Institutional Ownership and Technology Spillovers

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Institutional Ownership and Technology Spillovers

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This thesis consists of three studies investigating the role of both foreign institutional investors and technology spillovers in the global economy.

In Chapter 2, we show that foreign institutional ownership (FIO) positively influences risk-taking, and this positive relation is achieved through direct and indirect channels. FIO is found to be a substitute for country-level corporate governance in determining corporate risk-taking, indicating that foreign institutional investors play a significant role promoting risk-taking in countries with weaker corporate governance. Various robustness tests and careful considerations of endogeneity confirm our main conclusions.

In Chapter 3 we examine the effect of technology spillover on a firms' stock price crash risk. Existing literature suggests that firms readily absorb knowledge leakages from competitor firms. We find that technology spillovers provide the market with better knowledge of the innovation prospects of the firm. This relationship is driven primarily by the transparency of knowledge leakages. Good corporate governance environments facilitate this which further emphasizes the informational role of technology spillovers. The transparency it provides to the potential performance of the firms' projects offers the market an avenue to discriminate between good and bad projects at an earlier stage, reducing the crash risk associated with bad projects. This reduction in information asymmetry has a real effect on the firms' capital structure. In particular, the reduction in information asymmetries associated with technology spillovers allows a firm to be less reliant on financial leverage.

In Chapter 4, we show that non-target rival firms exhibit positive cumulative abnormal returns (CARs) in a cross-border acquisition. Higher CARs are associated with the size of the potential technology spillovers that rivals can absorb from the acquiring firm. Technology spillovers from cross-border acquisitions have real effects on Tobin's Q, Total Factor Productivity, and Innovation for the rival firm. The impact of technology spillovers increases with horizontal acquisitions, intellectual property rights, as well as a firm's absorptive capacity. Our paper sheds new light on the role of cross-border acquisitions in facilitating horizontal international technology spillovers in emerging markets, which has previously been found to have either a negative or an insignificant effect.

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Abstract

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In Chapter 2, we show that foreign institutional ownership (FIO) positively influences risk-taking, and this positive relation is achieved through direct and indirect channels. FIO is found to be a substitute for country-level corporate governance in determining corporate risk-taking, indicating that foreign institutional investors play a significant role in promoting risk-taking in countries with weaker corporate governance. Various robustness tests and careful considerations of endogeneity confirm our main conclusions.

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Chapter 1

Introduction

This thesis provides three separate chapters that examine (1) role of foreign institutional ownership (2) the role of technology spillovers and (3) the role of foreign direct investments (FDI) in facilitating cross-country technology spillovers, which are all crucial factors for global economic growth. We begin by introducing the role of foreign institutional ownership and then tie in technology spillovers in later chapters.

Foreign capital is rapidly becoming an essential source of financing for firms worldwide. According to the World Investment Report, 2010 and 2013, global FDI increased from $154 billion in 1991 to $1.35 trillion in 2013, and global foreign portfolio investments (FPI) increased from $106 billion in 1991 to $744 billion in 2010. Although the growth in foreign investment is alarming, the most significant finding is that 52% of the global FDI flows was captured by developing economies in 2012, with developed economies generating approximately two-thirds of the global FDI outflows. As a result, understanding the role of institutional investors originating from both developed and developing economies is an important area of research.

More importantly, while there is a wealth of research on institutional investors, the empirical evidence concerning the role of foreign institutional investors is mixed. In particular, Bae, Chan, Ng (2004) finds that foreign investibility or alternatively a stock's accessibility to foreigners in emerging markets will lead to increased stock return volatility of the invested firm. They attribute this finding to foreign investors exposing the firm to world market risk. While Baekaert and Harvey (2000) find that liberalization does not increase volatility by much on average, but instead it leads to a reduction in the cost of capital and an increase in growth opportunities. However, the role of foreign institutional investors in actual firm decisions is a relatively under-explored area.

Therefore, this study sheds light on the practical role of foreign institutional investors in the global economy.

The first study explores whether foreign institutional investors promote corporate risk-taking in economies around the world. Corporate risk-taking is essential because it is a fundamental driver of firm performance and growth (Acemoglu and Zilibotti,1997; Baumol, Litan, and Schramm, 2007; DeLong and Summers, 1991; John, Litov, and Yeung, 2008). However, agency theory dictates that managers will avoid risky projects even if it enhances firm value due to career and reputation concerns (Amihud and Lev, 1981). As a result, motivating corporate risk-taking is an ever-growing body of literature that explores how to promote corporate risk-taking both theoretically and empirically. However, little research has been done on the role of foreign institutional investors in promoting corporate risk-taking in an international context. Therefore, understanding the role that foreign institutional investors play in promoting corporate risk-taking is an important research question as corporate risk-taking is essential for firm growth and subsequently a country's economic growth.

To investigate the role of foreign institutional ownership on corporate risk-taking, we use firm-level institutional ownership data from FactSet Ownership (LionShares) database for 42 economies across the 2000-2015 period. Our study provides several new findings. First, it shows that foreign institutional ownership has a positive effect on corporate risk-taking around the world. Second, we show that foreign institutional ownership and corporate governance are substitutes in determining corporate risk-taking. This is complemented by the finding that only foreign institutional ownership from developed countries contribute significantly to corporate risk-taking. Third, we show that our results are robust to various forms of risk-taking such as the R&D expenditure, innovation, and acquisitions. Fourth, and most importantly, we show multiple possible economic mechanisms that can allow foreign institutional investors to promote risk-taking such as: (1) Monitoring; (2) Improving firm-level disclosure; (3) Insuring managers against downside risk; (4) Financing; (5) Promoting human capital development; (6) International diversification; and (7) Promoting internationalization through cross-listing and geographic expansions.

For both our second and third studies, we use a comprehensive dataset of international patent applications from the Thomson Innovation's Derwent World Patents Index (DWPI), using this dataset, we construct a global measure of innovation and technology spillovers for firms in 28 economies for the 1998-2013 period. This is a significant extension to studies that focus on technology spillovers which usually focus on the US economy due to the availability of patent matched data from the National Bureau of Economic Research (NBER).

The second study extends the literature on the benefits of domestic technology spillovers in an international context. Specifically, technology spillovers are externalities that occur when a firm discloses or implements innovative technology, valuable information is being revealed to rival firms creating knowledge spillovers (Bloom, Schankerman, and Van Reenan, 2013). The recipients of these beneficial externalities are then able to acquire new technology at a cheaper cost than what is required to invent it, enhancing their productivity and innovative capabilities (Jaffe, 1986, 1988). As a result, it has been shown that absorbing technology spillovers is an avenue for improved firm value, productivity, and innovation (Bloom et al., 2013).

In this study, we examine the role of technology spillovers from an informational perspective. We show that technology spillovers are negatively associated with a firm's stock price crash risk, where stock price crash risk represents a large negative firm-specific return generally associated with information asymmetries between shareholder and manager. Our study has several interesting findings. First, the reduction in stock price crash risk is driven by the transparency of a firm's technological rival's investments. Since technology spillovers have previously been shown to have real effects on a firm's investment decisions, this suggests that the reduction in information asymmetries associated with the firm's investment decisions reduces a firm's stock price crash risk. Second, we show that the effect is stronger in more transparent institution environments, which provides further support for the information channel. Third, we show that this effect doesn't disappear in developing countries, which suggests that domestic firms in developing countries can become more transparent through the technology spillovers if there is a shock to the transparency of other technologically linked firms. Third, the reduction in information asymmetries associated with technology spillovers has a real effect on a firm's corporate financial policy. In particular, firms that have more technology spillovers will tend to reduce leverage and issue more equity. We hypothesize that this is caused by the poor collaterizability of innovative activities.

The third study examines technology spillovers and the role of FDI as a bridge for cross-border technology spillovers in emerging countries. More importantly, it has been shown that FDI damages rival firms in less developed countries. However, cross-country technology spillovers to these countries are potentially more important for global economic growth. Specifically, theories based on the Schumpeterian growth model posits that countries that diverge further from the theoretical global technology frontier can grow faster than those closer to the global technology frontier because they can make larger leaps in terms of technological advancement by absorbing cross-country knowledge spillovers. Therefore, facilitating cross-country knowledge spillovers is a plausible mechanism for global convergence in growth rates. Although the role of FDI in facilitating cross-country technology spillovers have frequently been examined in previous studies, there are very few studies that find a positive effect associated with FDI spillovers especially in developing and emerging markets. We posit that the role of FDI and technology spillovers may need to be investigated separately in order to truly determine whether there are cross-country technology spillovers from FDI.

By distinguishing the technology spillover component from FDI in a controlling cross-border acquisition, we are able to provide several findings. First, we find that the cumulative abnormal returns of non-target rival firms increase significantly based on the potential technology spillovers brought by an acquirer in a cross-border acquisition. After aggregating the deals to an annual firm-level, we confirm that this observation has a real effect in terms of the non-target rival firm's Tobin's Q, Total Factor Productivity, as well as Innovation. We then discuss separately the channels associated with our findings. First, we show that technology spillovers mainly occur through horizontal cross-border acquisitions, which suggests that only FDI that intends to replicate their production facilities in the foreign country or bring substantial intangible assets can facilitate cross-country technology spillovers. Second, we find that counter to the general perception of imitation and intellectual property rights in emerging countries, intellectual property rights actually increase the role of cross-border knowledge spillovers. This finding suggests that rather than considering intellectual property rights from the perspective of the domestic firm in terms of imitation, we may need to consider technology spillovers from the perspective of foreign acquirers. Existing studies suggest that there are both more cross-border acquisitions and increased synergistic benefits to countries where there is an improvement in intellectual property rights (Alimov and Officer, 2017). Moreover, the internalization theory suggests that poor intellectual property rights are the primary reason why foreign acquirers may choose to internalize their proprietary assets. Therefore, an improvement in intellectual property rights may allow foreign acquirers or foreign firms to more readily disclose their proprietary assets through licensing and other contractual agreements, which could increase the channel of cross-border technology spillovers to these countries. Third, we show that the absorptive capacity of domestic firms matters, in particular, skilled labor, innovativeness, as well as lower financial constraints all contribute to the absorption of international technology spillovers.

Chapter 2

Corporate Risk-Taking, Foreign Institutional Ownership, and the Role of Country-Level Corporate Governance[1]

[1] I would like to acknowledge fellow co-authors Dr. Donghui Li, Dr. Zhe An, and Dr. Sheng Xiao for their contributions to the writing, structure, and conceptualization of this chapter.

2.1 Introduction

A firm's competitive advantage and assurance of survival and performance are fundamentally shaped by its risk-taking (Faccio, Marchica and Mura, 2011). Investigating corporate risk-taking worldwide is challenging, given the vastly different patterns across countries in terms of firm operation, firm-country-level corporate governance, as well as other firm, industry, and country characteristics. In particular, no study yet has examined the impact of *foreign institutional ownership* (*FIO*) on corporate risk-taking in an international context.[2] Given that foreign capital is becoming an increasingly important source of financing around the world,[3] this paper fills this gap by providing a new set of extensive empirical evidence on this issue.

No consensus has been reached in the existing literature on whether foreign institutional investors play a beneficial or damaging role in the local economy and stock markets. On the one hand, the significant growth of international capital flows brings tremendous benefits to the global economy, such as promoting economic growth of the investee countries, reducing the cost of capital via risk sharing, and enhancing the monetary capital of invested firms. On the other hand, international capital flow also have some negative effects, such as destabilizing the investees' capital markets, exposing the invested firms to international risk and even financial crises. Thus, examining the impact of *FIO* on risk-taking provides valuable insight into this issue.

How can *FIO* influence corporate risk-taking? First, foreign institutional investors equip firms with both monetary and non-monetary capital (e.g. human capital, business relationships, managerial skills, marketing know-how, and new export market access)

[2] The most related study is Boubakri, Cosset and Saffar (2013), which only examines 381 newly privatized firms.
[3] According to the World Investment Report 2010 and 2013, global foreign direct investments increased from $154 billion in 1991 to $1.35 trillion in 2013, and global foreign portfolio investments increased from $106 billion in 1991 to $744 billion in 2010.

(Stiglitz, 2000; Li, Nguyen, Pham and Wei, 2011), which allows them to implement riskier and more-innovative projects (Boubakri et al., 2013). Second, foreign institutional investors take a more independent and active stance in terms of corporate governance practices due to their fewer conflicts of interest with invested firms, which implies a stronger monitoring role in improving the corporate governance of the invested firms (Gillan and Starks, 2003; Ferreira and Matos, 2008; Aggarwal, Erel, Ferreira and Matos, 2011). In turn, this improved corporate governance encourages firms to take more risks (John, Litov and Yeung, 2008; Boubakri et al., 2013). Third, foreign compared to domestic institutional investors are informationally disadvantaged, which provides them with the incentive to improve information disclosure in their invested firm (Kang and Stulz, 1997; Leuz, Lins, and Warnock, 2009; Baik, Kang, Kim and Lee, 2013). Improvements in information disclosure reduces the private benefits that managers can appropriate from the firm, which reduces managerial risk-avoidance (John et al., 2008). Fourth, foreign institutional investors are more risk tolerant due to their internationally diversified portfolios which provides them with a stronger capacity to push firms to undertake riskier investments by insuring managers against the downside risks associated with risk-taking (Aghion, Reenen, and Zingales, 2013; Bena, Ferreira, Matos and Pires, 2017; Luong, Moshirian, Nguyen, Tian and Zhang, 2017). Fifth, the presence of foreign institutional investors can help alleviate financial constraints. Specifically, they can act as an additional source of external financing as well as contribute indirectly by providing more effective monitoring and enhanced information disclosure (Aggarwal, Prabhala, and Puri, 2002; Khurana, Martin, and Pereira, 2006; Chemmanur, He, and Hu, 2009). Capital constraints inhibit a firm from undertaking innovative projects, which can directly influence the riskiness of a firms' investment policy (Hall, 2002). Sixth, foreign institutional investors can bring superior managerial skills as well as valuable training for existing employees (Stiglitz, 2000). Improvements in human capital can facilitate risk-taking by building up a firms' innovative capacity (Subramaniam and Youndt, 2005), which allows for increased risk-taking capabilities. Seventh, foreign institutional investors tend to take advantage of their internationally diversified portfolios, in which the capital has been invested in different countries, to push their invested firms to invest in riskier projects. Thus, such an advantage enables them to encourage managers to take more risks (Faccio et al., 2011). Finally, although foreign institutional investors are disadvantaged domestically, they have more exposure and knowledge of international markets which allows them to assist with internationalization of domestic firms. Global diversification of domestic firms provide firms with more risk-pooling options which allows them to undertake riskier projects (Grant, 1987).

The existing literature remains unclear on whether cross-country differences in corporate governance strengthen or attenuate the relation between *FIO* and corporate risk-taking. On the one hand, strong country-level corporate governance may strengthen the impact of *FIO* on corporate risk-taking (e.g. Li et al., 2011). On the other hand, the impact of *FIO* on corporate risk-taking could be attenuated by country-level corporate governance (e.g. Aggarwal et al., 2011). This paper endeavors to shed new light on this controversial issue.

Employing a large sample of 17,698 firms across 42 countries spanning the years 2000 to 2015, we document a positive relation between *FIO* and corporate risk-taking. Both direct and indirect channels contribute to this positive relationship. Our results further document that *FIO* acts as a substitute for country-level corporate governance in determining corporate risk-taking. Finally, the empirical results also show that the category of *FIO* matters – investments from high-governance countries into low governance countries, investments by long-term or independent investors, and investors with more internationally diversified portfolios result in greater risk-taking.

The endogeneity of *FIO* creates difficulties when we attempt to argue its causality effect on corporate risk-taking. However, the overall empirical evidence from various analysis suggests that our main findings, namely, the positive impact of *FIO* on corporate risk-taking, are valid after taking into account endogeneity. More specifically, the main conclusions still hold when employing non-United States (U.S.) and U.S. subsamples and when including additional control variables to capture firms' attractiveness to foreign investors. That is, dummy variables indicating whether a firm is an American Depository Receipt or whether a firm is included in the major index of its home country, when there is no overlapping in the samples, when the difference in difference approach is employed for both the dependent and independent variables, when instrumental variable 2SLS approach is employed, and finally when quasi-natural experiments are employed (additions (deletions) to (from) the Morgan Stanley Capital International All Country World Index, here onwards MSCI ACWI; cross-border M&As). Nevertheless, the empirical results above are only suggestive of an interesting association between *FIO* and risk-taking, not for the establishment of a strong causal relationship between them.

To investigate the specific channels through which *FIO* promote risk-taking, we take two steps. The first step is to investigate the direct channels, which include R&D, innovation, and M&As. The second step is to investigate the indirect channels, which include the following:

1. Monitoring channel (independent vs grey; long-term vs. short-term);

2. Disclosure channel (earnings management (total accruals and discretionary accruals), Big 4 audit choice);
3. Insurance channel (CEO turnover-performance sensitivity, and CEO pay-performance sensitivity);
4. Financing channel (external financing in the form of both equity and debt issuances, cost of equity capital, implied cost of capital (ICOC), annual stock returns, SEO under-pricing, and cost of debt);
5. Human capital (employment level, relative employment of high- and low-skilled labor, the efficiency of a firm's human capital employment);
6. International diversification channel;
7. Internationalization channel (the propensity for firms to cross-list in foreign markets and a firm's global geographic expansion).

These above indirect channels are hypothesized to lead to a higher level of corporate risk-taking. For example, the enhanced monitoring effects can reduce the underinvestment agency problem by pushing management to take more risks. In addition, appropriate CEO pay-performance sensitivity and/or turnover-performance sensitivity can directly influence managers' incentives to invest appropriately, causing managers to engage in sufficient risk-taking behavior. Furthermore, while the availability of cheaper capital does not directly lead to increased corporate risk-taking, it provides firms with the options to exploit potentially profitable investment opportunities. Moreover, investment in long-term human capital can indirectly improve a firms' innovative capacity, which allows firms to be more innovative.

This paper contributes to the existing literature in the following aspects. First, it contributes to the debate on the controversial role of *FIO* in local financial markets. Our paper documents a positive impact of *FIO* on local financial markets from the perspective of encouraging corporate risk-taking. Specifically, this study shows that foreign institutional investors equip firms with greater capabilities to take on riskier and more-innovative projects, complementing previous studies, including Stiglitz (2000), Li et al. (2011), Boubakri et al. (2013), Bena et al. (2017), and Luong et al. (2017). In addition, this study demonstrates that foreign institutional investors tend to take advantage of their internationally diversified portfolios (in which the capital has been invested in different countries) by encouraging invested firms to take riskier projects, which supports Faccio et al. (2011) who argues that controlling shareholders' portfolio diversification enables them to encourage managers to take more risks.

The study that most resembles our paper is Boubakri et al. (2013). However, our paper differs from Boubakri et al. (2013) in the following aspects. First, the "timing" of our *FIO* is different from theirs. In particular, we consider existing *FIO*, while the *FIO* they consider occurs during the privatization process. Our paper investigates the empirical issue of whether and how *FIOs* can influence corporate risk-taking worldwide, while their paper investigates the issue of whether a sale that changes the firms' ownership from state ownership to foreign ownership can encourage corporate risk-taking. Consequently, the samples are different. Their sample includes 381 newly privatized firms (i.e. a special group of firms that have experienced a change in control from the government owners to private owners). Our sample includes 17,698 firms across 42 developing and developed countries spanning the years 2000 to 2015, which, in essence, incorporates their sample. Second, there are structural differences between Boubakri et al. (2013) and our paper. These structural differences can lead to the supposed contradictory results (complementary vs substitution) that we observe when analyzing the impact of country-level governance institutions on foreign ownership and risk-taking. More specifically, Boubakri et al. (2013) find that *FIO* and country-leve corporate governance are complementary in determining corporate risk-taking, while we find that they are substitutes. Boubakri et al. (2013) hypothesize that the complementary effect of country-level governance institutions on foreign ownership and risk-taking is driven by the likelihood that the government may expropriate firm profits. The weaker the governance institution the more likely the government will expropriate firm profits and, as a result, the lower the incentive of foreign owners to take risks. This is, however, driven by the fact that their sample focuses on a dramatic change in ownership structure via the privatization process, which is defined as the deliberate sale by a government of state-owned enterprises (SOEs) or assets to private economic agents. Due to the nature of privatization in SOEs, there are many instances in which the state is still heavily involved in the firm. For example, in their sample, approximately 33.4% (534 out of 1,600) of the firms are still controlled by the state (i.e. the state maintains more than 50% ownership of the firm), while 39% (i.e. 517 out of 1,325) is considered politically connected (i.e. at least one member on the board of directors or senior officers is or was a politician) after privatization. The hypothesis associated with the fear of expropriation by the government can be directly linked to the heavy involvement of the state in these firms.

In contrast, our paper focuses on a sample of firms that have already been listed. These firms have less state involvement, and thus, the owners of these firms are less affected by the fear of government expropriation. This gives rise to the supposed contradictory results in our paper of the substitution effect between country-level governance and foreign ownership on risk-taking as government intervention is less likely. Foreign institutions are then incentivized to promote better corporate governance practices in domestic firms situated in weaker corporate governance environments, which, in turn, positively impacts risk-taking (John et al., 2008).

Second, this paper contributes to the literature on the firm-level determinants of corporate risk-taking. Recent literature examines the impact of large shareholder diversification (Faccio et al., 2011) and ownership structure via privatization (Boubakri et al., 2013) on corporate risk-taking. Anderson and Reeb (2003) document that the ownership of founder families (which are assumed to be large and undiversified blockholders) is associated with greater operating risk. Paligorova (2010) finds a positive relationship between the ownership of the largest shareholder and corporate risk-taking, while John et al. (2008) find an insignificant relation between ownership concentration and corporate risk-taking. This paper suggests that corporate risk-taking is also influenced by the level of *FIO*, thus complementing the existing literature.

Third, this paper contributes to the literature on the role of country-level institutional determinants in influencing corporate risk-taking. For example, John et al. (2008) find that better investor protection encourages firms to take riskier but value-enhancing investments. Acharya, Amihud, and Litov (2011) suggest that stronger creditor rights in bankruptcy discourage corporate risk-taking. Li, Griffin, Yue, and Zhao (2013) find that national culture, namely, individualism (uncertainty avoidance and harmony), positively (negatively) impact(s) corporate risk-taking. However, there is no consensus on the controversial joint role of country-level corporate governance and *FIO* in determining corporate risk-taking. For example, Li et al. (2011) find that the *stabilizing role* of large foreign investors (i.e. reducing firms' stock return volatility) is stronger in countries with stronger corporate governance. Conversely, Aggarwal et al. (2011) suggest that *FIO* improves firm-level corporate governance and this impact is more pronounced for firms located in countries with weaker shareholder protection. Our paper documents that country-level corporate governance and *FIO* are substitutes in determining corporate risk-taking, thus shedding additional light not only on the role of country-level corporate governance but also on its controversial joint role with *FIO*.

The remainder of this paper is organized as follows. Section 2.2 provides hypotheses development. Section 2.3 presents the empirical model and describes the data and sample. Sections 2.4-11 present the empirical results, and Section 2.12 concludes the paper.

2.2 Hypotheses Development

2.2.1 Foreign Institutional Ownership and Corporate Risk-Taking

Corporate risk-taking is fundamentally important, as it is directly linked to corporate and economic growth (John et al., 2008). As a result, promoting corporate risk-taking has become a key concern for both academia and industry practitioners. However, the agency conflicts resulting from the separation of ownership and control affect firms' risk-taking decisions. For example, due to career and reputation concerns, managers may choose to avoid risky projects even when they can enhance firm value (Amihud and Lev, 1981; Myers and Majluf, 1984; Holmstrom and Ricart I Costa, 1986; Hirshleifer and Thakor, 1992). Existing research focuses on aligning the interests of managers with shareholders by using various macroeconomic mechanisms (e.g. investor protection) and microeconomic mechanisms (e.g. equity-based compensation) so that managers are incentivized to engage in sufficient risk-taking behavior.

This paper investigates how *FIO* affects corporate risk-taking in an international context. There are multiple arguments that would justify a positive association between FIIs and corporate risk-taking. First, foreign institutional investors equip firms with both monetary and non-monetary capital (e.g. human capital, business relationship, managerial skills, marketing know-how, and new export market access) (Stiglitz, 2000;

Li et al., 2011), which allows them to implement riskier and more-innovative projects (Boubakri et al., 2013). For example, Bena et al. (2017) and Luong et al. (2017) find that *FIO* increases innovation output (i.e. the numbers of patents filed by invested firms), which is a likely outcome of risk-taking activities. In addition, foreign institutional investors could broaden the firms' investor base, which creates a risk-sharing effect that further increases the risk-taking potential of invested firms (Merton, 1987).

