,t}$ (i.e. *Ln*(*Sales*), *Herf*, $Herf^2$, *Leverage*, and *ROA*) that have been used in our main analysis. In addition, we add country-level control variables ($C_{i,t}$) including the total equity market capitalization to GDP ratio, total banking sector credits to GDP ratio, and total export amount to GDP ratio, representing country-specific equity and credit markets development as well as international trade. The macroeconomic data is from the World Bank.[16] Robust standard errors are clustered by country.

[15] Kaufmann, Kraay, and Mastruzzi (2009) report indices values every two years from 1996-2002, then report yearly values from 2003-2008. We use the time-series median value of each country. The advantage of using the Kaufmann, Kraay, and Mastruzzi (2009) indices is that they continuously update this variable and provide a comprehensive gauge of institutions. Traditional institutional quality measures such as Rule of Law and Control for Corruption in La Porta et al. (1998) use data from 1990. Another advantage of Kaufmann, Kraay, and Mastruzzi (2009) is that their survey is sponsored by the World Bank. Therefore, their data has a much wider coverage, and their survey methodology is systematic and consistent.

[16] Taiwan is not used in this analysis due to the absence of macroeconomic data.

Table 2.12: Institutional quality, financial liberalization and innovation

We estimate Equation (2.2): $Innovation_{i,j,t+2} = \alpha Industry_j \times LibFull_{i,t} + \alpha_H Industry_j \times LibHigh_{i,t} + \alpha_L Industry_j \times LibLow_{i,t} + \delta IQ_{i,t} + \gamma' X_{i,j,t} + \rho' C_{i,t} + \mu_t + \varepsilon_{i,j,t}$ to examine how institutional quality affects innovation performance. $Innovation_{i,j,t+2}$ and $Industry_j$are five innovation measures and four industry mechanism variables defined above. $LibFull_{i,t}$ is an indicator for countries that have already liberalized their financial markets before our sample period. $LibHigh_{i,t}(LibLow_{i,t})$ indicates whether a liberalizing country, which liberalized its markets during the sample period, has an institutional quality index value above (below) the median value of liberalizing countries. $IQ_{i,t}$ is one of the three institutional quality indices, Rule of Law, Regulatory Quality and Control of Corruption, from Kaufmann, Kraay, and Mastruzzi (2009). Panels A, B and C report results of the each of the three institutional quality index, respectively. $X_{i,j,t}$ denotes the same industry-level control variables in the main analysis. Three additional country-level control variables ($C_{i,t}$) are included: total equity market capitalization to GDP, banking sector credit to GDP, and export to GDP ratios. μ_t is year fixed effects. We only tabulate α, α_H, and α_L for simplicity. We also report the *p*-value of the Wald test with a null hypothesis as $\alpha_H = \alpha_L$. Industry is defined by two-digit SIC codes and our sample includes industries with two-digit SIC codes between 20 and 39. The sample period is 1980-2009. Robust standard errors in parentheses are clustered by country. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

(Table starts from the next page)

Table 2.12: Institutional quality, financial liberalization and innovation – continued

Rule of Law	*Patent*	*Citation*	*Generality*	*Originality*	*R&D*
Panel A1	(1)	(2)	(3)	(4)	(5)
Dependence × *LibFull*	1.157***	0.479***	0.069***	0.070***	1.764***
	(0.116)	(0.082)	(0.008)	(0.008)	(0.289)
Dependence × *LibHigh*	0.829***	0.455**	0.034***	0.039**	1.102***
	(0.208)	(0.206)	(0.011)	(0.014)	(0.285)
Dependence × *LibLow*	0.185*	-0.029	0.000	0.005	0.695***
	(0.096)	(0.036)	(0.003)	(0.004)	(0.251)
Wald test *p*-value	0.009	0.028	0.005	0.028	0.283
Panel A2					
Growth × *LibFull*	1.962***	0.707***	0.113***	0.122***	2.880***
	(0.130)	(0.116)	(0.012)	(0.011)	(0.266)
Growth × *LibHigh*	1.313***	0.588***	0.084***	0.086***	1.830***
	(0.297)	(0.160)	(0.015)	(0.017)	(0.307)
Growth × *LibLow*	-0.107	0.186	0.037**	0.035**	1.386***
	(0.293)	(0.170)	(0.017)	(0.016)	(0.280)
Wald test *p*-value	0.006	0.059	0.009	0.014	0.275
Panel A3					
Maturity × *LibFull*	-0.086***	-0.054***	-0.006***	-0.006***	-0.193***
	(0.018)	(0.012)	(0.001)	(0.001)	(0.025)
Maturity × *LibHigh*	-0.127***	-0.058***	-0.007***	-0.008***	-0.238***
	(0.023)	(0.014)	(0.001)	(0.001)	(0.023)
Maturity × *LibLow*	-0.204***	-0.065***	-0.008***	-0.009***	-0.187***
	(0.034)	(0.015)	(0.001)	(0.001)	(0.037)
Wald test *p*-value	0.071	0.693	0.611	0.373	0.194
Panel A4					
High-tech × *LibFull*	0.358***	0.159***	0.021***	0.022***	0.451***
	(0.025)	(0.024)	(0.002)	(0.001)	(0.036)
High-tech × *LibHigh*	0.238**	0.144**	0.011***	0.012**	0.256***
	(0.091)	(0.060)	(0.004)	(0.005)	(0.086)
High-tech × *LibLow*	-0.030	-0.006	-0.000	-0.000	0.206***
	(0.068)	(0.018)	(0.001)	(0.002)	(0.052)
Wald test *p*-value	0.046	0.026	0.014	0.034	0.607

Table 2.12: Institutional quality, financial liberalization and innovation – continued

Regulatory Quality	*Patent*	*Citation*	*Generality*	*Originality*	*R&D*
Panel B1	(1)	(2)	(3)	(4)	(5)
Dependence × *LibFull*	1.158***	0.480***	0.069***	0.070***	1.799***
	(0.115)	(0.081)	(0.008)	(0.008)	(0.288)
Dependence × *LibHigh*	0.820***	0.452**	0.033***	0.038**	1.067***
	(0.199)	(0.204)	(0.010)	(0.014)	(0.283)
Dependence × *LibLow*	0.160	-0.037	-0.001	0.004	0.579**
	(0.108)	(0.040)	(0.004)	(0.004)	(0.233)
Wald test *p*-value	0.008	0.026	0.004	0.023	0.187
Panel B2					
Growth × *LibFull*	1.929***	0.733***	0.113***	0.120***	3.052***
	(0.128)	(0.117)	(0.012)	(0.010)	(0.264)
Growth × *LibHigh*	1.329***	0.595***	0.084***	0.086***	1.858***
	(0.292)	(0.158)	(0.015)	(0.017)	(0.302)
Growth × *LibLow*	0.009	0.139	0.039**	0.041**	1.132***
	(0.321)	(0.155)	(0.016)	(0.017)	(0.244)
Wald test *p*-value	0.012	0.036	0.011	0.028	0.048
Panel B3					
Maturity × *LibFull*	-0.087***	-0.052***	-0.006***	-0.006***	-0.181***
	(0.017)	(0.012)	(0.001)	(0.001)	(0.028)
Maturity × *LibHigh*	-0.127***	-0.058***	-0.007***	-0.008***	-0.239***
	(0.023)	(0.014)	(0.001)	(0.001)	(0.024)
Maturity × *LibLow*	-0.201***	-0.072***	-0.008***	-0.009***	-0.205***
	(0.038)	(0.018)	(0.001)	(0.002)	(0.036)
Wald test *p*-value	0.098	0.458	0.519	0.491	0.385
Panel B4					
High-tech × *LibFull*	0.359***	0.162***	0.021***	0.022***	0.463***
	(0.024)	(0.024)	(0.002)	(0.002)	(0.040)
High-tech × *LibHigh*	0.237**	0.144**	0.011***	0.012**	0.250***
	(0.092)	(0.060)	(0.004)	(0.005)	(0.088)
High-tech × *LibLow*	-0.033	-0.016	-0.001	0.000	0.173***
	(0.065)	(0.020)	(0.002)	(0.002)	(0.053)
Wald test *p*-value	0.048	0.021	0.013	0.041	0.416

Table 2.12: Institutional quality, financial liberalization and innovation – continued

Control of Corruption	*Patent*	*Citation*	*Generality*	*Originality*	*R&D*
Panel C1	(1)	(2)	(3)	(4)	(5)
Dependence × *LibFull*	1.147***	0.475***	0.068***	0.070***	1.770***
	(0.116)	(0.081)	(0.008)	(0.008)	(0.291)
Dependence × *LibHigh*	0.803***	0.444**	0.032***	0.037**	1.068***
	(0.208)	(0.206)	(0.011)	(0.014)	(0.291)
Dependence × *LibLow*	0.170	-0.036	-0.001	0.004	0.591**
	(0.101)	(0.038)	(0.004)	(0.004)	(0.227)
Wald test *p*-value	0.011	0.029	0.006	0.030	0.201
Panel C2					
Growth × *LibFull*	1.921***	0.686***	0.109***	0.117***	2.884***
	(0.139)	(0.111)	(0.012)	(0.011)	(0.255)
Growth × *LibHigh*	1.282***	0.585***	0.083***	0.085***	1.829***
	(0.284)	(0.160)	(0.016)	(0.017)	(0.300)
Growth × *LibLow*	0.081	0.240	0.047***	0.047***	1.380***
	(0.302)	(0.162)	(0.016)	(0.015)	(0.240)
Wald test *p*-value	0.019	0.090	0.022	0.030	0.197
Panel C3					
Maturity × *LibFull*	-0.087***	-0.053***	-0.006***	-0.006***	-0.177***
	(0.017)	(0.012)	(0.001)	(0.001)	(0.025)
Maturity × *LibHigh*	-0.128***	-0.056***	-0.007***	-0.008***	-0.231***
	(0.023)	(0.013)	(0.001)	(0.001)	(0.025)
Maturity × *LibLow*	-0.202***	-0.067***	-0.008***	-0.009***	-0.211***
	(0.036)	(0.017)	(0.001)	(0.001)	(0.037)
Wald test *p*-value	0.086	0.543	0.483	0.368	0.597
Panel C4					
High-tech × *LibFull*	0.361***	0.158***	0.021***	0.022***	0.455***
	(0.025)	(0.023)	(0.002)	(0.002)	(0.037)
High-tech × *LibHigh*	0.241**	0.145**	0.012***	0.012**	0.266***
	(0.091)	(0.060)	(0.004)	(0.005)	(0.087)
High-tech × *LibLow*	-0.045	-0.006	-0.000	0.000	0.179***
	(0.077)	(0.022)	(0.002)	(0.002)	(0.054)
Wald test *p*-value	0.046	0.031	0.014	0.034	0.357

Table 2.12 reports the results with coefficient estimates of control variables suppressed for brevity. In Panel A, B and C, we use Rule of Law, Regulatory Quality and Control of Corruption as proxies for institutional quality, respectively. Our focus is on key coefficients of variables: α_H and α_L. At the bottom of each panel, we report the p-value of the Wald test with a null hypothesis that $\alpha_H = \alpha_L$. In Panel A1 columns (1), α_H and α_L are 0.829 and 0.185, and both are significant. Their positive signs are consistent with our main analysis that more external finance dependent industries produce more patents after financial liberalization. Most importantly, we compare the coefficient estimates of α_H and α_L. The p-value of the Wald test is 0.009, which rejects the null hypothesis that $\alpha_H = \alpha_L$ at the 1% confidence level. This finding suggests that the effect of financial liberalization on innovation performance of a given industry in countries with stronger institutional quality is more prominent than the effect on the same industry in countries with weaker institutional quality. We find similar findings in other columns of Panel A1. The Wald tests show that the difference between α_H and α_L is statistically significant in most cases. In Panels A2–A4 in which other economic mechanisms are examined, we find similar findings.

In Panels B and C, in which we replace the institutional quality proxy with Regulatory Quality and Control of Corruption, respectively, we compare the coefficient estimates of α_H and α_L and are able to reject the null hypothesis that $\alpha_H = \alpha_L$ in most cases. Our findings suggest that the effect of financial liberalization on innovation performance of an industry in countries with better institutional quality is more pronounced than the effect on the same industry in countries with poorer institutional quality. In summary, the results reported in Table 2.12 support our conjecture that financial liberalization motivates a greater amount of innovation in countries with better institutional quality.

2.6. Conclusion

In this chapter, we provide empirical evidence that documents the causal effect of financial liberalization on the economy, focusing on the promotion of technological innovation. Using a fixed effects identification strategy building on the seminal work of Rajan and Zingales (1998), we find that industries that are more dependent on external finance, have greater growth opportunities, are younger, and are more high-tech intensive exhibit a disproportionately higher level of innovation output following financial liberalization. We conduct a rich set of robustness tests and show that our results are robust to alternative specifications, alternative proxies for economic mechanism variables, alternative subsamples, and alternative proxies for financial liberalization. We also show that the positive effect of financial liberalization on innovation is more pronounced in countries with low implicit barriers to international investment.

This study contributes to both the literature on financial openness and economic growth and the emerging literature on finance and innovation. By providing the first rigorous empirical analysis that establishes a causal link between financial liberalization and technological innovation through various underlying economic mechanisms, this chapter sheds new light on the effects of financial liberalization on the economy.

Chapter 3.

The Real Effect of Mandatory IFRS Adoption: Evidence from Corporate Innovation

3.1. Introduction

The most significant regulatory change in accounting history is the mandatory adoption of International Financial Reporting Standards (IFRS) in over 100 countries (Daske et al., 2008). This major event has received tremendous attention, with reviews by Barth (2007), Soderstrom and Sun (2007), and Hail, Leuz, and Wysocki (2010a, 2010b). After years of debate on the pros and cons of IFRS, it is only recently that the literature has empirically documented the consequences of IFRS. The existing IFRS literature documents some positive capital market effects of IFRS adoption. For example Daske et al. (2008) find that mandatory IFRS increases market liquidity[17] and reduces the cost of capital. Similarly, Li (2010) finds mandatory IFRS adoption lowers the cost of capital using a sample of European Union (EU) countries. Mandatory IFRS adoption is also found to be beneficiary to the information environment. For example, Yip and Young (2012) show that mandatory IFRS improves accounting information comparability by making similar things more alike without making different things less different. Byard, Li, and Yu (2011) find that mandatory IFRS adoption in the EU yields smaller forecast errors and dispersions by analysts. Mandatory IFRS adoption is also found to be influential on investments. DeFond et al. (2011) document an increased ownership by foreign mutual funds in EU mandatory IFRS adopters. Further evidence is provided by Florou and Pope (2012) who show that both domestic and foreign institutional holdings are higher after mandatory adoption of IFRS in the EU.

However, very little attention has been paid to those individual firms who experienced this regulation change[18]. We know only that they are "forced" to adopt a new accounting system. If mandatory IFRS adopters merely accept an accounting

[17] Christensen, Hail, and Leuz (2013) argue that the liquidity effect is only prominent in five EU countries which simultaneously implemented mandatory IFRS adoption and enforcement changes.
[18] One exception is Daske et al. (2013) who take the perspective of IFRS adopters by identifying them as "label" or "serious" adopters. But the objective of their study still focuses on capital market effects.

system but do nothing else, it is unlikely that the benefits of IFRS would be long-lasting because the players in the real economy seem intact. If we optimistically expect that mandatory IFRS adopters indeed implement operational adjustments accordingly, then we would like to discover what kind of strategic adjustments were taken and what the possible consequences on the real economy are. Unfortunately, there are no answers to these important questions yet. Therefore, this thesis takes the first step towards filling this research gap. We examine these questions from a unique perspective of corporate innovation. It is well-known that technological innovation is a key driver of long-term economic growth (Solow, 1957; Rosenberg, 2004). If mandatory IFRS adoption affects corporate innovation, the impact of IFRS on the real economy is very likely to be prominent and long-term. An important empirical investigation is to verify whether and how mandatory IFRS adoption is related to corporate innovation.

We utilize mandatory IFRS adoption in the EU as a valuable opportunity to study the impacts of IFRS on corporate innovation. European Commission (EC) Regulation No. 1606/2002 requires all publicly-traded firms domiciled in the EU countries to adopt IFRS from 2005. This event provides a sufficiently large number of observations for which we are able to obtain high quality innovation data. We employ a Difference-in-Difference (DiD) approach by using mandatory IFRS adopters in the EU as a treatment group and local Generally Accepted Accounting Principles (GAAP) firms from other non-IFRS adoption countries as a control group. Our sample period is a nine-year event window (2001-2009) centred at year of mandatory IFRS adoption in 2005. Innovation data is collected from the Orbis database for individual firms, and we build four proxies for innovation - patent count, citation count, generality score and originality score - following the innovation literature (such as Hall, Jaffe, and Trajtenberg, 2001; Hsu, Tian, and Xu, 2014). Our main sample comprises a total of

13,327 individual firms from 30 countries, of which 18 are EU countries and 12 are non-IFRS adoption countries.

Our baseline analysis shows that mandatory IFRS adoption in the EU is positively correlated with corporate innovation. Mandatory IFRS adopters in the EU generate 6.7% more patents, receive 9% more citations, and exhibit higher generality and originality scores, compared to non-IFRS adopters from other countries after the 2005 adoption. To confirm this result, we then use a dynamic model by dividing the sample period into smaller sub-periods. The result of the dynamic model indicates that there were no existing differences in innovation performance between IFRS adopters and non-IFRS adopters before 2005. At the same time, the dynamic model suggests that the positive impact of mandatory IFRS on innovation appears prominent about three years after adoption. This finding means mandatory IFRS adopters indeed made strategic adjustments to become more innovative, and these adjustments take time.

We then conduct a range of robustness checks. First of all, we vary the year gap between the current period's financial data and the future period's innovation in our model. There is no evidence indicating that our finding is sensitive to the choice of year gap. In a second test, we expand the sample size by including voluntary IFRS adoption firms in the EU countries. This test is designed to check whether our result is driven by other major policy changes prevailing in the EU instead of mandatory IFRS adoption. The result does not support this conjecture as voluntary IFRS adopters in the EU do not show significant differences in terms of innovation compared to GAAP firms in non-IFRS adoption countries. Third, we exclude EU countries which implemented simultaneous reinforcement of regulation enforcement at the time of mandatory IFRS adoption. Our conclusion remains valid, meaning concurrent enforcement change is unlikely to be a joint driver of our result. Lastly, we include mandatory IFRS adopters

from non-EU countries and find that these non-EU adopters also experienced an improvement of innovation compared to local GAAP firms from non-IFRS adoption countries. This test highlights that the positive effect of mandatory IFRS adoption on corporate innovation is not limited within the EU. It precludes the possibility that our finding is due to other commonalities of EU countries, and it also rejects a suspicion that our result is biased by better innovation data coverage in the EU. In an additional test, we also find the positive effect of mandatory IFRS adoption is more prominent in countries with stronger institutions, including stronger investor protection, stricter security law and enforcement, and better rule of law.

Finally, we explore two possible channels through which mandatory IFRS adoption may facilitate innovation. The first channel is reduced cost of capital, a well-documented capital market effect of IFRS. Innovative firms are more likely to be subject to internal capital constraint (Brown, Fazzari, and Petersen; 2009) and thus rely on external finance. Reduced cost of capital makes it cheaper and easier for capital constrained firms to utilize external finance. Building an exogenous measure of dependence on external finance, we show consistent evidence that firms from external finance depending industries experienced a disproportionally higher improvement of innovation after mandatory IFRS adoption. The second possible channel we examine is increased institutional holdings demonstrated in Florou and Pope (2012). Aghion, Van Reenen, and Zingales (2013) show that increased ownership by institutional investors is positively correlated with corporate innovation, by reducing managers' career risk. We employ alternative proxies for operational risk assuming managers' career risk is higher in risky firms, and find firms from risky industries outperformed their counterparts following mandatory IFRS adoption. This result is consistent with our prediction.

This thesis contributes to two streams of literature. The primary contribution is to IFRS literature since this is the first study on the real effect of IFRS. As discussed before, the extant literature is largely silent on the important issue of whether mandatory IFRS adoption has an impact on the real economy. By showing a positive effect of mandatory IFRS adoption on corporate innovation, we present empirical evidence that mandatory IFRS adoption has a significant and long-term positive effect on the real economy by facilitating corporate innovation. Broadly speaking, our research also belongs to a large body of literature on accounting systems harmonization.

The second contribution is to a fast growing body of literature on motivating technological innovation. It is of great importance to motivate corporate innovation, considering the critical role played by innovation in sustaining economic growth. Holmstrom (1989) points out innovation activities may mix poorly with routine activities in an organization. Manso (2011) theoretically discussed several mechanisms to motivate innovation. There are a range of factors identified by the literature exhibiting positive or negative effects on corporate innovation, including timing of financial markets (Nanda and Rhodes-Kropf, 2013), laws (Acharya and Subramanian, 2009; Brown, Martinsson, and Petersen, 2013), domestic financial market development (Hsu, Tian, and Xu, 2014), firm boundaries (Seru, 2014), stock liquidity (Fang, Tian, and Tice, forthcoming), financial analysts following (He and Tian, 2013), banking competition (Cornaggia et al., forthcoming), product market competition (Aghion et al., 2005) and institutional investors (Aghion, Van Reenen, and Zingales, 2013; Chemmanur, Loutskina, and Tian, 2014). Our perspective is very different from all prior studies because we find the harmonization of accounting rules also facilitates corporate innovation.

The rest of the chapter proceeds as follows. Section 3.2 introduces the database of innovation, explains proxies for innovation and describes the sample selection procedure. Section 3.3 presents model specifications and reports empirical findings of the baseline and dynamic models, as well as robustness tests. Country-level institutional quality is also examined in this section. In Section 3.4, we discuss two possible channels through which mandatory IFRS affects corporate innovation, and provide empirical evidence. Finally, Section 3.5 concludes.

3.2. Data and Sample Selection

In this section, we introduce the global patent database used in this study, and explain the construction of key innovation variables. We also describe the process of sample selection and present summary statistics.

3.2.1. **Patent Database**

We use Bureau Van Dijk's Orbis patent database to construct our innovation variables. This database is sourced from the European Patent Office's (EPO) Worldwide Patent Statistical Database (PATSTAT). Similar to the USPTO, the EPO is one of the largest and most important patent offices in the world. The Orbis patent database offers a comprehensive coverage of more than 88 million patent applications[19] worldwide since 1850. These patents are filed by various types of entities, including publicly-traded and privately-held firms, individuals, governments and universities through 94 regional, national and international patent offices.

Because of its worldwide coverage, the Orbis patent database is more suitable for international studies. Many prior innovation studies, such as Hall, Jaffe, and Trajtenberg (2005), and Aghion, Van Reenen, and Zingales (2013) among many others,

[19] This number is by October 2014. Out of 88 million patents, 37.3 millions are granted patents.

are based on a single country, in most cases the US, and thus rely on the NBER USPTO patent data. Although the NBER patent database is an excellent source of patents filed in the US, its exclusion of international patents from other patent offices is an obvious limitation for international studies. An exception is Hsu, Tian, and Xu (2014) who use the distribution of US patents filed by foreign firms to estimate innovation activities in corresponding countries. However, observed foreign patenting activities may be very different from domestic innovation. For example Goto and Motohashi (2007) compare data from the USPTO and the Japan Patent Office (JPO), and find that the distribution of USPTO patents filed by Japanese firms is quite different from the distribution of domestic Japanese patents filed in the JPO. In addition, inconsistent administrative procedures across patent offices may contaminate the data and thus proper adjustments may be necessary (Webb et al., 2005). Using the Orbis patent database can help us overcome these shortcomings of the NBER patent database and enables us to more accurately identify innovation at the firm-level.

3.2.2. **Innovation Measures**

Following the innovation literature, we construct four measures for innovation: total number of granted patents, number of citations, generality score and originality score. The first measure is the total number of granted patents of each firm in every year. This variable captures the output side of innovation instead of the traditional input side of innovation such as R&D expense used in prior literature (such as Brown, Martinsson, and Petersen; 2013). The availability of patent count is better than R&D expenditure, because the latter is generally not reported by many non-US firms. We use a patent's application year to match other financial data because it usually takes years before a patent is eventually granted.

We only aggregate patents without priority numbers to prevent overestimating

patent count. The priority number is commonly used in the international patent system as "the number of the application in respect to which priority is claimed, i.e., it is the same as the application number of the claimed priority document" (Orbis manual). A simple example illustrates the functionality of priority number. For example, the Japanese car manufacturer Toyota generates an invention and applies for a patent to the JPO. Several months later, Toyota applies for a patent to the USPTO for the same invention expecting to have protection in the US. This subsequent USPTO patent is associated with a priority number, which is the application number of the prior JPO patent, indicating the same invention has been applied for patent before. So this USPTO patent is not considered as a novel new invention, and only one patent is counted for Toyota.

The raw patent count is subject to a truncation problem as shown by Hall, Jaffe, and Trajtenberg (2001, 2005). Due to the application-grant lag, many patents may not have been granted if they were applied for in the last several years of database coverage. Our download of the Orbis database is up to July 2014, so we follow Hall, Jaffe, and Trajtenberg's (2001, 2005) method to adjust raw patent count in the last five years of database coverage (2009-2014) using the application-grant lag distribution of 2004-2008. Specifically, we define the application-grant lag distribution (W_s), as the percentage of patents applied for in a given year that are granted in s years. For truncation-adjusted patent count (P_{adj}), we compute $P_{adj} = \frac{P_{raw}}{\sum_{s=0}^{2014-t} W_s}$, where P_{raw} is the raw patent count that at year t and $2009 \leq t \leq 2014$. After the adjustment of truncation, we need to transform the value. As the patent count is a discrete variable and highly right-skewed with a large number of zero patent observations in the sample, we use the logarithm of one plus discrete patent count as the dependent variable in regression

analysis following the innovation literature such as Atanassov (2013) and Hsu, Tian, and Xu (2014).

The second innovation measure we build is the number of citations. This measure captures the quality of innovation (Hall, Jaffe, and Trajtenberg, 2001) because a patent is very likely to be of great technological importance if it receives a high volume of citations from future patents. The raw citation count is subject to the truncation problem as well (Hall, Jaffe, and Trajtenberg, 2001) because a patent may keep receiving future citations after the end of the database coverage period. Another issue artificially distorting raw citation count is the inconsistency of administration procedures implemented by different patent offices. Webb et al. (2005) and Goto and Motohashi (2007) document that citations received by USPTO patents are significantly higher than citations received by EPO or JPO patents. They find the reason for this discrepancy is due to different administrative procedures among these patent offices. As the USPTO imposes a legal requirement on applicants to supply a complete list of citations at the time of application, applications are very likely to provide more than necessary citations in order to avoid any punishments. However, USPTO patent examiners may not have enough time to verify every citation (Webb et al., 2005). On the contrary, the EPO does not impose any kind of similar requirements. In the EPO, it is the patent examiners' duty to determine appropriate citations. The EPO follows a parsimonious philosophy by including only those most relevant and important citations. The JPO's policy has changed several times, and its current policy is a mixture of the USPTO and EPO. Additionally, the JPO's citation system contains some other unique features, described by Goto and Motohashi (2007). To reduce noise in the raw data, we choose a fixed effect adjustment approach suggested in Hall, Jaffe, and Trajtenberg (2001). Specifically for the raw citation count of each patent, we divide the raw value

by the average raw number of citations across all patents from the same patent offices and in the same year. This approach helps reduce year and patent office effects. After doing this adjustment, we then aggregate total citations received for each firm in every year. As with patent count, citation count is also a discrete variable. So similarly, we use the logarithm of one plus discrete value in regressions.

To capture the fundamental nature and importance of patents, we compute two additional citation-based innovation measures: generality and originality scores. Following Hall, Jaffe, and Trajtenberg (2001), a patent's generality score is defined as one minus the Herfindahl concentration index of technological classes for all the citations this patent receives.[20] A patent with a high generality score has a widespread impact on future patents from various technological classes. In a similar manner, a patent's originality score is defined as one minus the Herfindahl concentration index of technological classes for all prior patents that this patent cites. Therefore, a patent with a high originality score is inspired by prior inventions from a wide range of technological classes, thus is considered to be more original.

Although using patenting activities to measure innovation has been widely used, it is important to note that this type of measure has limitations. For example, not all kinds of innovation are well captured by patents. As gaining a patent requires public disclosure of technological details, some firms may choose to keep their inventions secret. Other conceptual innovation or operational optimization type innovations are not eligible to acquire patents under current regulations. There are other formats of intellectual property protection such as trademarks or copyright. Firms in different industries may choose different ways to materialise their innovation. Furthermore, patents only reflect successful innovative activities, leaving unsuccessful innovative

[20] In the Orbis patent database, technological classes are defined using the International Patent Classification (IPC) system. There are eight main classes in the IPC, as opposed to six main classes in the NBER USPTO patent database.

attempts unobserved. Nevertheless, there are no other widely accepted innovation measures yet (Acharya and Subramanian, 2009). Despite these imperfections, patenting activities still reflect very important technological innovations that are available for public access, and can be quantitatively measured. We also carefully design additional controls such as firm and year fixed effects in our analysis which strengthen the credibility of the findings.

3.2.3. **Sample Selection**

We employ firms from European Union (EU) countries which implemented mandatory IFRS adoption together from 2005 as a treatment group, and local GAAP firms from non-IFRS adoption countries as a control group. In order to analyse firms' innovation activities during pre- and post-IFRS mandatory adoption periods, our sample period is a nine-year (2001-2009) window centred around the mandatory adoption year of 2005. This length of sample period is appropriate, because a longer period may introduce unnecessary noise due to other events, while a shorter period may not sufficiently reflect the changes of innovation given its nature as a long-term activity. For EU countries, we only keep firms that switched to IFRS for the first time since 2005, following the IFRS literature (such as Li, 2010; Christensen, Hail, and Leuz, 2013). These EU firms are referred to as mandatory IFRS adopters. Other EU firms which voluntarily adopted IFRS before 2005 are excluded because their purpose of adoption is different. Similarly, we only keep local GAAP firms from other non-IFRS adoption countries, dropping voluntary IFRS adopters. Firm-year financial data is from the Worldscope database and we require every firm to have at least two years' financial data before and after 2005. We also impose a restriction on eligible sample countries to have a minimum of two firms and one patent record. Two-digit SIC code is used to classify industries, and financial industries (codes 60-69) and utility industries (code 49)

are excluded. Finally, our regression analysis controls for macroeconomic data from the World Bank, so countries (regions) lacking macroeconomic data are not included.

We begin with all EU countries and other non-IFRS adoption countries covered in the Worldscope database. After imposing the above conditions, our final sample consists of 13,327 individual firms from 30 countries, including 18 EU IFRS adoption countries [21] and 12 non-IFRS adoption countries. Table 3.1 reports the summary statistics. Within the EU group, the UK and France are the largest countries in terms of firm count with 626 and 367 firms respectively. Iceland, with only two firms, is the smallest country in the EU. Within the non-IFRS country group, the US with 3,837 firms is ranked first, followed by Japan with 2,629 firms. Russia with 13 firms is at the bottom of this group. Table 3.1 also reports the pooled average of innovation measures. In terms of patent count, the US, Japan, China, South Korea and Germany are the top five. Only Germany belongs to the mandatory IFRS adoption group and other four are non-IFRS countries. Ranking by the number of citations, the US, Japan, Germany and South Korea retain the top positions. The Netherlands replaces China as the fifth ranked country. Within both the IFRS adoption and non-IFRS adoption groups, we find some countries such as Ireland, Portugal and Brazil have relatively low values of innovation measures. In general, there is a noticeable heterogeneity of innovation measures within both the treatment and control groups. But no conclusion can be drawn so far that a particular group is dominant in terms of innovation measures.

[21] Iceland and Norway are not members of the EU, but belong to the European Economic Area (EEA). Because they agreed to adopt the EU capital market directives, we group them as EU countries following Christensen, Hail, and Leuz (2013).

Table 3.1: Summary statistics for IFRS adoption and non-IFRS adoption countries

This table reports summary statistics and sample composition. *EU Ctry* indicates whether a sample country is categorized as a member of the European Union. IFRS Year lists the year of mandatory IFRS adoption. Firm is the number of sample firms. *Patent*, *Citation*, *Generality* and *Originality* are patent count, citation count, and pooled average of generality score and originality score of each country.

Country	*EU Ctry*	*IFRS Year*	*Firm*	*Patent*	*Citation*	*Generality*	*Originality*
Austria	Yes	2005	13	109	70	0.028	0.023
Belgium	Yes	2005	47	117	68	0.004	0.021
Denmark	Yes	2005	63	1,653	1,433	0.012	0.023
Finland	Yes	2005	97	589	154	0.003	0.011
France	Yes	2005	367	8,196	637	0.005	0.013
Germany	Yes	2005	222	19,331	16,043	0.015	0.032
Greece	Yes	2005	209	35	7	0.000	0.002
Hungary	Yes	2005	5	50	0	0.000	0.000
Iceland	Yes	2005	2	40	7	0.059	0.102
Ireland	Yes	2005	32	3	25	0.002	0.001
Italy	Yes	2005	90	691	130	0.002	0.009
Norway	Yes	2005	97	550	125	0.003	0.009
Poland	Yes	2005	67	19	0	0.000	0.000
Portugal	Yes	2005	33	5	0	0.000	0.000
Spain	Yes	2005	83	309	7	0.001	0.005
Sweden	Yes	2005	197	5,666	4,051	0.009	0.023
Netherlands	Yes	2005	85	6,995	4,571	0.008	0.019
UK	Yes	2005	626	2,249	191	0.001	0.006
Brazil	No	Non IFRS	43	4	0	0.000	0.001
Canada	No	Non IFRS	688	1,326	1,522	0.007	0.019
China	No	Non IFRS	1,065	37,897	1,309	0.001	0.001
India	No	Non IFRS	387	1872	516	0.006	0.020
Indonesia	No	Non IFRS	234	56	0	0.000	0.000
Japan	No	Non IFRS	2,969	185,871	89,483	0.022	0.045
Malaysia	No	Non IFRS	570	39	0	0.000	0.000
Mexico	No	Non IFRS	84	15	1	0.000	0.001
Russia	No	Non IFRS	13	15	3	0.000	0.000
South Korea	No	Non IFRS	780	49,940	13,334	0.012	0.018
Thailand	No	Non IFRS	322	41	26	0.000	0.000
United States	No	Non IFRS	3,837	234,646	399,587	0.041	0.084

3.3. Research Design and Empirical Results

In this section, we first describe the model specification of the baseline regression and present empirical results. Then we use a dynamic model to verify the finding. Next, we conduct a series of robustness tests. In the last part of this section, we further examine how country-level institutional quality interacts with IFRS and innovation.

3.3.1. Baseline Model Specification

We employ a DiD approach as the baseline analysis. Specifically, we use the following model:

$$Innovation_{i,t+2} = \alpha + \beta_1 MandatoryIFRS_i \times PostIFRS_t + \sum \gamma \times Ctrls_t + \mu_i + \tau_t + \epsilon \quad (3.1)$$

where $Innovation_{i,t+2}$ is one of the four innovation measures built in the previous section for firm *i* in year *t*+2. As discussed before, we use application year to determine the timing of patents. But this timing may not be the real point of time when an innovative activity initially begins. Generally, it may take some time before an innovative activity achieves a successful outcome to be eligible for patenting. It may also take some time before individual firms initiate new projects in response to significant policy changes such as mandatory IFRS adoption in this case. Because the accurate start of innovation is unobservable from the data, we approximate the gap between IFRS and patent application by a two-year lag in our main analysis. The two-year gap is comparable to most other contemporaneous innovation studies such as Tian and Wang (2011), Atanassov (2013) and Hsu, Tian, and Xu (2014). $MandatoryIFRS_i$ is a binary variable that is set to one for firm *i* from mandatory IFRS adoption countries and zero otherwise. $PostIFRS_t$ is another binary variable that is set to one for year *t* if *t*

is between 2005 and 2009 inclusive, and zero otherwise (2001-2004). $Ctrls_t$ are a range of firm-level, industry-level and country-level time-varying control variables which may affect innovation. Following Atanassov (2013), Hsu, Tian, and Xu (2014) and Brown, Martinsson, and Petersen (2013), we use total assets, market-to-book ratio, leverage, return on assets (ROA), tangible assets scaled by total assets, capital expenditures scaled by total assets, percentage of insider holdings and the number of analysts following as firm specific control variables. On industry-level, we control for industry concentration measured by the sales Herfindahl index for each two-digit SIC industry in every country. Its squared term is also included to control for any non-linear relationship between industry concentration and innovation (Aghion et al., 2005; Atanassov, 2013). On country-level, we control for the logarithm of Gross Domestic Production (GDP) per capita and total stock market capitalisation scaled by GDP as proxies for country and capital market development. Our model includes firm fixed effect (μ_i) to alleviate the concern of omitted variables such as unobservable firm characteristics. Year fixed (τ_t) effect is controlled to absorb external annual shocks such as the recent Global Financial Crisis of 2008 and the Euro-zone debt crisis in 2013. After including firm and year fixed effects, individual terms of $MandatoryIFRS_i$ and $PostIFRS_t$ are no longer explicitly listed. Our main variable of interest is the coefficient (β_1) of interaction term. If β_1 is positively significant, it means there is a significant improvement of innovation for mandatory IFRS adopters during the post-IFRS adoption period compared to non-IFRS adopters. We estimate robust standard errors clustered by country because mandatory IFRS adoption is a country-level event.

3.3.2. **Baseline Result**

Table 3.2 reports the result of the baseline analysis. In the first column, the coefficient of *MandatoryIFRS* × *PostIFRS* is 0.066 and is significant at the 5% level. It

means during the post-IFRS adoption period, mandatory IFRS adopters generate about 6.6% more patents, on average, than non-IFRS adopters. This outcome is not only statistically significant, but also economically significant. In the second column when citation count is the dependent variable, the coefficient of interaction terms is 0.089 and is significant at the 1% level. It means mandatory IFRS adopters receive about 9% more citations, on average, than non-IFRS adopters during the post-IFRS period. In column (3) and (4), the coefficients of interaction terms are also positive and significant. It indicates that generality and originality scores are consistently higher for mandatory IFRS adopters as opposed to non-IFRS adopters during the post-IFRS period. Across all columns, the adjusted R-squared values are reasonably high indicating a good fit for our specification. Overall, our baseline result empirically shows that mandatory IFRS adoption facilitates innovation.

Table 3.2: Results of baseline model

This table reports the regression results of Equation (3.1). *Patent*, *Citation*, *Generality* and *Originality* are patent count, citation count, generality score and originality score computed based on data from the Orbis database. *MandatoryIFRS* is a binary variable with a value of one for mandatory IFRS adopters and zero otherwise. *PostIFRS* is a binary variable with a value of one through 2005-2009, and zero through 2001-2004. *Total Assets* is total book assets. *M/B Ratio* is market-to-book ratio. *Leverage* is total debt to assets. *ROA* is return on assets. Tangible is tangible assets scaled by total assets. *CAPEX* is capital expenditure scaled by total assets. *Insider Holdings* is the percentage of outstanding shares owned by insiders. *Analysts* is the number of financial analysts following. *Herf* and $Herf^2$ are sales based industry concentration index and its squared term. *GDP per Capita* is the logarithm of GDP per capita. *Market/GDP* is total stock market capitalization scaled by total GDP. The sample period is 2001-2009. Sample countries include EU countries and non-IFRS adoption countries. All regressions are estimated with firm and year fixed effects. Robust standard errors in parentheses are clustered by country. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Patent	*Citation*	*Generality*	*Originality*
MandatoryIFRS × PostIFRS	0.066**	0.089***	0.018***	0.007***
	(0.031)	(0.032)	(0.005)	(0.002)
Total Assets	0.023***	0.009*	0.001	0.002**
	(0.005)	(0.004)	(0.001)	(0.001)
M/B Ratio	0.002*	0.002***	0.000***	0.001***
	(0.001)	(0.000)	(0.000)	(0.000)
Leverage	0.011	0.000	-0.001***	-0.002***
	(0.009)	(0.005)	(0.000)	(0.001)
ROA	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Tangible	0.022	0.016	0.004	0.004*
	(0.017)	(0.017)	(0.003)	(0.002)
CAPEX	-0.051	-0.003	-0.002	-0.003
	(0.042)	(0.017)	(0.004)	(0.002)
Insider Holdings	0.005	0.003	0.000	-0.000
	(0.008)	(0.005)	(0.001)	(0.000)
Analysts	0.001	-0.001	-0.001**	0.000*
	(0.003)	(0.003)	(0.000)	(0.000)
Herf	-0.052	-0.067	-0.019	-0.001
	(0.185)	(0.116)	(0.021)	(0.012)
$Herf^2$	0.060	0.064	0.017	0.004
	(0.147)	(0.095)	(0.018)	(0.011)
GDP per Capita	0.776***	0.328***	0.061***	0.032***
	(0.188)	(0.099)	(0.016)	(0.009)
Market/GDP	-0.001*	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-7.575***	-3.314***	-0.617***	-0.309***
	(1.829)	(1.021)	(0.160)	(0.082)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	111,738	111,738	111,738	111,738
Adj R^2	0.826	0.796	0.434	0.605

3.3.3. **Dynamics**

A critical assumption of the DiD approach is parallel trends in the treatment and control groups before the event. Therefore, we introduce a dynamic model to verify this assumption by investigating whether there was an existing difference of innovation between mandatory IFRS adopters and non-IFRS adopters before 2005. The dynamic model is:

$$Innovation_{i,t} = \alpha + \beta_1 MandatoryIFRS_i \times Before_{1-2} + \beta_2 MandatoryIFRS_i \times Transition + \beta_3 MandatoryIFRS_i \times After_{1-2} + \beta_4 MandatoryIFRS_i \times After_{3-4} + \sum \gamma \times Ctrls_t + \mu_i + \tau_t + \epsilon \quad (3.2)$$

In this dynamic model, we use contemporaneous innovation measures ($Innovation_{i,t}$) as the dependent variable. We further divide the sample period into smaller sub-periods. $Before_{1-2}$ is a binary variable indicating one and two years before IFRS adoption (2003-2004). $Transition$ is a binary variable indicating the year of adoption (2005). $After_{1-2}$ and $After_{3-4}$ are also binary variables indicating one and two years after adoption (2006-2007) and three and four years after adoption (2008-2009) respectively. Other control variables and fixed effects are the same as in the baseline regression.

Table 3.3 reports the results of the dynamic model. In the first column, we find the coefficient (β_1) of $MandatoryIFRS_i \times Before_{1-2}$ is not significant. Similarly in other columns, $\beta_1$is not significant either. Therefore, there is no evidence showing that there was an existing difference of innovation between the treatment and control group before IFRS adoption. The assumption of DiD is not violated. We also observe that throughout the sub-periods after IFRS adoption, only the coefficient (β_4) of $MandatoryIFRS_i \times After_{3-4}$ becomes positive and significant in most columns. Column (3) is an exception as β_3 is significant at the 10% level. It means that

mandatory IFRS adopters become more innovative compared to non-IFRS adopters from about three to four years after the adoption. This finding is consistent with our prior conjecture that it may take time for firms to adjust their operations in response to policy changes. It is also consistent with the long-term nature of innovation discussed before.

Table 3.3: Results of dynamic model

This table reports the regression results of the dynamic model specified by Equation (3.2). *Patent, Citation, Generality* and *Originality* are patent count, citation count, generality score and originality score computed based on data from the Orbis database. *MandatoryIFRS* is a binary variable with a value of one for mandatory IFRS adopters and zero otherwise. $Before_{1-2}$, *Transition*, $After_{1-2}$, and $After_{3-4}$ are binary variables indicating sub-periods of 2003-2004, 2005, 2006-2007 and 2008-2009 respectively. The sample period is 2001-2009. Sample countries include EU countries and non-IFRS adoption countries. All other firm-, industry- and country-level control variables are the same as in Table 3.2. All regressions are estimated with firm and year fixed effects. Robust standard errors in parentheses are clustered by country. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Patent	*Citation*	*Generality*	*Originality*
Mandatory IFRS × $Before_{1-2}$	-0.020	-0.004	-0.001	-0.000
	(0.026)	(0.009)	(0.002)	(0.002)
Mandatory IFRS × *Transition*	-0.032	-0.001	0.005	-0.000
	(0.042)	(0.029)	(0.005)	(0.003)
Mandatory IFRS × $After_{1-2}$	-0.035	0.009	0.010*	-0.000
	(0.031)	(0.027)	(0.005)	(0.002)
Mandatory IFRS × $After_{3-4}$	0.066***	0.080**	0.021***	0.005**
	(0.020)	(0.035)	(0.007)	(0.003)
Firm-level Controls	Yes	Yes	Yes	Yes
Industry-level Controls	Yes	Yes	Yes	Yes
Country-level Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	112,011	112,011	112,011	112,011
Adj R^2	0.836	0.839	0.490	0.609

3.3.4. **Robustness Tests**

We conduct a number of robustness tests to see whether our finding is driven by other factors.

3.3.4.1. Extending the Year Gap

In our baseline regression, we use innovation measures in year $t + 2$. So the first robustness test is to extend the year gap between current financial variables and future innovation measures to see if the result is affected. We repeat regression of Equation (3.1) by increasing the year gap between financial variables and innovation measures to three or five years[22]. In Table 3.4, we report results using a five-year gap. In all four columns, the coefficients of interaction terms (*MandatoryIFRS* × *PostIFRS*) remain positive and significant, which suggests that mandatory IFRS adopters still produce more innovation than GAAP firms after 2005 if we match the current period's financial variables with innovation measures in five years' time. For simplicity, we do not tabulate the result of the three-year gap because the result is statistically the same. Therefore, our finding is not sensitive to the choice of year gap.

[22] When we set the year gap at five, financial variables for 2009, which is the last year of our sample period, are matched with innovation measures for 2014 which is the most recent year of available information in the Orbis database. If we further prolong the year gap, many observations will be lost as there are no matchable innovation measures. In addition, we may misalign the timing of innovation if the year gap is set too long, such as allocating innovations which happened during the post-IFRS adoption period into the pre-IFRS adoption period. Therefore, we only extend the year gap up to five years.

Table 3.4: Robustness test for extending year gap

This table reports the regression results repeating Equation (3.1) by replacing innovation measures in *t*+2 with *t*+5. *Patent, Citation, Generality* and *Originality* are patent count, citation count, generality score and originality score computed based on data from the Orbis database. *MandatoryIFRS* is a binary variable with a value of one for mandatory IFRS adopters and zero otherwise. *PostIFRS* is a binary variable with a value of one through 2005-2009, and zero through 2001-2004. The sample period is 2001-2009. Sample countries include EU countries and non-IFRS adoption countries. All other firm-, industry- and country-level control variables are the same as in Table 3.2. All regressions are estimated with firm and year fixed effects. Robust standard errors in parentheses are clustered by country. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Patent	*Citation*	*Generality*	*Originality*
MandatoryIFRS × *PostIFRS*	0.127***	0.124**	0.017***	0.023***
	(0.037)	(0.053)	(0.006)	(0.007)
Firm-level Controls	Yes	Yes	Yes	Yes
Industry-level Controls	Yes	Yes	Yes	Yes
Country-level Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	111,473	111,473	111,473	111,473
Adj R^2	0.685	0.559	0.283	0.484

3.3.4.2.Including Voluntary IFRS Adopters

Our treatment countries are all EU countries. This may cause a concern that our finding is due to other policy changes within the EU, such as changes in monetary policy, instead of mandatory IFRS adoption. A possible consequence of this conjecture is that all types of firms, no matter mandatory IFRS adopters or voluntary IFRS adopters in the EU will benefit from these policy changes. Because we exclude voluntary IFRS adopters, which switched to IFRS before 2005 EC Regulation, in our main analysis, we now include them in this robustness test.

Accordingly, we modify Equation (3.1) by including an additional interaction term as shown below:

$$Innovation_{i,t+2} = \alpha + \beta_1 MandatoryIFRS_i \times PostIFRS_t + \beta_2 VoluntaryIFRS_i \times PostIFRS_t + \sum \gamma \times Ctrls_t + \mu_i + \tau_t + \epsilon \quad (3.3)$$

$VoluntaryIFRS_i$ is a binary variable indicating voluntary IFRS adopters in the EU countries. All other variables in Equation (3.3) are exactly the same as those in Equation (3.1). If other policy changes rather than mandatory IFRS adoption drives our results in the main analysis, we expect to see significant β_1 as well as significant β_2. Both coefficients are expected to be positive.

Table 3.5 reports the results of Equation (3.3). Clearly only $\beta_1$is positive and significant in every column, while β_2 is insignificant in all specifications. We do not discover significant improvement of innovation among voluntary IFRS adopters after 2005 compared to non-IFRS adopters. So it is unlikely that our results are driven by other major policy changes within the EU instead of the mandatory IFRS adoption.

Table 3.5: Robustness test for including voluntary IFRS adopters

This table reports the regression results of Equation (3.3). Pa*tent, Citation, Generality* and *Originality* are patent count, citation count, generality score and originality score computed based on data from the Orbis database. *MandatoryIFRS* is a binary variable with a value of one for mandatory IFRS adopters and zero otherwise. *VoluntaryIFRS* is a binary variable with a value of one for voluntary IFRS adopters and zero otherwise. *PostIFRS* is a binary variable with a value of one through 2005-2009, and zero through 2001-2004. The sample period is 2001-2009. Sample countries include EU countries and non-IFRS adoption countries. All other firm-, industry- and country-level control variables are the same as those in Table 3.2. All regressions are estimated with firm and year fixed effects. Robust standard errors in parentheses are clustered by country. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Patent	*Citation*	*Generality*	*Originality*
MandatoryIFRS × *PostIFRS*	0.066**	0.089***	0.018***	0.006***
	(0.031)	(0.032)	(0.005)	(0.002)
VoluntaryIFRS × *PostIFRS*	0.016	0.026	0.004	0.001
	(0.040)	(0.038)	(0.007)	(0.003)
Firm-level Controls	Yes	Yes	Yes	Yes
Industry-level Controls	Yes	Yes	Yes	Yes
Country-level Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	115,732	115,732	115,732	115,732
Adj R^2	0.828	0.795	0.431	0.604

3.3.4.3.Excluding Countries Bundling IFRS and Enforcement Change

Another concern is that innovation improvement in the EU countries is not solely driven by mandatory IFRS adoption. Christensen, Hail, and Leuz (2013) argue bundling mandatory IFRS adoption with substantive changes of accounting regulation enforcement in a few EU countries are the reason behind the observed increase in liquidity. They attribute the consequent capital market effect following mandatory IFRS adoption mainly to stricter regulation enforcement. To investigate this possibility, we downsize our treatment sample by excluding firms from the six EU countries of Finland, Germany, the Netherlands, Norway, the UK and Iceland which bundled mandatory IFRS adoption with enforcement changes. Other non-IFRS countries are still kept as the control group. If our original results are mainly driven by policy bundling, we may not observe significant differences, in terms of innovation, between IFRS adopters in the remaining EU countries and GAAP firms in non-IFRS adoption countries.

Table 3.6 reports the results of Equation (3.1) based on the reduced sample. We can see that the coefficient of interaction term is still positive and significant in every column. Considering Germany, the Netherlands, and the UK are top innovative countries in the EU, we do not find evidence that our result is driven by bundling mandatory IFRS adoption with change of enforcement[23].

[23] We repeat this robustness test by further excluding Sweden which implemented enforcement change in 2007, and the result is statistically unchanged.

Table 3.6: Robustness test for excluding policy bundling EU countries

This table reports the regression results of Equation (3.1) by excluding the six EU countries of Finland, Germany, the Netherlands, Norway, the UK and Iceland which bundled mandatory IFRS adoption with change of accounting regulation enforcement. *Patent, Citation, Generality* and *Originality* are patent count, citation count, generality score and originality score computed based on data from the Orbis database. *MandatoryIFRS* is a binary variable with a value of one for mandatory IFRS adopters and zero otherwise. *PostIFRS* is a binary variable with a value of one through 2005-2009, and zero through 2001-2004. The sample period is 2001-2009. Sample countries include EU countries (excluding five bundling countries) and non-IFRS adoption countries. All other firm-, industry- and country-level control variables are the same as those in Table 3.2. All regressions are estimated with firm and year fixed effects. Robust standard errors in parentheses are clustered by country. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Patent	*Citation*	*Generality*	*Originality*
MandatoryIFRS × *PostIFRS*	0.078**	0.097***	0.019***	0.008***
	(0.033)	(0.030)	(0.005)	(0.002)
Firm-level Controls	Yes	Yes	Yes	Yes
Industry-level Controls	Yes	Yes	Yes	Yes
Country-level Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	102,171	102,171	102,171	102,171
Adj R^2	0.824	0.795	0.436	0.609

3.3.4.4.Including Mandatory IFRS Adopters outside of the EU

We further investigate whether the impact of mandatory IFRS adoption on innovation is limited to within the EU. Member countries of the EU share much commonality such as a single market and united monetary policy. These countries are also very geographically close enabling easy cross-border labour and knowledge flow. These factors may, explicitly or implicitly, improve the productivity of EU countries thus making them more likely to benefit from the uniformity of accounting standard. To address this concern, we expand the treatment group in a different way by including mandatory IFRS adopters from other non-EU IFRS adoption countries, namely Australia, South Africa, Philippines and Switzerland. These countries also started mandatory IFRS adoption since 2005. These countries are diversified in their economic development and geographic locations.

There is another purpose to include non-EU IFRS adoption countries. The baseline result may be biased by better innovation data coverage within the EU because the ultimate source of data is from the EPO. If EU mandatory IFRS adopters outperform non-IFRS adopters only due to data bias, we may not observe an obvious difference between non-EU IFRS adopters and non-IFRS adopters.