Second, foreign compared to domestic institutional investors are less likely to have existing business relationships with firm managers. This implies that they have fewer conflicts of interest with invested firms and serve as more efficient monitors than domestic institutional investors. Therefore, they are able to take a more independent and active stance in terms of corporate governance practices, which implies they play a stronger monitoring role in improving the corporate governance of invested firms (Gillan and Starks, 2003; Ferreira and Matos, 2008; Aggarwal et al., 2011). For example, Aggarwal et al. (2011) document that *FIO* increases the proportion of independent directors and prevents the invested firms from adopting staggered boards. While Gillan and Starks (2003) suggests that foreign institutional investors can be a catalyst for corporate governance improvements through either direct intervention or through indirect supply-demand effects. More importantly, John et al. (2008) suggests that improved corporate governance encourages firms to take more risks and leads to improved performance and potentially increased risk-taking because it limits managers' ability to acquire private benefits, which reduces managerial risk-avoidance. This view is called the *monitoring channel*.

Third, foreign institutional investors suffer from an informational disadvantage compared to domestic institutional investors, therefore they have the incentives to improve the information disclosure in the invested firm (Baik et al., 2013; Kang and Stulz, 1997; Leuz et al., 2010). For example, Ayers, Ramalingegowda, and Yeung (2011) shows that domestic institutional investors located closer to the firm have better access to private information. Similarly, Choe, Kho, and Stulz (2005) finds that domestic institutional investors have preferential access to firm private information. Past literature provides evidence that foreign institutional investors can improve information disclosure by promoting the appointment of Big 4 auditors (Guedhami, Pittman and Saffar, 2009; Kim, Pevzner, and Xin, 2019), improving accounting standards (Bradshaw, Bushee, and Miller, 2004; Fang, Maffett, and Zhang, 2015), restraining earnings management (Lel, 2019). Improving information disclosure assures that foreign institutional investors receive more benefits in terms of increased firm value and *correct* investment decisions when they choose to become a shareholder of a particular firm. In turn, improved information disclosure is associated with benefits such as a reduction in information asymmetries (Bhat, Hope, and Kang, 2006; Arping and Sautner, 2012) as well as improvements in corporate governance (Khurana et al., 2006; Hermalin and Weisbach, 2012), which are both associated with increased corporate risk-taking (John et al., 2008). This view is called the *disclosure channel*.

Fourth, foreign institutional investors due to their internationally diversified portfolios can provide insurance to managers against failure risks arising from risky projects. Specifically, psychology research finds that standard pay-for-performance incentive schemes have positive effects on motivating effort in routine tasks, but are less effective in encouraging risky tasks that require exploration (Manso, 2001). In particular, under standard incentive schemes, the threat of failure from taking risky projects may render these schemes ineffective since managers' career and reputation concerns outweigh the financial rewards. Therefore, optimal incentive schemes should exhibit certain levels of tolerance for failure, implying that compensation should be, to some extent, less sensitive to performance (Holmstrom, 1989). In an experimental study, Ederer and Manso (2013) show that the threat of contractual termination discourages managers' incentive to be innovative. In addition, Aghion et al. (2013) finds that institutional investors support more innovative and riskier activities by reducing the probability of firing a CEO after poor performance, indicating that institutional investors can provide insurance to managers against failures associated with risk-taking. Given that foreign institutional investors tend to more internationally diversified, they will have a greater tolerance towards risk-taking; therefore, they have more incentives to promote corporate risk-taking by shielding managers from punishments associated with taking risks. This view is called the *insurance channel.*

Fifth, the presence of foreign institutional investors can help alleviate financial constraints. In terms of directly financing domestic firms, Aggarwal et al. (2002) finds that at the median, institutional investors account for three-quarters of the shares offered. This is also confirmed by Chemmanur et al. (2009), who finds that institutions are able to obtain more allocations in Seasoned Equity Offering (SEO) with better long-run stock returns. This suggests that the presence of foreign institutional investors can provide domestic firms with additional external financing options. Other than financing the firms directly, foreign institutional investors can also alleviate financial constraints by providing more effective monitoring and improvements in information quality (Khurana et al., 2006). Specifically, information asymmetry and agency costs is well documented as the primary reasons for external capital constraints (Stulz, 1999; Hall, 2002). Past literature has focused on the concept of "finance gap", where firms are unable to exploit potentially profitable investment opportunities due to insufficient capital (Storey, 1994; Deakins, 1996; Jarvis, 2000; Cosh et al., 2009). These capital constraints can restrain a firm's innovative activity and as a result the riskiness of the firms' investment policy (Hall, 2002). Brown, Fazzari and Petersen (2009) argue that from 1994 to 2004, the U.S. experienced a finance-driven cycle in R&D when there was a significant rise in privately financed R&D. This suggests that foreign institutional investors can increase the riskiness of a firms' investment policy by alleviating a firms' financial constraints. This view is called the *financing channel.*

Sixth, foreign institutional investors can bring improvements to human capital by bringing superior managerial skills as well as valuable training for existing employees (Stiglitz, 2000). Specifically, risk-taking requires more than just financial capital but also human capital. For example, while R&D expenditure, which is associated with risk-taking, is necessary for innovation, it is not sufficient for developing innovative capacity. According to Subramaniam and Youndt (2005), developing innovative capacity requires investments in intellectual capital such as human, structural, and relational capital. Firms that lack innovative capacity are less likely to pursue risky investment policies such as innovation. Therefore, by facilitating investments in human capital, foreign institutional investors can build up the capabilities of the firm to innovate, which could lead to riskier investment policies. Bena et al. (2017) provides support for this by providing evidence that foreign institutional investors foster long-term investments in human capital and innovation. This view is called the *human capital channel.*

Seventh, foreign institutional investors are more internationally diversified which provides them with the incentives to push firms they invest in to undertake riskier investments (Bena et al., 2017). According to Faccio et al. (2011), if a risk-averse shareholder's portfolio is not diversified, the increased variance of her wealth (for instance, an increase in firm-specific risk) leads to reduced expected utility for her. This implies the preference of a poorly diversified shareholder to decrease firm risk, and a well-diversified shareholder to increase firm risk in order to enhance her expected utility. As seen from the above analysis, internationally diversified foreign institutional investors are more likely to push invested firms to take more risk as foreign institutional investors can effectively reduce their overall portfolio risk through international diversification, thus, their increased expected utility facilitates their enhanced incentives to push managers to pursue riskier investments. Additionally, foreign institutional investors who are more internationally diversified can also broaden the firms' investor base providing improved risk-sharing opportunities (Merton, 1987). For example, Li et al. (2011) suggests that the presence of foreign agents allows for improved risk-sharing between domestic and foreign agents. This suggests that foreign institutional investors can reduce the risk exposure of domestic investors, which allows them to be less averse to riskier firm investments. This view is called the *international diversification channel.*

Finally, foreign institutional investors are informationally disadvantaged in domestic markets but are informationally advantaged in international markets, which provides them with the expertise to drive internationalization in domestic firms. Specifically, Ferreira, Massa, and Matos (2010) finds that foreign institutional investors build "bridges" for more international M&A investments by reducing transaction costs. Similarly, Andriosopoulos and Yang (2015) finds that foreign institutional ownership is positively associated with the probability of engaging in cross-border M&As as well as the deal size of M&As. This suggests that their exposure and networks in international markets allows them to provide better advice and expertise to speed up the internationalization of domestic firms. For example, the knowledge and networks of foreign institutional investors can provide a competitive advantage for the domestic firm by providing knowledge on the optimal mode of entry, differences in regulations, and molding products and services based on differences in customer preferences. Based on modern portfolio theory, firms that are engaged in international activities can reduce their exposure by diversifying in countries with lower correlations in operations. This can create a risk-spreading effect that allows firms to undertake riskier projects than domestic firms with fewer risk-pooling options (Grant, 1987). This view is called the *internationalization channel.*

Although there is considerable evidence to suggest that *FIO* is positively associated with corporate risk-taking, there is also evidence to support the contrary. First, foreign institutional investors are not only informationally disadvantages but are also disadvantaged due to their unfamiliarity with the regulatory environment, as well as potential language and cultural barriers (Baik et al., 2013; Kang and Stulz, 1997). As a result, foreign compared to domestic institutional investors may suffer from more severe information asymmetries with managers which can weaken their monitoring role leading to reduced corporate risk-taking.

Second, foreign capital flows is frequently described as “hot money”, which describes capital with short-term investment horizons. Specifically, Krugman (1998) documents that in the 1997 Asian financial crisis, foreign capital was flowing into emerging Asia at a rate of about $100 billion a year in 1996, however by the second half of 1997 it was flowing out at about the same rate.[4] Similarly, Tesar and Warner (1995) finds that foreign relative to domestic equity investments tend to have higher turnover rates. This is also supported by Bae, Chan, and Ng (2004) who finds that firms that are more accessible to foreign investors tend to be more volatile than firms that are less accessible to foreign investors. Institutional investors with short-term preferences have

[4] More recently, from January to August 2019, foreign portfolio investments from Philippines recorded a net outflow of $1.1 billion, which reversed the net inflows of $602 million over the same period in 2018.

been shown to pressure managers to pursue short-term profit goals, which drives managers away from long-term investments such as risk-taking (Coffee, 1991; Chote and Linger, 1986; Porter, 1992; Bushee, 1998; Chen, Harford, and Li, 2007; Alvarez, Jara, and Pombo, 2018). For example, Bushee (1998) finds that institutional investors with high portfolio turnover increases the probability that managers will reduce R&D in order to reverse a decline in earnings.

Third, while foreign institutional investors tend to have more internationally diversified portfolios, which allows them to tolerate the risks associated with long-term investments, there is often a trade-off between diversification and monitoring. Specifically, concentrated ownership provides shareholders with stronger incentives to acquire costly information to monitor firms (Shleifer and Vishny, 1986; Edmans, 2009; Ekholm and Maury, 2014). However, investors will only allocate resources to acquire information if the benefits exceed the costs. Notably, in a survey conducted by Goldstein (2011), the main constraints to engagement for an institutional investor is time followed by staffing considerations. For a foreign institutional investor with a highly diversified portfolio, each firm may only represent a small proportion of their entire portfolio which reduces the benefits associated with acquiring information for a particular firm. This suggests that while foreign institutional investors may have a stronger tolerance for risks, this will be counteracted by the fact that they lack the incentives to monitor and promote corporate risk-taking.

Finally, foreign institutional investors are potentially less tolerant of failure, which worsens the career concerns of managers when pursuing risky investment opportunities. As discussed previously, foreign investors suffer from an informational disadvantage compared to domestic investors. Brennan and Cao (1997) argues that due to their informational disadvantage, foreign investors tends to exhibit trend following behaviours or momentum based strategies when investing in overseas markets rather than relying on their own information. Specifically, foreign investors tend to buy when the market is rising and sell when the market is falling (Warther, 1994; Karolyi, 2002; Kim and Wei, 2002; Grinblatt and Keloharju, 2000; Dahlquist and Robertsson, 2001). This suggests that when there is negative news, the presence of foreign institutional investors will exacerbate the effect of negative news on stock price. Subsequently, the presence of foreign institutional investors can act as a catalyst that amplifies the negative effect of poor performance rather provide insurance against poor performance in risk-taking activities as suggested by Aghion et al. (2013).

Consequently, the existing empirical evidence on the role of *FIO* on corporate risk-taking is mixed, therefore it remains an empirical question of whether and how *FIO* influences corporate risk-taking. Thus, we form the following hypotheses:

Hypothesis 1a (H1a): *FIO is significantly and positively related to corporate risk-taking.*

Hypothesis 1b (H1b): *FIO is significantly and negatively related to corporate risk-taking.*

Existing research indicates that strong country-level corporate governance, such as better investor protection and transparent information environments, promotes corporate risk-taking (John et al., 2008). However, the controversial joint role of country-level corporate governance and *FIO* in determining corporate risk-taking remains unclear.

On the one hand, Li et al. (2011) find that large foreign investors lead to a greater reduction in firms' stock return volatility in countries with stronger corporate governance. In addition, due to the information disadvantage of foreign institutional investors (Brennan and Cao, 1997; Kang and Stulz, 1997; Choe, Kho and Stulz, 2005; Leuz, 2006; Chan, Menkveld and Yang, 2008), their impact on corporate risk-taking is expected to be stronger in countries with better corporate governance, where investors are well protected and information is more credible. This implies that country-level corporate governance strengthens the impact of *FIO* on corporate risk-taking. That is, *FIO* and country-level corporate governance are complements.

On the other hand, Aggarwal et al. (2011) suggest that corporate governance practices *travel around the world* through foreign institutional investors. In particular, *FIO* from countries with stronger corporate governance leads to substantial improvements in the firm-level corporate governance of invested firms in countries with weaker corporate governance. Rossi and Volpin (2004) find that acquirers are typically from countries with stronger investor protection than those of their targets' countries in cross-border M&As, suggesting that foreign acquisitions play a governance role by improving the investor protection of target firms. Bris and Cabolis (2008) find that acquisition premiums are higher in cross-border M&As where acquirers are from countries with stronger country-level corporate governance. In addition, Guedhami et al. (2009) find that the role of foreign investors in promoting the appointment of Big 4 audit firms is strengthened in countries with weaker country-level corporate governance. That is, the role of *FIO* is expected to be stronger if the firms are located in countries with weaker corporate governance. Conversely, in countries with stronger corporate governance, domestic investors are able to advance their interests successfully and easily influence managers to adopt riskier projects. Thus, the presence of foreign institutional investors is less likely to exert a strong impact on corporate risk-taking. The above analysis implies that *FIO* and country-level corporate governance environments are substitutes. Our above analysis leads to the following hypotheses:

Hypothesis 2a (H2a): *FIO and country-level corporate governance are complements in determining corporate risk-taking.*

Hypothesis 2b (H2b): *FIO and country-level corporate governance are substitutes in determining corporate risk-taking.*

2.2.2 Framework

In this section, we highlight the specific mechanisms that can allow foreign institutional ownership to influence a firms' corporate risk-taking behaviour in Figure 2.1. When a foreign institutional investor invests in a firm from a foreign country, they bring unique characteristics that allows them to deviate from domestic institutional investors. Specifically, we categorize the channels as either direct or indirect channels. We define direct channels as the channels that are directly related to risk-taking. In contrast indirect channels are those that influences other relevant factors that indirectly influences corporate risk-taking. For example, the corporate governance channel can lead to improvements in corporate governance that can indirectly lead to corporate risk-taking.

As illustrated in Figure 2.1, there are several indirect channels that will influence the manager's decision making in the domestic firm. In section A of Figure 2.1, we focus on the incentives associated with the foreign institutional investors influence on a firms' corporate risk-taking. The two channels that motivate foreign institutional investors to act in this way include:

1. ***International Diversification Channel***: foreign institutional investors tend to hold more internationally diversified portfolios, which allows them to be less susceptible to firm-specific risk and as a result provides them with a stronger incentive to influence firms to pursue riskier investments.

2. ***Corporate Governance Channel:*** foreign institutional investors are both informationally disadvantaged and prone to cross-country variations in governance, therefore they have stronger incentives to spread good governance practices.

Alternatively, in section B of Figure 2.1, we focus on the primary methods in which foreign institutional investors can influence corporate risk-taking. The two primary methods include:

1. ***Monitoring Channel:*** foreign institutional investors are less likely to have existing business relationships with the firm managers in the domestic firm. This allows them to be more efficient monitors and play a stronger monitoring role.
2. ***Insurance Channel:*** foreign institutional investors have been shown to have significant effect on CEO compensation, therefore they also have the capacity to influence the incentive structure of the domestic firm. Based on the international diversification channel, foreign institutional investors have a greater tolerance for risk which allows them to insure managers against the downsides associated with risk-taking.

In section C of Figure 2.1, we focus on other indirect channels that foreign institutional investors can influence inadvertently from the previous indirect channels or directly contributing to it such as:

1. ***Disclosure Channel***: foreign institutional investors are informationally disadvantaged compared to domestic institutional investors in domestic markets. Foreign institutional investors have the incentive to directly

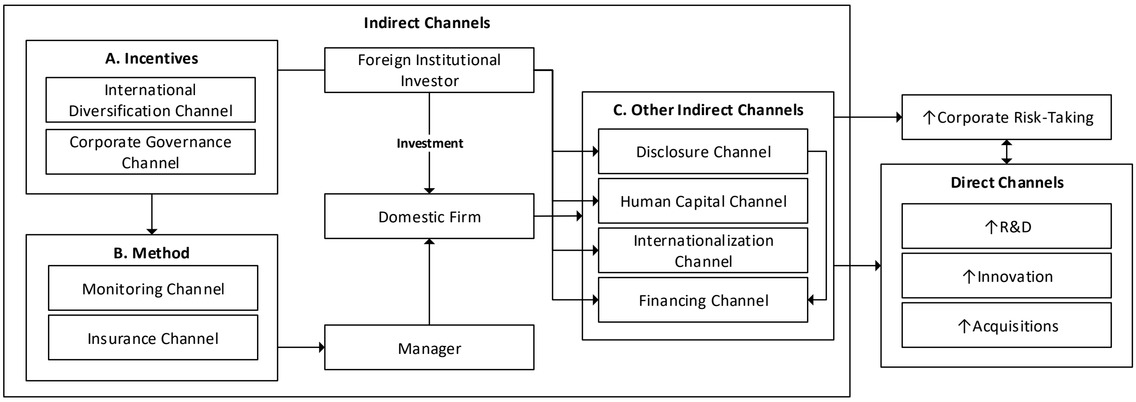
improve the information disclosure in the invested firm. Alternatively, the disclosure channel can also be driven by improved corporate governance.

2. ***Human Capital Channel:*** foreign institutional investors have been shown to promote long-term investments in human capital by disciplining corporate insiders against pursuing short-term goals through the monitoring channel. However, it has also been suggested that foreign institutional investors can bring improvements to human capital by bringing superior managerial skills as well as valuable training for existing employees to domestic firms.
3. ***Internationalization Channel:*** foreign institutional investors are both informationally disadvantaged and exposed to cross-country variations in governance. Therefore, they have an incentive to pursue internationalization through cross-listing to bond the firm's legal, regulatory, and disclosure requirements to stronger corporate governance countries. Alternatively, while foreign institutional investors are informationally disadvantaged compared to domestic institutional investors in local markets, they are informationally advantaged in international markets. As a result, they can use their knowledge and networking to facilitate internationalization through geographic expansions.
4. ***Financing Channel:*** it has been shown that institutional investors can impact firms by relaxing financial constraints. This can be achieved through signalling by foreign institutional investors or alternatively other vehicles that reduce the information asymmetries, such as improvements in corporate governance, monitoring, or improved disclosure.

In section D of Figure 2.1, we highlight two direct channels that are generally considered interchangeable with corporate risk-taking. The two direct channels are:

1. ***Innovation:*** foreign institutional investors have more exposure to innovative activities around the world. Foreign institutional investors can facilitate knowledge spillovers from more innovative countries by using their networks to open doors for the exchange of knowledge and ideas.
2. ***Acquisitions:*** Similar to the internationalization channel, foreign institutional ownership has been shown to increase both the size and likelihood of cross-border acquisitions. This suggests foreign institutional investors act as a facilitator for cross-border acquisitions in international markets by reducing transaction costs and asymmetric information.

Figure 2.1: Foreign Institutional Ownership and Corporate Risk-Taking
This figure details the channels that allows foreign institutional ownership to influence a firm's corporate risk-taking.



2.3 Empirical Design

2.3.1 Empirical Model

To examine the relation between foreign (and domestic) institutional ownership and corporate risk-taking, we estimate the following model,

$$Risk\_taking_{i,t} = \alpha + \beta_1 FIO_{i,t} + \beta_2 DIO_{i,t} + \beta_3 CONTROLS_{i,t} + \varepsilon,$$

where firm is indexed by *i* and year by *t*. *Risk_taking* is the corporate risk-taking variable (see details in Section 2.3.2). The foreign (domestic) institutional ownership

(*FIO* (*DIO*)) is calculated by aggregating the equity holdings of foreign (domestic) institutions as a percentage of the firm's market capitalization. *CONTROLS* denotes a set of firm- and country-level control variables that have been shown to influence corporate risk-taking in previous literature (Boubakri et al., 2013), including return on assets (*ROA*), financial leverage (*LEVERAGE*), firm size (*SIZE*), sales growth (*SALESGROWTH*), capital expenditure (*CAPEX*), GDP growth (*GDPGROWTH*), the economic freedom index (*ECONFREEDOM*), GDP per capita (*GDP*), and market interest rates (*IR*).[5] In addition, we include year-, industry-, and country-fixed effects to control for the unobserved year, industry, and country determinants of corporate risk-taking. Standard errors are clustered at the country level. If β_1 (β_2) is positive (negative) and significant, then **H1a** (**H1b**) is supported. That is, *FIO* increases (decreases) corporate risk-taking.

To examine whether *FIO* and country-level corporate governance are complements or substitutes in determining corporate risk-taking, we estimate the following model,

$$Risk\_taking_{i,t} = \alpha + \beta_1 FIO_{i,t} + \beta_2 FIO_{i,t} \times CG + \beta_3 DIO_{i,t} + \beta_4\, DIO_{i,t} \times CG$$

$$+ \beta_5 CG + \beta_6 CONTROLS_{i,t} + \varepsilon,$$

where *CG* denotes a particular country-level corporate governance variable (see details in Section 2.3.3). If the coefficient estimate of *FIO* ×*CG* (i.e. β_2) is positive (negative) and significant, then **H2a** (**H2b**) is supported. That is, *FIO* complements (substitutes) the role of country-level corporate governance in determining corporate risk-taking.

[5] Variable definitions are provided in Appendix A.

2.3.2 Corporate Risk-taking Variables

Our primary corporate risk-taking variable (*RISK1*) is based on the *ROA* volatility of firms. Following the existing literature (John et al., 2008; Hilary and Hui, 2009; Acharya et al., 2011; Faccio et al., 2011; Boubakri et al., 2013), *RISK1* is constructed as the volatility of firms' *ROA* over a five-year overlapping period (i.e. year 0 to +4). *ROA* is the ratio of earnings before interest and taxes to total assets.

We also construct alternative corporate risk-taking variables that are widely used in the literature, including:

(1) the earnings range (*RISK2*), which defined as the maximum minus the minimum *ROA* over the overlapping five-year window;

(2) country-adjusted earnings volatility (*RISK3*); and

(3) country-industry-adjusted earnings volatility (*RISK4*).

In addition, we employ a corporate risk-taking variable (*SRVOL*) at the market level, calculated as the standard deviation of monthly stock returns over a two-year period (i.e. 0 to +1).

2.3.3 Country-level Corporate Governance Variables

The first set of country-level corporate governance variables focuses on the information environment of each country. In particular, the Financial Transparency Index (*FINTRA*) measures the availability of financial information to those outside the firm, and the Financial Analysts Index (*ANALYST*) is the number of analysts following the largest 30 companies of each country. The Overall Transparency Score (*OTSCO*) measures the institutional and political transparency. The Disclosure Requirements Index (*DISREQ*) measures the degree of disclosure requirements, and the Liability Standard Index (*LIASTA*) measures the procedural difficulty in recovering losses from the issuer, distributors, and accountants. A higher score of these indexes indicates better information availability and credibility.

The second set of country-level corporate governance variables focuses on the legal origin, shareholder protection, and control of corruption in each country. In particular, *LEGCOM* is a dummy variable equal to one if a country adopts a common law system (which provides better shareholder protection than a civil law system), and zero otherwise, and *ANTID* measures the level of shareholder protection of each country. Furthermore, the Corporate Governance Index (*CGI*) measures the percentage of firms in the country that satisfy the following: protection of minority shareholders, quality training, willingness to delegate authority, discouragement of nepotism, and corporate governance. In addition, Control of Corruption (*COC*) captures the perceptions of the extent to which public power is exercised for private gain. A higher score of these indexes indicates stronger shareholder protection and better control of corruption.

2.3.4 Data and Sample

Firm-level accounting data, stock returns, and information on country-level control variables are collected from Worldscope, Datastream, and World Development Indicators (WDI), respectively. Foreign and domestic institutional ownership data are collected from the FactSet Ownership (LionShares) database. Country-level corporate governance variables are obtained from La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998), Bushman, Piotroski and Smith (2004), Kaufmann (2004), Bellver and Kaufmann (2005), La Porta, Lopez-de-Silanes and Shleifer (2006), and Kaufmann, Kraay and Mastruzzi (2009).

To construct the corporate risk-taking variables, we require at least five consecutive years of earnings data to be available for a firm (i.e. beginning from the current year). To reduce the outlier effect, firm-level variables are winsorized at the 1st and 99th percentiles. If any variable of interest is missing for a given year, we remove the firm-year observation. We also exclude financial and regulated utility firms. Finally, our sample consists of 17,698 firms (i.e. 115,726 firm-year observations) across 42 countries from 2000 to 2015.[6]

Table 2.1 reports the sample distribution by country, year, and industry. As shown in Panel A, the sample coverage is better for developed countries than for developing countries. In particular, the U.S. contributes the most firm-year observations to the sample (i.e. 31,928 firm-year observations, or 27.59% of the sample). In the robustness test, we examine a subsample that excludes U.S. firms; the results are qualitatively unchanged. Panel B shows that more firm-year observations are available in later years due to better data availability, and Panel C shows that our sample covers firms from various industries.

[6] The sample starts from 2000 because institutional ownership data are not available prior to 2000 in Factset. We collect the accounting data until 2015, enabling us to construct the corporate risk-taking variables until 2011. For example, the five-year *ROA* values from 2011 to 2015 are used to calculate *RISK1* in 2011. Thus, our sample of corporate risk-taking ends in 2011.

Table 2.1 Sample Distribution

This table reports the sample distribution by country (Panel A), year (Panel B), and industry (Panel C).

Panel A: Distribution by Country		
Market	N.O. of Firm-year Obs. [1]	N.O. of Firms [2]
Argentina	154	30
Australia	4,263	749
Belgium	646	94
Brazil	496	88
Canada	5,185	893
Chile	524	74
China	5,985	1,594
Croatia	170	42
Denmark	160	57
Egypt	259	42
Finland	406	92
France	1,557	387
Germany	930	349
Greece	140	49
Hong Kong	4,936	694
India	4,333	778
Indonesia	1,110	160
Ireland	220	44
Israel	1,261	224
Italy	1,536	202
Japan	25,956	3,120
Malaysia	2,705	462
Mexico	600	77
Netherlands	1,043	129
New Zealand	494	66
Norway	734	136
Pakistan	416	103
Peru	139	22
Philippines	444	57
Poland	380	103
Russia	471	93
Singapore	2,167	323
South Africa	1,439	202
Spain	196	72
Sri Lanka	105	21
Sweden	899	188
Switzerland	1,558	180
Thailand	1,568	217
Ukraine	65	20
United Kingdom	7,856	1,144
United States	31,928	4,216
Vietnam	292	105
Total	115,726	17,698

Table 2.1 Cont.

Panel B: Distribution by Year	
Year	N.O. of Firm-year Obs. [1]
2000	7,883
2001	8,899
2002	9,028
2003	8,846
2004	9,281
2005	9,430
2006	9,747
2007	10,394
2008	10,750
2009	10,627
2010	10,762
2011	10,079
Total	115,726

Panel C: Distribution by Industry		
Industry	N.O. of Firm-year Obs. [1]	N.O. of Firms [2]
Basic Materials	12,258	2,043
Consumer Goods	18,862	2,835
Consumer Services	18,161	2,638
Health Care	9,581	1,538
Industrials	34,110	5,013
Oil & Gas	6,035	986
Technology	15,014	2,389
Telecommunications	1,705	256
Total	115,726	17,698

Table 2.2 reports the summary statistics of corporate risk-taking, foreign and domestic institutional ownership, and firm- and country-level control variables. Unsurprisingly, the statistics of our corporate risk-taking variables are different from those in Boubakri et al. (2013), as their sample covers only 381 privatized firms. In general, the key explanatory variables resemble those used in the literature. For example, the means of *FIO* and *DIO* are 0.041 and 0.174, respectively.

Table 2.2 Summary Statistics

This table reports the summary statistics of corporate risk-taking variables, foreign and domestic institutional ownership variables, and firm- and country-level control variables. Variable definitions are provided in Appendix A.

	N.O. of Obs.	Mean	Std. Dev.	25th	Median	75th
	[1]	[2]	[3]	[4]	[5]	[6]
Corporate Risk-taking						
RISK1	115,726	0.067	0.082	0.017	0.035	0.081
RISK2	115,726	0.165	0.201	0.042	0.087	0.198
RISK3	115,726	0.067	0.080	0.019	0.036	0.079
RISK4	115,726	0.068	0.078	0.021	0.039	0.081
SRVOL	111,148	0.068	0.036	0.043	0.059	0.083
Institutional Ownership						
FIO	115,726	0.041	0.070	0.001	0.012	0.049
DIO	115,726	0.174	0.274	0.002	0.035	0.206
Control Variables						
ROA	115,726	0.020	0.045	0.163	-0.800	0.348
LEVERAGE	115,726	0.205	0.170	0.190	0.000	0.812
SIZE	115,726	12.363	12.424	2.141	5.561	17.249
SALESGROWTH	115,726	0.215	0.105	0.632	-0.664	4.573
CAPEX	115,726	0.054	0.034	0.061	0.000	0.339
GDPGROWTH	404	3.698	3.115	1.810	3.670	5.524
ECONFREEDOM	404	7.253	0.829	6.550	7.265	7.910
GDP	404	9.174	1.405	7.958	9.273	10.457
IR	404	4.873	7.807	1.445	3.490	5.725
Country-level Corporate Governance Variables						
FINTRA	34	0.303	0.757	-0.122	0.371	0.801
ANALYST	34	15.190	7.949	8.870	14.885	20.600
ACCSTD	32	64.063	12.213	60.500	64.500	72.500
OTSCO	42	0.835	0.769	0.470	0.965	1.430
DISREQ	36	0.657	0.198	0.500	0.667	0.833
LIASTA	36	0.516	0.250	0.330	0.524	0.660
LEGCOM	36	0.417	0.500	0.000	0.000	1.000
ANTID	36	3.250	1.381	2.000	3.000	4.00
CGI	42	62.276	23.796	38.400	64.450	84.400
COC	42	0.778	1.107	-0.271	0.781	1.896

2.4 Baseline Results

2.4.1 Does Foreign Institutional Ownership Increase Corporate Risk-Taking?

Table 2.3 presents the coefficient estimates when regressing corporate risk-taking variables on foreign and domestic institutional ownership. The empirical results show that *FIO* is positively related to all five corporate risk-taking variables at the 1% significance level, indicating that foreign institutional investors promote corporate risk-taking. These results are both statistically and economically significant. As shown in Column 1, the coefficient estimate of *FIO is* 0.053. That is, a one-standard-deviation increase in *FIO* is associated with a 5.5% (= 0.053×0.070/0.067) increase *RISK1* relative to its sample mean, given that the standard deviation of *FIO* is 0.070 and the mean of *RISK1* is 0.067. The results support **H1**a**.** That is, firms with higher *FIO* tend to take more risks. Conversely, we find that *DIO* is significantly and negatively related to corporate risk-taking, indicating that domestic institutional investors are more risk averse than foreign institutional investors.

Table 2.3 FIO and Corporate Risk-taking

This table reports the OLS estimation of the following model:

$$Risk\_taking_{i,t} = \alpha + \beta_1 FIO_{i,t} + \beta_2 DIO_{i,t} + \beta_3 CONTROLS_{i,t} + \varepsilon.$$

Risk_taking is the corporate risk-taking variable. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *CONTROLS* denotes a set of control variables, including *ROA, LEVERAGE, SIZE, SALESGROWTH, CAPEX, GDPGROWTH, ECONFREEDOM, GDP,* and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

Corporate risk-taking	*RISK1*	*RISK2*	*RISK3*	*RISK4*	*SRVOL*
	[1]	[2]	[3]	[4]	[5]
FIO	0.053***	0.130***	0.049***	0.053***	0.021***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
DIO	-0.025***	-0.063***	-0.024***	-0.027***	-0.023***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA	-0.185***	-0.448***	-0.180***	-0.167***	-0.058***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LEVERAGE	0.007***	0.018***	0.007***	0.008***	0.025***
	(0.002)	(0.001)	(0.001)	(0.000)	(0.000)
SIZE	-0.009***	-0.021***	-0.009***	-0.008***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SALESGROWTH	0.008***	0.019***	0.008***	0.007***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CAPEX	0.008	0.020	0.005	0.000	-0.004*
	(0.153)	(0.177)	(0.348)	(0.964)	(0.080)
GDPGROWTH	0.000***	0.001***	0.000***	0.000***	0.000***
	(0.002)	(0.003)	(0.003)	(0.008)	(0.000)
ECONFREEDOM	0.003*	0.007	0.005**	0.004***	0.011***
	(0.073)	(0.112)	(0.010)	(0.009)	(0.000)
GDP	0.002	0.004	-0.006	-0.008*	-0.026***
	(0.738)	(0.713)	(0.199)	(0.082)	(0.000)
IR	0.000***	0.001***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)
Year-fixed effect	Yes	Yes	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes	Yes	Yes
Country-fixed effect	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.424	0.421	0.431	0.437	0.497
N	115,726	115,726	115,726	115,726	111,148

2.4.2 FIO and Country-level Corporate Governance: Complements or Substitutes?

To examine whether *FIO* and country-level corporate governance are complements or substitutes, we include a country-level corporate governance variable and its interaction with *FIO* (i.e. *FIO ×CG*) in the regressions. If the coefficient estimate of *FIO ×CG* is significant and positive (negative), then **H2a** (**H2b**) is supported. That is, *FIO* and country-level corporate governance are complements (substitutes).

We employ a series of variables to measure different aspects of country-level corporate governance, including information environment (*FINTRA*, *ANALYST*, *ACCSTD*, *OTSCO*, *DISREQ*, and *LIASTA*), legal origin (*LEGCOM*), shareholder protection (*ANTID* and *CGI*), and control of corruption (*COC*). As shown in Table 2.4, the coefficient estimates of *FIO ×CG* are negative and significant for all country-level corporate governance variables except *ACCSTD*; however, the sign is still negative.[7] For example, Column 1 shows that the coefficient estimate (p-value) of *FIO ×FINTRA* is -0.034 (0.003). That is, a one-standard-deviation increase in *FIO* is associated with a 9.2% (= (0.096-0.034×0.234)×0.070/0.067) increase in *RISK1* relative to its sample mean in the countries with a lower *FINTRA* (e.g. *FINTRA* = 0.234 in Malaysia), compared to a 4.4% (= (0.096-0.034×1.590)×0.070/0.067) increase in *RISK1* relative to its sample mean in the countries with a higher *FINTRA* (e.g. *FINTRA* = 1.590 in the U.S.). As shown in Columns 2-10, the results are similar to those in Column 1. In particular, *FIO ×CG* is negatively and significantly related to *RISK1* when using alternative country-level corporate governance variables. This result suggests that the positive impact of *FIO* on corporate risk-taking is attenuated in countries with stronger

[7] For brevity, we only report the results by using *RISK1* as a corporate risk-taking variable. The results are qualitatively similar when using *RISK2*, *RISK3*, *RISK4*, or *SRVOL* as a dependent variable.

corporate governance. Thus, the results support **H2b**, indicating that *FIO* and country-level corporate governance are substitutes in determining corporate risk-taking.

Table 2.4 FIO and Country-level Corporate Governance: Complements or Substitutes?

This table reports the OLS estimation of the following model:

$$Risk\_taking_{i,t} = \alpha + \beta_1 FIO_{i,t} + \beta_2 FIO_{i,t} \times CG + \beta_3 DIO_{i,t} + \beta_4 DIO_{i,t} \times CG + \beta_5 GC + \beta_6 CONTROLS_{i,t} + \varepsilon.$$

Risk_ taking is the corporate risk-taking variable (*RISK1*). The results are qualitatively similar when using alternative risk-raking variables. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *CG* denotes country-level corporate governance variable. *CONTROLS* denotes a set of control variables, including *ROA*, *LEVERAGE*, *SIZE*, *SALESGROWTH*, *CAPEX*, *GDPGROWTH*, *ECONFREEDOM*, *GDP*, and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

CG =	*FINTRA*	*ANALYST*	*ACCSTD*	*OTSCO*	*DISREQ*	*LIASTA*	*LEGCOM*	*ANTID*	*CGI*	*COC*
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
FIO	0.096***	0.135***	0.262**	0.116***	0.209***	0.151***	0.108***	0.140***	0.170***	0.107***
	(0.000)	(0.000)	(0.040)	(0.000)	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
FIO ×CG	-0.034***	-0.003***	-0.003	-0.035***	-0.173**	-0.113***	-0.074***	-0.017*	-0.001**	-0.029***
	(0.003)	(0.003)	(0.114)	(0.002)	(0.038)	(0.008)	(0.000)	(0.067)	(0.040)	(0.007)
DIO	0.024	0.028	0.222	-0.033	0.020	0.040	0.031	0.001	-0.083	0.008
	(0.427)	(0.496)	(0.194)	(0.296)	(0.767)	(0.268)	(0.197)	(0.979)	(0.128)	(0.733)
DIO×CG	-0.014	-0.001	-0.003	0.020	-0.005	-0.028	-0.030	0.004	0.001*	0.009
	(0.485)	(0.537)	(0.244)	(0.170)	(0.943)	(0.425)	(0.184)	(0.667)	(0.072)	(0.613)
CG	0.021**	0.001**	0.001**	0.019**	0.030	0.026	0.030***	0.003	0.000*	0.010
	(0.039)	(0.022)	(0.030)	(0.010)	(0.350)	(0.186)	(0.001)	(0.428)	(0.095)	(0.238)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-fixed effect	No	No	No	No	No	No	No	No	No	No
Adj. R^2	0.413	0.414	0.411	0.405	0.407	0.407	0.415	0.406	0.401	0.400
N	106,994	106,253	106,512	115,726	108,363	108,363	108,363	108,363	115,726	115,726

To further verify the above findings, we construct two subsamples, one consisting of firms in developing countries (i.e. developing country investees) and the other consisting of firms in developed countries (i.e. developed country investees). Then, we examine the impact of *FIO* from developed (i.e. $FIO_{Developed}$) and developing (i.e. $FIO_{Developing}$) countries on corporate risk-taking in each subsample.

Table 2.5 shows that $FIO_{Developed}$ positively and significantly influences corporate risk-taking for both developing and developed investee countries, while the coefficient estimates of $FIO_{Developing}$ are positive but insignificant. This result suggests that foreign institutional investors from only developed countries can strengthen the risk-taking of invested firms but not those from developing countries. Remarkably, $FIO_{Developed}$ has a larger impact on corporate risk-taking in developing investee countries (as shown in Column 1) than that in developed investee countries (as shown in Column 2). In particular, the coefficient estimate of $FIO_{Developed}$ is 0.057 in Column 1 compared to 0.051 in Column 2. That is, for firms in developing (developed) investee countries, a one-standard-deviation increase in $FIO_{Developed}$ is associated with an 8.7% (4.9%) increase in *RISK1* relative to its sample mean.[8] This result indicates that the impact of $FIO_{Developed}$ on corporate risk-taking is smaller in developed investee countries, which are presumed to have stronger corporate governance. It lends further support for **H2b** in that country-level corporate governance substitutes the role of *FIO* in influencing corporate risk-taking.

[8] 8.7% = 0.057×0.070/0.046 (4.9% = 0.051×0.070/0.072), where 0.070 is the standard deviation of $FIO_{Developed}$ and 0.046 (0.072) is the sample mean of *RISK1*.

Table 2.5 FIO and Corporate Risk-taking: Developing v.s Developed Investee Country

This table reports the OLS estimation of the following model:
$Risk\_taking_{i,t} = \alpha + \beta_1 FIO_{Developed,i,t} + \beta_2 FIO_{Developing,i,t} + \beta_3 DIO_{i,t} + \beta_4 CONTROLS_{i,t} + \varepsilon.$
Risk_taking is the corporate risk-taking variable (*RISK1*). The results are qualitatively similar when using alternative risk-raking variables. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *CONTROLS* denotes a set of control variables, including *ROA*, *LEVERAGE*, *SIZE*, *SALESGROWTH*, *CAPEX*, *GDPGROWTH*, *ECONFREEDOM*, *GDP*, and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

	Developing Investee Countries	*Developed Investee Countries*
	[1]	[2]
$FIO_{Developed}$	0.057***	0.051***
	(0.000)	(0.000)
$FIO_{Developing}$	0.101	0.034
	(0.557)	(0.614)
DIO	-0.039***	-0.023***
	(0.000)	(0.000)
Control variables	Yes	Yes
Year-fixed effect	Yes	Yes
Industry-fixed effect	Yes	Yes
Country-fixed effect	Yes	Yes
Adj. R^2	0.164	0.439
N	23,212	92,514

To summarise, our empirical results demonstrate a substitution effect between *FIO* and country-level corporate governance in determining corporate risk taking. That is, foreign institutional investors effectively promote corporate risk-taking in countries with weaker corporate governance, and this increasing role is attenuated in countries with stronger corporate governance.

2.5 Endogeneity Tests

We show that *FIO* increases corporate risk-taking. However, it is possible that foreign institutional investors are attracted to invest in firms that engage in more corporate risk-taking or that an unobserved factor affects both *FIO* and corporate risk-taking.[9] To address issues related to reverse causality and omitted variable, we adopt both regression-based and event-study approaches, which are described as follows.

2.5.1 Regression Based Approaches

We address the endogeneity issue by employing four different regression-based approaches. The first approach is based on a subsample analysis. Due to the nature of our risk-taking variables (i.e. the five-year forward-looking *ROA* volatility), it is likely that there are high autocorrelations between the consecutive years of our corporate risk-taking variables. To mitigate this concern, we re-examine the baseline regression using a subsample and ensure that there are no overlaps in the risk-taking variables. In particular, the subsample only includes observations for years 2000, 2005, and 2010. As shown in Column 1 of Table 2.6, the results are qualitatively unchanged, suggesting that it is unlikely that our findings are driven by the autocorrelations between the consecutive years of risk-taking variables.

[9] For example, firms with an effective corporate governance mechanism may attract more foreign investments (Leuz, Lins and Warnock, 2009). Meanwhile, an effective corporate governance mechanism may also motivate managers to take higher risk.

Table 2.6 FIO and Corporate Risk-taking: Endogeneity Tests

Table 2.6 reports the results of regression-based approaches that attempt to address the endogeneity issue. The dependent variable is the corporate risk-taking variable (*RISK1*). The results are qualitatively similar when using alternative risk-raking variables. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *MSCI* is a dummy variable equal to one if a firm is included in the MSCI ACWI, and zero otherwise. *CONTROLS* denotes a set of control variables, including *ROA*, *LEVERAGE*, *SIZE, SALESGROWTH, CAPEX, GDPGROWTH*, *ECONFREEDOM*, *GDP*, and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

Table 2.6 FIO and Corporate Risk-taking: Endogeneity Tests

	Subsample (2000, 2005, 2010)	*One-year Difference*	*Five-year Difference*	*Firm-fixed Effect*	*1st stage: FIO*	*2nd stage: RISK1*
	[1]	[2]	[3]	[4]	[5]	[6]
FIO / $\widehat{FIO}$	0.057***	0.013***	0.033***	0.035***		0.167***
	(0.000)	(0.006)	(0.003)	(0.000)		(0.001)
DIO	-0.026***	0.000	-0.007**	-0.006***	-0.006	-0.024***
	(0.000)	(0.972)	(0.026)	(0.000)	(0.482)	(0.000)
MSCI					0.054***	
					(0.000)	
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry-fixed effect	Yes	No	No	No	Yes	Yes
Country-fixed effect	Yes	No	No	No	Yes	Yes
Firm-fixed effect	No	No	No	Yes	No	No
Adj. R^2	0.402	0.049	0.093	0.745	0.316	0.417
N	28,075	96,025	42,303	115,726	115,726	115,726
Under-identification test (H0: under-identified)						
(A) Kleibergen-Paap rk LM statistic						10.436
P-value						0.001
Weak instruments (H0: Instruments are weak)						
(B) First-stage F statistic (*FIO*)						71.643
P-value						0.000
(C) Kleibergen-Paap Wald rk F statistic						71.643
10% critical value						16.380

The second approach involves using the *difference regressions*.[10] In particular, we take the one-year (or five-year) difference of the dependent and independent variables and then examine the baseline regression with these differenced variables rather than their levels. By taking the differences, we remove the unobservable time-invariant firm factors that could drive the relation between *FIO* and corporate risk-taking. Columns 2 and 3 present the results of *one-year-difference* and *five-year-difference regressions*, respectively. The results remain qualitatively unchanged.

The third approach is using firm-fixed effects to control for time-invariant unobservable firm heterogeneity. Here, we address a similar endogeneity issue as the *difference regressions*, the relative efficiency of these two approaches depends on the underlying process of the error term. It is important to examine whether the results are consistent when using both approaches. As shown in Column 4 of Table 2.6, the results are similar to those in the *difference regressions*.

The fourth approach is to use 2SLS regression. We use the membership in the MSCI ACWI as an instrumental variable for *FIO* (Aggarwal et al., 2011; Luong et al., 2017). The MSCI ACWI is designed to measure the performance of the global equity market, and it contains approximately 85% of the free float-adjusted market capitalization in each country. On the one hand, foreign institutional investors rely on MSCI ACWI as a benchmark in their portfolio holdings; thus, it creates exogenous variations in *FIO*. In particular, Ferreira and Matos (2008) and Leuz et al. (2009) find that firms with MSCI membership attract more foreign capital. On the other hand, it is unlikely that MSCI membership directly influences firms' risk-taking behavior. In particular, the rule of

[10] The *difference regression* approach is widely used in previous literature to address the endogeneity issue (e.g. Wooldridge,2010; Li et al., 2011; Chen, Du, Li and Ouyang, 2013; among others).

inclusion in the MSCI ACWI relies solely on a firm's free-float adjusted market capitalization ranking within a country rather than its expected risk-taking. We define the instrumental variable (*MSCI*) as a dummy variable equal to one if a firm is included in the MSCI ACWI, and zero otherwise. Column 5 of Table 2.6 shows that *MSCI* significantly increases *FIO* in the 1st stage regression, indicating that foreign investors tend to use MSCI ACWI as a benchmark in their portfolio holdings. Then, we extract its fitted value in the 1st stage regression as the instrumented *FIO* (i.e. $\widehat{FIO}$) and examine its impact on corporate risk taking in the 2nd stage regression. Column 5 of Table 2.6 shows that $\widehat{FIO}$ increases corporate risk-taking, which is consistent with the results in the baseline regression.

The bottom panel of Table 2.6 reports the results of diagnostic tests to assess the validity of *MSCI* as an instrumental variable. First, it satisfies the rank condition, since the p-value of the Kleibergen-Paap rk LM statistic is 0.001, rejecting the null hypothesis that the equation is under-identified. A test of the significance of the instrumental variable in the first-stage regressions yields an F statistic of 71.643, exceeding Staiger and Stock's (1997) rule of thumb value of 10 as well as Stock and Yogo's (2005) 10% critical value for one instrument and one endogenous regressor (i.e. 16.38). These results reject the null hypothesis that the instruments are weak.[11] Therefore, the diagnostic tests strongly support the validity of the 2SLS regression results.

[11] Instruments are weak if the conventional α-level Wald test based on instrumental variable statistics has an actual size that could exceed a certain threshold, for example, 10% if the true rejection rate is 5% (Stock, Wright and Yogo, 2002). For one endogenous regressor and one instrument, the tabulated critical value for an actual size of 10% is 16.38. Since our Kleigbergen-Paap (2006) rk Wald statistics of 71.643 and 26.500 (i.e. the same as the F statistic in our context) far exceeds the 10% critical value, the maximum size distortion is no larger than 5%. Therefore, our results are not affected by the weak instrument problem.

2.5.2 Stock Additions (Deletions) to (from) the MSCI ACWI

To further establish a causal effect of *FIO* on corporate risk-taking, we conduct a quasi-natural experiment by using stock additions (deletions) to (from) the MSCI ACWI (Bena et al., 2017). In particular, we carry out a difference-in-differences (DiD) estimation around the time of stock additions (deletions) to (from) the MSCI ACWI. We identify 244 (99) stock additions (deletions) in our sample, which are identified as treated firms. For each treated firm, we match a control firm by using the nearest neighbor propensity score matching approach. Specifically, we estimate a logit model with the dependent variable equal to one if a firm experiences a stock addition (deletion), and zero otherwise. The logit model controls for the same set of independent variables as those used in the baseline regression, the one-year risk-taking growth variable (is denoted $Growth_{RISK1}$, and helps ensure that the parallel trend assumption of the DiD estimation is satisfied) (Luong et al., 2017), and industry-, year-, and country-fixed effects. Then, each treated firm is matched to a control firm based on the nearest neighbour propensity score matching with replacement.

Panel A shows the pre-treatment (i.e. two years before the treatment) means of the treated and matched control firms and the tests of the difference in means between the two groups. In general, we are unable to reject the hypothesis of equal means between the treated and matched control firms. In addition, the pre-treatment $Growth_{RISK1}$ is not significantly different between the treated and matched control firms. This suggests that there is no observable pre-treatment trend in corporate risk-taking outcomes between the two groups of firms, thus providing evidence to support the parallel trend assumption.