Accordingly, we modify Equation (3.1) by introducing an additional variable as below:

$$Innovation_{i,t+2} = \alpha + \beta_1 MandatoryIFRS_i \times PostIFRS_t + \beta_2 MandatoryIFRS_i \times PostIFRS_t \times EUCtry_c + \sum \gamma \times Ctrls_t + \mu_i + \tau_t + \epsilon \quad (3.4)$$

EUCtry is a binary variable indicating country *c* from the EU (with value one) or otherwise (with value zero). Therefore, the benchmark group is still local GAAP firms in non-IFRS adoption countries. The coefficient β_1 indicates the difference of

innovation between mandatory IFRS adopters in non-EU countries and benchmark countries. The coefficient β_2 indicates the marginal increase of innovation of mandatory IFRS adopters in the EU in additional to IFRS adopters in non-EU countries.

Table 3.7 reports the results of Equation (3.4). We find that the coefficient (β_1) of *MandatoryIFRS* × *PostIFRS* is positive and significant in every column. This means non-EU mandatory IFRS adopters also experienced improvement of innovation during the post-IFRS period compared to non-IFRS adopters. Noticeably, none of the coefficient (β_2) of *MandatoryIFRS* × *PostIFRS* × *EUCtry* is significant in any column. This indicates that mandatory IFRS adopters in the EU do not exhibit any marginal improvement on top of IFRS adopters in non-EU countries. Our finding does not support the conjecture that the improvement of innovation by mandatory IFRS adoption is limited to within the EU[24]. Therefore, it is unlikely that our main result is biased by better innovation data coverage in Europe.

To sum up, based on results from our baseline model, dynamic model and a variety of robustness tests, we find a positive effect of mandatory IFRS adoption on corporate innovation.

[24] Because Switzerland is geographically a European country, we repeat similar analysis but exclude Switzerland. The result is statistically the same.

Table 3.7: Robustness test for including mandatory IFRS adopters in non-EU countries

This table reports the regression results of Equation (3.4) by including non-EU mandatory IFRS adopters in Australia, South Africa, Philippines and Switzerland. *Patent, Citation, Generality* and *Originality* are patent count, citation count, generality score and originality score computed based on data from the Orbis database. *MandatoryIFRS* is a binary variable with a value of one for mandatory IFRS adopters and zero otherwise. *PostIFRS* is a binary variable with a value of one through 2005-2009, and zero through 2001-2004. *EUCtry* is a binary variable with a value of one for EU countries and zero otherwise. The sample period is 2001-2009. Sample countries include EU countries and non-IFRS adoption countries, and non-EU IFRS adoption countries. All other firm-, industry- and country-level control variables are the same as those in Table 3.2. All regressions are estimated with firm and year fixed effects. Robust standard errors in parentheses are clustered by country. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Patent	*Citation*	*Generality*	*Originality*
MandatoryIFRS × *PostIFRS*	0.088**	0.088***	0.018***	0.007***
	(0.034)	(0.025)	(0.004)	(0.002)
MandatoryIFRS × *PostIFRS*×*EUCtry*	-0.021	0.001	0.000	-0.001
	(0.012)	(0.015)	(0.003)	(0.002)
Firm-level Controls	Yes	Yes	Yes	Yes
Industry-level Controls	Yes	Yes	Yes	Yes
Country-level Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	121,127	121,127	121,127	121,127
Adj R^2	0.827	0.797	0.434	0.605

3.3.5. **Country-level institutions**

IFRS aims to harmonize accounting rules around the world; however, the principle-based nature of IFRS allows managers considerable flexibility in implementation (DeFond et al., 2011). The quality of IFRS adoption is subject to a range of factors. Bushman and Piotroski (2006) highlight that financial reporting incentives are shaped by a country's institutional structure and they find evidence that bad news is more quickly reflected in accounting figures in countries with stronger investor protection and more efficient law system. Burgstahler, Hail, and Leuz (2006) find that high quality of legal institution alleviates earnings manipulation which is a type of discretion afforded by accounting rules. Ball, Robin, and Wu (2003) show that a high-quality accounting standard does not necessary guarantee high-quality financial reporting if legal institutions are weak. Daske et al. (2008) and Li (2010) document that the capital market effects of mandatory IFRS adoption are stronger in countries with stronger legal institutions. Other IFRS studies also emphasize the importance of country-level institutions to IFRS adoption (such as DeFond et al., 2011; Florou and Pope, 2012; Yip and Young, 2012). Therefore, we conduct an additional analysis exploring the heterogeneity of mandatory IFRS adoption in a context of corporation innovation, by taking country-level institutions into account.

We first employ the anti-self-dealing index from Djankov et al. (2008) as a proxy for country-level institutions. This index captures the core issue of corporate governance – outside investor protection. Strong investor protection imposes a powerful monitoring force on managers, thus reduceing the possibility of financial information manipulation and other misbehaviors. We expand Equation (3.1) to accommodate country-level institutions as below:

$$Innovation_{i,t+2} = \alpha + \beta_1 MandatoryIFRS_i \times PostIFRS + \beta_2 PostIFRS \times Antiself_c$$
$$+\beta_3 MandatoryIFRS_i \times PostIFRS \times Antiself_c$$
$$+\sum \gamma \times Ctrls_t + \mu_i + \tau_t + \epsilon \quad (3.5)$$

$Antiself_c$ is a binary variable with value one (zero) for countries whose anti-self-dealing index is above (below) the sample median including both sample EU countries and other non-IFRS adoption countries. Therefore, the variable of interest now is the triple interaction term (β_3). It evaluates the marginal effect of innovation for mandatory adopters during the post-IFRS periods in response to different levels of institutional quality. All other variables are the same as in the baseline model.

Table 3.8 presents the results. From the results, we can see that the coefficient of the triple interaction term (*MandatoryIFRS* × *PostIFRS* × *Antiself*) is positive and significant in all four columns. Therefore, the positive effect of mandatory IFRS adoption on innovation is more prominent in countries with stronger investor protection.

To confirm this result, we also employ alternative proxies for institutional quality. We use the disclosure index and liability index from La Porta, Lopez-De-Silanes, and Shleifer (2006). These two indices capture the quality of security law and the strength of enforcement, both of which are also directly related to information disclosure and investor protection. Another proxy used is the rule of law index from Kaufmann, Kraay, and Mastruzzi (2009). This index is a comprehensive measure of jurisdiction system quality. Each of the above three indices is transformed into binary values relative to the sample median similar to the anti-self-dealing index. We repeat Equation (3.5) by replacing $Antiself_c$ with each of three indices respectively. In untabulated results, we find consistent evidence that country-level institutional quality strengthens the positive effect of mandatory IFRS adoption on corporate innovation. Our finding is consistent with prior literature.

Table 3.8: Country institutional quality, IFRS and innovation

This table reports the regression results of Equation (3.5). *Patent, Citation, Generality* and *Originality* are patent count, citation count, generality score and originality score computed based on data from the Orbis database. *MandatoryIFRS* is a binary variable with a value of one for mandatory IFRS adopters and zero otherwise. *PostIFRS* is a binary variable with a value of one through 2005-2009, and zero through 2001-2004. *Antiself* is a binary variable indicating whether a country's anti-self-dealing index is above or below the sample median. The sample period is 2001-2009. Sample countries include EU countries and non-IFRS adoption countries. All other firm-, industry- and country-level control variables are the same as those in Table 3.2. All regressions are estimated with firm and year fixed effects. Robust standard errors in parentheses are clustered by country. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Patent	*Citation*	*Generality*	*Originality*
MandatoryIFRS × *PostIFRS*	-0.046	-0.016	-0.003	-0.005**
	(0.038)	(0.020)	(0.003)	(0.002)
PostIFRS × *Antiself*	-0.112**	-0.095***	-0.020***	-0.012***
	(0.048)	(0.031)	(0.005)	(0.002)
MandatoryIFRS × *PostIFRS* × *Antiself*	0.114**	0.126***	0.024***	0.010***
	(0.048)	(0.035)	(0.006)	(0.003)
Firm-level Controls	Yes	Yes	Yes	Yes
Industry-level Controls	Yes	Yes	Yes	Yes
Country-level Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	111,738	111,738	111,738	111,738
Adj R^2	0.826	0.797	0.434	0.605

3.4. Underlying Channels

In this section, we discuss possible underlying channels through which mandatory IFRS adoption facilitates corporate innovation. We hypothesize two channels: one is reduced cost of capital and the other is increased institutional investor holdings. Some supporting evidence is provided accordingly.

3.4.1. **Reduced Cost of Capital**

According to the literature, IFRS reduces cost of capital for at least two reasons. Firstly, IFRS enhances financial disclosure because IFRS generally requires more disclosure than local accounting rules (Ashbaugh and Pincus, 2001). Enhanced disclosure helps lower the cost of capital by mitigating information asymmetry (Diamond and Verrecchia, 1991) or by lowering systematic risk (Barry and Brown, 1985; Lambert, Leuz, and Verrecchia, 2007). Secondly, adoption of IFRS increases cross-border comparability of financial information (DeFond et al., 2011; Yip and Young; 2012). Chan, Covrig, and Ng (2005) and Covrig, DeFond, and Hung (2007) argue that the cost of acquiring and processing information, particularly faced by foreign investors, is reduced as a consequence of IFRS. De Franco, Kothari, and Verdi (2011) find that analyst following and the accuracy of forecasts are positively correlated with accounting information comparability. Therefore, it is reasonable to expect a drop in the cost of capital when the information cost is lowered. Indeed, Daske et al. (2008) and Li (2010) provide evidence that the cost of capital is reduced following mandatory IFRS adoption.

We can make a logic inference hypothesizing that reduced cost of capital is a possible underlying channel through which mandatory IFRS adoption facilitates innovating. Brown, Fazzari, and Petersen (2009) argue that innovative firms are more

likely to be subject to capital constraints thus relying on external financing. Brown, Martinsson, and Petersen (2012), Brown, Martinsson, and Petersen (2013) and Hsu, Tian, and Xu (2014) all empirically document that increased availability of external finance promotes corporate innovation. As lowering the cost of capital generally makes it cheaper and easier for financially constrained firms to obtain external financing, we conjecture that reduced cost of capital is a way to improve innovation.

To test this hypothesis, we rely on an exogenous variable, dependence on external finance. Dependence on external finance is an inherent firm characteristic thus is unlikely to be affected by IFRS adoption. Our logic is that if mandatory IFRS adoption facilitates innovation through reduced cost of capital, then firms which are more dependent on external finance should experience a disproportionally higher increase in innovation following mandatory IFRS adoption. In their seminal work, Rajan and Zingales (1998) argue that there are technological reasons for some industries to be more dependent on external finance and such technological differences persist across countries. Rajan and Zingales' approach has been widely used in the literature (such as Gupta and Yuan, 2009; Brown, Martinsson, and Petersen, 2013; Hsu, Tian, and Xu, 2014). The original Rajan and Zingales dependence on external finance is defined as the portion of capital expenditure not internally generated. Brown, Martinsson, and Petersen (2013) propose a modified version of dependence on external finance by dividing the amount of capital expenditure not funded by operational cash flow over the total amount of capital expenditure plus R&D costs. They argue this modification more realistically reflects the degree of external finance reliance particularly for innovative firms. Hence, we follow Brown, Martinsson, and Petersen's (2013) method to calculate dependence on external finance for each two-digit SIC industry using US data from the

Compustat database. We compute dependence on external finance over 1990-1999, as an initial condition outside of our sample period. We use the following Equation:

$$Innovation_{i,t+2} = \alpha + \beta_1 MandatoryIFRS_i \times PostIFRS + \beta_2 PostIFRS \times DepFin_j + \beta_3 MandatoryIFRS_i \times PostIFRS \times DepFin_j + \sum \gamma \times Ctrls_t + \mu_i + \tau_t + \epsilon \quad (3.6)$$

where $DepFin_j$ is the value of dependence on external finance of industry j. All other variables are the same as in Equation (3.1). According to our hypothesis, the coefficient (β_3) of triple interaction term is expected to be positive and significant. The sample includes both EU countries and non-IFRS adoption countries except for the US, because the value of dependence on external finance is constructed using US data.

We report the result in Table 3.9. As expected, β_3 is significant at the 1% level in the first three columns when the dependent variable is patent, citation and generality score, but is insignificant in the last column of originality score. The empirical evidence in general supports our hypothesis that industries more reliant on external finance experience a disproportional increase in innovation following mandatory IFRS adoption. Therefore, reduced cost of capital is a possible channel through which mandatory IFRS adoption motivates corporate innovation.

Table 3.9: Reduced cost of capital, mandatory IFRS adoption and innovation

This table reports the regression results of Equation (3.6). *Patent, Citation, Generality* and *Originality* are patent count, citation count, generality score and originality score computed based on data from the Orbis database. *MandatoryIFRS* is a binary variable with a value of one for mandatory IFRS adopters and zero otherwise. *PostIFRS* is a binary variable with a value of one through 2005-2009, and zero through 2001-2004. *DepFin* is the value of dependence on external finance for each industry calculated with US data. The sample period is 2001-2009. Sample countries include EU countries and non-IFRS adoption countries, but exclude the US. All other firm-, industry- and country-level control variables are the same as those in Table 3.2. All regressions are estimated with firm and year fixed effects. Robust standard errors in parentheses are clustered by country. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Patent	*Citation*	*Generality*	*Originality*
MandatoryIFRS × *PostIFRS*	0.081*	0.034*	0.007**	0.007*
	(0.040)	(0.017)	(0.003)	(0.003)
PostIFRS × *DepFin*	-0.066***	-0.032***	-0.008***	-0.004**
	(0.010)	(0.010)	(0.002)	(0.002)
MandatoryIFRS × *PostIFRS* × *DepFin*	0.049***	0.031***	0.007***	0.003
	(0.015)	(0.011)	(0.002)	(0.002)
Firm-level Controls	Yes	Yes	Yes	Yes
Industry-level Controls	Yes	Yes	Yes	Yes
Country-level Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	79,397	79,397	79,397	79,397
Adj R^2	0.767	0.680	0.314	0.507

3.4.2. **Increased Institutional Investor Holdings**

Recent accounting literature documents noticeable impacts of IFRS adoption on stock holdings of institutional investors. Bradshaw, Bushee, and Miller (2004) first document that institutional investors change their stock holdings in response to firm-level accounting choices. Covrig, DeFond, and Hung (2007) find that stock holdings of foreign mutual funds increase when non-US firms voluntarily adopt IFRS. DeFond et al. (2011) find a similar increase in foreign mutual fund stock ownership in the EU following mandatory IFRS adoption. Florou and Pope (2012) find evidence that stock holdings of both domestic and foreign institutional investors in EU firms become higher after mandatory IFRS adoption, and the increase is driven by active (value and growth) investors rather than passive (index and income) investors.

Regarding the relationship between institutional ownership and innovation, the most direct evidence is Aghion, Van Reenen, and Zingales (2013) who theoretically and empirically show that larger institutional ownership is positively associated with corporate innovation. Bushee (1998) holds a similar view that the existence of sophisticated institutional investors restrains myopic investment decisions such as cutting R&D to boost short-term profitability. There are other studies identifying particular types of institutional investors, such as corporate venture capital shown by Chemmanur, Loutskina, and Tian (2014), could foster innovation. Therefore, by combining the two strands of literature we can logically conjecture that increased institutional holdings is another possible channel through which mandatory IFRS adoption could improve corporate innovation[25].

[25] There could be a negative impact of institutional investors on corporate innovation. For example, passive investors who demand stable cash dividends may exert pressures on managers to focus on short-term profitability. Innovation may be suppressed in this case due to its long-term and risky nature. Bushee (1998) finds if the ownership of momentum trading institutional investors is extremely high, it is more likely to observe myopic R&D investment. However, the increased holdings of value and growth

Unlike the dependence on external finance, it is difficult to assert which type of industries benefit most from the increased institutional holdings. Aghion, Van Reenen, and Zingales (2013) argue their evidence is more consistent with "career risk" theory, meaning that the existence of institutional investors alleviates managers' career concern because managers are less likely to be fired if they launch innovative projects defined by high probabilities of failure. Manso (2011) similarly proposes that failure tolerance is important by giving managers enough incentives to take on innovative projects. Generally, managers in industries with higher operational risk are more likely to be subject to greater career risk. They may prefer conservative projects generating stable profits rather than pursuing risky innovation projects. Therefore, we hypothesize that firms from industries with greater operational risk may experience a larger increase in innovation due to bigger institutional holdings after mandatory IFRS adoption. As a proxy for operational risk, we calculate five-year industry median ROA volatility from 1995-1999 using US data[26] for every two-digit SIC industry. We repeat Equation (3.6) by replacing dependence on external finance with ROA volatility. All countries except for the US are used in the analysis. One concern is that risky industries may generate insufficient internal funds, thus are more dependent on external finance as well. To alleviate this concern, we test the Pearson correlation between these two variables and find they are not significantly correlated (coefficient = 0.18, p-value = 0.19). So ROA volatility captures another characteristic of industries.

investors in Florou and Pope (2012) should be more likely to discipline managers and reduce myopic behaviors.

[26] Similar to dependence on external finance, we assume there are persistent reasons around the world for some industries to be more risky than others. Particularly in an era of globalization, economy and technology shocks would spread worldwide quickly. In addition, most countries in the sample are developed countries, and are closely related to the US market. Therefore, using US data as a proxy for industry risk is a reasonable, although not perfect, choice.

Table 3.10: Increased institutional holdings, mandatory IFRS adoption and innovation

This table reports the regression results of Equation (3.6) by replacing dependence on external finance with ROA volatility. Patent, Citation, Generality and Originality are patent count, citation count, generality score and originality score computed based on data from the Orbis database. *MandatoryIFRS* is a binary variable with a value of one for mandatory IFRS adopters and zero otherwise. *PostIFRS* is a binary variable with a value of one through 2005-2009, and zero through 2001-2004. *ROAVol* is the value of ROA volatility for each industry calculated with US data. The sample period is 2001-2009. Sample countries include EU countries and non-IFRS adoption countries, but exclude the US. All other firm-, industry- and country-level control variables are the same as those in Table 3.2. All regressions are estimated with firm and year fixed effects. Robust standard errors in parentheses are clustered by country. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Patent	*Citation*	*Generality*	*Originality*
MandatoryIFRS × *PostIFRS*	0.036	0.004	0.000	0.004
	(0.024)	(0.019)	(0.002)	(0.004)
PostIFRS × *ROAVol*	-1.278***	-0.719**	-0.214***	-0.031
	(0.390)	(0.346)	(0.059)	(0.034)
MandatoryIFRS × *PostIFRS* × *ROAVol*	1.092**	0.668*	0.188***	0.014
	(0.466)	(0.373)	(0.065)	(0.050)
Firm-level Controls	Yes	Yes	Yes	Yes
Industry-level Controls	Yes	Yes	Yes	Yes
Country-level Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	79,768	79,768	79,768	79,768
Adj R^2	0.778	0.736	0.349	0.518

Table 3.10 presents the result of ROA volatility. The coefficient of *MandatoryIFRS* × *PostIFRS* × *ROAVol* is positive and significant at the 5% level in the first column. It is also positive and significant at the 10% and 1% level in the second and third column respectively, but is insignificant in the last column of originality score. This result is generally consistent with our hypothesis that risky industries benefit more from increased institutional holdings.

As a robustness check, an alternative proxy for risk is employed. We compute the percentage of R&D expense to annual revenue based on the US industry median over the 1990s. Industries with high R&D expenditure percentages are considered to be high-tech industries and thus are more risky. Repeating the above analysis using the alternative proxy, we find a very similar result which means that the innovation performance of risky high-tech industries increases more than other industries in the EU following mandatory IFRS adoption.

To sum up, reduced cost of capital and increased institutional holdings are two logically valid channels through which mandatory IFRS adoption facilitates corporate innovation. Our empirical results support these hypotheses.

3.5. Conclusion

In this chapter, we investigate the real effect of mandatory IFRS adoption from a unique perspective of corporate innovation. Using firm-level innovation data for a large number of mandatory IFRS adopters from 18 EU countries and local GAAP firms from 12 non-IFRS adoption countries over a period of 2001-2009, we document the positive effect of mandatory IFRS adoption on corporate innovation.

Our finding is valid to a range of robustness tests, including enlarging the year gap between innovation data and financial data, incorporating different types of firms in the EU, excluding policy bundling EU countries, and including mandatory IFRS

adopters from non-EU countries. We also find the positive effect of mandatory IFRS adoption on corporate innovation is stronger in countries with higher institutional quality. In the last part of the chapter, we hypothesize that reduced cost of capital and increased institutional holdings are two possible channels through which mandatory IFRS adoption facilitates corporate innovation. Using exogenously generated variables of dependence on external finance and operational risk, we provide empirical evidence supporting the validity of these two channels.

This chapter provides the first piece of empirical evidence showing the operational adjustments by mandatory IFRS adopters. Our finding implies a potentially pronounced and long-lasting impact of mandatory IFRS adoption on the real economy.

Chapter 4.

Institutional Environment and Dividend Cash-flow Sensitivity

4.1. Introduction

The dividend literature has identified that payout policy is related to firm-level attributes such as profitability, growth, earned/contributed equity mix and cash-flow risk (see for example, Denis and Osobov, 2008; Chay and Suh, 2009; von Eije and Megginson, 2008). Among these characteristics, cash-flow risk attracts relatively less attention although its critical role in shaping the payout policy has been implied by prior literature. Lintner's (1956) survey is probably the first one highlighting the conservativeness of dividend policy considering cash-flow risk. Jagannathan, Stephens, and Weisbach (2000) argue that firms generating larger operational cash flow are more likely to pay dividend. They also find that firms usually evaluate future cash-flow uncertainty before deciding the format of payout, which is normal dividend or share repurchase. In a more recent survey, Brav et al. (2005) show that even CFOs in the 21st century still rank future cash-flow stability a main concern of dividend policy. This phenomenon is consistent with dividend signalling theory as well. Because once a firm initiates dividend payment, it would be deemed as a very negative signal by the markets if the firm consequently reduces the payout ratio due to insufficient cash (Bhattacharya, 1979; Miller and Rock, 1985). In order to avoid such a situation, high cash-flow risk firms would rather not to pay dividends or keep the payout ratio low in the first place.

Chay and Suh's (2009) paper is the first study empirically proving the negative relationship between dividend policy and cash-flow uncertainty. In an international sample and utilizing stock return volatility (SRVOL) as a proxy for cash-flow uncertainty, they document that the probability of paying dividends as well as the payout ratio is negatively responsive to a firm's cash-flow uncertainty. The negative relationship between dividend and cash-flow uncertainty prevails in most of their sample countries. However, their results exhibit another interesting feature: the strength

of the negative association between dividend and stock return volatility varies significantly among countries. For example, their results show a significantly negative relationship between dividend and cash-flow uncertainty in developed countries, while the dividend cash-flow sensitivity is insignificant for some emerging countries (for instance see the coefficients of China and Portugal in their Table 6). We also notice the difference in the magnitude of coefficients. One example is that the coefficient of SRVOL for the US (see their Table 4 Panel A) is -7.07, while the coefficients of SRVOL for Turkey and Greece are -0.91 and -0.82 respectively in their Table 6. The heterogeneity of coefficients indicates that the payout policy of firms in some countries such as China and Turkey is not as responsive to stock return volatility as those of firms from countries such as the US This phenomenon indicates a question: why does the strength of the negative relationship between dividends and cash-flow uncertainty vary between developed and emerging markets?

One possible explanation is from the perspective of information content: return volatility in some countries may not truly nor fully reflect the real firm-specific cash-flow risk. Prior literature shows the country-level institutional environment, such as information transparency, investor protection and corruption, can affect the informativeness of stock price. For instance, Morck, Yeung, and Yu (2000) find that stock price in emerging markets exhibits more synchronous movements, so that return volatility is more likely due to market-wide news such as political events or rumors, instead of firm-specific news. Their evidence associates the lack of capitalization of firm-specific information in emerging markets with poor institutional environment, including the presence of corruption and insufficiency of investor protection. Bushman, Piotroski, and Smith (2004) examine financial reporting, auditing quality and information transmission, and find that stock return reflects more firm-specific

information in countries with better information transparency. Jin and Myers (2006) argue that the information opaqueness, coupled with insufficient investor protection, makes it easier for insiders to manipulate cash-flow distribution thus expropriate outside investors, so outsiders may not be able to perceive enough information about firm-specific risk. They also point out that information transparency and investor protection are mutually reinforcing. Information transparency helps investors gain better knowledge of firm performance, and reciprocally strong investor protection reduces managers' opportunity for concealing information. In addition, government actions may affect market competitions, which in turn can vary the information contents of return volatility. Irvine and Pontiff (2009) document that if government encourages market competition, idiosyncratic return volatility will increase correspondingly, thus improving stock price informativeness. So at country-level, whether the volatility of individual stock return accurately represents firm-specific cash-flow uncertainty is contingent on the overall institutional environment of that country. When price movements are mostly caused by non-firm-specific news, the connection between an individual firm's dividend policy and its return volatility is likely to be weak.

There could be other possible channels for institutional environment to impact dividend cash-flow sensitivity. Lending corruption in the bank system is one example. High cash-flow risk firms may still easily obtain funds from banks by bribing bank staff or government officers, especially when a country's control of corruption is weak. Illegal activities help reduce firms' cash constraints (Khwaja and Mian, 2005), enabling firms to pay generous dividends regardless of operating cash-flow risk. Extant empirical evidence implies that dividend cash-flow sensitivity could be diluted in some countries due to corruption. Beck, Demirguckunt, and Levine (2006) point out that forcing information disclosure on the banking system helps prevent lending corruption. They

further comment that this solution achieves better outcomes in countries with more efficient legal institutions. Aggarwal and Goodell (2009) find that country-level political and legal institutions are the determinants of national preferences on financial intermediations. It has also been shown that in many developing countries, political connections can impact a range of dimensions of the financial markets, including firms' investments (Cull and Xu, 2005), share valuation (Johnson and Mitton, 2003) and bailout of failing corporations (Faccio, Masulis, and McConnell, 2006). Therefore, we follow the literature conjecturing the importance of political and legal institutions in shaping dividend cash-flow sensitivity.

For the aforementioned reasons, we hypothesize that the observed heterogeneity of dividend cash-flow sensitivity in Chay and Suh (2009) is related to the difference in institutional environment across countries. Our hypothesis is that the negative association between dividend payout and stock return volatility is stronger in countries with a healthy institutional environment. Conversely, we expect weaker negative dividend cash-flow sensitivity in countries with a less robust institutional environment. We examine country-level institutional environment from several aspects including information transparency, investor protection, and legal and political institutions. We collect a range of proxy indices for institutional environment from many sources including Bushman, Piotroski, and Smith (2004), Kaufmann (2004), Kaufmann, Kraay, and Mastruzzi (2009), World Economic Forum Global Competitiveness Reports (2009-2010).

We construct a large international sample comprising 38,467 individual firms from 52 countries from 1994 to 2011. We adopt two analytical frameworks to test the interactive effects of cash-flow uncertainty and institutional environment on dividend policy. The first framework is country-level which is comprised of two stages. First of

all, we follow Chay and Suh (2009) by regressing dividend payout variables on observed stock return volatility (SRVOL). The obtained coefficients of SRVOL in this stage therefore reflect the sensitivity of dividend on cash-flow risk of each sample country. In the second stage regression, we use generated sensitivity coefficients as the dependent variables and country-level proxy indices measuring institutional environment as the independent variables. We expect country-level institutional variables could explain the heterogeneity of sensitivity coefficients.