Table 2.7 Stock Additions (Deletions) to (from) the MSCI ACWI

This table shows the results of difference-in-differences regressions of corporate risk-taking around the time of stock additions (deletions) to (from) the MSCI ACWI. Panel A shows the pre-treatment (i.e. two years before the treatment) means of treated and control firms and tests of the difference in means between the two groups. Treated firms are those firms that experience a stock addition (deletion) to (from) the MSCI ACWI. Each treated firm is matched to a control firm by using the nearest neighbor propensity score matching approach. *TREATED* is a dummy variable equal to one if a firm is added (deleted) to the MSCI ACWI, and zero otherwise. *POST* is a dummy variable equal to one in the year a firm is added (deleted) to the MSCI ACWI and thereafter, and zero otherwise. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

Panel A: Summary Statistics (Pre-event)				
Stock Additions to the MSCI ACWI				
	Pre-event Treated Firms (N=244)	*Pre-event Control Firms (N=244)*	*Difference in Means*	
	Mean	*Mean*	*Difference [1]-[2]*	*T-statistic*
	[1]	[2]	[3]	[4]
FIO	0.044	0.044	-0.001	-0.166
DIO	0.292	0.290	0.002	0.058
ROA	0.051	0.038	0.013	1.549
LEVERAGE	0.251	0.260	-0.009	-0.574
SIZE	13.541	13.472	0.070	0.493
SALESGROWTH	0.178	0.176	0.002	0.045
CAPEX	0.060	0.061	-0.001	-0.224
$Growth_{RISK1}$	0.149	0.083	0.066	1.084

Table 2.7 Panel A Cont.

Stock Deletions from the MSCI ACWI				
	Pre-event Treated Firms (N=99)	*Pre-event Control Firms (N=99)*	*Difference in Means*	
	Mean [1]	*Mean* [2]	*Difference [1]-[2]* [3]	*T-statistic* [4]
FIO	0.100	0.092	0.008	0.580
DIO	0.109	0.113	-0.004	-0.126
ROA	0.059	0.060	-0.001	-0.107
LEVERAGE	0.198	0.210	-0.012	-0.471
SIZE	14.067	14.187	-0.119	-0.708
SALESGROWTH	0.137	0.155	-0.017	-0.529
CAPEX	0.042	0.045	-0.003	-0.453
$Growth_{RISK1}$	0.211	0.223	-0.013	-0.114

Table 2.7 Cont.

Panel B: Difference-in-differences Estimation				
Stock Additions to the MSCI ACWI				
	FIO	*FIO*	*RISK1*	*RISK1*
	[1]	[2]	[3]	[4]
TREAT×POST	0.053***	0.045***	0.008***	0.015***
	(0.000)	(0.000)	(0.000)	(0.000)
DIO		-0.001		-0.001
		(0.962)		(0.842)
Control variables	No	Yes	No	Yes
Year-fixed effect	Yes	Yes	Yes	Yes
Firm-fixed effect	Yes	Yes	Yes	Yes
Adj. R^2	0.868	0.871	0.613	0.653
N	2,300	2,300	2,300	2,300
Stock Deletions from the MSCI ACWI				
	FIO	*FIO*	*RISK1*	*RISK1*
	[1]	[2]	[3]	[4]
TREAT×POST	-0.028**	-0.023*	-0.011*	-0.011***
	(0.024)	(0.056)	(0.088)	(0.007)
DIO		-0.160***		-0.056***
		(0.001)		(0.006)
Control variables	No	Yes	No	Yes
Year-fixed effect	Yes	Yes	Yes	Yes
Firm-fixed effect	Yes	Yes	Yes	Yes
Adj. R^2	0.880	0.885	0.591	0.650
N	920	920	920	920

Following our previous analysis, we conduct the DiD estimation in a multivariate regression framework by estimating the following model,

$$Risk\_taking_{i,t} = \alpha + \beta_1 TREAT_i \times POST_t + \beta_2 DIO_{i,t} + \beta_3 CONTROLS_{i,t} + \varepsilon,$$

where *TREAT* is a dummy variable equal to one if a firm experiences a stock addition (deletion), and zero otherwise. *POST* is a dummy variable that indicates the post-event years. The key variable of interest is *TREAT*×*POST*, which captures the difference in corporate risk-taking between treated and matched control firms following stock additions (deletions) to (from) the MSCI ACWI.

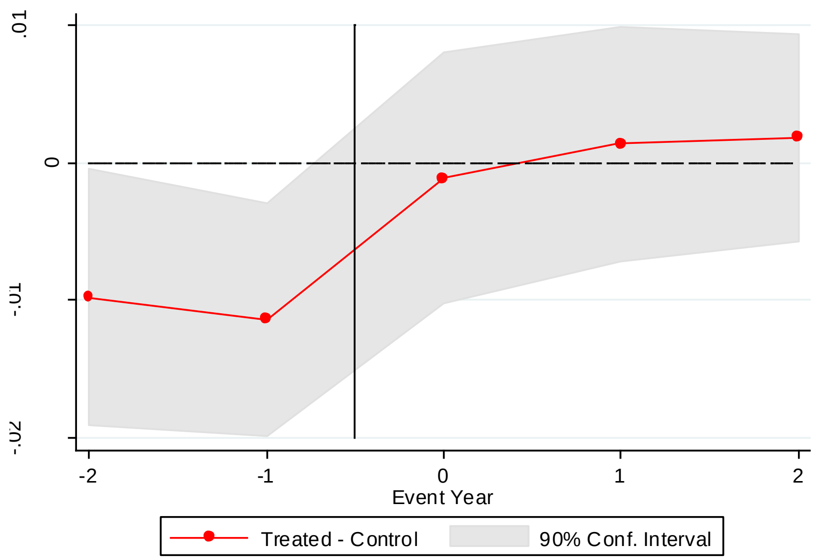
Panel B of Table 2.7 reports the empirical results of the DiD estimations. The dependent variable is *FIO* in Columns 1 and 2. The positive (negative) and statistically significant coefficient estimates of *TREAT*×*POST* indicate that, on average, treated firms receive a significant increase (decrease) in *FIO* following the stock additions (deletions) to (from) the MSCI ACWI. In Columns 3 and 4, the dependent variables is *RISK1*. The coefficient estimates of *TREAT*×*POST* are positive (negative) and statistically significant, indicating that the treated firms experience a significantly larger increase (decrease) in corporate risk-taking relative to the control firms after a stock is added (deleted) to (from) the MSCI ACWI.

Panel A (B) of Figure 2.2 shows the evolution of the differences in *RISK1* between the treated and matched control firms in the two years before and after the stock additions (deletions) to (from) the MSCI ACWI. The events occur between years (-1 to 0). We find that the figures in both panels follow a relative parallel trend in the pre-event period, and the differences in *RISK1* between the treated and matched control firms are significantly increased (decreased) after the stock additions (deletions). In sum, the results are qualitatively similar to those obtained by using the 2SLS approach, indicating that the exogenous variations in *FIO* from stock additions (deletions) to (from) the MSCI ACWI significantly increase (decrease) corporate risk-taking.

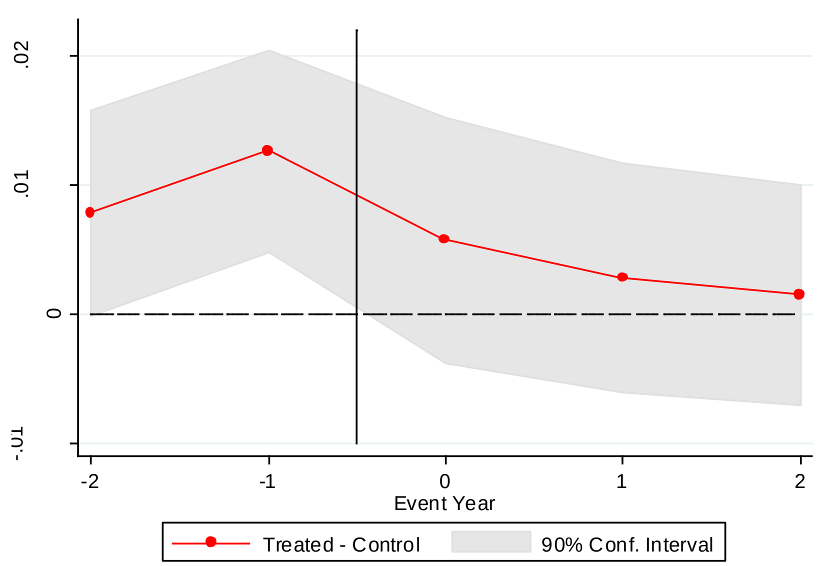
Figure 2.2: Corporate Risk-taking of Treated and Control Firms around Stock Additions (Deletions) to (from) the MSCI ACWI

This figure shows the difference in *RISK1* between treated and control firms in the two years before and after the stock additions (deletions) to (from) the MSCI ACWI. The events occur between years (-1 to 0). Treated firms consist of 244 (99) stock additions (deletions) to the MSCI ACWI.

Panel A: Stock Additions to the MSCI ACWI



Panel B: Stock Deletions from the MSCI ACWI



2.6 Corporate Risk-taking around Foreign Block Purchases

To further clarify the causality direction in the relation between *FIO* and corporate risk-taking, we conduct an event study in a cross-border M&A context.[12] Specifically, we focus on the changes in corporate risk-taking of target firms, where *FIO* is increased due to foreign block purchases.[13] To ensure that the event windows are independent of each other, we limit our sample to firms that are targeted by a foreign block purchase for the first time. There are 464 firms that satisfy the above criteria. We calculate the average *ROA* volatility for pre- and post-event periods up to five years. For the pre-event period, we compute the average *ROA* volatility from the years (-5 to -1), (-4 to -1), and (-3 to -1). For the post-event period, we compute the average *ROA* volatility from the years (+1 to +3), (+1 to +4), and (+1 to +5). We match each treated firm with a control firm with the closest market capitalization in the same industry, country, and year.

Panel A of Table 2.8 shows a significant increase in corporate risk-taking after foreign block purchases. In particular, it shows that the differences in average *ROA* volatility between treated firms and matched control firms are positive and significant at the 1% level in Rows 4-6 (i.e. after foreign block purchases) but not in Rows 1-3 (i.e. before foreign block purchases). This implies that foreign block purchases generate ex-post increases in corporate risk-taking, but they are not driven by the ex-ante corporate risk-taking. It is unlikely that the previous findings arise simply because foreign investors (who face information disadvantages compared to domestic investors) are able to forecast corporate risk-taking and choose to acquire firms that take higher risk (French and Poterba,

[12] Our methodology is similar to that of Li et al. (2011), which suggest that the stock-volatility-reduction effect is a causal outcome of large foreign shareholder participation. The M&A data are collected from the SDC Platinum M&A Database.

[13] We use the *block purchase indicator* in the Platinum M&A Database to identify block purchases.

1991; Kang and Stulz, 1997; Dahlquist and Robertsson, 2001; Portes and Rey,2005). Thus, the above evidence suggests that the observed increased corporate risk-taking is a causal outcome of the increased *FIO* due to foreign block purchases.

Table 2.8 Corporate Risk-taking around Foreign Block Purchases

This table presents the announcement effect of corporate risk-taking around foreign block purchases. We match each treated firm with a control firm by size in Panel A and by propensity score in Panel B. We compute and compare the average *ROA* volatility of treated firms and control firms. The average *ROA* volatility is reported for pre-event periods (-5 to -1), (-4 to -1), and (-3 to -1) and for post-event periods (+1 to +3), (+1 to +4), and (+1 to +5). Columns 1 and 2 report the average *ROA* volatility for treated firms and control firms, respectively. The difference and its t-statistic are reported in Columns 3 and 4. ***, **, * denotes statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

Panel A: Size-matched Sample				
	Treated Firms (N=464)	*Control Firms (N=464)*	*Difference in Means*	
	Average ROA Volatility	*Average ROA Volatility*	*Difference* [1]-[2]	*T-statistic*
	[1]	[2]	[3]	[4]
Year (-5 to -1)	0.098	0.091	0.007	0.703
Year (-4 to -1)	0.091	0.084	0.007	0.761
Year (-3 to -1)	0.081	0.080	0.001	0.125
Year (+1 to +3)	0.106	0.059	0.047	3.811***
Year (+1 to +4)	0.109	0.067	0.042	3.629***
Year (+1 to +5)	0.113	0.075	0.039	3.484***

Table 2.8 Cont.

Panel B: Propensity-score-matched Sample				
	Pre-event Treated Firms (N=270)	*Pre-event Control Firms (N=270)*	*Difference in Means*	
	Mean	*Mean*	*Difference* [1]-[2]	*T-statistic*
	[1]	[2]	[3]	[4]
FIO	0.065	0.058	0.007	0.902
DIO	0.104	0.101	0.003	0.145
ROA	0.010	0.020	-0.010	-0.776
LEVERAGE	0.255	0.263	-0.008	-0.453
SIZE	12.448	12.498	-0.050	-0.274
SALESGROWTH	0.173	0.189	-0.017	-0.449
CAPEX	0.057	0.051	0.006	1.250
	Average ROA Volatility	*Average ROA Volatility*	*Difference* [1]-[2]	*T-statistic*
	[1]	[2]	[3]	[4]
Year (-5 to -1)	0.074	0.068	0.006	0.824
Year (-4 to -1)	0.068	0.062	0.007	0.902
Year (-3 to -1)	0.063	0.056	0.007	1.016
Year (+1 to +3)	0.064	0.049	0.014	2.182**
Year (+1 to +4)	0.068	0.053	0.015	2.290**
Year (+1 to +5)	0.080	0.058	0.021	2.793***

In addition, we use the nearest neighbour propensity score matching approach to match the treated firms and control firms, which allows us to control for other economic motivations (compared to only matching by market capitalization in the previous test). Specifically, we estimate a logit model with the dependent variable equal to one if a firm is announced to be the target of a foreign block purchase, and zero otherwise. The logit model controls for the one-year lagged variables used in the baseline regression (i.e. *FIO*, *DIO*, *ROA*, *LEVERAGE*, *SIZE*, *SALESGROWTH*, and *CAPEX*) as well as year-, industry-, and country-fixed effects. Then, each treated firm is matched to a control firm based on the nearest neighbour propensity score with replacement. By matching on the propensity score, we ensure that the economic motivations for foreign block purchasers are similar between the treated and matched control firms along the propensity score characteristics.

Panel B of Table 2.8 reports the results of the propensity score matched sample. As a diagnostic test, we compare the differences in the means of the firm-level variables between the treated and matched control firms, and find that the observed characteristics are not significantly different between the two groups. This suggests that the predicted probability of being announced as a target of foreign block purchases does not differ significantly across the two samples. Consistent with the results in Panel A, the differences in average *ROA* volatility for treated firms and matched control firms are statistically insignificant (positive at the 1% significance level) before (after) foreign block purchases. This suggests that the variation in corporate risk-taking across the two samples is likely to be attributed to foreign block purchases. Therefore, after controlling for other economic motivations (e.g. profitability, financial leverage, firm size), the motivation of corporate governance improvement by foreign institutional investors remains.

We have found that corprate risk-taking, on average, increases after foreign block purchases. However, it is unclear how these foreign acquirers promote the risk-taking of target firms. To clarify this, we consider the corprate risk-taking of the control firm as the risk-taking norm of the treated firm. This is plausible because they have similar firm characteristics and corporate risk-taking before a foreign block purchase. Then, we define the abnormal risk taking (i.e. $\Delta Risk\_taking$) as the difference in corporate risk-taking between the treated and matched control firms. Next, we employ the following multivariate regression framework to examine the impact on abnormal risk taking,

$$\Delta Risk\_taking_{i,t} = \alpha + \beta_1 FBP_{i,t-1} + \beta_2 \Delta CG + \beta_3 CONTROLS_{i,t-1} + \varepsilon,$$

where *FBP* is the percentage of shares acquired by a foreign block purchase. ΔCG is the difference in country-level corporate governance variables between acquirer and target firm nations. *CONTROLS* includes various deal characteristics and the differences in country-level variables between acquirer and target firms, including *PREMIUM*, *ALLCASH*, *FRIENDLY*, *INDUSRTY, CONTINENT*, *LANGUAGE*, ΔGDP, and $\Delta GDPGROWTH$.

Table 2.9 presents the results of the multivariate regression. As shown in Column 1, FBP is positively related to $\Delta Risk\_taking$, indicating that a higher percentage of foreign block purchases is related to a larger difference in corporate risk-taking between treated and matched control firms. In Columns 2, 3 and 4, we control for $\Delta ACCSTD$ and $\Delta ANTID$, which represent the differences in country-level accounting transparency and shareholder protection between the acquirer and target firm nations. The results show that they are both positive and statistically significant, suggesting that the corporate risk-taking of target firms is largely influenced by the convergence in corporate governance standards. Acquirers in countries with stronger corporate governance standards have greater expectations in terms of the governance practices of target firms. Thus, these acquirers are more likely to act on their expectations by pressuring target firms to adopt stronger governance practices (Aggarwal et al., 2011). As a result, the governance motivation behind foreign block purchases is an important factor in encouraging the risk-taking of target firms. In contrast, the coefficient estimates of ΔGDP and $\Delta GDPGROWTH$ are mostly insignificant. The *INDUSTRY* dummy, which captures whether the target and acquirer firms share the same two-digit SIC code, is also insignificant. This suggests that the economic motivation to horizontally integrate has no impact on the risk-taking of target firms. These results suggest that the governance motivation is more pronounced than the economic motivation behind the positive impact of foreign block purchases on corporate risk-taking.

Table 2.9 Foreign Block Purchases and Corporate Risk-taking

This table reports the OLS estimation of the following model:

$$\Delta Risk\_taking_{i,t} = \alpha + \beta_1 FBP_{i,t-1} + \beta_2 \Delta CG + \beta_3 CONTROLS_{i,t-1} + \varepsilon.$$

$\Delta Risk\_taking$ is the difference in corporate risk-taking between the treated and matched control firms. *FBP* is the percentage of shares acquired by a foreign block purchase. ΔCG is the difference in *ACCSTD* and *ANTID* between acquirer and target firms. *CONTROLS* denotes a set of deal characteristics as well as the differences in country-level variables between acquirer and target firms, including $PREMIUM$, *ALLCASH*, *FRIENDLY*, *INDUSTRY*, *CONTINENT*, *LANGUEGE*, ΔGDP, and $\Delta GDPGROWTH$. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

	[1]	[2]	[3]	[4]
FBP	0.105*	0.177**	0.136*	0.178**
	(0.050)	(0.020)	(0.081)	(0.020)
$\Delta ACCSTD$		0.004***		0.003**
		(0.003)		(0.010)
$\Delta ANTID$			0.011**	0.007*
			(0.013)	(0.099)
PREMIUM	0.000	-0.001	-0.001	-0.001
	(0.881)	(0.217)	(0.195)	(0.186)
ALLCASH	0.001	-0.012	-0.006	-0.012
	(0.939)	(0.431)	(0.670)	(0.435)
FRIENDLY	0.016*	0.017	0.017*	0.019*
	(0.080)	(0.118)	(0.096)	(0.074)
INDUSTRY	-0.016	0.010	0.008	0.012
	(0.112)	(0.500)	(0.610)	(0.426)
CONTINENT	0.002	0.016	0.001	0.018
	(0.835)	(0.127)	(0.926)	(0.102)
LANGUAGE	-0.030**	-0.033***	-0.035*	-0.040**
	(0.016)	(0.010)	(0.063)	(0.013)
ΔGDP	-0.009**	-0.013	-0.008	-0.011
	(0.036)	(0.119)	(0.153)	(0.155)
$\Delta GDPGROWTH$	0.000	0.001	0.001	0.001
	(0.884)	(0.768)	(0.826)	(0.854)
Year-fixed effect	Yes	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes	Yes
Country-fixed effect	Yes	Yes	Yes	Yes
Adj. R^2	0.336	0.397	0.391	0.402
N	253	196	205	196

2.7 Channels of the Positive Impact of Foreign Institutional Ownership on Corporate Risk-Taking

2.7.1 Direct Channels

2.7.1(i) Foreign Institutional Ownership (FIO) and Innovation (R&D and Patent)

Foreign institutional investors equip firms with both financial and non-financial capital, which allows them to implement riskier projects. Innovation as a likely outcome of risk-taking activities is encouraged by foreign institutional investors. That is, *FIO* encourages firms to input more resources and generate more innovation outputs. This section examines whether *FIO* can increase both the input and output of innovation in our sample. Specifically, to measure innovation input, we construct a variable for research and development (R&D) expenditure (denoted *R&D*). This variable is calculated as the average R&D ratio (i.e. the ratio of R&D expenses to the book value of assets over a five year overlapping period beginning from the current year. In addition, we construct two innovation output variables. In particular, *LnPatent* (*LnCitePat*) is computed as the natural logarithm of one plus the total number of patents granted (citations made to a firm's patents) in each year, scaled by the mean of patent applications filed (citations received by each patent) in that year for the same technology group. As shown in Table 2.10 Panel A, *FIO* significantly increases all three innovation variables, indicating that foreign institutional investors not only encourage firms to input more resources for innovation but also push them to generate more innovation outputs. Following the literature, *FIO* is likely to affect firm innovation over a longer period of time (Luong et al., 2017). To clarify this relationship, we extend our analysis to include 2- and 3-year ahead innovation measures in Table 2.10 Panel B. For both innovation measures, we find that there is no significant difference between the coefficient and statistical significance on *FIO* between the 1-, 2-, and 3-year ahead measures. This confirms the findings by Luong et al. (2017), who finds that there are both short- and long-term mechanisms that allow *FIO* to influence firm innovation.

Overall, our results support the findings in prior literature. For example, Guadalupe, Kuzmina and Thomas (2012) find that firms acquired by foreign acquirers engage in more product and process innovation accompanied by increased assimilation of foreign technologies. Bena et al. (2017) find that foreign institutional investors can utilize their independent position to provide more effective monitoring of corporate insiders, which reduces managerial entrenchment and fosters long-term investments in fixed capital, innovation and human capital. Similarly, Luong et al. (2017) find that foreign institutional investors can enhance firm innovation by playing an active monitoring role, alleviate managers' career and reputation concerns by insuring them against failures associated with innovative activities, as well as facilitating knowledge spillovers by promoting business networks and cross-border M&As around the world.

Table 2.10 Foreign Institutional Ownership and Innovation

This table reports the OLS estimation of the following model:

$$Innovation_{i,t} = \alpha + \beta_1 FIO_{i,t-1} + \beta_2 DIO_{i,t-1} + \beta_3 CONTROLS_{i,t-1} + \varepsilon.$$

Innovation variables include *R&D*, *LnPatent*, and *LnCitePat*. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *CONTROLS* denotes a set of control variables, including *ROA*, *LEVERAGE*, *SIZE*, *SALESGROWTH*, *CAPEX*, *GDPGROWTH*, *ECONFREEDOM*, *GDP*, and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

Panel A: Innovation			
	R&D	*LnPatent*	*LnCitePat*
	[1]	[2]	[3]
FIO	0.063***	0.681***	0.949***
	(0.000)	(0.007)	(0.000)
DIO	-0.005	0.048	0.262***
	(0.343)	(0.474)	(0.000)
Control variables	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes
Country-fixed effect	Yes	Yes	Yes
Adj. R^2	0.450	0.302	0.157
N	115,726	42,582	42,582

Panel B: 2-year and 3-year ahead innovation				
	$LnPatent_{t+1}$	$LnPatent_{t+2}$	$LnCitePat_{t+1}$	$LnCitePat_{t+2}$
	[1]	[2]	[3]	[4]
FIO	0.684***	0.700**	0.916***	0.901***
	(0.009)	(0.012)	(0.000)	(0.000)
DIO	0.048	0.050	0.259***	0.274***
	(0.486)	(0.489)	(0.000)	(0.000)
Control variables	Yes	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes	Yes
Country-fixed effect	Yes	Yes	Yes	Yes
Adj. R^2	0.305	0.308	0.154	0.152
N	39,105	35,442	39,105	35,442

2.7.1(ii) Foreign Institutional Ownership (FIO) and Acquisitions

Based on our prior results, *FIOs* are associated with greater corporate risk-taking. This result is a likely outcome of promoting innovative activities, which include risky M&A activities that are major corporate investments that carry a great deal of uncertainty (Datta, Iskandar-Datta and Raman, 2001; Kravet, 2014; Croci and Petmezas, 2015). In particular, Croci and Petmezas (2015) find that there is greater excess stock return volatility after an acquisition announcement. Similarly, Bargeron, Lehn, Moeller and Schlingemann (2014) find that acquisition announcements are associated with an increase in bidder implied volatility. While, Furfine and Rosen (2011) demonstrates that mergers increase the default risk of the acquiring firm. Therefore, M&As are risk-taking investments that exhibit significant uncertainty which translates to an increase in managerial risk (Datta et al., 2001). Due to risks associated with M&A investments, managers are likely to avoid M&A investments due to career concerns.