The second analytical framework is firm-level. This framework is more comprehensive because it incorporates both firm-level variables and country-level institutional environment variables simultaneously. Doing this allows us to examine the impacts of cash-flow uncertainty, institutional environment and their interaction terms on dividend at the same time. The firm-level analysis framework also keeps many more observations than country-level analysis, hence it prevents Generated-Regressor problems (Pagan, 1984).

The results from both the country-level and firm-level frameworks empirically support our hypothesis suggesting stronger negative dividend cash-flow sensitivity in countries with higher information transparency, stronger investor protection, and better political institutions reducing corruption. We also confirm that the negative dividend cash-flow sensitivity is a universal phenomenon in our sample covering more countries and a longer time horizon than Chay and Suh (2009). In addition, the negative association always holds: both before and during the recent Global Financial Crisis (GFC) of 2008. But we do not find enough evidence to show that the occurrence of the GFC amplifies the interactive impacts of country-level institutional environment and firm-level cash-flow uncertainty on dividend policy.

This study contributes to the literature in several ways. First of all, we contribute to the dividend literature by further developing Chay and Suh's (2009) work through examining firm-level determinants of dividend policy in a broader context of country-level institutional environment. Although Chay and Suh find consistently negative relationship between dividends and cash-flow uncertainty across developed and developing countries, they do not investigate the variation of the magnitude of such negative relationship among different countries. We notice that the accuracy of stock return volatility representing cash-flow risk is contingent on country-level institutional environment that such negative relationship is stronger when countries have stronger institutional quality. Our findings strengthen the understanding of international heterogeneity of payout policies in the real world. Our second contribution is revealing another channel, through cash-flow risk, connecting institutional environment with dividend policy. This channel is additional to the more direct one illustrated by La Porta et al. (2000). Hence, this study enriches a growing strand of corporate finance literature which recognizes the importance of institutional environment on financial markets. Pioneered by La Porta et al. (1998) who interpret financial market development from the perspective of legal institutions, more and more studies have shown that country-level institutional environment including laws, politics and information is relevant to financial markets, including corporate valuation (La Porta et al., 2002), institutional ownership (Li et al., 2006), capital structure (Fan, Titman, and Twite, 2012), international investment (Gelos and Wei, 2005), IPO underpricing (Boulton, Smart, and Zutter, 2011) and mergers and acquisitions (Acemoglu, Johnson, and Mitton, 2009). Finally, we contribute to the literature on risk and dividend and provide empirical evidence confirming the importance of cash-flow risk in determining payout policy. Our results are consistent with Chay and Suh (2009) suggesting a prevailing negative

dividend cash-flow sensitivity around the world. Our third contribution is to show that dividend cash-flow sensitivity remained negative even in recent global financial turmoil.

This chapter proceeds as follows. Section 4.2 discusses the two analysis frameworks, Section 4.3 explains data and variables, and Section 4.4 presents empirical results. Robustness tests are in Section 4.5. Finally, Section 4.6 concludes.

4.2. Analysis Frameworks

To evaluate how institutional environment shapes dividend cash-flow uncertainty, we use two different analytical frameworks: country-level analysis framework and firm-level analysis framework. In this section we explain these two frameworks.

4.2.1. Country-level Analysis Framework

The country-level analysis framework involves two stages. In the first stage we follow Chay and Suh (2009) to regress dividend payout on firm specific variables for individual firms from every country in the sample. Different types of dependent variables are used in each model. The dependent variables include a dummy variable (*Div*), which indicates whether a firm pays dividends (with value one) or not (with value zero), a dividend-to-earnings ratio (*Div/Earn*) and a dividend-to-sales ratio (*Div/Sales*). These two ratios capture the dividends paid. Considering the increasing popularity of share repurchase as a substitute to the ordinary dividend, we sum share repurchase and ordinary dividend to formulate total payout ratios (*Total/Earn* and *Total/Sales*) as two supplementary dependent variables. For firms not paying any format of dividends, their payout ratios are set to zero. Firm-level independent variables are: stock return volatility (*SRVOL*), retained earnings-to-total equity ratio (*RE/TE*), insider ownership (*Own*), market-to-book ratio (*MBRatio*), logarithm of total assets (*LogTA*), return on assets

(*ROA*), and cash holdings (*Cash*). These firm-level variables have been used widely in previous dividend literature.

Equation (4.1) below illustrates the first stage country-level analysis:

$$DepVar = \alpha + \beta_1 SRVOL + \beta_2 RE/TE + \beta_2 Own + \beta_3 MBRatio + \beta_4 LogTA + \beta_5 ROA + \beta_6 Cash + \varepsilon \quad (4.1)$$

DepVar is one of the dependent variables discussed before. The coefficient β_1 represents the dividend cash-flow uncertainty of a particular country. The regression analysis is implemented for each country in the sample separately.

Then in the second stage, we run regressions using β_1 as the dependent variable on proxy indices for country-specific institutional environment and other country-level control variables. Because we have 52 sample countries, 52 observations are used in the second stage. Equation (4.2) illustrates the second stage of country-level analysis.

$$\beta_1 = \alpha + \gamma_1 CtryV_i + \sum \varphi_j \, Ctry \; Ctrl \; V_j + \varepsilon \quad (4.2)$$

where *CtryV* is one of the country-level institutional environment indices and *CtryCtrlV* are country-level control variables. We explain the details of these variables in the next section. As we hypothesize dividend cash-flow sensitivity is more negative in a stronger institutional environment, γ_1 is expected to be negative in Equation (4.2).

4.2.2. **Firm-level Analysis Framework**

The firm-level analysis framework incorporates both firm and country specific variables simultaneously in one model. We multiply institutional environment and *SRVOL* to illustrate how institutional environment shapes dividend cash-flow sensitivity. The following Equation (4.3) describes the firm-level analysis framework.

$$DepVar = \alpha + \beta_1 SRVOL + \beta_2 CtryV_i + \beta_3 SRVOL \times DM \; CtryV_i + \sum \gamma_j CtrlV_j + \varepsilon \quad (4.3)$$

DepVar is one of the dependent variables introduced before, including the dummy variable (*DIV*), dividend payout ratios or total payout ratios. *CtryV* is one of the country-level proxies for institutional environment. *DM CtryV* represents demeaned *CtryV* because the mean values of country-level proxy indices are generally not zero. *CtrlV* include both firm-level variables (such as *RE/TE*, *Own*, *MBRatio*, *LogTA*, *ROA* and *Cash*) and country-level control variables. We expect $\beta_1$and β_3 to be negative, and β_2 to be positive in Equation (4.3). We cluster robust standard errors of Equation (4.3) by countries as suggested by Petersen (2009).

Prior studies such as Holderness (2008) and McLean, Zhang, and Zhao (2012) show that a firm-level analysis framework at least improves the accuracy of estimation in two ways compared to a country-level framework. The first improvement is that it keeps as much information as possible. The second stage of the country-level analysis method has only 52 observations available, while the firm-level analysis framework contains many more firm-year observations. The second advantage of firm-level analysis is that it prevents Generated-Regressor problems (Pagan, 1984) as it does not take regression generated coefficients as the dependent variable.

4.3. Data

We collect firm-level financial variables from the Worldscope database. Our sample period is 1994-2011[27]. To begin with, we collect all firms covered by the Worldscope database. In order to prevent counting a firm more than once when it has issued multiple levels of securities or has been listed in more than one security exchange, we only include securities tagged as "Major Security" and "Primary Quote". Following La Porta et al. (2000), we drop firms from Luxembourg and firms listed in

[27] The start of our sample period from 1994 is the same as Chay and Suh (2009). We extend the sample period up to 2011 because this study was conducted in 2012. Therefore, 2011 was the latest year with available data.

countries with mandatory dividend policies such as Brazil, Chile, Colombia, Greece and Venezuela. We exclude financial and utility firms. Any firm-observation where dividend, net income, sales and total assets information is missing; where book value of equity is negative; and where dividend or net income is greater than sales is dropped. Furthermore, since we run regressions for each country in the country-level framework, we require every sample country to have at least 50 individual firms. Our final sample consists of 38,467 individual firms from 52 countries with a total of 283,650 firm-year observations. Table 4.1 reports the details of sample composition.

Table 4.1: Sample composition

This table summarizes the number of firms in each sample country and total number of firms included in the sample covering 1994-2011.

Country/Region	No. Firms	Country/Region	No. Firms	Country/Region	No. Firms
Argentina	75	Ireland	81	Serbia	50
Australia	1481	Israel	416	Romania	118
Austria	124	Italy	317	Russia	291
Belgium	136	Japan	4367	Singapore	753
Bulgaria	174	Jordan	134	South Africa	579
Canada	2003	Kuwait	114	South Korea	1746
China	1383	Malaysia	1085	Spain	189
Croatia	91	Mexico	145	Sri Lanka	147
Cyprus	84	Morocco	50	Sweden	559
Czech Republic	53	Netherlands	173	Switzerland	256
Denmark	198	New Zealand	139	Taiwan, Province of China	1654
Egypt	98	Norway	267	Thailand	464
Finland	162	Oman	75	Turkey	253
France	1112	Pakistan	111	United Kingdom	2884
Germany	1070	Peru	109	United States	9307
Hong Kong	1180	Philippines	188	Vietnam	556
India	659	Poland	338		
Indonesia	371	Portugal	98	Total firms	38,467

Proxy indices measuring country-level institutional environment are collected from a variety of sources. We examine different aspects of institutional environment such as information transparency and investor protection, as well as legal and political institutions. To measure information transparency, we collect six indices (*Audit*, *AcctStd*, *Media*, *WEF Audit*, *WEF Info* and *WEF Ex Reg*) from Bushman, Piotroski, and Smith (2004), World Economic Forum (WEF) Global Competitiveness Report 2009-2010. These indices score the strictness of financial reporting, regulation of security exchange and auditing activities as well as media development all pertaining to the quality of information environment.

To capture investor protection, we use four indices (*WEF Board*, *Corp Gov*, *WEF Investor* and *WEF Minority*) from Kaufmann (2004) and WEF Global Competitiveness Report 2009-2010. These indices measure the efficiency of board of directors, corporate governance quality, investors' rights and minority shareholder protection respectively.

Finally for legal and political institutions, we select 14 indices. Kaufmann, Kraay, and Mastruzzi (2009) publish and update scores of *Voice and Accountability*, *Political Stability and Absence of Violence*, *Government Effectiveness*, *Regulatory Quality*, *Rule of Law* and *Control of Corruption* for 212 countries. These six indices comprehensively reflect the quality of political and legal institutions in different countries. The original indices cover several years within the period of 1996-2008, so we take the chronological average scores for each of the indices and rename them as *Gov1 – Gov6* in our models. We also calculate the first principle component (*Gov_PCA*) of these six indices to represent the overall institutional environment. We also collect seven indices (*Legal Eff*, *WEF Legal*, *Corp Ethics*, *Corrupt Illegal*, *Corrupt Legal*, *Public Ethics* and *WEF Ethics*) from Kaufmann (2004) and WEF Global

Competitiveness Report (2009-2010) as measures of legal institutions and corruption control. We should point out that since different aspects of the overall institutional environments are not mutually exclusive; some indices are relevant to more than one aspect. For example, *Regulatory Quality* and *Rule of Law* from Kaufmann, Kraay, and Mastruzzi (2009) are relevant to both investor protection and legal institutions.

Considering various levels of economic developments across sample countries, we use country-level control variables. We use GDP per capita growth rate (*GDPCapG*) and logarithm of GDP (*logGDP*) to control for economic development. Stock market to GDP ratio (*MV/GDP*) and median firm size (*MedMV*) are used to control for the differences in the development of financial markets across countries. These country-level control variables are common in cross-country studies (such as La Porta et al., 1998; Doidge, Andrewkarolyi, and Stulz, 2007). Appendix A lists details of the variable definitions and sources of data. Appendix B reports values of proxy indices for institutional environment in every sample country.

4.4. Empirical Results

4.4.1. **Results of Country-Level Framework**

We first examine the first stage results of country-level framework. Table 4.2 reports the coefficient of *SRVOL* (β_1) from Equation (4.1). There are in fact five groups of β_1 since the dependent variable of Equation (4.1) includes a dummy variable *Div* and four dividend payout ratios (*Div/Earn*, *Div/Sales*, *Total/Earn* and *Total/Sales*). We condense β_1 from five models into a single table leaving other firm-level control variables of *RE/TE*, *Own*, *MBRatio*, *LogTA*, *ROA* and *Cash* untabulated for the sake of conciseness. Nevertheless, our results are very similar to Chay and Suh (2009). High *RE/TE*, *LogTA* and *ROA* are positively correlated with dividend payout while *Cash* is

negatively correlated in most cases. The coefficients of *MBRatio* exhibit mixed positive and negative signs for different countries, while insider ownership proxied by *Own* has an insignificant relationship with dividend payout in our sample. The key point of this stage is confirming the coefficients of *SRVOL* are always significantly negative for the majority of sample countries regardless of the choice of dependent variables. Our results indicate firms' propensity of paying dividend and payout ratios are significantly lower when their future cash-flow uncertainty is higher.

Table 4.2: Stage one result of country-level framework

This table reports the coefficients of *SRVOL* (β_1) of Equation (4.1). $\beta_1(Div)$ is obtained from logit regression on *Div*. $\beta_1(Div/Earn)$, $\beta_1(Div/Sales)$, $\beta_1(Total/Earn)$ and $\beta_1(Total/Sales)$ are from tobit regressions on *Div/Earn*, *Div/Sales*, *Total/Earn* and *Total/Sales* ratios respectively. Other firm-level variables (i.e. *RE/TE*, *Own*, *MBRatio*, *LogTA*, *ROA* and *Cash*) are controlled but not reported. Chi-square (t-) statistics are reported in parentheses for logit (tobit) regressions. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Country/Region	β_1(*Div*)	β_1(*Div/Earn*)	β_1(*Div/Sales*)	β_1(*Total/Earn*)	β_1(*Total/Sales*)
Argentina	-4.77***	-2.20***	-0.21***	-1.85***	-0.34***
	(13.25)	(-4.34)	(-4.63)	(-3.62)	(-4.33)
Australia	-12.08***	-3.33***	-0.30***	-3.33***	-0.63***
	(494.63)	(-27.28)	(-24.65)	(-25.66)	(-20)
Austria	-2.60	-1.02***	0.02	-1.20***	-0.08
	(2.12)	(-2.73)	(0.76)	(-3.11)	(-1.02)
Belgium	-16.56***	-3.18***	-0.25***	-3.36***	-0.58***
	(48.43)	(-7.7)	(-5.8)	(-7.99)	(-5.44)
Bulgaria	-3.93***	-1.15**	-0.08**	-1.15**	-0.15**
	(11.94)	(-2.27)	(-2.28)	(-2.25)	(-2.47)
Canada	-15.90***	-6.02***	-0.52***	-5.66***	-0.88***
	(765.71)	(-29.1)	(-29.64)	(-28.31)	(-25.23)
China	-7.77***	-2.21***	-0.19***	-2.19***	-0.23***
	(174.81)	(-14.58)	(-12.86)	(-14.45)	(-11.05)
Croatia	-3.14	-2.33**	-0.18**	-2.33**	-0.22**
	(2)	(-2.06)	(-2.21)	(-2.08)	(-2.2)
Cyprus	-7.50***	-3.15***	-0.26***	-3.15***	-0.31***
	(14.54)	(-4.04)	(-4.18)	(-4.03)	(-4)
Czech Republic	-9.71***	-3.21***	-0.31***	-3.20***	-0.57**
	(9.86)	(-2.83)	(-3.21)	(-2.83)	(-2.52)
Denmark	-12.15***	-1.79***	-0.17***	-2.23***	-0.38***
	(89.09)	(-8.05)	(-7.93)	(-8.91)	(-7.58)
Egypt	-5.46***	-1.22***	-0.18***	-1.17***	-0.31***
	(17.64)	(-4.48)	(-5.46)	(-4.34)	(-4.01)
Germany	-9.43***	-3.03***	-0.18***	-2.90***	-0.33***
	(372.19)	(-20.47)	(-18.93)	(-19.7)	(-15.65)
Spain	-6.74***	-1.55***	-0.22***	-1.62***	-0.43***
	(34.52)	(-7.32)	(-8.75)	(-7.19)	(-7.86)
Finland	-10.45***	-2.22***	-0.22***	-2.36***	-0.36***
	(52.09)	(-9)	(-10.37)	(-9.2)	(-8.54)
France	-8.92***	-2.02***	-0.17***	-2.03***	-0.31***
	(362.27)	(-20.39)	(-21.04)	(-20.2)	(-17.55)
Hong Kong	-6.53***	-1.74***	-0.19***	-1.65***	-0.28***
	(403)	(-24.18)	(-23.3)	(-23.18)	(-18.43)
Indonesia	-3.80***	-1.21***	-0.09***	-1.22***	-0.11***
	(67.07)	(-10.17)	(-8.56)	(-10.17)	(-7.07)
Ireland	-16.76***	-2.26***	-0.19***	-2.02***	-0.24***
	(54.21)	(-6.76)	(-7.02)	(-5.29)	(-5.32)

Table 4.2: Stage one result of country-level framework – continued

Country/Region	β_1(*Div*)	β_1(*Div/Earn*)	β_1(*Div/Sales*)	β_1(*Total/Earn*)	β_1(*Total/Sales*)
Israel	-7.04***	-2.81***	-0.26***	-2.63***	-0.41***
	(78.52)	(-8.47)	(-9.37)	(-8.14)	(-8.76)
India	-2.43***	-0.70***	-0.04***	-0.78***	-0.07***
	(16.58)	(-7.13)	(-5.11)	(-6.98)	(-3.21)
Italy	-8.72***	-2.12***	-0.16***	-2.28***	-0.24***
	(78.17)	(-8.45)	(-8.84)	(-8.92)	(-8.38)
Jordan	-9.90***	-6.18***	-0.52***	-6.22***	-0.82***
	(18.96)	(-5.3)	(-5.47)	(-5.31)	(-4.85)
Japan	-6.80***	-1.08***	-0.03***	-1.22***	-0.04***
	(905.67)	(-31.3)	(-32.69)	(-33.48)	(-25.5)
Kuwait	-7.92***	-1.99***	-0.29***	-2.19***	-0.85***
	(15.39)	(-3.48)	(-3.88)	(-4)	(-3.91)
Sri Lanka	-3.64***	-1.40***	-0.18***	-1.39***	-0.28***
	(12.9)	(-5.96)	(-6.03)	(-5.64)	(-5.25)
Morocco	-6.90	-1.87*	-0.13	-1.34	-0.23
	(1.34)	(-1.93)	(-1.34)	(-1.42)	(-1.22)
Mexico	-7.24***	-2.07***	-0.19***	-1.44***	-0.16***
	(31.13)	(-5.76)	(-5.89)	(-4.71)	(-3.95)
Malaysia	-5.79***	-1.54***	-0.14***	-1.59***	-0.22***
	(226.68)	(-18.92)	(-19.03)	(-19.05)	(-16.57)
Netherlands	-13.38***	-2.74***	-0.24***	-4.06***	-0.63***
	(65.7)	(-8.51)	(-9.41)	(-9.16)	(-7.44)
Norway	-12.92***	-3.99***	-0.29***	-3.57***	-0.43***
	(89.34)	(-8.51)	(-7.6)	(-7.83)	(-5.23)
New Zealand	-17.38***	-3.18***	-0.45***	-3.34***	-1.04***
	(52.39)	(-7.32)	(-9.46)	(-7.27)	(-8.32)
Oman	2.78	-0.12	0.05	-0.12	0.09
	(1.33)	(-0.23)	(0.68)	(-0.23)	(0.85)
Peru	-2.55***	-0.72***	-0.09***	-0.62**	-0.12***
	(10.1)	(-2.88)	(-3.59)	(-2.42)	(-2.79)
Philippines	-2.92***	-1.25***	-0.12***	-1.11***	-0.14**
	(17.9)	(-6.58)	(-5.22)	(-5.06)	(-2.38)
Pakistan	-8.75***	-1.87***	-0.13***	-1.77***	-0.15***
	(33.14)	(-6.17)	(-4.82)	(-5.74)	(-4.45)
Poland	-6.97***	-3.37***	-0.20***	-3.34***	-0.23***
	(53.58)	(-9.28)	(-8.65)	(-9.1)	(-8.05)
Portugal	-3.88***	-0.81***	-0.07***	-1.00***	-0.14***
	(10.8)	(-2.67)	(-2.96)	(-3.07)	(-3.06)
Romania	-4.30***	-2.07***	-0.13***	-2.07***	-0.19***
	(15.75)	(-4.16)	(-3.37)	(-4.16)	(-3.3)
Serbia	-5.41	-1.37	-0.12	-1.37	-0.13
	(0.63)	(-0.55)	(-0.62)	(-0.55)	(-0.63)

Table 4.2: Stage one result of country-level framework – continued

Country/Region	β_1(*Div*)	β_1(*Div/Earn*)	β_1(*Div/Sales*)	β_1(*Total/Earn*)	β_1(*Total/Sales*)
Russia	-2.63***	-0.27	-0.04**	-0.33	-0.06
	(8.19)	(-1.26)	(-1.97)	(-1.36)	(-1.24)
Singapore	-6.67***	-1.88***	-0.18***	-1.88***	-0.29***
	(202.71)	(-18.07)	(-18.23)	(-17.52)	(-14.68)
South Africa	-7.37***	-1.73***	-0.23***	-1.95***	-0.65***
	(153.22)	(-15.34)	(-15.94)	(-15)	(-14.99)
South Korea	-3.62***	-0.67***	-0.05***	-0.75***	-0.07***
	(160.3)	(-12.14)	(-19.94)	(-11.48)	(-10.27)
Sweden	-12.72***	-3.05***	-0.25***	-3.39***	-0.37***
	(192.67)	(-15.88)	(-13.7)	(-16.12)	(-12.47)
Switzerland	-17.03***	-3.06***	-0.38***	-2.43***	-0.55***
	(170.27)	(-14.91)	(-17.07)	(-11.57)	(-11.47)
Thailand	-10.25***	-2.32***	-0.21***	-2.32***	-0.29***
	(71.63)	(-9.43)	(-9.59)	(-9.33)	(-7.79)
Turkey	-0.81	-0.75***	-0.09***	-0.75***	-0.13***
	(1.21)	(-2.9)	(-4.31)	(-2.87)	(-3.5)
Taiwan	-7.60***	-2.38***	-0.20***	-2.31***	-0.25***
	(325.56)	(-21.47)	(-23.02)	(-20.62)	(-19.86)
United States	-8.13***	-2.73***	-0.18***	-3.22***	-0.36***
	(2134.33)	(-49.4)	(-48.24)	(-52.53)	(-41.81)
United Kingdom	-9.89***	-1.89***	-0.18***	-2.11***	-0.35***
	(926.5)	(-29.73)	(-34.3)	(-27.81)	(-25.09)
Vietnam	-0.29	-0.16	-0.01	-0.86	-0.21
	(0.02)	(-0.13)	(-0.15)	(-0.83)	(-1.23)

Before proceeding to the second stage, we implement preliminary difference in means tests. We divide the 52 sample countries into two groups according to whether the values of a particular institutional environment index are above or below the sample median. Because every country is now associated with its own dividend cash-flow sensitivity coefficients β_1s from stage one regressions, and we hypothesize that β_1s are more negative in countries with higher institutional environment scores, we formulate the test as $\overline{\beta_1}_{Above\ Meian} - \overline{\beta_1}_{Below\ Meian}$. If the difference in means is significantly negative, our hypothesis is supported.

Table 4.3 presents the results of the difference in means tests. Obviously Δ(*Div*), Δ(*Div/Earn*), Δ(*Div/Sales*), Δ(*Total/Earn*) and Δ(*Total/Sales*) are significantly negative for almost proxy indices, so our hypothesis that negative dividend cash-flow sensitivity is more prominent in countries with good institutional environment is supported by difference in means tests.

Table 4.3: Differences in means tests

This table reports the results of difference in means tests. For each of 24 country-level institutional environment indices, we divide the 52 sample countries into two groups according to whether a country's value is above or below the median. We then test whether the differences in means of $\beta_1$between the two groups (mean of above median group minuses mean of below median group) are significant. Δ(*Div*), Δ(*Div/Earn*), Δ(*Div/Sales*), Δ(*Total/Earn*) and Δ(*Total/Sales*) represent the difference in means of β_1 obtained from the first stage logit and tobit regressions on *Div, Div/Earn, Div/Sales, Total/Earn* and *Total/Sales* respectively. T-statistics are reported in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

	Δ(Div)	**Δ(Div/Earn)**	**Δ(Div/Sales)**	**Δ(Total/Earn)**	**Δ(Total/Sales)**		**Δ(Div)**	**Δ(Div/Earn)**	**Δ(Div/Sales)**	**Δ(Total/Earn)**	**Δ(Total/Sales)**
Audit	-3.98**	-0.81**	-0.08**	-1.01***	-0.21***	*Gov1*	-5.70***	-0.93***	-0.08**	-1.14***	-0.18***
	(-2.62)	(-2.25)	(-2.15)	(-3.01)	(-2.83)		(-5.27)	(-2.81)	(-2.37)	(-3.51)	(-2.8)
AcctStd	-4.76***	-0.96***	-0.11***	-1.07***	-0.25***	*Gov2*	-5.36***	-0.90***	-0.07**	-1.08***	-0.13**
	(-3.42)	(-2.93)	(-3.64)	(-3.42)	(-3.9)		(-4.79)	(-2.72)	(-2.06)	(-3.28)	(-2.03)
Media	-4.91***	-1.09***	-0.08**	-1.25***	-0.19**	*Gov3*	-5.18***	-0.74**	-0.07**	-0.91**	-0.14**
	(-3.46)	(-3.35)	(-2.35)	(-4.12)	(-2.71)		(-4.57)	(-2.17)	(-2.04)	(-2.68)	(-2.14)
WEF Audit	-5.03***	-1.06***	-0.10***	-1.24***	-0.21***	*Gov4*	-5.88***	-0.98***	-0.09***	-1.15***	-0.18***
	(-4.34)	(-3.27)	(-3.18)	(-3.85)	(-3.29)		(-5.52)	(-2.99)	(-2.81)	(-3.54)	(-2.84)
WEF Info	-2.81**	-0.64	-0.04	-0.65	-0.06	*Gov5*	-5.49***	-0.87**	-0.08**	-1.04***	-0.17**
	(-2.08)	(-1.61)	(-1.05)	(-1.62)	(-0.88)		(-4.96)	(-2.6)	(-2.49)	(-3.11)	(-2.6)
WEF Ex Reg	-4.19***	-1.06***	-0.09***	-1.20***	-0.19***	*Gov6*	-5.07***	-0.72**	-0.07**	-0.90**	-0.18***
	(-3.45)	(-3.29)	(-3.04)	(-3.74)	(-2.93)		(-4.43)	(-2.12)	(-2.31)	(-2.64)	(-2.89)
WEF Board	-4.55***	-0.55	-0.05	-0.73**	-0.15**	*Gov_PCA*	-5.87***	-1.02***	-0.08**	-1.21***	-0.17**
	(-3.83)	(-1.58)	(-1.65)	(-2.08)	(-2.26)		(-5.52)	(-3.15)	(-2.64)	(-3.76)	(-2.59)
Corp Gov	-5.04***	-0.60*	-0.06*	-0.79**	-0.17***	*Corp Ethics*	-5.66***	-1.05***	-0.10***	-1.25***	-0.23***
	(-4.33)	(-1.72)	(-1.77)	(-2.26)	(-2.7)		(-5.13)	(-3.22)	(-3.19)	(-3.87)	(-4.03)
WEF Investor	-3.12**	-0.36	-0.03	-0.46	-0.08	*Corrupt Illegal*	-5.66***	-1.05***	-0.10***	-1.25***	-0.23***
	(-2.35)	(-1)	(-0.95)	(-1.26)	(-1.21)		(-5.13)	(-3.22)	(-3.19)	(-3.87)	(-4.03)
WEF Minority	-4.75***	-0.93***	-0.08***	-1.11***	-0.19***	*Corrupt Legal*	-5.10***	-0.82**	-0.09***	-0.98***	-0.20***
	(-4.05)	(-2.84)	(-2.71)	(-3.39)	(-2.98)		(-4.4)	(-2.41)	(-2.75)	(-2.88)	(-3.27)
WEF Legal	-1.58	0.15	0.02	0.07	0.01	*Public Ethics*	-5.61***	-1.03***	-0.10***	-1.22***	-0.21***
	(-1.16)	(0.41)	(0.64)	(0.19)	(0.09)		(-5.06)	(-3.17)	(-3.15)	(-3.76)	(-3.64)
Legal Eff	-5.66***	-1.05***	-0.10***	-1.25***	-0.23***	*WEF Ethics*	-5.15***	-0.98***	-0.09***	-1.17***	-0.20***
	(-5.13)	(-3.22)	(-3.19)	(-3.87)	(-4.03)		(-4.51)	(-3)	(-2.97)	(-3.61)	(-3.21)

Next we run second stage regressions specified by Equation (4.2). Table 4.4 reports the OLS regression results using β_1 from logit model on *Div*. Table 4.5 and 4.6 present OLS regression results using β_1 from tobit models on *Div/Earn* and *Div/Sales*. In models 1-6 of Table 4.4, we test proxy indices for financial reporting and information transparency. Except for *WEF Info*, the coefficients of other indices are negative and significant, meaning that firms are less likely to pay dividends when future cash-flow uncertainty is high and such conservativeness is more obvious in countries with stricter financial reporting regulations and higher information transparency. Similarly in models 1-6 of Table 4.5 and 4.6, most coefficients of *CtryV* are negative and significant. Results of these two tables show that for dividend paying firms, they prefer to pay less when future cash-flow risk is high and such conservativeness is stronger in countries with a better information environment.

We then look at another group of country-level institutional environment proxies. In model 7-10 of Table 4.4-4.6, we find that most coefficients of corporate governance and investor protection indices are significantly negative. These models are consistent with the hypothesis that negative dividend cash-flow sensitivity is more prominent when countries have stronger corporate governance and investor protection. Finally, the remaining models in the three tables test the last hypothesis using proxy indices for legal and political institutions. Most proxy indices also have significantly negative coefficients. Hence our hypothesis is still valid in countries with robust legal and political institutions as well as stricter corruption controls. We also test β_1 from tobit models on *Total/Earn* and *Total/Sales* and find very similar results as in Table 4.5 and 4.6. These results are not tabulated. Overall, the country-level analysis framework supports our hypothesis that dividend cash-flow sensitivity is stronger in countries with a better institutional environment.

Table 4.4: Stage two result of β_1(*Div*)

This table reports the second stage OLS regression results. The dependent variable is β_1 from the first stage logit regression on *Div* dummy. *CtryV* is country-level institutional environment index. "CtryV Name" column lists the index used in each regression. *GDPCapG* is GDP per capita growth rate. *MV/GDP* is stock market value scaled by country's GDP. *LogGDP* is the logarithm of GDP. *MedMV* is the logarithm of median firm value in the country/region. Definition and details of each variable are in Appendix A. N is number of observations. Adj R^2 is adjusted R-square. Robust standard errors are used and t-statistics are reported in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Model	*CtryV*	Control Variables					CtryV Name	N	Adj. R^2
		GDPCapG	*MV/GDP*	*LogGDP*	*MedMV*	*Constant*			
1	-2.93***	0.67	0.01	1.13	0.57	-16.79	Audit	33	0.23
	(-3.45)	-0.99	-0.62	-1.57	-0.54	(-1.17)			
2	-0.38***	0.85	0.01	0.48	-0.78	19.13	AcctStd	35	0.33
	(-4.01)	-1.43	-0.85	-0.74	(-0.86)	-1.27			
3	-0.15***	0.46	0	0.97	0.41	-10.53	Media	35	0.23
	(-3.02)	-0.67	-0.17	-1.35	-0.41	(-0.76)			
4	-4.28***	-0.06	0.00	-0.37	-0.87	26.74***	WEF Audit	52	0.36
	(-4.21)	(-0.38)	-0.32	(-0.87)	(-1.28)	-2.7			
5	-0.51	0.37*	-0.01	0.17	-0.8	-0.11	WEF Info	41	0.09
	(-0.87)	-1.88	(-0.96)	-0.29	(-0.96)	(-0.01)			
6	-3.71***	-0.04	0.00	-0.44	-0.79	22.11**	WEF Ex Reg	52	0.27
	(-3.16)	(-0.2)	(-0.13)	(-0.97)	(-1.08)	-2.04			
7	-4.40***	0.11	0.00	-0.14	-0.77	22.84**	WEF Board	52	0.32
	(-3.73)	-0.7	(-0.35)	(-0.31)	(-1.1)	-2.29			
8	-0.14***	-0.04	0.00	0.37	-0.67	6.24	Corp Gov	50	0.36
	(-4.23)	(-0.23)	-0.27	-0.78	(-0.96)	-0.81			
9	-0.95**	0.23	-0.01	-0.3	-0.8	7.82	WEF Investor	51	0.21
	(-2.25)	-1.34	(-0.61)	(-0.61)	(-1.01)	-0.85			
10	-3.59***	-0.04	0.00	-0.47	-0.88	22.82**	WEF Minority	52	0.30
	(-3.48)	(-0.24)	(-0.48)	(-1.06)	(-1.23)	-2.19			
11	-0.61*	0.27	-0.01	-0.31	-0.9	6.72	WEF Legal	51	0.17
	(-1.77)	-1.58	(-0.48)	(-0.61)	(-1.07)	-0.7			
12	-0.11***	0.03	0.00	0.02	-0.60	4.74	Legal Eff	50	0.30
	(-3.56)	-0.14	-0.42	-0.03	(-0.82)	-0.59			

Table 4.4: Stage two result of $\beta_1(Div)$ – continued

Model	*CtryV*	Control Variables					CtryV Name	N	Adj. R^2
		GDPCap	*MV/GD*	*LogGD*	*MedMV*	*Constant*			
13	-2.87***	0.03	-0.01	0.04	-0.51	0.35	*Gov1*	52	0.34
	(-4.04)	-0.21	(-1.54)	-0.1	(-0.76)	-0.05			
14	-2.36***	0.22	-0.01	-0.35	-0.02	-5.5	*Gov2*	52	0.28
	(-3.21)	-1.37	(-0.88)	(-0.76)	(-0.02)	(-0.72)			
15	-3.44***	0.01	0.00	-0.03	-0.3	-0.95	*Gov3*	52	0.37
	(-4.29)	-0.04	(-0.14)	(-0.06)	(-0.45)	(-0.13)			
16	-3.64***	0.05	0.00	-0.19	-0.31	-0.34	*Gov4*	52	0.34
	(-3.96)	-0.29	(-0.13)	(-0.43)	(-0.45)	(-0.05)			
17	-3.23***	-0.02	0.00	-0.1	-0.45	1.03	*Gov5*	52	0.36
	(-4.19)	(-0.13)	(-0.48)	(-0.23)	(-0.68)	-0.14			
18	-2.81***	0.00	0.00	-0.22	-0.28	-0.8	*Gov6*	52	0.36
	(-4.27)	0.00	(-0.24)	(-0.51)	(-0.42)	(-0.11)			
19	-1.38***	0.02	0.00	-0.1	-0.3	-1	*Gov_PCA*	52	0.37
	(-4.36)	-0.12	(-0.45)	(-0.23)	(-0.46)	(-0.14)			
20	-0.14***	0.07	0.01	-0.2	-0.09	0.79	*Corp Ethics*	50	0.35
	(-4.11)	-0.46	-0.51	(-0.46)	(-0.13)	-0.11			
21	-0.13***	0.00	0.01	-0.04	-0.31	3.32	*Corrupt*	50	0.37
	(-4.31)	-0.03	-0.75	(-0.1)	(-0.45)	-0.45			
22	-0.12***	0.19	0.00	-0.39	0.09	-2.55	*Corrupt Legal*	50	0.29
	(-3.39)	-1.15	(-0.08)	(-0.84)	-0.13	(-0.33)			
23	-0.11***	0.11	0.00	-0.23	-0.08	-0.64	*Public Ethics*	50	0.32
	(-3.71)	-0.69	-0.31	(-0.5)	(-0.11)	(-0.08)			
24	-2.54***	0.01	0.00	-0.23	-0.47	11.43	*WEF Ethics*	52	0.35
	(-4.1)	-0.09	(-0.02)	(-0.52)	(-0.7)	-1.45			

Table 4.5: Stage two result of β_1(*Div/Earn*)

This table reports the second stage OLS regression results. The dependent variable is β_1 from the first stage tobit regression on *Div/Earn*. *CtryV* is country-level institutional environment index. "CtryV Name" column lists the index used in each regression. *GDPCapG* is GDP per capita growth rate. *MV/GDP* is stock market value scaled by country's GDP. *LogGDP* is the logarithm of GDP. *MedMV* is the logarithm of median firm value in the country/region. Definition and details of each variable are in Appendix A. N is number of observations. Adj R^2 is adjusted R-square. White standard errors are used and t-statistics are reported in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Model	***CtryV***	**Control Variables**					**CtryV Name**	**N**	**Adj. R^2**
		GDPCapG	***MV/GDP***	***LogGDP***	***MedMV***	***Constant***			
1	-0.53**	0.15	0.00	0.08	0.38	-6.17*	*Audit*	33	0.09
	(-2.47)	-0.88	-0.31	-0.46	-1.45	(-1.71)			
2	-0.06**	0.14	0.00	-0.04	0.10	0.13	*AcctStd*	35	0.06
	(-2.22)	-0.9	-0.38	(-0.22)	-0.4	-0.03			
3	-0.03***	0.02	0.00	0.06	0.33	-3.71	*Media*	35	0.20
	(-3.11)	-0.1	-0.35	-0.35	-1.43	(-1.16)			
4	-0.85***	0.02	0.00	0.03	-0.02	2.28	*WEF Audit*	52	0.15
	(-2.77)	-0.32	-0.26	-0.23	(-0.11)	-0.76			
5	-0.24	0.1	0.00	0.17	0.11	-4.22	*WEF Info*	41	0.02
	(-1.37)	-1.62	(-0.46)	-0.96	-0.45	(-1.52)			
6	-0.74**	0.02	0.00	0.02	-0.01	1.33	*WEF Ex Reg*	52	0.10
	(-2.15)	-0.4	(-0.04)	-0.11	(-0.03)	-0.42			
7	-0.71*	0.06	0.00	0.06	0.01	0.53	*WEF Board*	52	0.08
	(-1.97)	-1.2	(-0.33)	-0.46	-0.07	-0.17			
8	-0.01	0.06	0.00	0.13	0.06	-2.96	*Corp Gov*	50	0.05
	(-1.38)	-1.07	(-0.23)	-0.84	-0.26	(-1.2)			
9	-0.07	0.08	0.00	0.01	0.03	-2.38	*WEF Investor*	51	0.01
	(-0.57)	-1.55	(-0.74)	-0.03	-0.14	(-0.88)			
10	-0.71**	0.02	0.00	0.01	-0.02	1.44	*WEF Minority*	52	0.11
	(-2.32)	-0.39	(-0.28)	-0.07	(-0.12)	-0.47			
11	-0.02	0.08	0.00	-0.01	0.05	-2.83	*WEF Legal*	51	0.01
	(-0.17)	-1.62	(-0.81)	(-0.04)	-0.21	(-1.03)			
12	-0.02*	0.05	0.00	0.11	0.04	-2.59	*Legal Eff*	50	0.09
	(-1.93)	-0.92	-0.17	-0.8	-0.19	(-1.08)			

Table 4.5: Stage two result of β_1(*Div/Earn*) – continued

Model	*CtryV*	Control Variables					CtryV Name	N	Adj. R^2
		GDPCapG	*MV/GDP*	*LogGDP*	*MedMV*	*Constant*			
13	-0.55**	0.04	0.00	0.11	0.05	-3.02	*Gov1*	52	0.13
	(-2.55)	-0.78	(-0.96)	-0.79	-0.25	(-1.38)			
14	-0.46**	0.07	0.00	0.03	0.15	-4.14*	*Gov2*	52	0.10
	(-2.12)	-1.57	(-0.55)	-0.25	-0.69	(-1.86)			
15	-0.62**	0.04	0.00	0.09	0.09	-3.28	*Gov3*	52	0.12
	(-2.49)	-0.73	(-0.13)	-0.66	-0.45	(-1.51)			
16	-0.67**	0.04	0.00	0.06	0.09	-3.16	*Gov4*	52	0.12
	(-2.4)	-0.86	(-0.1)	-0.46	-0.44	(-1.44)			
17	-0.61**	0.03	0.00	0.08	0.06	-2.9	*Gov5*	52	0.13
	(-2.59)	-0.56	(-0.3)	-0.6	-0.3	(-1.33)			
18	-0.51**	0.03	0.00	0.06	0.09	-3.26	*Gov6*	52	0.12
	(-2.49)	-0.7	(-0.19)	-0.42	-0.46	(-1.49)			
19	-0.26**	0.04	0.00	0.08	0.09	-3.28	*Gov_PCA*	52	0.14
	(-2.63)	-0.75	(-0.29)	-0.59	-0.44	(-1.52)			
20	-0.02**	0.06	0.00	0.08	0.12	-3.26	*Corp Ethics*	50	0.10
	(-2.09)	-1.16	-0.18	-0.56	-0.57	(-1.42)			
21	-0.02**	0.04	0.00	0.1	0.09	-2.82	*Corrupt Illegal*	50	0.11
	(-2.25)	-0.88	-0.33	-0.75	-0.41	(-1.22)			
22	-0.02*	0.08	0.00	0.05	0.15	-3.79	*Corrupt Legal*	50	0.07
	(-1.7)	-1.57	(-0.16)	-0.35	-0.69	(-1.64)			
23	-0.02**	0.06	0.00	0.07	0.13	-3.45	*Public Ethics*	50	0.10
	(-2.04)	-1.25	-0.13	-0.54	-0.59	(-1.51)			
24	-0.42**	0.04	0.00	0.05	0.06	-1.25	*WEF Ethics*	52	0.10
	(-2.2)	-0.82	(-0.13)	-0.37	-0.3	(-0.51)			

Table 4.6: Stage two result of β_1(*Div/Sales*)

This table reports the second stage OLS regression results. The dependent variable is β_1 from the first stage tobit regression on *Div/Sales*. *CtryV* is country-level institutional environment index. "CtryV Name" column lists the index used in each regression. *GDPCapG* is GDP per capita growth rate. *MV/GDP* is stock market value scaled by country's GDP. *LogGDP* is the logarithm of GDP. *MedMV* is the logarithm of median firm value in the country/region. Definition and details of each variable are in Appendix A. N is number of observations. Adj R^2 is adjusted R-square. White standard errors are used and t-statistics are reported in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Model	*CtryV*	Control Variables					CtryV Name	N	Adj. R^2
		GDPCapG	*MV/GDP*	*LogGDP*	*MedMV*	*Constant*			
1	-0.05**	0.01	0.00	0.03	0.02	-0.49	*Audit*	33	0.09
	(-2.23)	-0.69	(-0.51)	-1.4	-0.83	(-1.35)			
2	-0.01***	0.01	0.00	0.02	0.00	0.19	*AcctStd*	35	0.15
	(-2.77)	-0.61	(-0.2)	-0.91	(-0.18)	-0.51			
3	-0.00**	0.00	0.00	0.02	0.02	-0.32	*Media*	35	0.12
	(-2.41)	-0.07	(-0.58)	-1.38	-0.75	(-0.95)			
4	-0.09***	0.00	0.00	0.01	-0.02	0.4	*WEF Audit*	52	0.23
	(-3.14)	(-0.26)	(-0.53)	-1.15	(-0.9)	-1.48			
5	-0.01	0.01	0.00	0.03*	-0.01	-0.18	*WEF Info*	41	0.09
	(-0.95)	-1.21	(-1.51)	-1.83	(-0.57)	(-0.76)			
6	-0.07**	0.00	0.00	0.01	-0.01	0.25	*WEF Ex Reg*	52	0.14
	(-2.14)	-0.02	(-0.95)	-0.97	(-0.72)	-0.87			
7	-0.08**	0	0.00	0.02	-0.01	0.26	*WEF Board*	52	0.17
	(-2.45)	-0.64	(-1.14)	-1.41	(-0.71)	-0.96			
8	0.00	0.00	0.00	0.02	0.00	-0.16	*Corp Gov*	50	0.12
	(-1.67)	-0.66	(-0.99)	-1.54	(-0.23)	(-0.71)			
9	-0.01	0.00	0.00	0.01	-0.01	-0.02	*WEF Investor*	51	0.09
	(-1.28)	-1.08	(-1.38)	-1	(-0.65)	(-0.09)			
10	-0.06**	0.00	0.00	0.01	-0.02	0.25	*WEF Minority*	52	0.15
	(-2.21)	-0.05	(-1.26)	-0.93	(-0.78)	-0.86			
11	0.00	0.01	0.00	0.01	-0.01	-0.13	*WEF Legal*	51	0.06
	(-0.22)	-1.21	(-1.61)	-0.78	(-0.39)	(-0.52)			
12	-0.00*	0.00	0.00	0.02	0.00	-0.15	*Legal Eff*	50	0.13
	(-1.8)	-0.68	(-0.73)	-1.39	(-0.24)	(-0.69)			

Table 4.6: Stage two result of β_1(*Div/Sales*) – continued

Model	*CtryV*	Control Variables					CtryV Name	N	Adj. R^2
		GDPCapG	*MV/GDP*	*LogGDP*	*MedMV*	*Constant*			
13	-0.05**	0.00	-0.00*	0.02	-0.01	-0.15	*Gov1*	52	0.17
	(-2.5)	-0.36	(-1.97)	-1.61	(-0.47)	(-0.72)			
14	-0.03	0.01	0.00	0.01	0.00	-0.24	*Gov2*	52	0.11
	(-1.58)	-1.15	(-1.6)	-1.04	(-0.06)	(-1.12)			
15	-0.05**	0.00	0.00	0.02	-0.01	-0.17	*Gov3*	52	0.15
	(-2.27)	-0.37	(-1.14)	-1.45	(-0.27)	(-0.84)			
16	-0.06**	0.00	0.00	0.02	-0.01	-0.16	*Gov4*	52	0.15
	(-2.22)	-0.48	(-1.09)	-1.28	(-0.28)	(-0.79)			
17	-0.05**	0.00	0.00	0.02	-0.01	-0.14	*Gov5*	52	0.17
	(-2.43)	-0.19	(-1.31)	-1.41	(-0.41)	(-0.67)			
18	-0.05**	0.00	0.00	0.02	0.00	-0.17	*Gov6*	52	0.17
	(-2.44)	-0.29	(-1.16)	-1.27	(-0.25)	(-0.83)			
19	-0.02**	0.00	0.00	0.02	-0.01	-0.17	*Gov_PCA*	52	0.16
	(-2.41)	-0.38	(-1.3)	-1.4	(-0.27)	(-0.85)			
20	-0.00**	0.00	0.00	0.02	0.00	-0.2	*Corp Ethics*	50	0.16
	(-2.15)	-0.83	(-0.66)	-1.22	-0.11	(-0.97)			
21	-0.00**	0.00	0.00	0.02	0.00	-0.16	*Corrupt Illegal*	50	0.17
	(-2.28)	-0.56	(-0.5)	-1.41	(-0.05)	(-0.77)			
22	-0.00*	0.01	0.00	0.01	0.00	-0.25	*Corrupt Legal*	50	0.13
	(-1.77)	-1.24	(-1.02)	-0.99	-0.24	(-1.2)			
23	-0.00*	0.00	0.00	0.01	0.00	-0.23	*Public Ethics*	50	0.14
	(-1.91)	-0.97	(-0.79)	-1.17	-0.12	(-1.07)			
24	-0.04**	0.00	0.00	0.02	-0.01	0.01	*WEF Ethics*	52	0.15
	(-2.16)	-0.41	(-1.06)	-1.22	(-0.4)	-0.07			

4.4.2. **Results of Firm-level Framework**

As noted before, country-level analysis may be limited by the small number of observations, and may be subject to Generated-Regressor problem. Therefore, we employ the firm-level framework specified by Equation (4.3). Table 4.7, 4.8 and 4.9 report firm-level logit and tobit regressions. We organize and report the results in a similar pattern as the results of the country-level framework. Model 1-6 of the three tables report proxy indices for information transparency, Model 7-10 for investor protection, and the remaining models for law system, political institutions and corruption control. For simplicity, the main variables of interest are cash-flow risk (*SRVOL*), proxies for country-level institutional environment (*CtryV*) and their interaction term (*X*). All other firm-level and country-level control variables as used in the country-level framework are controlled but not reported in tables.

The tables show the sample size for the firm-level framework is much larger than the second stage of the country-level framework. The number of observations is generally over 250,000 in the firm-level framework. In Table 4.7-4.9, we find that the coefficients of *SRVOL* are all significantly negative. This finding is consistent with the country-level framework as well as Chay and Suh (2009), meaning dividend payout policy is more conservative (not pay dividends or pay less dividends) when cash-flow uncertainty is high given the average level of institutional environment. At the same time, we notice that the majority of country-level institutional environment indices are positively correlated with dividend payout. This suggests for given future cash-flow risk, firms in countries with stronger institutions are more likely to pay (more) dividends. This is generally consistent with the spirit of La Porta et al. (2000). Most importantly, we multiply firm-level *SRVOL* with demeaned country-level institutional environment indices to form an interaction term *X*. Throughout these three tables, most coefficients

of *X* are negative and significant. Therefore, the interpretation is that the negative dividend cash-flow sensitivity is more prominent in countries with better institutional environment, in terms of information quality, investor protection, law system, political institutions and corruption controls. This is also consistent with the country-level framework above. In supplementary tests, we repeat the same firm-level analysis using total payout ratios (*Total/Earn* and *Total/Sales*) as alternative dependent variables and find very similar results. For simplicity, we do not tabulate these results.

To sum up, the country-level and firm-level analysis frameworks both confirm that the negative dividend cash-flow sensitivity is stronger in countries with a better institutional environment.