In this section, we consider whether *FIO* influence firm risk-taking by promoting a firm to undertake riskier investments in the form of M&As. To investigate this channel, we construct from Worldscope a measure of the net expenditure for asset acquisitions (ACQ_$ASSETS$), defined as the average net asset acquisition to asset ratio over a five-year overlapping period beginning from the current year. To generalize our findings to different types of acquisitions, we collect data on acquisitions announced and completed from the SDC Mergers and Acquisitions database during our sample period. Further, we restrict our sample to include only firms that have made at least one acquisition during the sample period. Using this data, we construct two different variables: (1) the number of acquisitions made each year (ACQ) and (2) the total value of all acquisitions scaled by assets for each year (ACQ_VALUE).[14]

Our results from Table 2.11 Column 1 suggest that FIO significantly increases net asset acquisition expenditures (ACQ_ASSETS) at 1% level. Specifically, a one-standard-deviation increase in FIO is associated with an approximate increase in ACQ_ASSETS of 15.2% $(= 0.111 \times 0.070/0.051)$, while DIO is insignificant at all conventional significance levels. In Table 2.11 Column 2, we estimate a Poisson model with the dependent variable equal to the number of acquisitions made during a year (ACQ). The results suggest that FIO is positively associated with the number of acquisitions made during a year at 1% level. To examine the size of the acquisitions, we restrict our sample to firms that have made at least one acquisition during the year. The results in Table 2.11 Column 3 suggest that FIO is positive and significant at 1% level, while DIO is negative and significant at 5% level. Overall, our results suggest that firms with greater FIO are not only more likely to undertake acquisitions but are also more likely to make larger acquisitions.

[14] Specifically, we focus on acquisitions classified as "*mergers*", "*acquisitions*", "*acquisitions of majority interest*", "*acquisitions of partial interest*", "*acquisitions of remaining interest*", "*acquisitions of assets*", or "*acquisitions of certain assets*".

Table 2.11 Foreign Institutional Ownership and Acquisitions

This table reports the OLS estimation of the following model:

$$Acquisitions_{i,t} = \alpha + \beta_1 FIO_{i,t-1} + \beta_2 DIO_{i,t-1} + \beta_3 CONTROLS_{i,t-1} + \varepsilon.$$

Acquisitions variables include *ACQ_ASSETS*, *ACQ*, and *ACQ_VALUE*. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *CONTROLS* denotes a set of control variables, including *ROA*, *LEVERAGE*, *SIZE*, *SALESGROWTH*, *CAPEX*, *GDPGROWTH*, *ECONFREEDOM*, *GDP*, and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

	ACQ_ASSETS	*ACQ*	*ACQ_VALUE*
	[1]	[2]	[3]
FIO	0.111***	0.858***	0.070***
	(0.009)	(0.000)	(0.004)
DIO	0.003	0.109	-0.041**
	(0.794)	(0.266)	(0.019)
Control variables	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes
Country-fixed effect	Yes	Yes	Yes
Adj. R^2	0.113	0.109	0.168
N	115,726	64,841	18.676

Based on past literature there are several reasons why *FIO* would promote a firm to undertake more M&A investments. In particular, it is well documented that there are substantial agency conflicts surrounding M&A investments (Lewellen, Loderer and Rosenfeld, 1985; Jensen, 1986; Morck, Shleifer and Vishny, 1990). Ferreira and Matos (2008) find that foreign institutional investors play a stronger role in monitoring corporations worldwide due to fewer potential business ties with management. Therefore, foreign institutional investors are well suited to monitor and discipline managers against the avoidance of risky M&A investments. Further, Li et al. (2011) find that foreign capital improves the quality of information in local markets which should reduce transaction costs as well as the risk exposures associated with M&A investments. In support of this, Ferreira et al. (2010) find that institutional investors are associated with higher M&A activity both domestically and internationally. Specifically, foreign institutional investors build “bridges” for more international M&A investments by reducing transaction costs. Similarly, Andriosopoulos and Yang (2015) find that *FIO* is positively associated with the probability of engaging in cross-border M&As as well as the size of M&As.

2.7.2 Indirect Channels

2.7.2(i) Monitoring Channel

The agency conflicts between managers and shareholders result from the separation of ownership and control rights. Due to career and reputation concerns, risk-averse managers could choose to avoid risky projects even if they enhance firm value (Myers, 1977; Amihud and Lev, 1981; Homstrom and Ricart I Costa, 1986; Hirshleifer and Thakor, 1992). The monitoring role of foreign institutional investors is thus an important governance mechanism to mitigate such agency conflicts. For example, Chen, Harford and Li (2007), Ferreira and Matos (2008), and Aggarwal et al. (2011) document that foreign institutional investors can effectively monitor managers because of their relatively greater independence, compared to domestic institutional investors. Becht, Franks, Mayer and Rossi (2009) argue that management intervention can encourage foreign institutional investors to align management incentives, thus monitor managers. Albuquerque, Brandão-Marques, Ferreira and Matos (2019) find that foreign direct investments (cross-border M&As) promote corporate governance spillovers in the host country. In this section, we examine whether *FIO* influences corporate risk-taking through its monitoring role.

Previous literature suggests that different types of institutional investors conduct different levels of monitoring. For example, Brickley, Lease and Smith (1988) find that mutual funds and investment advisors tend to be active monitors, while banks and insurance companies are more supportive of management action. Almazan, Hartzell and Starks (2005) suggest that investment advisors and investment companies have advantages in monitoring. In addition, Ferreira and Matos (2008) argue that *independent institutions*, such as mutual funds and investment advisors, actively collect information, are subject to fewer regulatory restrictions, and have fewer potential business relationships with the invested firms. That is, they play a stronger monitoring role, and they may intervene in management decisions. Conversely, *grey institutions*, such as banks, insurance companies, pension funds and endowments, have higher monitoring costs, are more loyal to corporate management, and are more likely to hold shares without reacting to the management actions of the invested firms.

To examine whether the impact of *FIO* on corporate risk-taking varies for different types of institutional investors, we construct FIO_{Type}, representing the *FIO* for a particular type of institution. Table 2.12 presents the estimating results of corporate risk-taking on *FIO* for each institutional type. Columns 3, 4, and 6 show that *FIO* is positively and significantly related to corporate risk-taking for foreign *independent institutions*, including mutual funds, investment advisors, hedge funds, and venture capital. As shown in Column 7, the empirical results are qualitatively unchanged if we use an aggregated measure of foreign *independent institutions* (i.e. $FIO_{Independent}$). On the other hand, Columns 1, 2, and 5 in Table 2.12 show insignificant results for foreign *grey institutions*, including banks, insurance companies, pension funds, and endowments. This result indicates that foreign *independent institutions* actively and effectively monitor the firms, in turn influencing their corporate risk-taking decisions.

Bushee (1998) argues that institutional investors who frequently trade encourage managers to pursue short-term earnings goals, while long-term institutional ownership serves to reduce pressure on management and encourages them to pursue long-term investments. In addition, Chen et al. (2007) suggest that institutions focusing on long-term investments specialize in monitoring rather than trading.

To examine whether long-term *FIO* influences corporate risk-taking, we construct $FIO_{Long-term}$, representing the *FIO* held by long-term institutional investors. Following Gaspar, Massa and Matos (2005), we measure the investment horizon by constructing the investors' annual portfolio turnovers (i.e. churn rate, or *CR*).

$$CR_{v,t} = \frac{\sum_{i\in Q}\left|N_{i,v,t}P_{i,t} - N_{i,v,t-1}P_{i,t-1} - N_{i,v,t-1}\Delta P_{i,t}\right|}{\sum_{i\epsilon Q}\frac{N_{i,v,t}P_{i,t} + N_{i,v,t-1}P_{i,t-1}}{2}},$$

where firm is indexed by *i*, investor by *v*, and year by *t*. *Q* is the set of firms that are held by investor *v*. *P* and *N* are the stock price and the number of shares outstanding, respectively. Short-term investors tend to buy and sell their investments frequently, while long-term investors tend to hold their investments for longer periods of time. Thus, short-term investors should have a higher *CR* than long-term investors. We then calculate the annual average *CR* of each investor to represent their investor horizons. An investor is classified as a long-term investor if their yearly-average *CR* is below the median of the yearly average *CR* across all institutional investors.

As shown in Column 8 of Table 2.12, the coefficient estimate of $FIO_{Long-term}$ is positive and statistically significant at the 1% level. $FIO_{Excluding\ long-term}$ is also positively related to corporate risk-taking, but its magnitude is relatively small compared to that of $FIO_{Long-term}$ (i.e. 0.041 compared to 0.053), and its significance level is only at 10% level. Nevertheless, this results indicates that the positive impact of

FIO on corporate risk-taking is more pronounced for long-term foreign institutional investors. Overall, this indicates that the positive impact of *FIO* on corporate risk-taking is achieved through the *monitoring channel*. The results are consistent with Albuquerque et al.'s (2019) finding in that foreign direct investment promotes corporate governance spillovers in the host country, which in turns increases risk-taking (John et al., 2008).

Table 2.12 Foreign Institutional Ownership and Corporate Risk-taking: Monitoring

This table reports the OLS estimation of the following model:

$$Risk\_taking_{i,t} = \alpha + \beta_1 FIO_{Type,i,t} + \beta_2 FIO_{Excluding\ Type,i,t} + \beta_3 DIO_{i,t} + \beta_4 CONTROLS_{i,t} + \varepsilon.$$

Risk_taking is the corporate risk-taking variable (*RISK1*). The results are qualitatively similar when using alternative risk-raking variables. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *CONTROLS* denotes a set of control variables, including *ROA*, *LEVERAGE*, *SIZE*, *SALESGROWTH*, *CAPEX*, *GDPGROWTH*, *ECONFREEDOM*, *GDP*, and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

Type =	*Banks*	*Insurance Companies*	*Mutual Funds*	*Investment Advisors*	*Pension Funds & Endowments*	*Hedge Funds & Venture Capital*	*Independent*	*Long-term*
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
FIO_{Type}	-0.114	-0.029	0.036*	0.054***	0.118	0.063*	0.050***	0.053***
	(0.733)	(0.939)	(0.094)	(0.000)	(0.249)	(0.071)	(0.000)	(0.000)
$FIO_{Excluding\ Type}$	0.053***	0.053***	0.057***	0.051***	0.050***	0.052***	0.115	0.041*
	(0.000)	(0.000)	(0.000)	(0.009)	(0.000)	(0.000)	(0.250)	(0.078)
DIO	-0.025***	-0.025***	-0.025***	-0.025***	-0.025***	-0.025***	-0.025***	-0.025***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.424	0.424	0.424	0.424	0.424	0.424	0.424	0.424
N	115,726	115,726	115,726	115,726	115,726	115,726	115,726	115,726

2.7.2(ii) Disclosure Channel

This section examines how foreign institutional investors impact firm-specific information disclosure. This is of concern to foreign institutional investors because they are informationally disadvantaged compared to domestic institutional investors due to factors such as geographic distance, unfamiliarity with local industry, economic and regulatory environments and language and cultural barriers (Kang and Stulz, 1997; Leuz et al., 2009; Baik, Kang, Kim and Lee, 2013). Therefore, foreign institutional investors have more incentives to improve the information disclosure in their invested firms. Past literature documents that there are many advantages to improved information disclosure, such as reduction in information asymmetries (Arping and Sautner, 2012; Bhat, Hope and Kang, 2006), increased liquidity (Diamond and Verrecchia, 1991; Leuz and Verrecchia, 2000), improvements in corporate governance (Khurana et al., 2006; Hermalin and Weisbach, 2007), all of which ultimately lead to increased shareholder value (Akhibe and Martin, 2006; Ferrell, 2007; Marquardt and Wiedman, 2007). More importantly, John et al. (2008) document that better accounting disclosure leads to increased corporate risk-taking because it limits managers' ability to acquire private benefits, which reduces managerial risk-avoidance. For the same reason, Lambert, Leuz and Verrecchia (2007) argues that disclosure leads to better decision making by managers. Disclosure also reduces information asymmetries which enhances the monitoring role of both internal and external parties (Bhat et al, 2006; Hermalin and Weisbach, 2007). Therefore, improved information disclosure is hypothesized to be positively associated with increased corporate risk-taking.

First, we examine the impact of FIO on earnings management measured by total accruals (TA) and discretionary accruals (DA). Accruals are accounting adjustments to operating cash flows to better measure current-period firm performance (Dechow, 1994).

The main reason why this is necessary is due to the timing differences between cash flows and earnings, where revenues (expenses) have been earned (incurred) during the period but have not been received (paid) as cash flow. However, it has been shown empirically that accruals reduce the information content of accounting earnings (Wang, Swift and Lobo, 1994; Ali and Hwang, 1995; Cheng, Liu and Schaefer, 1997). This is particularly important when managers have the incentives to opportunistically manage earnings through accruals (Brown, 1999; Healy and Wahlen, 1999; Dechow and Skinner, 2000). Specifically, when managers engage in earnings management they can increase or decrease earnings by creating accruals. Although it is not possible to observe earnings management directly, past literature tends to focus on the management's use of accruals to measure earnings management. Therefore, as a preliminary measure of earnings quality we use total accruals (Healy, 1985; Jones, 1991). Total accruals (TA) in year *t* for firm *i* are computed as:

$$TA_{i,t} = \frac{\Delta CA_{i,t} - \Delta CL_{i,t} - \Delta CASH_{i,t} + \Delta STD_{i,t} - DEP_{i,t}}{A_{i,t-1}},$$

where $\Delta CA_{i,t}$ is the current assets in year *t* less current assets in year *t-1* for firm *i*, $\Delta CL_{i,t}$ is the current liabilities in year *t* less current liabilities in year *t-1* for firm *i*, $\Delta CASH_{i,t}$ is the cash and cash equivalents in year *t* less cash and cash equivalents in year *t-1* for firm *i*, $\Delta STD_{i,t}$ is the short-term debt in year *t* less short-term debt in year *t-1* for firm *i*, $DEP_{i,t}$ is the depreciation and amortization expense in year *t* for firm *i*, and $A_{i,t-1}$ is the total assets in year *t-1* for firm *i*. In Column 1 of Table 2.13, we document that *FIO* loads negatively and significantly on total accruals at the 1% level. This provides some preliminary evidence that foreign institutional investors reduce earnings management and improves earnings quality. Similarly, we also find that DIO is negatively associated with total accruals at the 1% level. This suggests that the presence of institutional investors in general tend to limit the firm's use of accruals.

Following existing literature, we also attempt to separate total accruals into the discretionary and nondiscretionary components. The non-discretionary component is generally regarded as the component of accruals due to economic conditions unrelated to manager's manipulation (Healy, 1985). While the discretionary component is the component of accruals that are up to the manager's discretion such as bad debt reserves, warranty costs, and inventory write-downs.

To separate the components, we use the model proposed by Dechow, Sloan, and Sweeney (1995), which is the modified version of the model developed by Jones (1991). We choose to use this model because it has been shown to provide the most powerful test for earnings management compared to other models (Dechow et al, 1995; Peasnell, Pope and Young, 2000; Kothari, Leone, Wasley, 2005). To construct a measure of discretionary accruals we estimate the model below using OLS:

$$TA_{i,t} = \alpha_1\left(\frac{1}{A_{i,t-1}}\right) + \alpha_2\left(\Delta REV_{i,t} - \Delta REC_{i,t}\right) + \alpha_3\left(PPE_{i,t}\right) + \epsilon_{i,t}$$

where $\Delta REV_{i,t}$ is the revenues in year *t* less revenues in year *t-1* scaled by total assets in year *t-1* for firm *i*, ΔREC_t is the net receivables in year *t* less net receivables in year *t-1* scaled by total assets in year *t-1* for firm *i*, $PPE_{i,t}$ is the gross property plant and equipment in year *t* scaled by total assets in year *t-1* for firm *i*, and $\epsilon_{i,t}$ is error term in year *t* for firm *i*.

The logic underlying the original Jones (1991) model is to fit the total accruals by changes in nondiscretionary accruals that are caused by changing conditions rather than manager's manipulation. The change in revenue is included to control for changes in working capital accounts and represents the changes in economic environment, while gross property plant and equipment is included to control for the accruals related to nondiscretionary depreciation expense. The modified version proposed by Dechow et al. (1995) makes one adjustment relative to the original Jones (1991) model by adjusting the change in revenue by the change in receivables. This adjustment is made because the implicit assumption from the original Jones (1991) model is that revenues are nondiscretionary. However, managers can also manage revenues through managing receivables. Therefore, by removing the change in receivables from the change in revenues, the model provides a better representation of the nondiscretionary component. To extract discretionary accruals (DA) from the model, we use the residuals from the OLS estimation, which measures the component of total accruals not explained by the nondiscretionary accruals component.

From Column 2 of Table 2.13, we find that FIO is negatively associated with discretionary accruals at the 5% level. This result implies that foreign institutional investors constrain managers from managing earnings since high discretionary accruals indicate earnings manipulations (Healy, 1985; DeAngelo, 1986; Jones, 1991). This confirms a recent study by Lel (2019) who documents that foreign institutional investors can restrain firm earnings management activities. Domestic institutional investors on the other hand have a positive and significant effect on discretionary accruals. Our results suggest that while domestic institutional investors reduce the use of accruals in general, they do not constrain the manager's incentive to manage earnings. Therefore, FIO is associated with better earnings quality. This casts doubt on the possibility that FIO increases our risk-taking variable due to earnings management rather than through an actual increase in risk-taking activities.

Second, we consider how foreign institutional investors affect the choice of a firm in employing auditors (*BIG4*). In particular, we are interested in how foreign institutional investors affect the propensity of a firm to employ a Big 4 audit firms. This is important because larger auditors provide higher quality audits due to their greater resource availability, personnel training/expertise, and reputation concerns (Dopuch and Simunic, 1980; De Angelo, 1981; Klein and Leffler, 1981; Li, Stokes, Taylor and Wong, 2009; Hennes, Leone and Miller, 2014). Higher quality audits provide more credibility to the firm's financial statements and bridges the information gap between insiders and outsiders (Jensen and Meckling, 1976; Watts and Zimmerman, 1980). To conduct this study, we collect the data of auditors for each firm-year in our sample from Worldscope database. We then define an indicator variable $BIG4$, which is equal to one when a firm employs a Big 4 auditing firm during the year, and zero otherwise. We then use $BIG4$ as a dependent variable in our logit regression model. In Column 3 of Table 2.13, we find that both foreign and domestic institutional ownership significantly increases the propensity for a firm to employ a Big 4 audit firms at the 1% level. However, the demand for high-quality audits is greater when there are higher levels of information asymmetries, which is particularly prevalent in weaker corporate governance countries. This view is supported by Choi and Wong (2007), that auditors serve as a substitute for legal protection in weaker legal environments. Therefore, we disaggregate our sample into developing and developed samples. In Column 4 of Table 2.13, for developing countries, we find that FIO significantly increases the propensity of a firm to employ a Big 4 audit firms, while DIO plays an insignificant role in a firm's choice to employ a Big 4 audit firms. In Column 5 of Table 2.13, for developed countries, we find that both foreign and domestic institutional investors is associated with an increased propensity to employ a Big 4 audit firm, however it is more statistically and economically significant for domestic institutional investors than for foreign institutional investors. This effect can be explained by the informational disadvantage possessed by foreign institutional investors compared to domestic institutional investors (Brennan and Cao, 1997; Kang and Stulz, 1997; Choe et al., 2005; Leuz, 2006; Chan et al., 2008). Foreign institutional investors have an increased incentive to demand external monitors in the form of external auditors to overcome their informational disadvantages, which is more prevalent in poorer corporate governance countries. This confirms a recent study by Kim, Pevzne and Xin (2019) who documents that Big 4 audit firms are more likely to be employed by firms with higher foreign institutional ownership.

Table 2.13 Foreign Institutional Ownership and Corporate Risk-taking: Disclosure

This table reports the OLS estimation of the following model:

$$DISCLOSURE_{i,t} = \alpha + \beta_1 FIO_{i,t-1} + \beta_2 DIO_{i,t-1} + \beta_3 CONTROLS_{i,t-1} + \varepsilon.$$

DISCLOSURE variables include *TA, DA, BIG4*. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *CONTROLS* denotes a set of control variables, including *ROA, LEVERAGE, SIZE, SALESGROWTH, CAPEX, GDPGROWTH, ECONFREEDOM*, *GDP*, and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

	TA	*DA*	*BIG4*	*BIG4*	*BIG4*
	[1]	[2]	[3]	[4]	[5]
Sample	Full Sample	Full Sample	Full Sample	*Developing Investee Countries*	*Developed Investee Countries*
FIO	-1.047***	-0.081**	3.783***	4.039***	3.629***
	(0.000)	(0.040)	(0.000)	(0.006)	(0.000)
DIO	-0.470***	0.027***	1.336***	-1.867	1.313***
	(0.000)	(0.000)	(0.000)	(0.170)	(0.000)
Control variables	Yes	Yes	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes	Yes	Yes
Country-fixed effect	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.024	0.026	0.175	0.235	0.131
N	113,499	110,434	62,779	11,745	51,034

Overall, our findings in this section suggest that foreign institutional investors improve information disclosure by reducing earnings management and employing better external monitors. Based on our previous discussion this should inherently reduce managerial risk-avoidance leading to greater risk-taking. Therefore, foreign institutional investors can promote risk-taking through the *disclosure channel*.

2.7.2(iii) Insurance Channel

Shareholders can reduce management's ability to invest inappropriately by monitoring managers. By doing so, actions taken by managers that do not benefit investors are more likely to be discovered. Shareholders can then take steps to either punish managers or force managers to make changes. However, monitoring itself may not be sufficient because monitoring is expensive, requires information and knowledge, and is retrospective in nature (Stulz, 1999). Therefore, to ensure that managers take sufficient risk, both monitoring and the correct incentives are required.

Standard pay-for-performance incentive schemes often focus on rewarding managers based on good company performance while punishing managers with lower rewards and/or termination for failures. Past literature such as Jensen and Murphy (2010) argues that more aggressive pay-for-performance and turnover-performance schemes provide managers with more incentives to take greater risk to enhance firm performance. However, research in psychology shows that pay-for-performance schemes are effective at inducing agents to exert more effort in routine tasks rather than exploring new untested approaches (Kohn, 1993; Amabile, 1996). Therefore, the relationship between aggressive pay-for-performance schemes and firm performance is likely driven by inducing more effort into what has worked before rather than taking greater risk. In support of this view, Manso (2011) explains that the threat of failure from risk-taking under standard pay-for-performance schemes may render these schemes ineffective for promoting risk-taking since manager's career and reputation concerns may outweigh the monetary rewards for successful risk-taking. Similarly, Ederer and Manso (2013) using a controlled laboratory experiment find that the threat of termination is detrimental to innovation. In addition, they find that incentive schemes that exhibit tolerance for failures as opposed to standard pay-for-performance schemes promote the discovery of superior strategies that can facilitate long term performance. Holmstrom (1989) explains this by arguing that performance measures associated with innovative activities are noisier and therefore optimal compensation schemes should be less sensitive to performance. Following this logic, Aghion, Reenen, and Zingales (2013) find that institutional investors support innovative activity by reducing the probability of firing a CEO after poor performance. Therefore, we begin by investigating whether foreign institutional investors also influence CEO turnover-performance sensitivity and CEO pay-for-performance sensitivity in the same way. Based on the literature, foreign institutional investors have been shown to have significant effects on CEO compensation, which suggests that they have the capacity to affect the incentive structure in the domestic firm in this way (Croci, Gonenc and Ozkan, 2012; Fernandes, Ferreira, Matos and Murphy, 2013). More importantly, *FIO* compared to their domestic counterpart should exhibit a greater tolerance for risk due to their internationally diversified portfolios, therefore they have a greater incentive to promote risk-taking by shielding managers from the punishments associated with risk-taking.