Table 4.7: Result of firm-level logit model on dividend payout dummy

This table reports logit regression results of Equation (4.3). The dependent variable is the dividend payout dummy variable (*Div*) indicating whether or not a firm pays dividends. *SRVOL* is stock return volatility. *CtryV* is country-level institutional environment index. "*CtryV* Name" column lists the index used in each regression. *X* is the interaction term of *SRVOL* and demeaned *CtryV*. All other firm-level and country-level control variables are included and are the same as in the country-level framework. N is number of observations. Robust standard errors are clustered by country. Chi-square statistics are reported in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Model	Main Variables			Firm-level Control	Country-level Control	CtryV Name	N
	SRVOL	*CtryV*	*X*				
1	-7.37***	0.51**	-1.65**	Yes	Yes	*Audit*	259,535
	-106.17	-5.11	-4.77	Yes	Yes		
2	-7.61***	0.05*	-0.17*	Yes	Yes	*AcctStd*	261,122
	-221.2	-3.07	-2.76	Yes	Yes		
3	-7.18***	0.01	-0.08**	Yes	Yes	*Media*	249,802
	-107.19	-0.49	-4.74	Yes	Yes		
4	-6.97***	0.83**	-3.18***	Yes	Yes	*WEF Audit*	278,649
	-149.04	-6.03	-11.98	Yes	Yes		
5	-7.26***	0.13	-0.77	Yes	Yes	*WEF Info*	261,031
	-95.69	-2.06	-1.41	Yes	Yes		
6	-7.28***	0.87**	-2.41**	Yes	Yes	*WEF Ex Reg*	278,649
	-87.2	-4.72	-3.94	Yes	Yes		
7	-6.84***	0.76**	-4.23***	Yes	Yes	*WEF Board*	278,649
	-90.82	-5.16	-15.36	Yes	Yes		
8	-6.46***	0.02*	-0.09***	Yes	Yes	*Corp Gov*	277,875
	-107.86	-3.37	-10.01	Yes	Yes		
9	-7.41***	0.06	-0.3	Yes	Yes	*WEF Investor*	278,202
	-68.08	-0.24	-0.47	Yes	Yes		
10	-7.18***	0.55**	-3.22***	Yes	Yes	*WEF Minority*	278,649
	-147.95	-5.41	-15.81	Yes	Yes		
11	-7.16***	0.22**	-0.3	Yes	Yes	*WEF Legal*	278,202
	-116.25	-5.21	-1.08	Yes	Yes		
12	-6.21***	0.03***	-0.09***	Yes	Yes	*Legal Eff*	277,875
	-157.51	-7.74	-21.38	Yes	Yes		

Table 4.7: Result of firm-level logit model on dividend payout dummy – continued

Model	Main Variables			Firm-level Control	Country-level Control	CtryV Name	N
	SRVOL	*CtryV*	*X*				
13	-7.41***	-0.06	-1.54**	Yes	Yes	*Gov1*	278,649
	(123.39)	(0.04)	(4.41)	Yes	Yes		
14	-6.76***	0.87***	-3.42***	Yes	Yes	*Gov2*	278,649
	(83.25)	(9.33)	(28.34)	Yes	Yes		
15	-7***	0.2	-2.11***	Yes	Yes	*Gov3*	278,649
	(149.8)	(0.46)	(7.67)	Yes	Yes		
16	-7.35***	-0.15	-1.81*	Yes	Yes	*Gov4*	278,649
	(150.95)	(0.13)	(3.22)	Yes	Yes		
17	-6.82***	0.41	-2.16***	Yes	Yes	*Gov5*	278,649
	(128.17)	(2.36)	(11.24)	Yes	Yes		
18	-7.08***	0.24	-1.98***	Yes	Yes	*Gov6*	278,649
	(188.47)	(1.18)	(11.3)	Yes	Yes		
19	-6.98***	0.12	-0.97***	Yes	Yes	*Gov_PCA*	278,649
	(147.39)	(1.14)	(11.1)	Yes	Yes		
20	-6.31***	0.04***	-0.13***	Yes	Yes	*Corp Ethics*	277,875
	(196.22)	(9.99)	(24.32)	Yes	Yes		
21	-6.35***	0.02**	-0.1***	Yes	Yes	*Corrupt Illegal*	277,875
	(228.66)	(5.42)	(26.05)	Yes	Yes		
22	-6.92***	0.05***	-0.12***	Yes	Yes	*Corrupt Legal*	277,875
	(115.93)	(14.78)	(21.62)	Yes	Yes		
23	-6.82***	0.02*	-0.09***	Yes	Yes	*Public Ethics*	277,875
	(194.98)	(3.44)	(11.05)	Yes	Yes		
24	-6.7***	0.49**	-2.33***	Yes	Yes	*WEF Ethics*	278,649
	(158.27)	(5.91)	(21.76)	Yes	Yes		

Table 4.8: Result of firm-level tobit model on dividend to earnings ratio

This table reports tobit regression results of Equation (4.3). The dependent variable is the dividend to earnings ratio (*Div/Earn*) indicating whether or not a firm pays dividends. *SRVOL* is stock return volatility. *CtryV* is country-level institutional environment index. "*CtryV* Name" column lists the index used in each regression. *X* is the interaction term of *SRVOL* and demeaned *CtryV*. All other firm-level and country-level control variables are included and are the same as in the country-level framework. N is number of observations. Robust standard errors are clustered by country. Chi-square statistics are reported in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Model	Main Variables			Firm-level Control	Country-level Control	CtryV Name	N
	SRVOL	*CtryV*	*X*				
1	-2.16***	0.08	-0.36	Yes	Yes	*Audit*	240,244
	(-7.09)	(1.34)	(-1.57)	Yes	Yes		
2	-2.26***	0.00	-0.04	Yes	Yes	*AcctStd*	241,750
	(-8.11)	(0.76)	(-1.39)	Yes	Yes		
3	-2.03***	0.00	-0.02***	Yes	Yes	*Media*	231,040
	(-8.24)	(1.41)	(-2.95)	Yes	Yes		
4	-2.27***	0.03	-0.01	Yes	Yes	*WEF Audit*	240,244
	(-7.96)	(0.58)	(-0.06)	Yes	Yes		
5	-2.07***	0.05**	-0.34*	Yes	Yes	*WEF Info*	241,866
	(-7.63)	(2.14)	(-1.92)	Yes	Yes		
6	-2.06***	0.18**	-1.12***	Yes	Yes	*WEF Ex Reg*	258,589
	(-7.92)	(2.47)	(-3.17)	Yes	Yes		
7	-2.21***	0.13	-0.29	Yes	Yes	*WEF Board*	258,589
	(-7.75)	(1.46)	(-0.87)	Yes	Yes		
8	-1.96***	0.00**	-0.02***	Yes	Yes	*Corp Gov*	257,879
	(-7.82)	(2.20)	(-3.56)	Yes	Yes		
9	-2.15***	0.01	-0.15	Yes	Yes	*WEF Investor*	258,162
	(-7.22)	(0.53)	(-1.43)	Yes	Yes		
10	-2.15***	0.12***	-0.82***	Yes	Yes	*WEF Minority*	258,589
	(-8.15)	(2.81)	(-2.88)	Yes	Yes		
11	-2.27***	0.02	0.00	Yes	Yes	*WEF Legal*	257,452
	(-7.35)	(0.91)	(0.12)	Yes	Yes		
12	-1.94***	0.01***	-0.02***	Yes	Yes	*Legal Eff*	257,879
	(-8.07)	(2.65)	(-3.31)	Yes	Yes		

Table 4.8: Result of firm-level tobit model on dividend to earnings ratio – continued

Model	Main Variables			Firm-level Control	Country-level Control	CtryV Name	N
	SRVOL	*CtryV*	*X*				
13	-2.21***	0.00	-0.42**	Yes	Yes	*Gov1*	258,589
	(-8.48)	(-0.00)	(-2.08)	Yes	Yes		
14	-2.09***	0.15***	-0.59**	Yes	Yes	*Gov2*	258,589
	(-7.90)	(2.58)	(-2.24)	Yes	Yes		
15	-2.11***	0.05	-0.55***	Yes	Yes	*Gov3*	258,589
	(-8.71)	(0.90)	(-3.00)	Yes	Yes		
16	-2.15***	0.02	-0.54***	Yes	Yes	*Gov4*	258,589
	(-8.84)	(0.31)	(-2.73)	Yes	Yes		
17	-2.08***	0.09	-0.53***	Yes	Yes	*Gov5*	258,589
	(-8.52)	(1.49)	(-2.88)	Yes	Yes		
18	-2.13***	0.06	-0.48***	Yes	Yes	*Gov6*	258,589
	(-8.84)	(1.33)	(-2.88)	Yes	Yes		
19	-2.11***	0.03	-0.23***	Yes	Yes	*Gov_PCA*	258,589
	(-8.67)	(1.18)	(-2.84)	Yes	Yes		
20	-2***	0.01***	-0.02***	Yes	Yes	*Corp Ethics*	257,879
	(-8.21)	(3.22)	(-2.62)	Yes	Yes		
21	-1.95***	0.01***	-0.02***	Yes	Yes	*Corrupt Illegal*	257,879
	(-8.55)	(2.76)	(-3.37)	Yes	Yes		
22	-2.11***	0.01***	-0.01	Yes	Yes	*Corrupt Legal*	257,879
	(-8.11)	(3.77)	(-0.65)	Yes	Yes		
23	-2.08***	0.00**	-0.02***	Yes	Yes	*Public Ethics*	257,879
	(-8.54)	(2.25)	(-2.75)	Yes	Yes		
24	-2.07***	0.09**	-0.48***	Yes	Yes	*WEF Ethics*	258,589
	(-8.49)	(2.22)	(-2.83)	Yes	Yes		

Table 4.9: Result of firm-level tobit model on dividend to sales ratio

This table reports tobit regression results of Equation (4.3). The dependent variable is the dividend to sales ratio (*Div/Sales*) indicating whether or not a firm pays dividends. *SRVOL* is stock return volatility. *CtryV* is country-level institutional environment index. "*CtryV* Name" column lists the index used in each regression. *X* is the interaction term of *SRVOL* and demeaned *CtryV*. All other firm-level and country-level control variables are included and are the same as in the country-level framework. N is number of observations. Robust standard errors are clustered by country. Chi-square statistics are reported in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Model	Main Variables			Firm-level Control	Country-level Control	CtryV Name	N
	SRVOL	*CtryV*	*X*				
1	-0.16***	0.00	-0.01	Yes	Yes	*Audit*	259,535
	(-5.25)	(0.77)	(-0.51)	Yes	Yes		
2	-0.16***	0.00	-0.00	Yes	Yes	*AcctStd*	261,122
	(-5.04)	(1.21)	(-1.61)	Yes	Yes		
3	-0.16***	0.00	0.00	Yes	Yes	*Media*	249,802
	(-5.70)	(0.02)	(-0.22)	Yes	Yes		
4	-0.15***	0.01***	-0.06***	Yes	Yes	*WEF Audit*	278,649
	(-5.29)	(2.79)	(-2.84)	Yes	Yes		
5	-0.15***	0.00**	-0.02**	Yes	Yes	*WEF Info*	261,031
	(-4.70)	(2.06)	(-2.43)	Yes	Yes		
6	-0.16***	0.01	-0.05**	Yes	Yes	*WEF Ex Reg*	278,649
	(-5.31)	(1.36)	(-2.08)	Yes	Yes		
7	-0.15***	0.01*	-0.06**	Yes	Yes	*WEF Board*	278,649
	(-5.23)	(1.65)	(-1.97)	Yes	Yes		
8	-0.16***	0.00	-0.00	Yes	Yes	*Corp Gov*	277,875
	(-5.70)	(0.96)	(-0.96)	Yes	Yes		
9	-0.16***	0.00	-0.01	Yes	Yes	*WEF Investor*	278,202
	(-4.92)	(0.57)	(-0.89)	Yes	Yes		
10	-0.16***	0.01**	-0.06***	Yes	Yes	*WEF Minority*	278,649
	(-5.27)	(2.53)	(-2.67)	Yes	Yes		
11	-0.16***	0.00	-0.01	Yes	Yes	*WEF Legal*	278,202
	(-4.84)	(0.76)	(-1.01)	Yes	Yes		
12	-0.15***	0.00**	-0.00**	Yes	Yes	*Legal Eff*	277,875
	(-5.38)	(1.99)	(-2.09)	Yes	Yes		

Table 4.9: Result of firm-level tobit model on dividend to sales ratio – continued

Model	Main Variables			Firm-level Control	Country-level Control	CtryV Name	N
	SRVOL	*CtryV*	*X*				
13	-0.17***	-0.00	-0.01	Yes	Yes	*Gov1*	278,649
	(-5.68)	(-0.56)	(-0.43)	Yes	Yes		
14	-0.16***	0.00	-0.02	Yes	Yes	*Gov2*	278,649
	(-6.19)	(0.58)	(-0.71)	Yes	Yes		
15	-0.16***	0.00	-0.03**	Yes	Yes	*Gov3*	278,649
	(-5.23)	(0.77)	(-2.21)	Yes	Yes		
16	-0.16***	0.00	-0.04**	Yes	Yes	*Gov4*	278,649
	(-5.05)	(0.83)	(-2.45)	Yes	Yes		
17	-0.16***	0.00	-0.02	Yes	Yes	*Gov5*	278,649
	(-5.73)	(0.75)	(-1.28)	Yes	Yes		
18	-0.16***	0.00	-0.03**	Yes	Yes	*Gov6*	278,649
	(-5.37)	(1.25)	(-2.25)	Yes	Yes		
19	-0.16***	0.00	-0.01*	Yes	Yes	*Gov_PCA*	278,649
	(-5.54)	(0.68)	(-1.67)	Yes	Yes		
20	-0.15***	0.00***	-0.00**	Yes	Yes	*Corp Ethics*	277,875
	(-5.44)	(2.70)	(-2.56)	Yes	Yes		
21	-0.15***	0.00**	-0.00**	Yes	Yes	*Corrupt Illegal*	277,875
	(-5.48)	(2.22)	(-2.26)	Yes	Yes		
22	-0.16***	0.00***	-0.00***	Yes	Yes	*Corrupt Legal*	277,875
	(-5.31)	(3.16)	(-2.93)	Yes	Yes		
23	-0.15***	0.00**	-0.00***	Yes	Yes	*Public Ethics*	277,875
	(-5.16)	(2.16)	(-3.10)	Yes	Yes		
24	-0.15***	0.01*	-0.03**	Yes	Yes	*WEF Ethics*	278,649
	(-5.46)	(1.83)	(-2.27)	Yes	Yes		

4.5. Robustness Tests

4.5.1. **Removing Dominant Sample Country**

In our firm-level framework, we have many more observations than in the country-level framework. We can easily identify some dominant countries with a larger number of firms than other sample countries. For example, according to Table 4.1, there are 9,307 firms from the US as the biggest sample country, followed by the UK with 2,884 firms. The biggest sample country (the US) has more than three times the firms of the second largest one (the UK). Therefore, it is possible that the results of firm-level framework may be biased by the dominant sample country. Fortunately, this potential problem does not affect our country-level framework, because its first stage regression is done country by country and its second stage regression gives equal weight to every sample country with one observation per sample country. To address the concern of dominant country bias, we implement robustness checks in the firm-level framework by removing US firms. We repeat all five logit and tobit models of Equation (4.3) and find results are statistically unchanged compared to results from the whole sample (results are not tabulated). Therefore, the results of the firm-level framework are not biased by the dominant sample country.

4.5.2. **Does the Financial Crisis Strengthen the Sensitivity?**

Our sample period from 1994 to 2011 covers the occurrence of the Global Financial Crisis (GFC) from 2008. Given the severity of the GFC and its widespread impacts on the global financial markets, we are interested to see if the negative dividend cash-flow uncertainty still holds during this extreme period, and whether such negative relationship is stronger during the GFC. We split the original sample period into two sub-periods: 1994-2007 and 2008-2011.

To begin with, we repeat the country-level framework over these two sub-periods. Table 4.10 reports β_1 of the first stage of the country-level framework over the period 1994-2007, and Table 4.11 reports result over the remaining period over 2008-2011[28]. From the two tables, we find that most β_1 are significantly negative regardless of periods before or after the GFC. So the GFC does not alter the negative relationship between dividend and cash-flow uncertainty.

Although the negative dividend cash-flow sensitivity is not changed by the GFC, we further check if the negative relationship becomes stronger during the financial turmoil due to higher operational risks within this special period. To do so, we implement a paired difference in means test using β_1 from two subsamples as $\overline{\beta_1}$(1994-2007) minus $\overline{\beta_1}$(2008-2011). If the dividend cash-flow sensitivity is more negative during the GFC, the test statistic should be significantly positive. Because we have five different dependent variables (*Div*, *Div/Earn*, *Div/Sales*, *Total/Earn* and *Total/Sales*), we compare five comparison groups. We find that in four out of five cases the test statistic is not significant, meaning $\overline{\beta_1}$(2008-2011) is not significantly larger than $\overline{\beta_1}$(1994-2007). One exception is to compare β_1 of tobit model when *Div/Earn* is the dependent variable. For this case only, the difference in means is 0.41 which is significant at the 5% level. Therefore, we do not find strong evidence showing that the negative dividend cash-flow sensitivity is strengthened by the GFC under our country-level framework.

We also continue the second stage analysis of country-level framework using β_1 generated from the two sub-periods. Results show that within both sub-periods, country-level institutional environment always strengthens the negative dividend cash-flow sensitivity.

[28] Vietnam does not have data in the period of 1994-2007, so it is not listed in Table 4.10.

Table 4.10: Stage one result of country-level framework over 1994-2007

This table reports the coefficients of *SRVOL* (β_1) of Equation (4.1) over the sub-period 1994-2007. β_1 (Div) is obtained from logit regression on *Div*. β_1 (*Div/Earn*), β_1 (*Div/Sales*), β_1(*Total/Earn*) and β_1(*Total/Sales*) are from tobit regressions on censored *Div/Earn*, *Div/Sales*, *Total/Earn* and *Total/Sales*, respectively. All other firm-level control variables are included but not reported. Chi-square (t-) statistics are reported in parentheses for logit (tobit) regressions. ***, ** and * indicate significance at the 10%, 5% and 1% levels respectively.

Country/Region	β_1(*Div*)	β_1(*Div/Earn*)	β_1(*Div/Sales*)	β_1(*Total/Earn*)	β_1(*Total/Sales*)
Argentina	-3.97***	-1.83***	-0.19***	-1.62***	-0.30***
	(8.13)	(-3.18)	(-3.82)	(-2.75)	(-3.64)
Australia	-12.29***	-3.35***	-0.31***	-3.33***	-0.68***
	(255.85)	(-21.13)	(-19.06)	(-19.77)	(-15.6)
Austria	2.60	-0.76*	0.01	-0.94**	-0.18*
	(1.22)	(-1.74)	(0.25)	(-2.05)	(-1.78)
Belgium	-13.17***	-3.35***	-0.23***	-4.01***	-0.86***
	(17.58)	(-6.16)	(-4.22)	(-6.59)	(-5.28)
Bulgaria	-3.71*	-0.95	-0.10*	-0.95	-0.10*
	(2.82)	(-1.4)	(-1.8)	(-1.4)	(-1.8)
Canada	-17.69***	-6.38***	-0.58***	-5.80***	-0.92***
	(502.22)	(-24.68)	(-25.27)	(-22.8)	(-19.36)
China	-5.78***	-1.69***	-0.15***	-1.69***	-0.16***
	(70.32)	(-9.82)	(-8.73)	(-9.83)	(-6.83)
Croatia	-313.40	-8.32	-0.81	-8.32	-1.13
	(0.34)	(-0.96)	(-0.93)	(-0.96)	(-0.91)
Cyprus	-8.49***	-2.59***	-0.33***	-2.59***	-0.37***
	(7.71)	(-3.07)	(-3.65)	(-3.07)	(-3.47)
Czech Republic	-10.19***	-3.06***	-0.28**	-3.05***	-0.51*
	(9.08)	(-2.59)	(-2.58)	(-2.59)	(-1.93)
Denmark	-10.27***	-1.50***	-0.14***	-1.90***	-0.34***
	(50.9)	(-6.58)	(-6.32)	(-7.42)	(-6.62)
Egypt	-6.90***	-1.31***	-0.22***	-1.20***	-0.25***
	(14.38)	(-3.53)	(-4.37)	(-3.33)	(-2.93)
Finland	-10.38***	-2.41***	-0.24***	-2.50***	-0.35***
	(37.95)	(-9.02)	(-9.96)	(-8.95)	(-7.94)
France	-8.95***	-2.04***	-0.18***	-2.11***	-0.35***
	(302.06)	(-19.26)	(-19.48)	(-19.48)	(-16.76)
Germany	-9.00***	-2.91***	-0.17***	-2.82***	-0.31***
	(279.11)	(-18.1)	(-16.63)	(-17.58)	(-13.58)
Hong Kong SAR	-6.44***	-1.70***	-0.19***	-1.64***	-0.28***
	(264.76)	(-19.37)	(-18.15)	(-18.75)	(-15.33)
India	-3.10***	-0.74***	-0.05***	-0.84***	-0.09***
	(18.21)	(-6.3)	(-4.65)	(-6.12)	(-3.06)
Indonesia	-4.49***	-1.43***	-0.09***	-1.46***	-0.11***
	(71.48)	(-10.09)	(-8.08)	(-10.15)	(-6.91)
Ireland	-13.93***	-1.81***	-0.18***	-1.78***	-0.26***
	(28)	(-5.14)	(-6.02)	(-4.52)	(-5.08)

Table 4.10: Stage one result of country-level framework over 1994-2007 – continued

Country/Region	β_1(*Div*)	β_1(*Div/Earn*)	β_1(*Div/Sales*)	β_1(*Total/Earn*)	β_1(*Total/Sales*)
Israel	-7.74***	-2.79***	-0.27***	-2.51***	-0.43***
	(40.22)	(-5.9)	(-6.67)	(-5.42)	(-5.77)
Italy	-9.40***	-1.95***	-0.17***	-2.19***	-0.23***
	(67.99)	(-7.4)	(-7.56)	(-7.96)	(-6.71)
Japan	-6.69***	-0.94***	-0.03***	-1.15***	-0.04***
	(607.51)	(-23.5)	(-29.72)	(-27.37)	(-23.5)
Jordan	-11.01**	-5.47***	-0.58***	-5.49***	-0.74***
	(4.5)	(-2.67)	(-2.67)	(-2.63)	(-2.64)
Kuwait	0.47	-0.74	-0.06	-0.84	0.19
	(0)	(-0.9)	(-0.4)	(-1)	(0.39)
Malaysia	-5.12***	-1.40***	-0.13***	-1.45***	-0.20***
	(136.81)	(-14.76)	(-15.24)	(-14.89)	(-13.32)
Mexico	-7.31***	-1.97***	-0.18***	-1.33***	-0.14***
	(21.69)	(-4.8)	(-5.08)	(-3.61)	(-3.04)
Morocco	-9.66	-2.56**	-0.29*	-2.44*	-0.68*
	(0.57)	(-1.97)	(-1.84)	(-1.83)	(-1.91)
Netherlands	-12.58***	-2.38***	-0.24***	-4.66***	-0.94***
	(39.87)	(-6.93)	(-8.47)	(-8.43)	(-6.99)
New Zealand	-24.22***	-4.29***	-0.62***	-4.38***	-1.45***
	(47.83)	(-7.08)	(-8.46)	(-6.74)	(-6.96)
Norway	-13.02***	-3.01***	-0.24***	-2.60***	-0.38***
	(52.66)	(-5.71)	(-5.41)	(-4.86)	(-3.55)
Oman	-0.75	-1.06	-0.11	-1.06	-0.12
	(0.02)	(-0.82)	(-0.54)	(-0.82)	(-0.56)
Pakistan	-7.39***	-1.59***	-0.10***	-1.47***	-0.12***
	(18.74)	(-4.72)	(-3.32)	(-4.37)	(-3.12)
Peru	-3.86***	-1.29***	-0.14***	-1.11***	-0.17***
	(14.7)	(-3.77)	(-4.33)	(-3.19)	(-3.32)
Philippines	-1.30	-0.96***	-0.07***	-0.74***	-0.06
	(2.66)	(-4.25)	(-2.6)	(-2.88)	(-0.76)
Poland	-6.87***	-2.96***	-0.19***	-3.11***	-0.23***
	(29.96)	(-6.98)	(-6.65)	(-6.75)	(-5.95)
Portugal	-3.80***	-0.84***	-0.09***	-1.07***	-0.15***
	(8.81)	(-2.74)	(-3.42)	(-3.14)	(-3.07)
Romania	-2.08	-1.46**	-0.05	-1.46**	-0.05
	(1.98)	(-2.26)	(-0.85)	(-2.26)	(-0.68)
Russia	0.30	-0.04	0.00	0.00	-0.02
	(0.03)	(-0.14)	(0.04)	(0.01)	(-0.27)
Singapore	-5.84***	-1.62***	-0.18***	-1.68***	-0.30***
	(91.69)	(-12.54)	(-14.6)	(-12.27)	(-11.44)
South Africa	-7.47***	-1.67***	-0.23***	-1.84***	-0.67***
	(131.47)	(-14.03)	(-14.45)	(-13.48)	(-13.52)
South Korea	-3.95***	-0.71***	-0.04***	-0.77***	-0.06***
	(129.94)	(-10.88)	(-15.91)	(-9.92)	(-7.09)

Table 4.10: Stage one result of country-level framework over 1994-2007 – continued

Country/Region	β_1(*Div*)	β_1(*Div/Earn*)	β_1(*Div/Sales*)	β_1(*Total/Earn*)	β_1(*Total/Sales*)
Spain	-5.12***	-1.42***	-0.22***	-1.51***	-0.38***
	(18.32)	(-6.86)	(-8.09)	(-6.61)	(-6.59)
Sri Lanka	-2.78**	-1.21***	-0.14***	-1.15***	-0.21***
	(3.98)	(-3.87)	(-3.35)	(-3.5)	(-2.78)
Sweden	-12.33***	-3.03***	-0.25***	-3.45***	-0.38***
	(124.48)	(-13.77)	(-12.84)	(-13.87)	(-10.63)
Switzerland	-17.45***	-3.17***	-0.36***	-2.75***	-0.51***
	(134.59)	(-14.18)	(-15.35)	(-11.37)	(-10.05)
Taiwan, China	-8.24***	-2.45***	-0.23***	-2.32***	-0.28***
	(235.7)	(-18.22)	(-20.43)	(-17.07)	(-17.74)
Thailand	-13.56***	-2.80***	-0.22***	-2.76***	-0.35***
	(53.13)	(-7.78)	(-6.94)	(-7.65)	(-6.41)
Turkey	0.14	-0.39	-0.06***	-0.38	-0.10***
	(0.03)	(-1.43)	(-2.89)	(-1.39)	(-2.93)
United Kingdom	-9.18***	-1.62***	-0.17***	-1.88***	-0.33***
	(559.52)	(-22.77)	(-28.82)	(-21.75)	(-20.81)
United States	-9.06***	-2.91***	-0.19***	-3.13***	-0.35***
	(1875.71)	(-46.71)	(-45.48)	(-44.67)	(-35.04)

Table 4.11: Stage one result of country-level framework over 2008-2011

This table reports the coefficients of *SRVOL* (β_1) of Equation (4.1) over the sub-period 2008-2011. β_1 (Div) is obtained from logit regression on *Div*. β_1 (*Div/Earn*), β_1 (*Div/Sales*), β_1(*Total/Earn*) and β_1(*Total/Sales*) are from tobit regressions on censored *Div/Earn*, *Div/Sales*, *Total/Earn* and *Total/Sales*, respectively. All other firm-level control variables are included but not reported. Chi-square (t-) statistics are reported in parentheses for logit (tobit) regressions. ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Country/Region	β_1(*Div*)	β_1(*Div/Earn*)	β_1(*Div/Sales*)	β_1(*Total/Earn*)	β_1(*Total/Sales*)
Argentina	-14.18***	-5.01***	-0.40***	-3.67***	-0.64***
	(10.31)	(-4.15)	(-3.62)	(-3.15)	(-2.88)
Australia	-10.13***	-3.16***	-0.28***	-3.11***	-0.44***
	(144.65)	(-13.8)	(-13.47)	(-13.04)	(-9.77)
Austria	-5.66	-2.07**	-0.01	-3.07***	-0.05
	(2.15)	(-2.31)	(-0.25)	(-3.28)	(-0.31)
Belgium	-23.05***	-2.93***	-0.31***	-2.44***	-0.34**
	(24.55)	(-4.33)	(-4.05)	(-3.86)	(-2.23)
Bulgaria	-3.75***	-1.26*	-0.06	-1.26*	-0.15*
	(7.78)	(-1.87)	(-1.48)	(-1.85)	(-1.82)
Canada	-14.20***	-6.04***	-0.48***	-5.74***	-0.82***
	(245.75)	(-16.09)	(-16.78)	(-16.74)	(-15.78)
China	-2.12	-0.30	-0.04	-0.21	-0.07
	(2.03)	(-0.94)	(-1.22)	(-0.66)	(-1.44)
Croatia	-3.64	-2.51**	-0.20**	-2.52**	-0.25**
	(1.96)	(-2.06)	(-2.29)	(-2.1)	(-2.31)
Cyprus	-6.93**	-4.18***	-0.18**	-4.16***	-0.23**
	(5.73)	(-2.72)	(-2.12)	(-2.71)	(-2.11)
Czech Republic	-61.94	-4.78	-0.29***	-4.78	-0.67***
	(1.86)	(-1.61)	(-2.91)	(-1.61)	(-3.32)
Denmark	-11.51***	-2.18***	-0.27***	-3.43***	-0.54***
	(14.96)	(-2.68)	(-3.87)	(-3.67)	(-3.4)
Egypt	-4.90**	-1.27***	-0.16***	-1.29***	-0.38***
	(5.49)	(-3.26)	(-3.8)	(-3.3)	(-3.16)
Finland	-9.68***	-1.96***	-0.22***	-2.02***	-0.33***
	(9.13)	(-2.97)	(-4.14)	(-3.03)	(-2.78)
France	-10.28***	-2.19***	-0.15***	-2.02***	-0.21***
	(71.39)	(-8.1)	(-8.27)	(-7.65)	(-6.05)
Germany	-11.11***	-3.40***	-0.24***	-3.17***	-0.42***
	(91.12)	(-9.29)	(-9.26)	(-8.79)	(-7.74)
Hong Kong SAR	-6.17***	-1.63***	-0.17***	-1.50***	-0.22***
	(109.97)	(-12.83)	(-12.23)	(-12.01)	(-8.29)
India	-1.94*	-0.66***	-0.03**	-0.75***	-0.06
	(3.23)	(-3.78)	(-2.53)	(-3.89)	(-1.61)
Indonesia	-1.55	-0.35*	-0.06***	-0.33	-0.07*
	(1.96)	(-1.69)	(-2.87)	(-1.57)	(-1.74)
Ireland	-20.67***	-4.44***	-0.25***	-4.22***	-0.24*
	(13.86)	(-3.64)	(-2.89)	(-3.01)	(-1.89)

Table 4.11: Stage one result of country-level framework over 2008-2011 – continued

Country/Region	β_1(*Div*)	β_1(*Div/Earn*)	β_1(*Div/Sales*)	β_1(*Total/Earn*)	β_1(*Total/Sales*)
Israel	-6.66***	-2.94***	-0.27***	-2.86***	-0.42***
	(37.89)	(-6.18)	(-7.09)	(-6.21)	(-7.13)
Italy	-7.48***	-2.90***	-0.16***	-2.89***	-0.26***
	(13.85)	(-4.21)	(-4.92)	(-4.37)	(-4.85)
Japan	-7.51***	-1.47***	-0.04***	-1.51***	-0.05***
	(308.94)	(-21.54)	(-17.63)	(-20.26)	(-13.41)
Jordan	-8.76***	-6.33***	-0.49***	-6.32***	-0.77***
	(11.27)	(-4.48)	(-4.55)	(-4.49)	(-3.87)
Kuwait	-8.16***	-2.04***	-0.30***	-2.35***	-0.93***
	(13.76)	(-2.74)	(-3.44)	(-3.41)	(-3.85)
Malaysia	-8.24***	-1.91***	-0.19***	-1.92***	-0.26***
	(93.5)	(-11.77)	(-11.36)	(-11.71)	(-9.46)
Mexico	-7.16***	-2.12***	-0.19***	-1.50***	-0.20**
	(8.38)	(-2.86)	(-2.68)	(-2.64)	(-2.24)
Morocco	-7.38	-2.39*	-0.09	-1.44	-0.07
	(1)	(-1.72)	(-0.76)	(-1.11)	(-0.38)
Netherlands	-14.29***	-3.76***	-0.23***	-3.28***	-0.30***
	(20.63)	(-4.95)	(-4.55)	(-4.07)	(-2.76)
New Zealand	-11.37***	-2.24***	-0.32***	-2.38***	-0.61***
	(12.9)	(-3.31)	(-5.06)	(-3.45)	(-5.08)
Norway	-11.69***	-5.81***	-0.38***	-5.08***	-0.46***
	(25.78)	(-5.72)	(-5.09)	(-5.65)	(-3.32)
Oman	3.01	-0.06	0.06	-0.06	0.11
	(1.03)	(-0.11)	(0.82)	(-0.11)	(0.96)
Pakistan	-12.63***	-2.63***	-0.29***	-3.13***	-0.33***
	(11.12)	(-3.62)	(-3.87)	(-3.45)	(-3.46)
Peru	0.71	0.24	0.01	0.22	0.00
	(0.21)	(0.66)	(0.2)	(0.58)	(0.02)
Philippines	-7.60***	-1.99***	-0.26***	-1.99***	-0.40***
	(24.71)	(-5.64)	(-5.95)	(-4.89)	(-4.45)
Poland	-7.61***	-4.11***	-0.21***	-3.92***	-0.25***
	(25.54)	(-6.28)	(-5.47)	(-6.33)	(-5.39)
Portugal	-1.69	-0.82	0.04	-1.02	-0.06
	(0.29)	(-0.69)	(0.59)	(-0.91)	(-0.49)
Romania	-6.96***	-2.73***	-0.22***	-2.73***	-0.35***
	(17.84)	(-3.68)	(-3.86)	(-3.68)	(-3.82)
Russia	-3.35***	-0.34	-0.06**	-0.38	-0.07
	(8.87)	(-1.14)	(-2.16)	(-1.2)	(-1.13)
Serbia	-5.41	-1.37	-0.12	-1.37	-0.13
	(0.63)	(-0.55)	(-0.62)	(-0.55)	(-0.63)
Singapore	-7.13***	-2.10***	-0.18***	-2.02***	-0.27***
	(88.35)	(-11.66)	(-10.54)	(-11.24)	(-8.65)

Table 4.11: Stage one result of country-level framework over 2008-2011 – continued

Country/Region	β_1(*Div*)	β_1(*Div/Earn*)	β_1(*Div/Sales*)	β_1(*Total/Earn*)	β_1(*Total/Sales*)
South Africa	-9.84***	-2.29***	-0.28***	-2.78***	-0.67***
	(33.55)	(-7.15)	(-7.7)	(-7.71)	(-7.47)
South Korea	-4.32***	-0.74***	-0.07***	-0.91***	-0.12***
	(65.36)	(-7.3)	(-13.47)	(-7.66)	(-8.97)
Spain	-15.04***	-3.14***	-0.25***	-2.75***	-0.61***
	(20.77)	(-3.7)	(-3.92)	(-3.47)	(-4.03)
Sri Lanka	-4.46***	-1.62***	-0.22***	-1.63***	-0.35***
	(8.37)	(-4.57)	(-5.17)	(-4.39)	(-4.54)
Sweden	-11.88***	-3.13***	-0.30***	-3.25***	-0.37***
	(49.28)	(-7.51)	(-6.85)	(-7.59)	(-6.53)
Switzerland	-13.32***	-2.53***	-0.49***	-1.74***	-0.78***
	(24.99)	(-5.06)	(-8.75)	(-3.91)	(-6.7)
Taiwan, China	-6.90***	-2.41***	-0.17***	-2.43***	-0.22***
	(96)	(-12.65)	(-12.63)	(-12.5)	(-10.82)
Thailand	-7.85***	-1.90***	-0.19***	-1.93***	-0.23***
	(22.65)	(-5.49)	(-6.49)	(-5.53)	(-4.58)
Turkey	-8.60***	-2.59***	-0.23***	-2.60***	-0.29***
	(19.23)	(-3.58)	(-4.24)	(-3.58)	(-2.59)
United Kingdom	-8.35***	-2.23***	-0.17***	-2.45***	-0.40***
	(179.57)	(-13.7)	(-14.06)	(-13.43)	(-11.67)
United States	-5.63***	-2.35***	-0.18***	-3.71***	-0.44***
	(286.38)	(-18.85)	(-18.86)	(-27.5)	(-23.66)
Vietnam	-0.29	-0.16	-0.01	-0.86	-0.21
	(0.02)	(-0.13)	(-0.15)	(-0.83)	(-1.23)

Finally, we implement the firm-level framework for 1994-2007 and 2008-2011 repeating Equation (4.3). We find very similar results as in Table 4.7-4.9. The coefficients of *SRVOL* are significantly negative within both sub-periods. Most coefficients of proxy indices for country-level institutional environment remain positive and significant, and most interaction terms remain significantly negative within both sub-periods.

Therefore, results of both the country-level and firm-level analysis frameworks show the negative relationship between dividend and cash-flow uncertainty is persistent during the period of the GFC. The occurrence of the GFC does not strengthen the relationship either.

4.6. Conclusion

In this chapter, we examine the heterogeneity of dividend cash-flow sensitivity within a context of country-level institutional environment. Building on the finding of Chay and Suh (2009), we hypothesize the negative relationship between dividend and cash-flow uncertainty is stronger in countries with a robust institutional environment. Using data from 38,467 firms from 52 countries over the period of 1994-2011, we employ a wide range of proxy variables for country-level institutions from different sources. Utilizing country-level as well as firm-level frameworks, we find empirical evidence that country-specific institutions intensify dividend cash-flow sensitivity. Our finding is robust to alternative measures of dividend payout, and is not driven by the dominant sample country. In an additional test, we find that dividend cash-flow sensitivity is not affected by the recent Global Financial Crisis. Our results highlight the complexity of understanding corporate dividend policy in the real world by emphasizing country-level institutions.

Chapter 5.

Concluding Remarks

In this thesis, we examine several aspects of globalization relevant to international finance. More specifically, we first find that financial markets liberalization and integration has a positive impact on technological innovation, which is one of the ultimate drivers of long-term economic growth. The stimulation is disproportionately higher for industry sectors which are more dependent on external finance, have better future growth opportunities, are younger and are high-tech intensive. Country-level institutional quality is found to intensify this positive effect. Next, we study accounting harmonization demonstrated by the introduction of IFRS. Evidence shows that mandatory IFRS adopters in the EU countries exhibit better innovative performance than local GAAP firms in other non-IFRS adoption countries. Country-level institutions also have an interaction effect with the promotion effect of IFRS on innovation. Moreover, the reduced cost of capital and increased institutional investor holdings are two possible underlying reasons. Finally, we identify the important role of institutions in shaping the negative relationship between dividend payout and future cash-flow uncertainty. The negative relationship is stronger in countries with better information quality, investor protection, legal and political systems, and control of corruption. The Global Financial Crisis does not alter nor intensify these interactions.

This thesis sheds some new light on globalized financial markets. Although financial markets liberalization has been extensively studied before, this thesis emphasizes the critical role played by financial markets liberalization in stimulating technological innovation. Policy makers may carefully design policies to facilitate the integration of financial markets into global markets, particularly the policies fostering technological innovation. In addition, the positive impact of accounting harmonization on technological innovation may provide policy makers and financial managers, especially those from countries which have not adopted IFRS, an incentive to adopt

internationally universal accounting rules. This finding also provides a unique angle to international investors in analysing investment opportunities, taking accounting systems into consideration. Moreover, understanding the interrelationship between country-level institutional quality and firm-level dividend cash-flow risk may also benefit investors and financial managers in evaluating investment projects. Finally, the importance of country-level institutional quality in shaping financial markets may draw the attention of governments on improving their countries' institutional quality.

References

Acemoglu, D., S. Johnson, and T. Mitton. 2009. Determinants of Vertical Integration: Financial Development and Contracting Costs. The Journal of Finance 64: 1251-90.

Acharya, V. V., and K. V. Subramanian. 2009. Bankruptcy Codes and Innovation. Review of Financial Studies 22: 4949-88.

Acs, Z. J., and D. B. Audretsch. 1988. Innovation in Large and Small Firms - an Empirical-Analysis. American Economic Review 78: 678-90.

Aggarwal, R., and J. W. Goodell. 2009. Markets and Institutions in Financial Intermediation: National Characteristics as Determinants. Journal of Banking & Finance 33: 1770-80.

Aghion, P., N. Bloom, R. Blundell, R. Griffith, and P. Howitt. 2005. Competition and Innovation: An Inverted-U Relationship. Quarterly Journal of Economics 120: 701-28.

Aghion, P., S. Bond, A. Klemm, and I. Marinescu. 2004. Technology and Financial Structure: Are Innovative Firms Different? Journal of the European Economic Association 2: 277-88.

Aghion, P., J. Van Reenen, and L. Zingales. 2013. Innovation and Institutional Ownership. American Economic Review 103: 277-304.

Allayannis, G., G. W. Brown, and L. F. Klapper. 2003. Capital Structure and Financial Risk: Evidence from Foreign Debt Use in East Asia. The Journal of Finance 58: 2667-710.

Allen, F., and D. Gale. 1999. Diversity of Opinion and Financing of New Technologies. Journal of Financial Intermediation 8: 68-89.

Armstrong, C. S., M. E. Barth, A. D. Jagolinzer, and E. J. Riedl. 2010. Market Reaction to the Adoption of IFRS in Europe. The Accounting Review 85: 31-61.

Ashbaugh, H., and M. Pincus. 2001. Domestic Accounting Standards, International Accounting Standards, and the Predictability of Earnings. Journal of Accounting Research 39: 417-34.

Atanassov, J. 2013. Do Hostile Takeovers Stifle Innovation? Evidence from Antitakeover Legislation and Corporate Patenting. The Journal of Finance 68: 1097-131.

Ayyagari, M., A. Demirgüç-Kunt, and V. Maksimovic. 2012. Firm Innovation in Emerging Markets: The Role of Finance, Governance, and Competition. Journal of Financial and Quantitative Analysis 46: 1545-80.

Ball, R., A. Robin, and J. S. Wu. 2003. Incentives versus Standards: Properties of Accounting Income in Four East Asian Countries. Journal of Accounting and Economics 36: 235-70.

Barry, C. B., and S. J. Brown. 1985. Differential Information and Security Market Equilibrium. Journal of Financial and Quantitative Analysis 20: 407-22.

Barth, M. E. 2007. Research, Standard Setting, and Global Financial Reporting. Now Publishers Inc, Hanover, MA.

Beck, T., A. Demirguckunt, and R. Levine. 2006. Bank Supervision and Corruption in Lending. Journal of Monetary Economics 53: 2131-63.

Beck, T., and R. Levine. 2002. Industry Growth and Capital Allocation: Does Having a Market- or Bank-based System Matter? Journal of Financial Economics 64: 147-80.

Bekaert, G. 1995. Market Integration and Investment Barriers in Emerging Equity Markets. World Bank Economic Review 9: 75-107.

Bekaert, G., and C. Harvey. 2000. Foreign Speculators and Emerging Equity Markets. The Journal of Finance 55: 565-613.

Bekaert, G., C. Harvey, and C. Lundblad. 2005. Does Financial Liberalization Spur Growth? Journal of Financial Economics 77: 3-55.

Bekaert, G., C. Harvey, and C. Lundblad. 2011. Financial Openness and Productivity. World Development 39: 1-19.

Bekaert, G., C. Harvey, C. Lundblad, and S. Siegel. 2007. Global Growth Opportunities and Market Integration. The Journal of Finance 62: 1081-137.

Bekaert, G., C. Harvey, C. Lundblad, and S. Siegel. 2011. What Segments Equity Markets? Review of Financial Studies 24: 3841-90.

Bena, J. A. N., and K. A. I. Li. 2014. Corporate Innovations and Mergers and Acquisitions. The Journal of Finance 69: 1923-60.

Bhattacharya, S. 1979. Imperfect Information, Dividend Policy, and "The Bird in the Hand" Fallacy. The Bell Journal of Economics 10: 259-70.

Black, S. E., and P. E. Strahan. 2002. Entrepreneurship and Bank Credit Availability. The Journal of Finance 57: 2807-33.

Booth, L., V. Aivazian, A. Demirguc-Kunt, and V. Maksimovic. 2001. Capital Structures in Developing Countries. The Journal of Finance 56: 87-130.

Boulton, T. J., S. B. Smart, and C. J. Zutter. 2011. Earnings Quality and International IPO Underpricing. Accounting Review 86: 483-505.

Bradley, D., I. Kim, and X. Tian. 2013. The Causal Effect of Labor Unions on Innovation. Working Paper.

Bradshaw, M. T., B. J. Bushee, and G. S. Miller. 2004. Accounting Choice, Home Bias, and US Investment in Non-US Firms. Journal of Accounting Research 42: 795-841.

Brav, A., J. R. Graham, C. R. Harvey, and R. Michaely. 2005. Payout Policy in the 21st Century. Journal of Financial Economics 77: 483-527.

Brown, J. R., S. M. Fazzari, and B. C. Petersen. 2009. Financing Innovation and Growth: Cash Flow, External Equity, and the 1990s R&D Boom. The Journal of Finance 64: 151-85.

Brown, J. R., G. Martinsson, and B. C. Petersen. 2012. Do Financing Constraints Matter for R&D? European Economic Review 56: 1512-29.

Brown, J. R., G. Martinsson, and B. C. Petersen. 2013. Law, Stock Markets, and Innovation. The Journal of Finance 68: 1517-49.

Burgstahler, D. C., L. Hail, and C. Leuz. 2006. The Importance of Reporting Incentives: Earnings Management in European Private and Public Firms. The Accounting Review 81: 983-1016.

Bushee, B. J. 1998. The Influence of Institutional Investors on Myopic R&D Investment Behavior. The Accounting Review 73: 305-33.

Bushman, R. M., and J. D. Piotroski. 2006. Financial Reporting Incentives for Conservative Accounting: The Influence of Legal and Political Institutions. Journal of Accounting and Economics 42: 107-48.

Bushman, R. M., J. D. Piotroski, and A. J. Smith. 2004. What Determines Corporate Transparency? Journal of Accounting Research 42: 207-52.

Byard, D., Y. Li, and Y. Yu. 2011. The Effect of Mandatory IFRS Adoption on Financial Analysts' Information Environment. Journal of Accounting Research 49: 69-96.

Carrieri, F., I. Chaieb, and V. Errunza. 2013. Do Implicit Barriers Matter for Globalization? Review of Financial Studies 26: 1694-739.

Chan, K., V. Covrig, and L. Ng. 2005. What Determines the Domestic Bias and Foreign Bias? Evidence from Mutual Fund Equity Allocations Worldwide. The Journal of Finance 60: 1495-534.

Chang, X., D. McLean, B. Zhang, and W. Zhang. 2013. Patents and Productivity Growth: Evidence from Global Patent Awards. Working Paper.

Chari, A., and P. B. Henry. 2004. Risk Sharing and Asset Prices: Evidence from a Natural Experiment. The Journal of Finance 59: 1295-324.

Chari, A., and P. B. Henry. 2008. Firm-specific Information and the Efficiency of Investment. Journal of Financial Economics 87: 636-55.

Chava, S., A. Oettl, A. Subramanian, and K. V. Subramanian. 2013. Banking Deregulation and Innovation. Journal of Financial Economics 109: 759-74.

Chay, J. B., and J. Suh. 2009. Payout Policy and Cash-flow Uncertainty. Journal of Financial Economics 93: 88-107.

Chemmanur, T. J., E. Loutskina, and X. Tian. 2014. Corporate Venture Capital, Value Creation, and Innovation. Review of Financial Studies 27: 2434-73.

Christensen, H. B., L. Hail, and C. Leuz. 2013. Mandatory IFRS Reporting and Changes in Enforcement. Journal of Accounting and Economics 56: 147-77.

Cornaggia, J., Y. Mao, X. Tian, and B. Wolfe. Forthcoming. Does Banking Competition Affect Innovation? Journal of Financial Economics.

Covrig, V. M., M. L. DeFond, and M. Hung. 2007. Home Bias, Foreign Mutual Fund Holdings, and the Voluntary Adoption of International Accounting Standards. Journal of Accounting Research 45: 41-70.

Cull, R., and L. C. Xu. 2005. Institutions, Ownership, and Finance: the Determinants of Profit Reinvestment among Chinese Firms. Journal of Financial Economics 77: 117-46.

Daske, H., L. Hail, C. Leuz, and R. Verdi. 2008. Mandatory IFRS Reporting around the World: Early Evidence on the Economic Consequences. Journal of Accounting Research 46: 1085-142.

Daske, H., L. Hail, C. Leuz, and R. Verdi. 2013. Adopting a Label: Heterogeneity in the Economic Consequences Around IAS/IFRS Adoptions. Journal of Accounting Research 51: 495-547.

De Franco, G. U. S., S. P. Kothari, and R. S. Verdi. 2011. The Benefits of Financial Statement Comparability. Journal of Accounting Research 49: 895-931.

DeFond, M., X. Hu, M. Hung, and S. Li. 2011. The Impact of Mandatory IFRS Adoption on Foreign Mutual Fund Ownership: The Role of Comparability. Journal of Accounting and Economics 51: 240-58.

Denis, D. J., and I. Osobov. 2008. Why Do Firms Pay Dividends? International Evidence on the Determinants of Dividend Policy. Journal of Financial Economics 89: 62-82.

Diamond, D. W., and R. E. Verrecchia. 1991. Disclosure, Liquidity, and the Cost of Capital. The Journal of Finance 46: 1325-59.

Djankov, S., R. La Porta, F. Lopez-de-Silanes, and A. Shleifer. 2008. The Law and Economics of Self-dealing. Journal of Financial Economics 88: 430-65.

Doidge, C., G. Andrewkarolyi, and R. Stulz. 2007. Why Do Countries Matter So Much for Corporate Governance? Journal of Financial Economics 86: 1-39.

Edison, H. J., M. W. Klein, L. A. Ricci, and T. Sløk. 2004. Capital Account Liberalization and Economic Performance: Survey and Synthesis. IMF Staff Papers 51: 220-56.

Edison, H. J., and F. E. Warnock. 2003. A Simple Measure of the Intensity of Capital Controls. Journal of Empirical Finance 10: 81-103.

Faccio, M., R. W. Masulis, and J. J. McConnell. 2006. Political Connections and Corporate Bailouts. The Journal of Finance 61: 2597-635.

Fan, J. P. H., S. Titman, and G. Twite. 2012. An International Comparison of Capital Structure and Debt Maturity Choices. Journal of Financial and Quantitative Analysis 47: 23-56.

Fang, V., X. Tian, and S. Tice. Forthcoming. Does Stock Liquidity Enhance or Impede Firm Innovation? The Journal of Finance.

Florou, A., and P. F. Pope. 2012. Mandatory IFRS Adoption and Institutional Investment Decisions. The Accounting Review 87: 1993-2025.

Gelos, R. G., and S. J. Wei. 2005. Transparency and International Portfolio Holdings. The Journal of Finance 60: 2987-3020.

Goldsmith, R. W. 1969. Financial Structure and Development. New Haven: Yale University Press.

Goto, A., and K. Motohashi. 2007. Construction of a Japanese Patent Database and a First Look at Japanese Patenting Activities. Research Policy 36: 1431-42.

Gupta, N., and K. Yuan. 2009. On the Growth Effect of Stock Market Liberalizations. Review of Financial Studies 22: 4715-52.

Hail, L., C. Leuz, and P. Wysocki. 2010a. Global Accounting Convergence and the Potential Adoption of IFRS by the US (Part I): Conceptual Underpinnings and Economic Analysis. Accounting Horizons 24: 355-94.

Hail, L., C. Leuz, and P. Wysocki. 2010b. Global Accounting Convergence and the Potential Adoption of IFRS by the US (Part II): Political Factors and Future Scenarios for US Accounting Standards. Accounting Horizons 24: 567-88.

Hall, B. H., A. Jaffe, and M. Trajtenberg. 2001. The NBER Patent Citation Data File: Lessons, Insights and Methodological Tools. NBER Working Paper No. 8498. [spell out NBER, and add location]

Hall, B. H., A. Jaffe, and M. Trajtenberg. 2005. Market Value and Patent Citations. Rand Journal of Economics 36: 16-38.

He, J., and X. Tian. 2013. The Dark Side of Analyst Coverage: The Case of Innovation. Journal of Financial Economics 109: 856-78.

Henry, P. B. 2000a. Do Stock Market Liberalizations Cause Investment Booms? Journal of Financial Economics 58: 301-34.

Henry, P. B. 2000b. Stock Market Liberalization, Economic Reform, and Emerging Market Equity Prices. The Journal of Finance 55: 529-64.

Henry, P. B. 2003. Capital-account Liberalization, the Cost of Capital, and Economic Growth. American Economic Review 93: 91-96.

Holderness, C. G. 2008. Do Differences in Legal Protections Explain Differences in Ownership Concentration? Working paper.

Holmstrom, B. 1989. Agency Costs and Innovation. Journal of Economic Behavior & Organization 12: 305-27.

Hsu, P. H., X. Tian, and Y. Xu. 2014. Financial Development and Innovation: Cross-Country Evidence. Journal of Financial Economics 112: 116-35.

IMF. 2008. Globalization: A Brief Overview. http://www.imf.org/external/np/exr/ib/2008/053008.htm. Accessed 10 Nov. 2014.

Irvine, P. J., and J. Pontiff. 2009. Idiosyncratic Return Volatility, Cash Flows, and Product Market Competition. Review of Financial Studies 22: 1149-77.

Jagannathan, M., C. P. Stephens, and M. S. Weisbach. 2000. Financial Flexibility and the Choice between Dividends and Stock Repurchases. Journal of Financial Economics 57: 355-84.

Jayaratne, J., and P. E. Strahan. 1996. The Finance-Growth Nexus: Evidence from Bank Branch Deregulation. The Quarterly Journal of Economics 111: 639-70.

Jin, L., and S. C. Myers. 2006. R2 around the World: New Theory and New Tests. Journal of Financial Economics 79: 257-92.

Johnson, S., and T. Mitton. 2003. Cronyism and Capital Controls: Evidence from Malaysia. Journal of Financial Economics 67: 351-82.

Kaufmann, D. 2004. Corruption, Governance and Security: Challenges for the Rich Countries and the World. Working paper.

Kaufmann, D., A. Kraay, and M. Mastruzzi. 2009. Governance Matters VIII: Aggregate and Individual Governance Indicators, 1996-2008. World Bank Policy Research Working Paper No. 4978.

Khwaja, A. I., and A. Mian. 2005. Do Lenders Favor Politically Connected Firms? Rent Provision in an Emerging Financial Market. The Quarterly Journal of Economics 120: 1371-411.

King, R. G., and R. Levine. 1993. Finance and Growth: Schumpeter Might Be Right. The Quarterly Journal of Economics 108: 717-37.

Kose, M. A., E. Prasad, K. Rogoff, and S. J. Wei. 2009. Financial Globalization: A Reappraisal. IMF Staff Papers 56: 8-62.

La Porta, R., F. Lopez-De-Silanes, and A. Shleifer. 2006. What Works in Securities Laws? The Journal of Finance 61: 1-32.

La Porta, R., F. Lopez-De-Silanes, A. Shleifer, and R. Vishny. 2002. Investor Protection and Corporate Valuation. The Journal of Finance 57: 1147-70.

La Porta, R., F. Lopez-De-Silanes, A. Shleifer, and R. W. Vishny. 1998. Law and Finance. Journal of Political Economy 106: 1113-55.

La Porta, R., F. Lopez-de-Silanes, A. Shleifer, and R. W. Vishny. 2000. Agency Problems and Dividend Policies around the World. The Journal of Finance 55: 1-33.

Lambert, R., C. Leuz, and R. E. Verrecchia. 2007. Accounting Information, Disclosure, and the Cost of Capital. Journal of Accounting Research 45: 385-420.

Li, D., F. Moshirian, P. K. Pham, and J. Zein. 2006. When Financial Institutions Are Large Shareholders: The Role of Macro Corporate Governance Environments. The Journal of Finance 61: 2975-3007.

Li, S. 2010. Does Mandatory Adoption of International Financial Reporting Standards in the European Union Reduce the Cost of Equity Capital? The Accounting Review 85: 607-36.

Lintner, J. 1956. Distribution of Incomes of Corporations Among Dividends, Retained Earnings, and Taxes. The American Economic Review 46: 97-113.

Manso, G. 2011. Motivating Innovation. Journal of Finance 66: 1823-60.

McLean, R. D., T. Zhang, and M. Zhao. 2012. Why Does the Law Matter? Investor Protection and Its Effects on Investment, Finance, and Growth. The Journal of Finance 67: 313-50.

Miller, M. H., and K. Rock. 1985. Dividend Policy under Asymmetric Information. The Journal of Finance 40: 1031-51.

Mitton, T. 2006. Stock Market Liberalization and Operating Performance at the Firm Level. Journal of Financial Economics 81: 625-47.