To test this avenue, we collect compensation data for senior managers and directors from Standard & Poor's Capital IQ (CIQ) database. We then use the managerial title variable 'profunctionname' reported in CIQ to identify the top executive in each firm-year. Specifically, if the profunctionname for a manager takes on the value 'Chief Executive Officer', we label this manager as the top executive. If there are multiple managers with this title for a single firm-year, we label the highest paid manager as the top executive. If there are no managers with this title for a firm-year we look for managers with the title 'Co-Chief Executive Officer' followed by 'President' and 'Co-President'. For Co-CEOs and Co-Presidents, we take the average of the compensation variables. After identifying the top executive for each firm-year, we construct the variable $CEO\_TURN_{i,t}$ as a binary variable that takes on the value of one if the top executive in firm i at the end of the fiscal year t is different from the top executive from the previous fiscal year $t-1$, and zero otherwise. Using the compensation data for the top executive, we construct $\Delta CEO\_CASH_{i,t}(\Delta CEO\_TOTAL_{i,t})$ which is the change in the level of annual cash compensation, which includes salary, bonus, and other cash compensation (annual total compensation, which includes salary, bonus, equity, long-term incentive plans, options, and other compensation). Column 1 of Table 2.14 demonstrates that profitability growth decreases the likelihood of CEO turnover based on the negative and significant coefficient on $\Delta ROA_{i,t-1}$. This negative relationship, however, is weakened by foreign institutional investors which is established by the positive and significant interaction term, $FIO_{i,t-1} \times \Delta ROA_{i,t-1}$, at the 5% level. This result suggests that greater *FIO* reduces the CEO turnover-performance sensitivity. In Columns 2 and 3, we investigate the effect of *FIO* on CEO pay-performance sensitivity in terms of the change in annual cash compensation and change in annual total compensation, respectively. In both columns we find that the change in shareholder wealth, $\Delta WEALTH_{i,t-1}$, which is the change in shareholders' wealth, is both positive and significant. This suggests that the change in CEO's pay increases with the change in shareholder's wealth. In terms of the effect of *FIO*, we find that the interaction term, $FIO_{i,t-1} \times \Delta WEALTH_{i,t-1}$, is negative and significant at the 10% and 1% for Columns 2 and 3 respectively. This result indicates, like CEO turnover-performance sensitivity, that foreign institutional investors weaken CEO pay-performance sensitivity.

Table 2.14 Foreign Institutional Ownership and Corporate Risk-taking: Insurance

This table reports the OLS estimation of the following model in Column 1:

$$CEO\_TURN_{i,t} = \alpha + \beta_1 \Delta ROA_{i,t-1} + \beta_2 FIO_{i,t-1} \times \Delta ROA_{i,t-1} + \beta_3 DIO_{i,t-1} + \beta_4 DIO_{i,t-1} \times \Delta ROA_{i,t-1} + \beta_5 FIO_{i,t-1} + \beta_6 DIO_{i,t-1} + \beta_7 LOG(MV)_{i,t} + \varepsilon$$

CEO_TURN is a dummy variable that equals 1 if the CEO in firm i in year t is different from the CEO from the year $t-1$, and 0 otherwise. ΔROA is the percentage change in ROA.
OLS estimation of the following model is reported in Columns 2 and 3:

$$\Delta CEO\_CASH(TOTAL)_{i,t} = \alpha + \beta_1 \Delta WEALTH_{i,t-1} + \beta_2 FIO_{i,t-1} \times \Delta WEALTH_{i,t-1} + \beta_3 DIO_{i,t-1} + \beta_4 DIO_{i,t-1} \times \Delta WEALTH_{i,t-1} + \beta_5 FIO_{i,t-1} + \beta_6 DIO_{i,t-1} + \beta_7 LOG(MV)_{i,t} + \varepsilon.$$

$\Delta CEO\_CASH(TOTAL)$ is the change in the level of salary and bonus compensation (total compensation, which includes salary, bonus, equity, long-term incentive plans, options, and other compensation). $\Delta WEALTH$ is the change in market value. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. $LOG(MV)$ is the natural logarithm of market value. Beneath each coefficient estimate is the p-value in parentheses based on robust standard *errors* clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

	CEO_TURN [1]	ΔCEO_CASH [2]	ΔCEO_TOTAL [3]
ΔROA	-0.057***		
	(0.000)		
$FIO \times \Delta ROA$	0.208**		
	(0.041)		
$DIO \times \Delta ROA$	-0.036		
	(0.264)		
$\Delta WEALTH$		0.000*	0.000***
		(0.094)	(0.006)
$FIO \times \Delta WEALTH$		-0.001*	-0.001***
		(0.057)	(0.010)
$DIO \times \Delta WEALTH$		-0.000	-0.000
		(0.114)	(0.205)
FIO	0.021	-0.272	-0.667
	(0.430)	(0.806)	(0.386)
DIO	-0.006	0.215	0.433
	(0.648)	(0.160)	(0.158)
$LOG(MV)$	-0.018***	-0.203***	-0.644***
	(0.000)	(0.001)	(0.000)
Year-fixed effect	Yes	Yes	Yes
Firm-fixed effect	Yes	Yes	Yes
Adj. R^2	0.165	0.259	0.089
N	65,776	65,108	65,108

Our results imply that foreign institutional investors have an encouraging influence in terms of firm risk-taking policy on the incentive schemes of the firm's managers. Specifically, CEO turnover and compensation are less sensitive to performance in the presence of foreign institutional investors. Foreign institutional investors can promote corporate risk-taking by insuring managers against career and reputation concerns associated with the downsides of risk-taking. Therefore, *FIO* increases corporate risk-taking through the *insurance channel*. The results are consistent with Luong et al. (2017), who find that *FIO* promote innovation by insulating managers from punishment for innovation failures.

2.7.2(iv) Financing Channel

According to John D. Rockefeller, "The hardest problem all through my business career was to obtain enough capital to do all the business I wanted to do and could do, given the necessary amount of money" (Chernow, 1998). This quote emphasizes that the most difficult element of doing business is raising capital. Similarly, past literature has focused on a 'finance gap', where firms are unable to exploit potentially profitable investment opportunities due to insufficient funds (Storey, 1994; Deakins, 1996; Jarvis, 2000; Cosh, Cumming and Hughes, 2009). Information asymmetry and agency costs have been well documented as the primary reasons for external capital constraints (Stulz, 1999; Hall, 2002). These capital constraints can restrain a firm's innovative activity and as a result the riskiness of the firm's investment policy (Hall, 2002). Notably, Brown, Fazzari and Petersen (2009) argue that from 1994 to 2004, the US experienced a finance-driven cycle in R&D when there was a significant rise in privately financed R&D. In this section, we explore whether *FIO* can alleviate these capital constraints, which should have a direct impact on the riskiness of the firm's investment policy.

We begin by investigating how FIO influences the way a firm to raise capital. Specifically, we construct from Worldscope four variables each scaled by total assets:

(1) Sale/issue of common and preferred equity (EQ_ISSUE);

(2) Sale/issue of common and preferred equity minus common and preferred redeemed, retired, or converted equity (NET_EQ_ISSUE);

(3) Long-term borrowings ($DEBT\_ISSUE$);

(4) Long-term borrowings plus increase/decrease in short-term borrowing minus reductions in long-term debt (NET_DEBT_ISSUE).

Columns 1 and 2 of Table 2.15 Panel A show that FIO is associated with an increase in both equity issuances (EQ_ISSUE) and net equity issuances (NET_EQ_ISSUE) at the 1% level. Similarly, in Columns 3 and 4 of Table 2.15 Panel A, the effect of FIO on debt issuances ($DEBT\_ISSUE$) and net debt issuances (NET_DEBT_ISSUE) is positive and significant at the 10% and 1%, respectively. These results suggest that firms in the presence of foreign institutional investors are more likely to seek external financing in the form of both equity and debt issuances.

While we find that foreign institutional investors incentivize firms to raise more capital, it is also important to evaluate the cost of raising capital. It is possible that foreign institutional investors provide new investment opportunities through technology spillovers from foreign countries, incentivizing firms to raise capital even if it is at a higher cost (Dierkens, 1991; Luong et al, 2017). In particular, we construct the implied cost of capital (*ICOC*) and annual stock returns (*STOCK_RET*) to measure the cost of equity capital.[15] In addition, we construct a measure of the cost associated with seasoned equity offerings (SEOs).[16] *SEO_UNDERPRICE* is defined as negative one times the return from the closing price on the day prior to the offer date to the offer price. If the SEO is offered at a price below the fair market price, then the SEO is underpriced. Therefore, a larger value of *SEO_UNDERPRICE* indicates a more underpriced SEO.

Column 1 of Panel B of Table 2.15 shows that *FIO* is negatively associated with *ICOC* at the 1% significance level, indicating that the *ex-ante* measure of equity capital cost is expected to be reduced by foreign institutional investors. Consequently, the reduction in the cost of equity capital means that firms are more likely to raise new equity financing in the future, thus increasing the likelihood and magnitude of corporate risk-taking. Two alternative measures of equity capital cost, namely, *STOCK_RET* and *SEO_UNDERPRICE*, confirm the results of *ICOC*. More specifically, Columns 2 and 3 show that *FIO* significantly reduces both *STOCK_RET* and *SEO_UNDERPRICE*. In terms of the magnitude of the regression coefficients, *FIO* has larger coefficients than *DIO* in all three measures except for stock returns, for which the coefficient of the former (i.e., -0.510) is only slightly smaller than that of the latter (i.e., -0.522). This result demonstrates that foreign institutional investors generally play a significant role in reducing the cost of equity.

[15] The definition of *ICOC* is provided in Appendix B.

[16] Using the SEO underpricing setting can directly and accurately measure the cost of raising equity capital; while indirect measures such as *ICOC* rely on the assumption of various valuation models and inputs. We collect the SEO data and impose a number of restrictions. First, the issues must include primary offerings; therefore, any offering that is underpriced is considered a cost of raising capital for the firm. Second, the issues must include data on the stock price and trading volume from Datastream.

As a proxy for the cost of debt, we employ the at-issue yield spreads on corporate bonds over treasury bonds with comparable maturity (*SPREAD*). Column 4 of Panel B of Table 2.15 implies that firms with higher *FIO* experience lower cost of debt issues. In terms of magnitude, the coefficient of *FIO* (i.e., -109.718) is much larger than that of *DIO* (i.e., -47.092), which demonstrates that foreign institutional investors generally play a significant role in reducing the cost of debt.

Table 2.15 FIO and Corporate Risk-taking: Financing

Panel A reports the OLS estimation of the following model:

$$CAPITAL\_ISSUE_{i,t} = \alpha + \beta_1 FIO_{i,t-1} + \beta_2 DIO_{i,t-1} + \beta_3 CONTROLS_{i,t-1} + \varepsilon.$$

CAPITAL_ISSUE include EQ_ISSUE, NET_EQ_ISSUE, $DEBT\_ISSUE$, NET_DEBT_ISSUE. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *CONTROLS* denotes a set of control variables, including *ROA*, *LEVERAGE*, *SIZE*, *SALESGROWTH*, *CAPEX*, *GDPGROWTH*, *ECONFREEDOM*, *GDP*, and *IR*. Panel B reports the OLS estimation of the following model:

$$COST\_OF\_CAPITAL_{i,t} = \alpha + \beta_1 FIO_{i,t-1} + \beta_2 DIO_{i,t-1} + \beta_3 CONTROLS_{i,t-1} + \varepsilon.$$

COST_OF_CAPITAL include $ICOC$, $STOCK\_RET$, $SEO\_UNDERPRICE$, $SPREAD$. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *CONTROLS* denotes a set of control variables and differs between columns. Column 1 and 2 includes *MV*, *MTBV*, *LEVERAGE*, *CAPEX*, *ASSETGROWTH*, *ACCRUALS*, *SMTH*, *NOA*, *ANALYST_DISPERSION*, *ANALYSTS*. Column 3 includes *MV*, *ROS*, *PRICE*, *VOLATILITY*, *CAR_POSITIVE*, *ROA*, *LEVERAGE*, *CAPEX*, *SALESGROWTH*, *CAPEX*, *ECONFREEDOM*, *GDPC*, *GGDP*, *IR*. Column 4 includes *PRINC_AMT*, *MATURITY*, *SUBORD*, *CALLABLE*, *CHGCONTROL*, *RATING*, *LEVERAGE*, *CAPEX*, *SIZE*, *SALESGROWTH*, *ECONFREEDOM*, *GDPC*, *GGDP*, *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard *errors* clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

Panel A. External Financing				
	EQ_ISSUE [1]	*NET_EQ_ISSUE* [2]	*DEBT_ISSUE* [3]	*NET_DEBT_ISSUE* [4]
FIO	0.079***	0.056***	0.022*	0.031***
	(0.000)	(0.000)	(0.094)	(0.000)
DIO	0.011	-0.007	-0.013*	0.006***
	(0.108)	(0.323)	(0.064)	(0.000)
Control variables	Yes	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes	Yes
Country-fixed effect	Yes	Yes	Yes	Yes
Adj. R^2	0.284	0.296	0.150	0.062
N	115,722	115,722	115,722	115,722

Table 2.15 Cont.

Panel B. Cost of Capital				
	ICOC	*STOCK_RET*	*SEO_UNDERPRICE*	*SPREAD*
	[1]	[2]	[3]	[4]
FIO	-0.022***	-0.510***	-0.091**	-109.718***
	(0.005)	(0.002)	(0.040)	(0.006)
DIO	-0.016***	-0.522***	-0.024*	-47.092***
	(0.000)	(0.000)	(0.060)	(0.000)
Control variables	Yes	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes	Yes
Industry-fixed effect	No	No	Yes	Yes
Country-fixed effect	No	No	Yes	Yes
Firm-fixed effect	Yes	Yes	No	No
Adj. R^2	0.625	0.350	0.126	0.717
N	27,043	42,302	8,785	2,866

Overall, our results suggest that firms in the presence of foreign institutional investors a higher *FIO*, raise more external capital at lower costs in terms of both equity and debt. Based on our previous results, foreign institutional investors can alleviate financial constraints through monitoring and improvements in information quality (Khurana et al., 2006). The greater availability of external financing should have a significant positive effect on the investment risk-taking policy of the firm. Thus, foreign institutional investors can promote corporate risk-taking through *the financing channel*.

2.7.2(v) The Human Capital Channel

Risk-taking activities require not only financial capital but also human capital. Subramaniam and Youndt (2005) suggest that developing innovative capacity requires investments in intellectual capital, such as human, structural, and relational capital. This channel is particularly important for innovation because it is by nature an activity that is knowledge intensive.

To empirically examine the effect of FIO on human capital, we collect the number of employees, salary expense, as well as net profit from Worldscope for each firm-year within our sample. Using this data, we construct human capital three variables:

(1) the natural logarithm of the number of employees ($LABOR$), which measures the level of employment;

(2) the natural logarithm of the salary of an average employee (AV_STAFF_COST), which measures the relative employment of high- and low-skilled labor;

(3) net profit excluding salary expenses divided by salary expenses ($LABOR\_EFF$), which measures the firm's efficiency in using its human capital (Chen, Zhu and Xie, 2004).

In Column 1 of Table 2.16, we find that both *FIO* and *DIO* promote the level of employment in the invested firm at the 1% level. However, in Column 2 of Table 2.16, we find that only *FIO* is positively associated with the relative employment of high-skilled labour at the 10% level. Similarly, in Column 3 of Table 2.16, only *FIO* has a positive effect on how well a firm utilizes its human capital at the 10% significance level. This set of results implies that while *FIO* is positively associated with employment, it does not come at the cost of employing more low-skilled workers. Therefore, *FIO* promotes investment in human capital by employing more high-skilled labour while improving in how a firm utilizes its human resources.

Our results support the findings by Bena et al. (2017), who finds that foreign institutional investors promote long-term investments in human capital by disciplining corporate insiders who pursue short-term goals. In addition, it also lends support to Stiglitz (2000), who suggests that foreign institutional investors can bring improvements to human capital by bringing superior managerial skills as well as valuable training for existing employees. As a result, foreign institutional investors can promote corporate risk-taking by fostering improvements in the risk-taking capabilities of the firm through investments in *the human capital channel.*

Table 2.16 Foreign Institutional Ownership and Human Capital

This table reports the OLS estimation of the following model:

$$Human\ Capital_{i,t} = \alpha + \beta_1 FIO_{i,t-1} + \beta_2 DIO_{i,t-1} + \beta_3 CONTROLS_{i,t-1} + \varepsilon.$$

Human Capital variables include *LABOR*, *AV_STAFF_COST*, and *HUMANCAPEFF*. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *CONTROLS* denotes a set of control variables, including *ROA*, *LEVERAGE*, *SIZE*, *SALESGROWTH*, *CAPEX*, *GDPGROWTH*, *ECONFREEDOM*, *GDP*, and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

	LABOR	*AV_STAFF_COST*	*HUMANCAPEFF*
	[1]	[2]	[3]
FIO	1.478***	0.311*	1.242*
	(0.000)	(0.068)	(0.064)
DIO	0.479***	0.064	0.359
	(0.000)	(0.336)	(0.327)
Control variables	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes
Country-fixed effect	Yes	Yes	Yes
Adj. R^2	0.792	0.757	0.171
N	37,950	37,943	47,342

2.7.2(vi) International Diversification Channel

According to Faccio et al. (2011), if a risk-averse shareholder's portfolio holding is not diversified, an increased variance of her wealth (e.g. an increase in firm-specific risk) leads to reduced expected utility for her. This implies the preference of a poorly diversified shareholder to decrease firm risk, and a well-diversified shareholder to increase firm risk, in order to enhance her expected utility. As seen from the above analysis, foreign institutional investors tend to increase the risk-taking of invested firms because they can effectively reduce their overall portfolio risk through international diversification. Therefore, their increased expected utility facilitates their enhanced incentives to push managers to pursue riskier investments.

To measure the extent of international diversification, we use three frequently used international diversification (*ID*) variables, including the international diversification index (*IDI*), country count (*CC*), and the foreign portfolio ratio (*FPR*) (Denis, Denis and Yost, 2002; Duru and Reeb, 2002; Thomas, 2002). In particular, *IDI* is the complements of the Herfindahl Index (*HHI*), with a range from zero to one,

$$IDI = 1 - HHI = 1 - \sum_{j=1}^{N} s_j^2,$$

where s_i denotes the market share of foreign institutional investors' portfolios in country j. *CC* is defined as the number of foreign markets in foreign institutional investors' portfolios. *FPR* is the percentage of foreign institutional investors' portfolios invested in foreign markets. A higher value of these variables indicates a higher level of international diversification. Next, we construct FIO_{High_ID} (FIO_{Low_ID}) as the ownership by internationally (under-) diversified foreign institutional investors, defined as those with *ID* measures above (below) its median. Then, we examine the impact of FIO_{High_ID} (FIO_{Low_ID}) on corporate risk-taking.

Columns 1, 2 and 3 of Table 2.17 show that the coefficient estimates of FIO_{High_ID} (FIO_{Low_ID}) are positive and significant at the 1% level (insignificant). This suggests that the motivation for foreign institutional investors to push managers to take more risks is largely attributable to their ability to diversify portfolios internationally.

Table 2.17 Foreign Institutional Ownership and Corporate Risk-taking: International Diversification

This table reports the OLS estimation of the following model:

$$Risk\_taking_{i,t} = \alpha + \beta_1 FIO_{High\_ID,i,t} + \beta_2 FIO_{Low\_ID,i,t} + \beta_3 DIO_{i,t} + \beta_4 CONTROLS_{i,t} + \varepsilon.$$

Risk_taking is the corporate risk-taking variable (*RISK1*). The results are qualitatively similar when using alternative risk-raking variables. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *CONTROLS* denotes a set of control variables, including *ROA, LEVERAGE, SIZE, SALESGROWTH, CAPEX, GDPGROWTH, ECONFREEDOM, GDP,* and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard *errors* clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

International Diversification (ID) =	*International Diversification Index (IDI)*	*Country Count (CC)*	*Foreign Portfolio Ratio (FPR)*	*Weighted IDI*
	[1]	[2]	[3]	[4]
FIO_{High_ID}	0.056***	0.055***	0.057***	
	(0.000)	(0.000)	(0.000)	
FIO_{Low_ID}	0.024	0.017	0.020	
	(0.603)	(0.773)	(0.560)	
FIO				0.011
				(0.104)
$FIO \times IDI_{FIO}$				0.044***
				(0.008)
IDI_{FIO}				0.000
				(0.975)
DIO	-0.025***	-0.025***	-0.025***	-0.024***
	(0.000)	(0.000)	(0.000)	(0.000)
$DIO \times IDI_{DIO}$				0.008
				(0.619)
IDI_{DIO}				0.003
				(0.657)
Control variables	Yes	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes	Yes
Country-fixed effect	Yes	Yes	Yes	Yes
Adj. R^2	0.424	0.424	0.424	0.410
N	115,726	115,726	115,726	78,649

In addition, we construct an aggregate *IDI* for all investors of a firm by weighting *IDI* by their percentage of ownership of the firm,

$$IDI_{IO} = \frac{\sum_{i=1}^{N} w_i IDI_i}{\sum_{i=1}^{N} w_i},$$

where w_i is the percentage of ownership of institutional investor i. Then, we separate IDI_{IO} into IDI_{FIO} and IDI_{DIO} to represent the weighted-average *ID* of foreign and domestic institutional investors, respectively.

Column 4 of Table 2.17 shows that the coefficient estimate of $FIO \times IDI_{FIO}$ is positive and significant, indicating that the positive impact of *FIO* on corporate risk-taking is more pronounced for internationally diversified foreign institutional investors. We further find that the results disappear for *DIO*. In particular, the coefficient estimates of both *DIO* and $DIO \times IDI_{DIO}$ are insignificant. This result suggests that the impact of international diversification on corporate risk-taking is only evident for foreign institutional investors. Although domestic institutional investors reduce their risk through international diversification, they are less effective in promoting managers due to their existing relationship with corporate management.

In sum, we find that foreign institutional investors with diversified international portfolios are more pronounced in promoting corporate risk-taking in invested firms. This is attributed to their ability to diversify away the firm-specific risk in their internationally positioned portfolios. However, this effect does not exist for domestic institutional investors, potentially due to their business ties with invested firms. Overall, foreign institutional investors increase corporate risk-taking through the *international diversification channel*.

2.7.2(vii) Internationalization Channel

In this section we explore whether foreign institutional investors support internationalization through a firm's propensity to cross-list ($CROSSLIST$) and expand globally (*GEO_EXP*). More specifically, cross-listing is the process a firm undertakes when it intends to list its shares on a foreign stock exchange in addition to its domestic exchange. We understand that another channel of internationalization is global geographic expansions which occur when a firm decides to operate in additional overseas geographic segments. Although both channels are associated with internationalization, these decisions are fundamentally different and must be explored separately.

First, our motivation for examining cross-listing is based on the "Bonding Hypothesis" proposed by Coffee (1999, 2002) and Stulz (1999). The bonding hypothesis stems from the fact that cross-listing requires a firm to abide by the host country's legal, regulatory and disclosure requirements. Therefore, firms that choose to cross-list in better corporate governance countries are voluntarily binding themselves to additional regulations, which signal their commitment to adopt a higher standard of corporate governance. As we have discussed previously, foreign institutional investors are informationally disadvantaged compared to domestic institutional investors due to their unfamiliarity with various aspects of the domestic market. Foreign institutional investors from stronger corporate governance countries have a strong motivation to promote cross-listing in firms originating from weaker corporate governance countries because cross-listing requires a firm to adopt corporate governance practices they are familiar with. This ensures that their foreign investments have the same level of protection as their domestic counterpart. By pushing a firm to cross-list, managers are not only advised to improve corporate governance but are obligated by regulation to do so. Therefore, foreign institutional investors are likely to promote cross-listing in firms that they are invested in.

To investigate the cross-listing avenue, we collect all non-OTC secondary listings as well as the date of the listing for each firm in our sample. We then estimate a logit model with the dependent variable equal to one for the year in which there is a secondary listing, and zero otherwise. In Column 1 of Table 2.18 Panel A, we find that there is preliminary evidence that the presence of foreign institutional investors significantly increases the propensity for a firm to cross-list. To explore if there is any evidence that cross-listing is corporate governance motivated we differentiate between cross-listing in developed and developing countries. This is important because cross-listing in a developed country by a firm from a developing country would place the firm under tougher regulatory scrutiny in terms of both shareholder protection and disclosure requirements. In Columns 2 and 3 of Table 2.18 Panel A, we find that foreign institutional investors compel firms from both developed and developing countries to cross-list in developed countries at a 1% significance level. Alternatively, we also explore the effect of foreign institutional investors on cross-listing in developing countries. In Column 1 of Table 2.18 Panel B, we find that foreign institutional investors promote cross-listing in developing countries at the 10% significance level. However, the results from Column 2 and 3 of Table 2.18 Panel B suggest that this effect is mainly driven by firms operating in developing countries rather than developed countries. In particular, the effect of foreign institutional investors on cross-listing in developing countries is not significant for firms from developed countries. This result suggests that the propensity to cross-list is at least partially corporate governance motivated.

Cross-listing can affect risk-taking in several ways. First, an improvement in investor protection due to additional legal, regulatory and disclosure requirements helps diminish the amount of private benefits that a manager can extract from a firm. Based on agency theory, a reduction in these private benefits should lead to a reduction in managerial risk-avoidance behaviour. In support of this, a number of studies find that firms that cross-list in the US reduce the agency problem associated with controlling shareholders trying to expropriate from minority shareholders (Coffee, 1999, 2002; Stulz, 1999; Reese and Weisbach, 2002; Doidge et al., 2004). In addition to increased disclosure requirements, firms that cross-list are also exposed to additional analyst and debt agency following in the foreign market which places managers under increased public scrutiny (Coffee, 2002). Second, cross-listing also provides the firm with other benefits that can facilitate risk-taking. In particular, the main purpose of cross-listing is to reduce the barrier of entry for international investors. The accessibility of the firm's shares to global investors coupled with the improvements in a firm's information environment will increase liquidity and broaden the stock holder base, which results in a reduction in the cost of capital. Third, other benefits include additional exposure of the firm to the foreign market, which facilitates product identification, labour relations, foreign acquisitions and export market access (Doidge et al., 2004; Hail and Leuz, 2006).

Next, we explore whether foreign institutional investors facilitate a firm's global geographic expansion. In contrast to domestic institutional investors, foreign institutional investors have informational advantages over domestic institutional investors in international markets. Specifically, due to their exposure and networks formed in international markets they can provide better advice and expertise to speed up global geographic expansions. For example, the knowledge and networks of foreign institutional investors can provide a competitive advantage for the firm by providing knowledge on the optimal mode of entry, differences in regulations, and molding products and services based on the differences in customer preferences. In support of this hypothesis, Ferreira et al. (2010) finds that foreign institutional investors act as facilitators in cross-border mergers and acquisitions by acting as a bridge between the two parties, which is a form of geographic exapansion.

To investigate this channel, we collect from Worldscope the number of geographic segments for each firm-year within our sample. A geographic segment exists when a firm has sales from a foreign subsidiary in a given year. A geographic expansion (contraction) occurs when the number of geographic regions increases (decreases) from the preceding year. We then estimate an ordered logit model, where an expansion (contraction) is equal to one (negative one) and zero otherwise. Column 1 of Table 2.18 Panel C shows that both foreign and domestic institutional investors significantly increase the propensity for a firm to expand geographically. We then determine whether this effect is common amongst developed and developing countries. In Column 2 and 3 of Table 2.18 Panel C, we find that foreign institutional investors are positively associated with geographic expansions at the 1% significance level whether the firm is from a developing or developed country. However, the positive effect of domestic institutional investors on geographic expansions is only prevalent in developed countries. This result provides evidence that foreign institutional investors are major proponents of geographical expansions worldwide.

Geographic expansions can enable firms to undertake riskier projects in several ways. Specifically, based on modern portfolio theory, diversified firms can reduce their risk exposure by diversifying in countries with lower correlation in operations. The reduction in risk suggests that geographical diversification can create a risk-spreading effect that allows firms to undertake riskier projects than domestic firms with fewer risk-pooling options (Grant, 1987). In support of this view, Shaked (1986) has shown that the US geographically diversified firms have lower systematic risk, probability of insolvency, and variance in returns. Lubatkin and Chatterjee (1994) provides evidence that corporate diversification can reduce stock return variance through lowering firm systematic risk. In the same vein, Mitton and Vorkink (2010) find that corporate diversification can reduce a firm's exposure to stock return skewness. Alternatively, firms that expand geographically also broaden their investment opportunities by allowing better access to technological knowledge and foreign product innovation. Kotabe (1990) suggests that these geographically diversified firms can enhance their innovative capabilities due to their increased access to global resources. Similarly, Benvignati (1987) shows that when geographically diversified firms operate in countries with foreign activities related to the firm's line of business, the firm can generate profit advantages over other domestic firms. Harris and Li (2009) find that conditional on international market entry, greater absorptive capacity of scientific knowledge is associated with better export performance. Although the main objective of geographic expansions is to access new markets, geographic expansions also allows a firm access to highly skilled talent around the world (Lewin, Massini and Peeters, 2009). Doh (2005) finds that the abundance and quality of human capital are increasingly important drivers to the decision of geographic expansions. More specifically, human capital has been shown to facilitate innovation, while the mobility of human capital is associated with technology spillovers (Dakhli and De Clercq, 2004; Faggian and McCann, 2009; Qiu and Wan, 2015). Based on the above discussion, we postulate that internationally diversified foreign institutional investors have both the incentive and the means to enable firms to take on riskier projects by facilitating geographical expansions.

Table 2.18 Foreign Institutional Ownership and Corporate Risk-taking: International Integration

This table reports the OLS estimation of the following model:

$$INTERNATIONAL\_INTEGRATION_{i,t} = \alpha + \beta_1 FIO_{i,t-1} + \beta_2 DIO_{i,t-1} + \beta_3 CONTROLS_{i,t-1} + \varepsilon.$$

INTERNATIONAL_INTEGRATION variables include *CROSSLIST* and *GEO_EXP*. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *CONTROLS* denotes a set of control variables, including FSALES_RATIO, SEGMENTS, *ROA*, *LEVERAGE*, *SIZE*, *SALESGROWTH*, *CAPEX*, *GDPGROWTH*, *ECONFREEDOM*, *GDP*, and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

Panel A. Cross-listing in Developed Countries				
	$CROSSLIST$	$CROSSLIST_{DEVELOPED}$	$CROSSLIST_{DEVELOPED}$	$CROSSLIST_{DEVELOPED}$
Sample	*Full Sample*	*Full Sample*	*Developing Investee Country*	*Developed Investee Country*
	[1]	[2]	[3]	[4]
FIO	1.982***	1.933***	3.887***	1.389***
	(0.000)	(0.001)	(0.000)	(0.002)
DIO	0.023	0.043	-4.906	0.098
	(0.827)	(0.721)	(0.344)	(0.356)
Control variables	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes
Industry-fixed effects	Yes	Yes	Yes	Yes
Country-fixed effects	Yes	Yes	Yes	Yes
Adj. R^2	0.197	0.758	0.212	0.197
N	49,831	399	46,265	49,831

Table 2.18 Cont.

Panel B. Cross-listing in Developing Countries			
	$CROSSLIST_{DEVELOPING}$	$CROSSLIST_{DEVELOPING}$	$CROSSLIST_{DEVELOPING}$
Sample	*Full Sample*	*Developing Investee Countries*	*Developed Investee Countries*
	[1]	[2]	[3]
FIO	2.348*	131.006***	1.115
	(0.064)	(0.000)	(0.211)
DIO	-1.050	84.968***	-1.003
	(0.155)	(0.000)	(0.171)
Control variables	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes
Industry-fixed effects	Yes	Yes	Yes
Country-fixed effects	Yes	Yes	Yes
Adj. R^2	0.197	0.758	0.212
N	49,831	399	46,265

Table 2.18 Cont.

Panel C. Geographic Expansions			
	GEO_EXP	*GEO_EXP*	*GEO_EXP*
Sample	*Full Sample*	*Developing Investee Countries*	*Developed Investee Countries*
	[1]	[2]	[3]
FIO	0.841***	0.779***	0.860***
	(0.000)	(0.002)	(0.000)
DIO	0.328***	-0.429	0.340***
	(0.000)	(0.581)	(0.000)
Control variables	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes
Industry-fixed effects	Yes	Yes	Yes
Country-fixed effects	Yes	Yes	Yes
Adj. R^2	0.021	0.035	0.022
N	83,699	13,553	70,146

2.8 Shareholder Interactions

In this section, we consider the potential interactions between *FIO* and other shareholders. In particular, Aggarwal et al. (2010) claims that *FIO* are able to play a lead role in improving governance and shareholder activism that local investors are unable to take. Moreover, the main method in which institutional investors influence management is either directly through utilizing their voting rights or indirectly through selling their shares. This suggests that for *FIO* to enact change, they will have to garner support from other shareholders. The FactSet Ownership (LionShares) database however, primarily provides us with institutional ownership data. Due to this limitation, we focus primarily on the interactions between *FIO* and different types of *DIO* on corporate risk-taking in Panel A of Table 2.19. To examine potential interaction effects for *FIO* and other shareholders we also supplement our data with free float datatypes from Datastream. Specifically, the free float datatypes from Datastream provides us with strategic holdings information, which are holdings greater than 5%, by governments, another company, pension funds, investment companies, employee/family, and foreign institutions. To account for the fact that there are potentially overlaps in ownership between the two databases, we utilize strategic holdings information for employee/family and governments in Panel B of Table 2.19.

In Column 1 of Table 2.19 Panel A, we find that the interaction between *FIO* and *DIO* is positive but insignificant at all conventional significance levels. This result suggests that statistically neither parties are influenced by the other. Therefore, we consider whether the interaction effect is associated with domestic institutional investor heterogeneity. In Column 2 of Table 2.19 Panel A, we find that the interaction between *FIO* and *DIO* does not depend on the development of the invested country. In Column 3 of Table 2.19 Panel A, we find that there is a significantly positive interaction effect between *FIO* and independent *DIO* at the 1% level. Furthermore, the interaction between *FIO* and grey *DIO* is significant at the 1% level but in the opposite direction. This result suggests that domestic institutional investor heterogeneity plays a significant role in the interaction between *FIO* and *DIO*. The results in Column 4 of Table 2.19 Panel A confirms the findings in Column 3, that is *FIO* influences *DIO* that are either more equipped or have preferences to monitor. That is, *FIO* influences both independent and long-term *DIO* to enhance corporate risk-taking. In Column 5 of Table 2.19 Panel A, we find that the interaction between *FIO* and internationally under-diversified *DIO* is positive and significant at the 5% level.

In Panel B of Table 2.19, we explore how *FIO* influences strategic holdings by employees/family and governments on risk-taking. As shown in Column 1 of Table 2.19 Panel B, the interaction between *FIO* and employee/family strategic holdings is positive and significant at the 10% level. This suggests that *FIO* monitors employee and family ownership by reducing the likelihood of expropriation by these parties. On the other hand, the interaction between *FIO* and government strategic holdings in Column 2 of Table 2.19 Panel B is negative and insignificant at all conventional significance levels.

Overall, our results suggest that *FIO* are more effective at motivating corporate risk-taking when there are more independent and long-term domestic institutional investors. This suggests that *FIO* can garner support from domestic institutional investors who are more likely to monitor and have less business ties with managers from the invested firm.

Table 2.19 Shareholder Interactions

Panel A reports the OLS estimation of the following model:

$$Risk\_taking_{i,t} = \alpha + \beta_1 FIO_{i,t} + \beta_2 FIO_{\,i,t} \times DIO_{Type,i,t} + \beta_3 DIO_{Type,i,t} + \beta_4 FIO \times DIO_{Excluding\ Typei,t} + \beta_5 DIO_{Excluding\ Typei,t} + \beta_6 CONTROLS_{i,t} + \varepsilon.$$

Risk_taking is the corporate risk-taking variable (*RISK1*). The results are qualitatively similar when using alternative risk-raking variables. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *CONTROLS* denotes a set of control variables, including *ROA*, *LEVERAGE*, *SIZE*, *SALESGROWTH*, *CAPEX*, *GDPGROWTH*, *ECONFREEDOM*, *GDP*, and *IR*.

Panel B reports the OLS estimation of the following model:

$$Risk\_taking_{i,t} = \alpha + \beta_1 FIO_{i,t} + \beta_2 FIO_{\,i,t} \times SH_{Type,i,t} + \beta_3 SH_{Type,i,t} + \beta_4 DIO_{i,t} + \beta_5 CONTROLS_{i,t} + \varepsilon.$$

SH is the percentage of strategic holdings. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

Panel A: Domestic Institutional Investors

Type =		*Developed*	*Independent*	*Long-term*	*High IDI*
	[1]	[2]	[3]	[4]	[5]
FIO	0.047***	0.047***	0.049***	0.045***	0.049***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$FIO * DIO_{Type}$	0.052	0.054	0.111***	0.067*	-0.013
	(0.362)	(0.321)	(0.009)	(0.099)	(0.896)
DIO_{Type}	-0.027***	-0.027***	-0.030***	-0.041***	-0.021***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
FIO		0.191	-0.939***	0.127	0.152**
		(0.450)	(0.000)	(0.340)	(0.044)
$DIO_{Excluding\ Type}$		-0.102***	0.022	0.009	-0.035***
		(0.001)	(0.544)	(0.186)	(0.000)
Control variables	Yes	Yes	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes	Yes	Yes
Country-fixed effect	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.424	0.424	0.424	0.424	0.424
N	115,726	115,726	115,726	115,726	115,726

Table 2.19 Cont.

Panel B: Strategic Holdings		
Type =	*Employee/Family*	*Government*
	[1]	[2]
FIO	0.047***	0.048***
	(0.000)	(0.000)
$FIO * SH_{Type}$	0.059*	-0.060
	(0.087)	(0.554)
SH_{Type}	-0.006	-0.003
	(0.345)	(0.859)
DIO	-0.026***	-0.025***
	(0.000)	(0.000)
Control variables	Yes	Yes
Year-fixed effect	Yes	Yes
Industry-fixed effect	Yes	Yes
Country-fixed effect	Yes	Yes
Adj. R^2	0.428	0.428
N	98,533	91,377

2.9 Is taking on greater risk always good?

Although the existing literature tends to argue for the positive side of corporate risk-taking (e.g. John et al, 2008), there may exist some negative aspects (side effects, in other words). We investigate this issue considering different aspects, including firm value (Tobin's Q), firm profitability (ROA), firm total asset growth, firm (ASSETGROWTH), sales growth, firm (SALESGROWTH), stock return volatility, (VOLATILITY), and firm stock price crash risk, (NCSKEW, DUVOL, COUNT).

More specifically, first, following John et al. (2008), we examine the effect of corporate risk-taking on firm value and firm growth. To measure firm value, we construct Tobin's Q and ROA. We define Tobin's Q, like in previous studies, as the market value of equity plus the book value of debt divided by the book value of assets (Claesssens and Laeven, 2003; Doidge et al., 2004; La Porta, L'opez-De-Silanes, Shleifer and Vishny, 2002). In Columns 1 and 2 of Table 2.20, when we relate Tobin's

Q and ROA, respectively, to corporate risk-taking, $RISK1$, we find that $RISK1$ is positively associated with both Tobin's Q and ROA at the 5% significance level. To address the concern regarding the optimal level of corporate risk-taking, we include the quadratic term, $RISK1^2$, to account for the possibility of a non-linear relationship between corporate risk-taking and firm value. If there is an optimal level of risk-taking in terms of firm value, we should find that the quadratic term is negative and significant. This would suggest that the relationship between corporate risk-taking is increasing at a decreasing rate towards an optimal level and then decreasing thereafter, which would imply the existence of an optimal level of corporate risk-taking. However, if the quadratic term is insignificant this would suggest that firm value linearly increases with corporate risk-taking, which would suggest that taking more risks is always good for firm value. In both cases, we find that when $RISK1^2$ is included in the model, it is insignificant at all conventional levels. Therefore, at least in terms of firm-value, taking greater risk is always beneficial to the firm.

Second, we consider the effect of corporate risk-taking on annual total asset and sales growth in Columns 3 and 4, respectively. In Column 3, we find that while $RISK1$ is insignificant, the quadratic term, $RISK1^2$ is positively and significantly associated with total asset growth at the 5% level. This suggests a non-linear relationship and that increases in corporate risk-taking increases total asset growth at an increasing rate. In Column 4, we find that $RISK1$ is positive and significantly associated with sales growth at the 5% level, while $RISK1^2$ is insignificant. This implies that there is a linear relationship between corporate risk-taking and sales growth. These results are consistent with the findings by John et al. (2008), who find that corporate risk-taking is positively associated with asset and sales growth. Overall, we find that corporate risk-taking is positively associated with both firm value and growth, however there is no evidence to suggest that there is definitively an optimal level of corporate risk-taking.

Third, we relate corporate risk-taking to potential downsides associated with corporate risk-taking. To do so, we construct annual stock return volatility, $VOLATILITY$, as the standard deviation of weekly stock returns each year. In Column 5, we find that corporate risk-taking is positively associated with annual stock return volatility at the 1% significance level. The quadratic term of risk-taking $RISK1^2$ is negative and significant at the 1% level, which is in the opposite direction. As expected, firms that take more risk will have more volatile stock returns, however, the results also suggest that there is non-linearity in the relationship. Specifically, the coefficients imply that for any level of risk-taking below 0.241, which is 2.23 standard deviations above the mean, risk-taking increases stock return volatility at a decreasing rate up to a maximum of 8.2% increase in stock return volatility relative to the mean. However, any risk-taking above 0.241, is associated with reductions in stock return volatility relative to the maximum.

Based on past literature, stock return volatility is a source of stock price risk. Campbell and Hentschel (1992) concludes in their study that stock return volatility feedback can partially explain return skewness. Similarly, Hutton, Marcus and Tehranian (2009) suggests that when investors are faced with increased stock return volatility, they reassess their risk premium upwards, resulting in a price drop that can generate negative skewness. Therefore, we consider the effect of risk-taking on stock price crash risk. In Column 1 to 3 in Table 2.21, we find that in all cases $RISK1$ is negatively associated with stock price crash risk at the 1% level. Like the results from stock return volatility, we find that the quadratic term $RISK1^2$ is positive and significant at the 1% level, which is in the opposite direction. This result implies that there is a convex relationship between risk-taking and stock price crash risk, and so the existence of an optimal level of risk-taking. Based on the coefficients, risk-taking below 0.264, which is equivalent to 2.8 standard deviations above the mean, is associated with a decrease in crash risk approaching a minimum of 65.4% decrease in stock price crash risk relative to the mean. Risk-taking above 0.264 is then associated with increases in stock price crash risk relative to the minimum. Interestingly, we find that the relationship between risk-taking and stock price crash risk is approximately the opposite of the relationship between risk-taking and stock return volatility. This suggests that the increase in stock volatility is not associated with increased stock price crash risk.

We then consider how FIO affects the optimal level of risk-taking, to do this, we use the fitted residuals from a regression between our risk-taking variable ($RISK1$) and the control variables as well as the fixed effects from the baseline regression. The residuals from the fitted regression model represent how the risk-taking value deviates from the predicted risk-taking value from the regression. We then take the negative absolute value of the residuals ($OPTIMAL\_RISK$), where a larger value implies a smaller deviation from the predicted optimal level of risk-taking. We then differentiate the effect of FIO on the predicted optimal level of risk-taking by taking a subsample of when a firm is either above or below the predicted optimal level of risk-taking. In Table 2.22, we regress both FIO and DIO on $OPTIMAL\_RISK$ for sub-samples of above and below optimal risk-taking firms in Columns 1 and 2, respectively. In Columns 1 and 2 of Table 2.22, we find that FIO has a positive and significant effect on optimal risk-taking when a firm is below the predicted optimal level, while FIO has an insignificant effect on optimal risk-taking when the firm is above the predicted optimal level. This result suggests that the effect of FIO on risk-taking is driven by foreign institutional investors promoting risk-taking in firms that are not taking sufficient risks.

Table 2.20 Effects of Risk-taking: Firm Value, Growth and Volatility

This table reports the OLS estimation of the following model:

$$EFFECTS\_OF\_RISK1_{i,t} = \alpha + \beta_1 RISK1_{i,t-1} + \beta_2 RISK1^2_{i,t-1} + \beta_3 CONTROLS_{i,t-1} + \varepsilon.$$

EFFECTS_OF_RISK1 variables include *TOBIN'S Q, ROA, ASSETGROWTH, SALESGROWTH, VOLATILITY*. *RISK1* is our corporate risk-taking variable. *CONTROLS* denotes a set of control variables, including *ROA*, *LEVERAGE*, *SIZE*, *SALESGROWTH*, *CAPEX*, *MTB*, *GDPGROWTH*, *ECONFREEDOM*, *GDP*, and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

VARIABLES	TOBIN'S Q [1]	ROA [2]	ASSETGROWTH [3]	SALESGROWTH [4]	VOLATILITY [5]
$RISK1$	0.973***	0.228**	0.096	0.240**	0.042***
	(0.000)	(0.016)	(0.246)	(0.018)	(0.008)
$RISK1^2$	0.112	-0.060	0.538**	-0.367	-0.087***
	(0.814)	(0.812)	(0.028)	(0.111)	(0.006)
ROA	-0.181*	0.165***	0.119***	-0.220***	-0.024***
	(0.089)	(0.000)	(0.000)	(0.000)	(0.000)
$LEVERAGE$	-0.171***	0.037**	-0.362***	-0.031*	0.014***
	(0.007)	(0.044)	(0.000)	(0.096)	(0.000)
$SIZE$	0.103***	0.009**	0.001	0.050***	-0.007***
	(0.000)	(0.016)	(0.915)	(0.000)	(0.000)
$SALESGROWTH$	0.005	0.007***	-0.028***	-0.092***	0.000
	(0.645)	(0.000)	(0.002)	(0.000)	(0.491)
$CAPEX$	-0.163	-0.016	0.457***	-0.005	0.013**
	(0.106)	(0.244)	(0.000)	(0.959)	(0.047)
MTB	0.054***	0.000	0.006***	-0.000	0.001***
	(0.000)	(0.338)	(0.000)	(0.936)	(0.000)
$ECONFREEDOM$	0.305***	-0.011*	0.070***	0.071***	0.010***
	(0.001)	(0.056)	(0.009)	(0.007)	(0.007)
$GDPC$	-0.936*	-0.045***	-0.224***	-0.358***	-0.023***
	(0.067)	(0.002)	(0.002)	(0.000)	(0.001)
$GGDP$	0.039**	0.002***	0.010**	0.012*	0.000
	(0.039)	(0.003)	(0.050)	(0.057)	(0.940)
IR	-0.003	-0.001*	0.003	0.007	0.001**
	(0.655)	(0.086)	(0.507)	(0.175)	(0.011)
Year-fixed effect	YES	YES	YES	YES	YES
Firm-fixed effect	YES	YES	YES	YES	YES
Adj. R^2	0.747	0.640	0.310	0.307	0.693
N	89,531	89,624	89,622	89,616	89,514

Table 2.21 Effects of Risk-taking: Stock Price Crash Risk

This table reports the OLS estimation of the following model:

$$CRASH\_RISK_{i,t} = \alpha + \beta_1 RISK1_{i,t-1} + \beta_2 RISK1^2_{i,t-1} + \beta_3 CONTROLS_{i,t-1} + \varepsilon.$$

CRASH_RISK variables include *NCSKEW, DUVOL, and COUNT*. *RISK1* is our corporate risk-taking variable. *CONTROLS* denotes a set of control variables, including *NCSKEW, SIGMA, RET, DTURN, ACCM, LEVERAGE, ROA, MTB, LOG(MV), GDPC, GGDP, MCAP*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

VARIABLES	NCSKEW [1]	DUVOL [2]	COUNT [3]
$RISK1$	-0.669***	-0.288***	-0.524***
	(0.001)	(0.002)	(0.001)
$RISK1^2$	1.265**	0.472*	1.079***
	(0.031)	(0.098)	(0.005)
$NCSKEW$	-0.139***	-0.065***	-0.093***
	(0.000)	(0.000)	(0.000)
$SIGMA$	-0.109	-0.043	0.535
	(0.936)	(0.955)	(0.562)
RET	0.056	0.024	0.145
	(0.765)	(0.806)	(0.295)
$DTURN$	1.880*	0.791	1.295
	(0.097)	(0.110)	(0.135)
$ACCM$	0.000	-0.000	0.002
	(0.963)	(0.785)	(0.218)
$LEVERAGE$	0.204***	0.083***	0.105***
	(0.003)	(0.004)	(0.001)
ROA	0.140***	0.056***	0.134***
	(0.004)	(0.004)	(0.007)
MTB	0.004	0.002	0.001
	(0.174)	(0.151)	(0.552)
$LOG(MV)$	0.191***	0.098***	0.103***
	(0.000)	(0.000)	(0.000)
$GDPC$	-0.408**	-0.188**	-0.242*
	(0.011)	(0.023)	(0.069)
$GGDP$	0.008*	0.003	0.006**
	(0.056)	(0.143)	(0.020)
$MCAP$	0.000	0.000	0.000
	(0.490)	(0.447)	(0.159)
Year-fixed effect	YES	YES	YES
Firm-fixed effect	YES	YES	YES
Adj. R^2	0.254	0.258	0.217
N	50,304	50,304	50,313

Table 2.22 Optimal Risk-taking

This table reports the OLS estimation of the following model:

$$OPTIMALRISK1_{i,t} = \alpha + \beta_1 FIO_{i,t-1} + \beta_2 DIO_{i,t-1} + \varepsilon.$$

OPTIMALRISK1 is the negative of the absolute value of the error term from our baseline regression without including *FIO* and *DIO*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

VARIABLES	ABOVE OPTIMAL [1]	BELOW OPTIMAL [2]
FIO	0.048	0.031*
	(0.101)	(0.090)
DIO	-0.011	-0.007
	(0.408)	(0.366)
Year-fixed effect	NO	NO
Industry-fixed effect	NO	NO
Country-fixed effect	NO	NO
Adj. R^2	0.006	0.011
N	43,018	72,708

2.10 The comparison between international diversification channel and corporate governance channel

Due to the similarities in country-level corporate governance between developed countries, the corporate governance channel does not sufficiently explain the positive effects of foreign institutional investors from developed countries ($FIO_{Developed}$) investing in developed countries. To empirically investigate whether this is the case, we first need to define a measure for the corporate governance channel. According to Aggarwal et al. (2011), foreign institutional investors from stronger corporate governance countries take credit for improving the corporate governance of the invested firm, especially in weaker corporate governance countries. Therefore, *the corporate governance channel* has been employed when there is a difference in country-level corporate governance between the foreign institutional investor's home country and the invested host country. To generalize our investigation to different measures of country-level corporate governance, we use principal component analysis (PCA) to transform our set of country-level corporate governance measures into a smaller set of uncorrelated principal components. We then use the first principal component, which accounts for most of the variability in our corporate governance measures, as a single measure of the overall country-level corporate governance. The difference in this country-level corporate governance measure between the foreign institutional investor's home country and invested country is then aggregated for each foreign investor from a developed country. This aggregation is performed by weighting the difference in country-level corporate governance by the percentage of ownership of the foreign investor,

$$\Delta CG_{FIO} = \frac{\sum_{i=1}^{N} w_i \Delta CG_i}{\sum_{i=1}^{N} w_i},$$

where w_i is the percentage of ownership of the foreign institutional investor i and ΔCG_i is the difference in country-level corporate governance between the country of the foreign investor and the domestic country.