Morck, R., B. Yeung, and W. Yu. 2000. The Information Content of Stock Markets: Why Do Emerging Markets Have Synchronous Stock Price Movements? Journal of Financial Economics 58: 215-60.

Nanda, R., and M. Rhodes-Kropf. 2013. Investment Cycles and Startup Innovation. Journal of Financial Economics 110: 403-18.

Obstfeld, M. 1994. Risk-Taking, Global Diversification, and Growth. American Economic Review 84: 1310-29.

Pagan, A. 1984. Econometric Issues in the Analysis of Regressions with Generated Regressors. International Economic Review 25: 221-47.

Park, W. G. 2008. International Patent Protection: 1960–2005. Research Policy 37: 761-66.

Petersen, M. A. 2009. Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches. Review of Financial Studies 22: 435-80.

Quinn, D. P. 1997. The Correlates of Change in International Financial Regulation. American Political Science Review 91: 531-51.

Quinn, D. P., and A. M. Toyoda. 2008. Does Capital Account Liberalization Lead to Growth? Review of Financial Studies 21: 1403-49.

Rajan, R. G., and L. Zingales. 1998. Financial Dependence and Growth. American Economic Review 88: 559-86.

Rodrik, D. 1998. Why Do More Open Economies Have Bigger Governments? Journal of Political Economy 106: 997-1032.

Romer, P. M. 1986. Increasing Returns and Long-Run Growth. Journal of Political Economy 94: 1002-37.

Rosenberg, N. 2004. Innovation and Economic Growth. OECD Conference on Innovation and Growth in Tourism. Switzerland.

Schmukler, S. L., and E. Vesperoni. 2006. Financial Globalization and Debt Maturity in Emerging Economies. Journal of Development Economics 79: 183-207.

Seru, A. 2014. Firm Boundaries Matter: Evidence from Conglomerates and R&D Activity. Journal of Financial Economics 111: 381-405.

Sevilir, M., and X. Tian. 2013. Acquiring Innovation. Working Paper.

Shaw, E. S. 1973. Financial Deepening in Economic Development. Oxford University Press. New York.

Soderstrom, N. S., and K. J. Sun. 2007. IFRS Adoption and Accounting Quality: A Review. European Accounting Review 16: 675-702.

Solow, R. M. 1957. Technical Change and the Aggregate Production Function. Review of Economics and Statistics 39: 312-20.

Stulz, R. M. 2005. The Limits of Financial Globalization. The Journal of Finance 60: 1595-638.

Thompson, S. B. 2011. Simple Formulas for Standard Errors that Cluster by Both Firm and Time. Journal of Financial Economics 99: 1-10.

Tian, X., and T. Y. Wang. 2011. Tolerance for Failure and Corporate Innovation. Review of Financial Studies 27: 211-55.

von Eije, H., and W. L. Megginson. 2008. Dividends and Share Repurchases in the European Union. Journal of Financial Economics 89: 347-74.

Webb, C., H. Dernis, D. Harhoff, and K. Hoisl. 2005. Analysing European and International Patent Citations: A Set of EPO Patent Database Building Blocks. OECD Science, Technology and Industry Working Papers.

World Economic Forum. 2009. The Global Competitiveness Report 2009-2010. http://www.weforum.org/reports/global-competitiveness-report-2009-2010. Accessed 1 Dec. 2010.

World Economic Forum. 2014. Outlook on the Global Agenda 2015. http://www.weforum.org/reports/outlook-global-agenda-2015. Accessed 5 Nov. 2014.

Yip, R. W. Y., and D. Young. 2012. Does Mandatory IFRS Adoption Improve Information Comparability? The Accounting Review 87: 1767-89.

Appendix A: Chapter 4 Variable Definition and Data Source

Variable Names	Definition	Data Source
Dependent Variables		
Div	Dummy variable taking value of 1 if a firm pays cash dividends or 0 otherwise.	Calculated from Worldscope database WC04551 (cash dividends).
Div/Sales	Cash dividends/annual sales	Worldscope database WC04551 (cash dividends), WC01001 (annual sales). All data is in US dollars. Winsorized at the 98th percentile.
Div/Earn	Cash dividends/net income	Worldscope database WC04551 (cash dividends), WC01551 (net income). All data is in US dollars. Winsorized at the 98th percentile.
Total/Sales	(Cash dividends + repurchases)/annual sales	Worldscope database WC04551 (cash dividends), WC04751 (common/preferred redeemed, retired, converted), WC01001 (annual sales). All data is in US dollars. Winsorized at the 98th percentile.
Total/Earn	(Cash dividends + repurchases)/net income	Worldscope database WC04551 (cash dividends), WC04751 (common/preferred redeemed, retired, converted), WC01551 (net income). All data is in US dollars. Winsorized at the 98th percentile.

Appendix A – continued

Firm-level Variables		
SRVOL	Stock return volatility, defined as the standard deviation of monthly stock returns over the most recent 2 years including the current year. Firms included in the sample should have valid stock return information for at least 15 months.	Calculated from Worldscope database RI (return index). Winsorized at the 2nd and 98th percentile.
LogTA	Log of total assets	Worldscope database WC02999 (book value of total assets). Winsorized at the 2nd and 98th percentile.
Cash	Percentage of cash holding defined as (cash + short term investments)/total assets	Worldscope database WC02001 (cash and short term investments), WC02999 (book value of total assets). All data is in US dollars. Winsorized at the 2nd and 98th percentile.
Own	Percentage of closely held shares by managers and executives out of the total common shares outstanding	Worldscope WC08021 (closely held shares %).
MBRatio	Market-to-book ratio	Worldscope MTBV (market-to-book ratio). Winsorized at the 2nd and 98th percentile.
RE/TE	(Retained earnings / total shareholders' equity)*100. Total shareholders' equity is the sum of common and preference share.	Worldscope WC03495 (retained earnings), WC03501 (common share), WC03451 (preferred stock). All data is in US dollars. Winsorized at the 2nd and 98th percentile.
ROA	Return of assets defined as EBIT/total assets	Worldscope WC18191 (EBIT), WC02999 (book value of total assets). All data is in US dollars. Winsorized at the 2nd and 98th percentile.

Appendix A – continued

Country-level Variables		
1. Information Transparency		
Audit	This index shows the percentage of firms in the country audited by the Big 5 accounting firms. A higher value implies better auditing practice.	Defined as "AUDIT" in Bushman, Piotroski and Smith (2004)
AcctStd	This index shows inclusion or omission of 90 important accounting items in firms' financial report. A higher value implies more accounting information disclosed.	Defined as "CIFAR" in Bushman, Piotroski and Smith (2004)
Media	This index ranks countries by the development of media. A higher value implies better media development.	Defined as "MEDIA" in Bushman, Piotroski and Smith (2004)
WEF Audit	This index measures the strength of auditing and reporting standards in each country. Range from 1 (extremely weak) to 7 (extremely strong).	World Economic Forum Global Competitiveness Report 2009-2010, item 1.17
WEF Info	This index measures the thoroughness and scope of financial information disclosure. A higher value implies better information disclosure.	World Economic Forum The Financial Development Report 2009
WEF Ex Reg	Index measuring the effectiveness of securities exchange regulation. Range from 1 (ineffective) to 7 (effective).	World Economic Forum Global Competitiveness Report 2009-2010, item 8.08

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2. Investor Protection		
WEF Board	This index measures corporate governance and efficacy of boards. Range from 1 (management has little accountability to investors and boards) to 7 (investors and boards exert strong supervision of management decisions).	World Economic Forum Global Competitiveness Report 2009-2010, item 1.18
Corp Gov	This index is a survey based measurement showing the percentage of firms in the country that give satisfactory rating to questions on minority shareholder protection, quality of training and corporate governance. A higher value implies a higher standard rating.	Defined as "Corporate Governance Index" in Corruption, Governance and Security: Challenges for the Rich Countries and the World by Daniel Kaufmann (2004)
WEF Investor	This index measures the strength of investor protection. A higher value implies more protection for investors. Range from 0 (worst) to 10 (best).	World Economic Forum Global Competitiveness Report 2009-2010, item 8.06
WEF Minority	This index measures the legal protection for minority shareholders' interests. Range from 1 (not protected at all) to 7 (fully protected).	World Economic Forum Global Competitiveness Report 2009-2010, item 1.19

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3. Political and Legal Institutions, Corruption		
Gov1	This index captures perceptions of the extent to which local citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association and a free media. A higher value implies a better governance standard rating.	Defined as "Voice and Accountability" in Governance Matters VIII (Kaufmann, Kraay and Mastruzzi, 2009). Take the average of scores for each country reported in Table C1 in 1996, 1998, 2000 and 2002-2008.
Gov2	This index captures perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means. A higher value implies a better governance standard rating.	Defined as "Political Stability and Absence of Violence" in Governance Matters VIII (Kaufmann, Kraay and Mastruzzi, 2009). Take the average of scores for each country reported in Table C2 in 1996, 1998, 2000 and 2002-2008.
Gov3	This index measures aspects including the quality of public services, quality of civil service and its degree of independence from political pressure, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. A higher value implies a better governance standard rating.	Defined as "Government Effectiveness" in Governance Matters VIII (Kaufmann, Kraay and Mastruzzi, 2009). Take the average of scores for each country reported in Table C3 in 1996, 1998, 2000 and 2002-2008.
Gov4	This index accesses the ability of the government in formulating and implementing sound policies and regulations that cultivate the development of private sector. A higher value implies a better governance standard rating.	Defined as "Regulatory Quality" in Governance Matters VIII (Kaufmann, Kraay and Mastruzzi, 2009). Take the average of scores for each country reported in Table C4 in 1996, 1998, 2000 and 2002-2008.

Appendix A – continued

Gov5	This index captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. A higher value implies a better governance standard rating.	Defined as "Rule of Law" in Governance Matters VIII (Kaufmann, Kraay and Mastruzzi, 2009). Take the average of scores for each country reported in Table C5 in 1996, 1998, 2000 and 2002-2008.
Gov6	This index measures the strictness of corruption control in each country. A higher value implies a better governance standard rating.	Defined as "Control of Corruption" in Governance Matters VIII (Kaufmann, Kraay and Mastruzzi, 2009). Take the average of scores for each country reported in Table C6 in 1996, 1998, 2000 and 2002-2008.
Gov_PCA	The first principle component of above 6 indices (Gov1 - Gov6), representing the comprehensive and overall quality of governance in each country	Calculated based on indices from Governance Matters VIII (Kaufmann, Kraay and Mastruzzi, 2009).
WEF Legal	Index measuring the degree of legal protection of borrowers' and lenders' rights. Range from 0 (worst) - 10 (best).	World Economic Forum Global Competitiveness Report 2009-2010, item 8.09
Legal Eff	This index is a survey based measurement showing the percentage of firms in the country that gives satisfactory rating to questions on judicial effectiveness and quality of laws. A higher value implies a higher standard rating.	Defined as "Judicial/Legal Effectiveness Index" in Corruption, Governance and Security: Challenges for the Rich Countries and the World by Daniel Kaufmann (2004)

Appendix A – continued

Corrupt Illegal	This index is a survey based measurement showing the percentage of firms in the country that gives satisfactory rating to questions on corporate ethics, corruption and bribery. A higher value implies a higher standard rating.	Defined as "Corporate Illegal Corruption Component" in Corruption, Governance and Security: Challenges for the Rich Countries and the World by Daniel Kaufmann (2004)
Corrupt Legal	This index is a survey based measurement showing the percentage of firms in the country that give satisfactory rating to questions on influencing legal political funding and undue political influence. A higher value implies a higher standard rating.	Defined as "Corporate Legal Corruption Component" in Corruption, Governance and Security: Challenges for the Rich Countries and the World by Daniel Kaufmann (2004)
Corp Ethics	Average of Corporate Illegal Corruption Component and Corporate Legal Corruption Component.	Defined as "Corporate Ethics Index" in Corruption, Governance and Security: Challenges for the Rich Countries and the World by Daniel Kaufmann (2004)
Public Ethics	This index is a survey based measurement showing the percentage of firms in the country that give satisfactory rating to questions related to public integrity, bribery and favouritism in the public sector. A higher value implies a higher standard rating.	Defined as "Public Sector Ethics Index" in Corruption, Governance and Security: Challenges for the Rich Countries and the World by Daniel Kaufmann (2004)
WEF Ethics	This index measures ethical behavior of firms in each country. Range from 1 (among the worst in the world) to 7 (among the best in the world).	World Economic Forum Global Competitiveness Report 2009-2010, item 1.16

Appendix A – continued

Other Country-level Control Variables		
GDPCapG	Average of annual GDP per capita growth over the sample period.	International Monetary Fund (IFM) World Economic Outlook database. All data is in US dollars.
MV/GDP	The value of stock market divided by GDP. We take the average of annual figures from each country/region over the sample period.	World Bank World Development Indicator database. Information on Taiwan was collected from Fact Books prepared by Taiwan Stock Exchange.
LogGDP	Average of log(GDP) over the sample period.	International Monetary Fund (IFM) World Economic Outlook database. All data is in US dollars.
MedMV	Logarithm of median firm value in each country/region. We take the average value over the sample period.	Worldscope database WC08002 (market capitalization). All data is in US dollars.

Appendix B: Values of Country-level Institutional Quality

Country/Region	*Audit*	*AcctStd*	*Media*	*WEF Audit*	*WEF Info*	*WEF Ex Reg*	*WEF Board*	*Corp Gov*	*WEF Investor*	*WEF Minority*	*WEF Legal*	*Legal Eff*
Argentina	-	68	68.29	3.9	5.6	4.1	4.3	36.2	4.7	3.7	4	12.3
Australia	4	80	89.25	6	4	5.8	5.6	88.4	5.7	5.2	9	89
Austria	3	62	87.53	6	2.3	4.9	5.1	78.4	4	5.2	7	83.9
Belgium	3	68	86.73	5.6	3.9	5.1	5.2	85.9	7	5.1	7	68.9
Bulgaria	-	-	-	4.3	-	3.5	4.1	20.5	6	3.6	8	22.4
Canada	4	75	93.37	6.1	4	5.2	5.7	84.4	8.3	5.6	6	81.6
China	-	-	-	4.7	4	4	4.4	35.3	5	4.3	6	42
Croatia	-	-	-	4.5	-	4.2	4	25.4	4	3.7	6	18.2
Cyprus	-	-	-	5.7	-	5	4.4	31.5	-	5.1	-	63.4
Czech Republic	-	-	-	5.3	3.2	4.9	5.2	42.8	5	4.1	6	37.4
Denmark	4	75	95.52	5.9	1.2	5.7	5.5	94.8	6.3	5.7	9	95.3
Egypt	-	-	-	5.1	1.3	4.3	4.6	49.3	5.3	4.6	3	46.9
Finland	4	83	94.82	6.2	1.4	5.6	5.6	95.4	5.7	5.9	7	92.1
France	3	78	86.14	5.6	2.4	5.3	5.1	73.7	5.3	4.9	7	76.4
Germany	4	67	90.99	5.8	4	5.3	5.3	90.8	5	5.4	7	85.5
Hong Kong	4	73	87.44	6	3.1	5.4	4.7	69.2	9	5	10	82.3
India	1	61	29.51	5.5	1.3	5.6	4.6	55.4	6	4.9	8	59.9
Indonesia	-	-	-	4.6	2.3	4.8	5	44.7	5.7	4.7	3	39.9
Ireland	4	81	83.34	5.3	4	4.5	4.9	80.4	8.3	5	8	77.7
Israel	2	74	82.47	5.2	3.7	4.5	4.7	73.2	8.3	5	9	72.9
Italy	4	66	78.98	4	3.8	4.2	3.9	32.6	5.7	3.4	3	40.7
Japan	4	71	91.79	5.3	3.3	4.9	5.1	79.2	7	4.9	7	75.9

Appendix B – continued

Country/Region	*Audit*	*AcctStd*	*Media*	*WEF Audit*	*WEF Info*	*WEF Ex Reg*	*WEF Board*	*Corp Gov*	*WEF Investor*	*WEF Minority*	*WEF Legal*	*Legal Eff*
Jordan	-	-	-	5.4	1.1	5.2	4.7	38.1	4.3	5.3	4	67
Kuwait	-	-	-	4.8	1.9	4	4.3	-	6.3	4.2	4	-
Malaysia	3	79	63.83	5.2	6.4	5	5.1	66.7	8.7	5.1	10	77.5
Mexico	3	71	59.95	4.7	3.1	4.5	4.3	38.4	6	4.3	4	29.8
Morocco	-	-	-	4.1	-	4.6	4.4	43.5	3	4.6	3	52.2
Netherlands	4	74	92	5.9	3.4	5.5	5.4	88.5	4.7	5.2	6	87.4
New Zealand	4	80	85.67	6.3	-	5.8	5.8	90.2	9.7	6	9	87.6
Norway	4	75	95.31	6.1	4	5.7	5.6	83.8	6.7	5.8	7	86.9
Oman	-	-	-	5.2	-	5.3	5	-	5	5.3	4	-
Pakistan	2	73	32.47	4.4	1.3	4.2	3.9	31.3	6.3	4.1	6	4.8
Peru	-	-	40.33	4.8	3.2	4.2	4.8	32.8	6.7	4.6	7	17.5
Philippines	1	64	44.26	4.9	1.2	4.2	4.7	48.9	4	4.3	3	17.7
Poland	-	-	-	4.9	2.5	4.9	4.5	26.4	6	4.5	8	18.3
Portugal	3	56	70.59	4.9	-	4.8	4.5	49.5	6	4.6	3	65
Serbia	-	-	-	4	-	3.6	3.9	18.7	5.3	3.1	7	15.8
Romania	-	-	-	4.7	-	4	4.6	39.5	6	4.3	8	29.7
Russia	-	-	-	3.7	1.3	3.3	4.5	29.9	5	3.2	3	15.8
Singapore	4	79	83.72	6.1	2.4	5.8	5.6	80.9	9.3	5.7	10	89.9
South Africa	4	79	59.56	6.2	2.9	5.9	5.8	80.9	8	5.5	9	71.4
South Korea	3	68	83.5	4.9	3.7	4.5	4.7	55.4	5.3	4.3	7	48.5
Spain	4	72	75.31	5	3.6	4.3	4.7	52.4	5	4.4	6	53
Sri Lanka	-	74	37.86	5.2	-	5	5.1	43.8	5.3	4.9	4	38.5

Appendix B – continued

Country/Region	*Audit*	*AcctStd*	*Media*	*WEF Audit*	*WEF Info*	*WEF Ex Reg*	*WEF Board*	*Corp Gov*	*WEF Investor*	*WEF Minority*	*WEF Legal*	*Legal Eff*
Sweden	4	83	95.47	6.1	4	5.9	5.9	92.6	5.7	6	5	93.2
Switzerland	3	80	93.78	5.7	1.7	5.8	5.3	82.8	3	4.9	8	90.5
Taiwan	2	58	-	5.3	-	4.9	5.2	72.1	5.3	4.7	4	65.1
Thailand	3	66	52.26	5	2	4.9	4.5	49.7	7.7	4.8	4	52.8
Turkey	1	58	58.55	4.2	2.4	4.3	3.8	36.4	5.7	3.9	4	37.2
United Kingdom	4	85	90.81	5.6	4	4.8	5.1	87.9	8	5.1	9	92.1
United States	4	76	96.72	5.3	4	4.7	5.2	89.8	8.3	5	8	83.7
Vietnam	-	-	-	3.8	1.7	4	4.5	38.1	2.7	4.4	7	35

Appendix B – continued

Country/Region	*Gov1*	*Gov2*	*Gov3*	*Gov4*	*Gov5*	*Gov6*	*Gov_PCA*	*Corp Ethics*	*Corrupt Illegal*	*Corrupt Legal*	*Pub Ethics*	*WEF Ethics*
Argentina	0.28	-0.09	-0.08	-0.42	-0.48	-0.38	-0.51	23.1	30.1	16.2	21.8	3.2
Australia	1.42	1.01	1.76	1.56	1.72	1.91	3.95	71.1	92	50.3	78.6	6.2
Austria	1.37	1.15	1.8	1.51	1.83	1.95	4.04	69.7	82.3	57.2	67.8	6.2
Belgium	1.39	0.92	1.68	1.24	1.31	1.38	3.31	65	75.9	54.1	64.1	5.5
Bulgaria	0.5	0.35	-0.02	0.5	-0.07	-0.13	0.45	28.5	38.6	18.4	25.2	3.4
Canada	1.5	1.04	1.86	1.5	1.7	1.99	4.03	63.1	83.3	42.9	59.7	6.2
China	-1.56	-0.32	-0.03	-0.22	-0.38	-0.46	-1.2	46.5	43.6	49.4	42.1	4.3
Croatia	0.38	0.41	0.43	0.35	0.04	-0.01	0.66	24.2	29.9	18.5	27.7	3.9
Cyprus	1.06	0.42	1.24	1.24	0.98	1.16	2.57	45.9	55.1	36.7	54.8	4.8
Czech Republic	0.97	0.91	0.84	1.05	0.87	0.46	2.12	31.5	32.1	30.9	35.4	3.8
Denmark	1.59	1.16	2.09	1.7	1.86	2.32	4.51	85.9	97.1	74.7	93.6	6.6
Egypt	-1.04	-0.67	-0.35	-0.27	-0.06	-0.49	-1.17	44.8	49.2	40.4	35	4.4
Finland	1.57	1.41	2.07	1.66	1.89	2.33	4.59	84.8	96.9	72.6	93.8	6.6
France	1.22	0.66	1.59	1.12	1.4	1.39	3.1	59.7	79.6	39.9	61.4	5.4
Germany	1.4	0.98	1.65	1.45	1.62	1.86	3.77	73.7	85	62.4	74.3	5.9
Hong Kong	0.34	0.81	1.48	1.82	1.3	1.61	3.12	75	90.8	59.1	82.2	5.8
India	0.37	-0.89	-0.05	-0.24	0.16	-0.36	-0.4	34.6	39.4	29.8	31.7	4.1
Indonesia	-0.4	-1.31	-0.36	-0.32	-0.72	-0.8	-1.61	40.3	38.2	42.4	47.3	3.5
Ireland	1.38	1.19	1.62	1.65	1.6	1.57	3.77	60.3	77.9	42.6	64.1	5.6
Israel	0.66	-1.07	1.08	1.02	0.95	1.05	1.61	58.4	80.1	36.7	64.3	5.2
Italy	1.02	0.67	0.72	0.91	0.63	0.48	1.84	40.9	47.3	34.4	33.9	3.6
Japan	0.96	1.01	1.22	0.95	1.31	1.18	2.78	62.4	78.7	46.2	62	5.4

Appendix B – continued

Country/Region	*Gov1*	*Gov2*	*Gov3*	*Gov4*	*Gov5*	*Gov6*	*Gov_PCA*	*Corp Ethics*	*Corrupt Illegal*	*Corrupt Legal*	*Pub Ethics*	*WEF Ethics*
Jordan	-0.58	-0.23	0.18	0.33	0.41	0.21	0.17	63.2	66.9	59.4	58.8	5
Kuwait	-0.41	0.29	0.22	0.25	0.66	0.8	0.79	-	-	-	-	4.2
Malaysia	-0.39	0.27	0.98	0.52	0.52	0.36	0.98	56.9	66.8	47.1	58.6	4.7
Mexico	0.12	-0.39	0.17	0.44	-0.43	-0.23	-0.13	31.1	40	22.2	23.3	3.6
Morocco	-0.63	-0.32	-0.05	-0.08	-0.03	-0.07	-0.47	37.5	46.3	28.6	46.1	3.9
Netherlands	1.57	1.1	1.89	1.71	1.72	2.08	4.23	85.2	91.1	79.2	84.3	6.4
New Zealand	1.58	1.19	1.79	1.69	1.82	2.26	4.34	82.5	96.4	68.7	89.7	6.7
Norway	1.57	1.25	1.92	1.3	1.88	2.04	4.18	84.9	91.2	78.6	90.1	6.3
Oman	-0.86	0.78	0.57	0.57	0.65	0.49	0.94	-	-	-	-	5.5
Pakistan	-1.05	-1.86	-0.59	-0.57	-0.83	-0.9	-2.38	22.8	22.1	23.5	10.3	3.6
Peru	-0.06	-0.89	-0.31	0.32	-0.66	-0.27	-0.77	29.6	39.3	19.9	23.5	3.7
Philippines	0.04	-1.04	-0.08	0.06	-0.39	-0.51	-0.78	14.1	20.8	7.4	7.6	3.3
Poland	0.98	0.64	0.61	0.74	0.62	0.45	1.68	19.8	25.3	14.4	19.1	4.5
Portugal	1.32	1.01	1.11	1.13	1.16	1.22	2.9	55.1	68.2	42	60.4	4.7
Serbia	-0.25	-0.95	-0.47	-0.55	-0.81	-0.59	-1.5	24.2	27	21.5	21.3	3.4
Romania	0.4	0.28	-0.21	0.21	-0.05	-0.19	0.16	20.2	21	19.5	28.4	3.6
Russia	-0.68	-0.76	-0.39	-0.42	-0.88	-0.91	-1.67	20.5	19.9	21.2	20.4	3.4
Singapore	-0.11	1.07	2.05	1.85	1.55	2.19	3.66	83	93.3	72.6	92.7	6.5
South Africa	0.72	-0.2	0.63	0.46	0.07	0.37	0.86	59	71.4	46.5	42.2	4.7
South Korea	0.66	0.23	0.94	0.71	0.88	0.45	1.64	36.4	41.9	31	40.9	4.6
Spain	1.19	0.27	1.4	1.22	1.2	1.23	2.74	51	62.2	39.7	59.4	4.9
Sri Lanka	-0.26	-1.46	-0.28	0	0.04	-0.2	-0.85	29.8	35.7	23.9	20.2	3.7

Appendix B – continued

Country/Region	*Gov1*	*Gov2*	*Gov3*	*Gov4*	*Gov5*	*Gov6*	*Gov_PCA*	*Corp Ethics*	*Corrupt Illegal*	*Corrupt Legal*	*Pub Ethics*	*WEF Ethics*
Sweden	1.55	1.25	1.96	1.5	1.81	2.17	4.3	77	93.9	60	84	6.7
Switzerland	1.52	1.25	1.97	1.56	1.84	2.06	4.28	74.2	89.3	59.1	81.7	6.4
Taiwan	0.81	0.58	0.94	1.05	0.89	0.68	2.08	57	69.3	44.6	65.9	4.9
Thailand	-0.01	-0.31	0.27	0.31	0.19	-0.2	0.12	28.7	45.8	11.6	36.3	4
Turkey	-0.25	-0.88	0.09	0.26	0.02	-0.13	-0.33	25.5	31.5	19.5	27.5	3.8
United Kingdom	1.33	0.62	1.76	1.69	1.65	1.9	3.77	80.3	93.2	67.4	79.7	5.9
United States	1.25	0.5	1.64	1.51	1.54	1.53	3.36	57.4	84	30.8	70.1	5.5
Vietnam	-1.48	0.27	-0.32	-0.54	-0.39	-0.61	-1.27	34.1	28.9	39.3	29.7	4

End of Thesis