To determine whether the positive effect of foreign institutional investors from developed countries on corporate risk-taking is driven by the corporate governance channel, we include the aggregated difference in the country-level corporate governance measure for foreign institutional investors from developed countries ($\Delta CG_{FIO_{Developed}}$) and its interaction with $FIO_{Developed}$ in the model from Table 2.5. In Column 1 of Table 2.23, we show that the interaction term ($FIO_{Developed} \times \Delta CG_{FIO_{Developed}}$) loads positively and significantly at the 5% significance level on risk-taking for a subsample consisting of firms from developing countries. The significant interaction term suggests that the effect of $FIO_{Developed}$ on corporate risk-taking is driven by the relative strength of country-level corporate governance for the foreign institutional investor. In Column 2 of Table 2.23, we find that the interaction term ($FIO_{Developed} \times \Delta CG_{FIO_{Developed}}$) in the developed countries subsample, is positive but insignificant at all conventional significance levels. This result confirms that the corporate governance channel does not drive the positive relation between foreign institutional investors from developed countries investing in developed countries.

Our results above suggest that the corporate governance channel is not employed in developed countries, therefore this result must be driven by an alternative channel. In this section, we explore whether *the international diversification channel* helps explain this effect. As in the previous section, we construct the international diversification index (IDI) for foreign institutional investors from developed countries. Similar to the process used for *the corporate governance channel*, we include the international diversification index for foreign institutional investors from developed countries ($IDI_{FIO_{Developed}}$) and its interaction with $FIO_{Developed}$ in the model from Table 2.5. In both Columns 3 and 4 of Table 2.23, the interaction term $FIO_{Developed} \times IDI_{FIO_{Developed}}$ is positive and significant at the 5% significance level. This result implies that the international diversification of the foreign institutional investors from developed countries facilitates corporate risk-taking in both developing and developed countries.

In summary, while the international diversification channel is valid for foreign institutional investors from developed countries investing in both developing and developed countries, the corporate governance channel is only valid in developing countries. This result provides evidence for the greater economic significance of foreign institutional investors from developed countries investing in developing countries compared to those from developed investing in developing countries.

Table 2.23 Corporate Governance or International Diversification?

This table reports the OLS estimation of the following model:

$$Risk\_taking_{i,t} = \alpha + \beta_1 FIO_{Developed,i,t} + \beta_2 FIO_{Developed,i,t} \times \Delta CG(IDI)_{FIO_{Developed}} + \beta_3 \Delta CG(IDI)_{FIO_{Developed}} + \beta_5 FIO_{Developing,i,t} + \beta_6 DIO_{i,t} + \beta_4 CONTROLS_{i,t} + \varepsilon.$$

Risk_taking is the corporate risk-taking variable (*RISK1*). The results are qualitatively similar when using alternative risk-raking variables. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. ΔCG is the ownership weighted difference in the first principal component of all our country-level corporate governance measures. *IDI* is the ownership weighted international diversification index. *CONTROLS* denotes a set of control variables, including *ROA, LEVERAGE, SIZE, SALESGROWTH, CAPEX, GDPGROWTH, ECONFREEDOM*, *GDP*, and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard *errors* clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

	Developing Investee Countries [1]	*Developed Investee Countries* [2]	*Developing Investee Countries* [3]	*Developed Investee Countries* [4]
$FIO_{Developed}$	0.002	0.031***	-0.002	0.014
	(0.932)	(0.005)	(0.952)	(0.128)
$FIO_{Developed} \times \Delta CG_{FIO_{Developed}}$	0.015**	0.003		
	(0.017)	(0.771)		
$\Delta CG_{FIO_{Developed}}$	0.001	-0.002***		
	(0.581)	(0.000)		
$FIO_{Developed} \times IDI_{FIO_{Developed}}$			0.078**	0.047**
			(0.041)	(0.031)
$IDI_{FIO_{Developed}}$			-0.010*	0.005
			(0.079)	(0.229)
$FIO_{Developing}$	0.179	0.038	0.183	0.030
	(0.114)	(0.628)	(0.109)	(0.695)
DIO	-0.040**	-0.019***	-0.044***	-0.020***
	(0.013)	(0.000)	(0.001)	(0.000)
Control variables	Yes	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes	Yes
Country-fixed effect	Yes	Yes	Yes	Yes
Adj. R^2	0.160	0.431	0.160	0.431
N	18,911	79,571	18,911	79,571

2.11 Robustness Tests

Similar to other international studies, the number of U.S. firms dominates the sample. In particular, there are 31,928 firm-year observations from the U.S., which corresponds to 27.59% of our entire sample. As a robustness check, we examine a subsample that excludes the U.S. firms. Columns 1 and 2 of Table 2.24 show that the results are similar to the baseline regression in both the non-U.S. and U.S. subsamples. Thus, our findings are not driven by the U.S. observations for U.S. firms.

We also perform a robustness check by including two additional control variables to mitigate concerns regarding the possibility of omitted variables. First, we include *ADR* (i.e. a dummy variable that equals one if a firm is an Amerian Depositary Receipt and zero otherwise) to capture the attractiveness of firms to foreign (i.e. the U.S.) institutional investors. An ADR is a stock that trades in the U.S. but represents a specified number of shares of a foreign firm. Thus, these "foreign" stocks are more attractive to the U.S. investors than those listed in their home countries. Second, we include *MajorIndex* (i.e. a dummy variable that equals to one if a firm is included in the major index of its home country, and zero otherwise) to identify large stocks.[17] These firms are more globally oriented in their activities and tend to adopt internationally recognized governance practices (Drobetz, Schillhofer and Zimmermann, (2004)). Thus, they are more attractive to foreign investors in forming their investment portfolios. Of our sampled firms, 5.4% are considered to be ADR, while 38.6% are included in a major index of their home countries.

We explicitly control for *ADR* and *MajorIndex* in the regression to examine whether the positive impact of *FIO* on corporate risk-taking remains valid. Column 3 of Table 2.24 shows that *ADR* (*MajorIndex*) significantly increases (decreases) corporate risk-taking. More importantly, our main findings remain qualitatively unchanged, that is, *FIO* increases corporate risk-taking even after controlling for these two additional variables. This result suggests that the positive relation between *FIO* and corporate risk-taking is still valid when controlling for the firms' attractiveness to foreign investors.

[17] *MajorIndex* is identified from the Worldscope item 05661 (i.e. stock index information). For example, the major index is the S&P 500 for U.S. firms, FT-SE 100 in the United Kingdom, and TOPIX in Japan.

Table 2.24 Robustness Tests

This table reports the OLS estimation of the following model:

$$Risk\_taking_{i,t} = \alpha + \beta_1 FIO_{i,t} + \beta_2 DIO_{i,t} + \beta_3 CONTROLS_{i,t} + \varepsilon.$$

Risk_taking is the corporate risk-taking variable (*RISK1*). The results are qualitatively similar when using alternative risk-raking variables. *FIO* (*DIO*) is the percentage of foreign (domestic) institutional ownership of a firm. *ADR* is a dummy variable equal to one if a firm is an American Depository Receipt, and zero otherwise). *MajorIndex* is a dummy variable equal to one if a firm is included in a major index of their country, and zero otherwise. *CONTROLS* denotes a set of control variables, including *ROA, LEVERAGE, SIZE, SALESGROWTH, CAPEX, GDPGROWTH, ECONFREEDOM, GDP,* and *IR*. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the country level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

	Non-U.S. Firms	U.S. Firms	Additional Control Variables
	[1]	[2]	[3]
FIO	0.047***	0.087***	0.053***
	(0.000)	(0.000)	(0.000)
DIO	-0.042***	-0.025***	-0.023***
	(0.003)	(0.000)	(0.000)
ADR			0.006***
			(0.008)
MajorIndex			-0.004**
			(0.015)
Control variables	Yes	Yes	Yes
Year-fixed effect	Yes	Yes	Yes
Industry-fixed effect	Yes	Yes	Yes
Country-fixed effect	Yes	No	Yes
Adj. R^2	0.401	0.403	0.424
N	83,798	31,928	115,726

2.12 Conclusion

Motivating corporate risk-taking is pivotal because corporate risk-taking is essential to corporate growth and economic growth (John et al., 2008). Along with the globalization of the world economy, foreign institutional investors are playing an increasingly significant role globally. Therefore, it is necessary to examine the impact of *FIO* on corporate risk-taking. Our main conclusions are described as follows.

We employ a large sample of 17,698 firms across 42 countries spanning the years 2000 to 2015, we show that *FIO* positively influences corporate risk-taking, and this positive relation is achieved through both direct and indirect channels. In addition, *FIO* is found to be a substitute for country-level corporate governance in determining corporate risk-taking, indicating that foreign institutional investors play a significant role in promoting managers to take risks in countries with weaker corporate governance. Various robustness tests and careful considerations of endogeneity confirm our main conclusions.

Our findings are robust to the use of alternative risk-taking variables and alternative approaches to address the endogeneity issue, including the following: examining the regression based on a subsample ensuring that there are no overlaps in risk-taking variables; using *difference regressions*, using a firm-fixed effect regression, and using a 2SLS regression; performing a quasi-natural experiment by using stock additions (deletions) to (from) the MSCI ACWI; and examining whether the increase in *FIO* due to cross-border M&As increases corporate risk-taking.

These findings have broad implications for academia, practitioners, and policy makers. For example, policymakers should carefully consider the costs and benefits related to foreign investments. Based on our findings, foreign investors from a context of stronger corporate governance are particularly effective at motivating corporate risk-taking in countries with weaker corporate governance, but not the other way around. This provides a new channel through which foreign investments can promote economic growth in developing countries.

Chapter 3

Technology Spillovers, Stock Price Crash Risk, and Corporate Financial Policy

3.1 Introduction

Technology innovation is critical for firm growth and performance. Firms' that innovate are able to strengthen their competitive advantage and sustain long-term productivity growth. However, firm innovation can also lead to considerable amounts of knowledge spillover through involuntary leakages. The recipients of these beneficial externalities are then able to acquire new technology at a cheaper costs than what is required to invent it, enhancing their productivity and innovative capabilities (Jaffe, 1986, 1988). While existing literature tend to focus on technology spillover as an instrument to improve firm valuation, productivity, and innovation, we emphasize that while innovation is a good thing, research tends to neglect the negative effects associated with risk-taking such as crash risk, a large negative outlier in the distribution of firm-specific returns (Callen and Fang, 2013). In particular, while technology spillovers enhance innovation, which is associated with more risk-taking, the positive externalities from technology spillovers allows innovations to be less risky through the information channel. Therefore, absorbing technology spillovers can provide an interesting trade-off between innovation and risk-taking. This trade-off should also have an important effect on how a firm finances these technology spillovers. It has been documented that firms experiencing knowledge spillovers will hold more liquid cash to absorb the spillovers (Qiu and Wan, 2015). The author's findings suggest that this is particularly prevalent in firms that experience financial constraints. However, given the benefits that are associated with spillovers we also examine how a firm raises capital for these technology spillovers.

An example which we would like to use to provide context to develop our hypothesis in the later sections is the acquisition of Validity, a fingerprint identification firm, by Synaptic in 2013. While acquisitions are not exactly innovations, we use this example because the purpose of this acquisition is to purchase the right to the use of Validity's patents in fingerprint identification technology, and innovating by integrating this technology for tablets, smart phones, and notebook PCs. Acquisitions are considered risky investments and this acquisition is risky because it could lead to poor performance if consumers are not interested or find fingerprint recognition intrusive to their privacy. The net result of this acquisition was a doubling of Synaptic's share price over the next 12 months. This isn't surprising though if we take into account the earlier acquisition of AuthenTec (a company also specializing in fingerprint identification) by Apple which lead to a substantial increase in Apple's share price, an explanation emerges that could give us insight as to why the investors were so optimistic about Synaptic's acquisition. Essentially, the nature of the acquisition of Validity by Synaptic can be characterized as a technology spillover from Apple. The significance of Apple's acquisition of AuthenTec to investors of Synaptic is twofold. First, Apple's acquisition of AuthenTec allows investors of Synaptic to gain additional knowledge so they can better evaluate whether this could be a potentially successful project if their firm chooses to undertake it, this allows for shareholders and investors of Synaptic to be more informed and become less vulnerable to any potential information barriers the managers create. Second, Apple's success after their acquisition of AuthenTec gives investors and shareholders of Synaptic confidence when their firm chose to undertake in a similar acquisition. The information in Apple's stock price after their acquisition of AuthenTec also provides managers of Synaptic more information on the prospects of undertaking their own acquisition in this area. Together, these two effects on the investors and managers of Synaptic which arises from technology spillover provides an explanation for the shareholder optimism even though acquisitions and mergers tend to be risky projects and tend to attract shareholder cautiousness.

To explain the significance of this example and how it relates to crash risk we must define what it is that we call crash risk. Crash risk as we have previously described is a large negative shock in firm-specific returns. It is largely agreed upon in previous studies that the key cause of crash risk is due to earnings management by managers to withhold bad news. Managers want to withhold bad news from investors due to managerial incentives such as career concerns and compensation contracts (Kothari, Shu and Wysocki, 2009). As a result, bad news associated with poorly performing projects tends to stockpile within a firm. When bad news accumulates to a certain threshold, managers are no longer able to hide the bad news effectively, and all the negative information will be released to the market at once. This leads to an extreme decline in stock price, which is the "crash risk" (Hutton, Marcus and Tehranian, 2009; Kim, Li and Zhang, 2011a, b). Simply put, crash risk occurs due to information asymmetries between shareholders and managers. From our example, we can see that the presence of technology spillover from Apple could potentially enhance the information of the investment being undertaken by Synaptic, whether it is for the shareholders or the manager. Under technology spillover, we find that if managers can already identify bad projects through project transparency then there is no incentive for the firm to absorb these projects. While for shareholders, the value of the project becomes much more transparent due to the past performance of the project for competitor firms. The spillover effect, especially for transparent spillovers will enhance the transparency of the manager's decision. If shareholders can already discriminate between good and bad projects at an earlier stage then all information should already be reflected in the stock price (Bleck and Liu, 2007), and there should be less incentive for managers to manage earnings. The reduction in information asymmetries associated with the project arising from information from Apple's acquisition could also have a significant effect on how a firm raises capital. Information asymmetries have typically been one of the primary costs of raising equity capital. Therefore, we also look at the effect of technology spillovers on capital structure and the costs of raising capital.

We test our hypotheses by using data for 28 economies for the 1999-2013 period. We utilize patent data from the Derwent World Patents Index (DWPI) available in Thomson Innovations to construct our measure of spatial proximity between firms. Existing studies in this area exclusively use the patents applied to the U.S. Patent and Trademark Office (USPTO) due to the accessibility of this data when constructing a measure of spatial proximity. Therefore, past studies are limited to investigating the effect of technology spillover in the US economy. By using firm-level patent data from 50 different local patent issuing authorities we forego this limitation and flaws associated with only focusing on a single economy.

Our baseline results reveal a negative relation between technology spillover and crash risk consistent with our second hypothesis. The effect is both economically and statistically significant, with a one standard deviation increase in our technology spillover measure leading to a reduction in crash risk by 12% relative to the mean. We then investigate plausible mechanisms that can drive this relationship between technology spillover and stock price crash risk. We explore the project transparency channel by measuring the information contained in the rivals' stock price. We find that the relationship between technology spillover and crash risk is driven by higher information content in the rivals' technology stock. This suggests that absorbing knowledge spillovers reduce firms' stock price crash risk through the information content in the project and all other related projects undertaken by competitors. To further emphasize this effect, we look at country-level corporate governance in the form of information environment and shareholder protection. The effect of technology spillover on crash risk is complemented by stronger information environment and shareholder protection. Moreover, the effect of transparency of the knowledge stock still continues to hold in weaker corporate governance environments. In terms of corporate financial policy, we find that technology spillovers has a negative effect on a firm's choice of leverage. This suggests that to absorb these positive externalities, firms also concurrently reduce their propensity to be financially constrained. However, we also find that firms exposed to more technology spillovers increase their use of equity financing. This result is justified in the supply-side regressions confirming that technology spillovers causes a significant increase in the cost of debt and a corresponding decrease in the cost of equity. This can be traced back to the reduction in information asymmetries which is a cost associated primarily with raising equity capital. However, the increase in the cost of debt is counter intuitive to the information asymmetry story. We hypothesize that the increase in the cost of debt is due to the poor collaterizability of innovative activities that comes from absorbing technology spillovers. To investigate if this is the case, we show that a country's creditor rights has a significant effect on the firm's debt financing from technology spillovers. Specifically, improved creditor rights, increases the firm's leverage and debt issuances, while decreasing the firm's cost of debt from technology spillovers. We hypothesize that this effect is due to the fact that stronger creditor rights allows creditors to impose their rights against patents just like other tangible assets, which reduces the effect of poor collaterizability associated with innovative activities (Mann, 2018).

Our study contributes to three strands of literature. First, we contribute to the literature on technology spillover as a driver of firm innovation. Previous literature provides strong empirical evidence that knowledge spillovers enhance firm innovation, and leads to multiple key benefits such as improved productivity and firm performance

(Bloom, Schankerman, and Van Reenan, 2013). These studies largely ignore the negative externalities associated with innovating, such as stock price crash risk. If there is no information content associated with a firm's absorption of technology spillovers, there could potentially be negative externalities associated with innovation. However, we show in this study that there is a substantial informational role associated with absorbing technology spillovers which improves a firm's project transparency and so reduces crash risk. This study therefore, provides evidence for another key benefit associated with absorbing knowledge spillovers.

Second, we contribute to the growing literature on the determinants of stock price crash risk. Evidence suggests that the main channel that affects crash risk is through managerial earnings management (Jin and Myers, 2006; Hutton et al., 2009; Kothari et al., 2009). Previous literature tends to focus on enhancing firm transparency through mechanisms of effective monitoring by institutional investors, and financial reporting practises (Defond, Hu, Hung and Li, 2011) as an answer to a firms' stock price crash risk. Our study focuses on the outside mechanism associated with crash risk. In particular, the role of investment transparency is an under explored area in the crash risk literature due to the difficulties in measuring a firm's investments. By leveraging the role of technology spillovers as an investment decision that is undertaken by the firm, we show that investment transparency is also a significant contributor to a reduction in a firm's stock price crash risk.

Third, we contribute to the literature on technology spillovers and its effect on corporate policy. Previous literature provides strong empirical evidence that firms retain cash in order to absorb spillovers (Qiu and Wan, 2015). This suggests that technology spillovers have real effects on corporate policies. We supplement this literature by documenting that external knowledge spillovers have real effects on a firm's corporate policy due to its' effect on information asymmetries which has a real effect on how a firm raises capital in order to finance technology spillovers in the form of both debt and equity.

The remainder of this paper proceeds as follows. Section 3.2 motivates and develops our testable hypotheses regarding the relationship between technology spillover, crash risk and corporate financial policy. Section 3.3 describes the empirical model used to test our hypothesis. Section 3.4 describes the data, variable construction and the summary statistics of our sample that will be used for our empirical analysis. Section 3.5 provides baseline results and a discussion of the results. Section 3.6 concludes.

3.2 Hypothesis Development

3.2.1. The Impact of Technology Spillover on Crash Risk and Corporate Financial Policy

In this section, we develop testable hypotheses on the effect of technology spillovers on a firms' stock price crash risk and corporate financial policy. Existing literature provides evidence that firms' do indeed absorb the positive externalities from these knowledge leakages. Qiu and Wan (2015) finds that firms tend to hold significantly more cash when they are exposed to spillovers in order to undertake these valuable projects when they arise. Similarly, evidence suggests that investment in knowledge creation by one party can also help facilitate innovation by others (Jaffe, Trajtenberg and Fogarty, 2000). Jaffe, Trajtenberg, and Henderson (1993) show that a firm's patents are more likely to be cited by others who are geographically closer. This suggests that firms absorb the knowledge spillovers occurring through the flow and interaction of local human capital. These positive externalities are then associated with many noticeable benefits to the absorbing firm. Griliches (1979), provides strong evidence that technology spillover will enhance R&D productivity. While, Tambe and Hitt (2014) finds that spillovers from peer firms' in IT-related innovations have contributed to 20-30% as much to a firms' productivity growth. Bloom, Schankerman, and Reenen (2006) finds that technology spillover improves a firms' market value, R&D productivity, innovation capabilities through patent count, and productivity. The exposure to knowledge spillovers can then be seen as a primary motivator of innovation and risk-taking. In terms of crash risk, recent studies maintain that the primary cause of crash risk, which is a large negative outlier in the distribution of firm-specific returns, is due to bad news hoarding. That is, managers will choose to withhold bad news from investors through earnings management due to managerial incentives such as career concerns and compensation contracts (Kothari et al., 2009). When the bad news accumulates to a certain threshold it becomes too costly for the manager to withhold from the market. As a result, all the negative information will be released at once, leading to an excessive drop in the firms' stock price (Jin and Myers, 2006; Hutton et al., 2009; Kothari et al., 2009). Based on our discussion we expect that technology spillover will affect a firms' stock price crash risk through two main channels: information and risk-taking.

These two different channels are expected to affect a firms' stock price crash risk in two different ways. We will discuss the two different channels below and they will be the basis from which we form our hypotheses.

First, if we identify technology spillover as a motivator of firm innovation then there is empirical evidence to suggest that this would exacerbate a firms' stock price crash risk. For example, Kim et al.(2011) finds that managers that take risks are concerned about the investors' perception of firm riskiness and will hide risk-taking information in order to support share price. Callen and Fang (2013) supports this notion by pointing out that managers of firms' with high risk-taking will be more likely to conceal and hoard bad news information from investors because bad news may be perceived by investors to be the realization of excessive risk-taking behaviour by managers. Risk-taking by managers will inherently worsen agency problems in the firm by prompting managers to selectively hoard bad news information from investors. Therefore, managers who actively seek risk-taking opportunities through mechanisms of spillovers will inherently face more exposure to losses as a result of these risky projects. These losses will be perceived as bad news to the firm and managers will choose to hide this information from the market by managing earnings and as a result drive up crash risk. This leads to our first hypothesis:

Hypothesis 1a. Technology spillover is significantly and positively associated with crash risk.

Second, if we consider technology spillover as an avenue of information to make potential risky projects of the firm more transparent to both the firm and its' shareholders then we would expect the opposite effect of technology spillover on a firms' stock price crash risk. In this regard, we believe the effect of technology spillover on crash risk is two-fold. From the perspective of the managers, information leakages related to R&D investments propagate through the financial markets and provides information (Hayek, 1945; Dow and Gorton, 1997; Subrahmanyam and Titman, 1999). Bond, Edmans and Goldstein (2012) formalize the informational role of prices to affect real decisions such as the manager's decision to undertake risky project. Recent studies have also shown that firms use the information contained in their own stock prices to make decisions ranging from corporate disclosure, cash savings, investment to takeovers (Chen, Goldenstein and Jiang, 2007; Bakke and Whited, 2010; Edmans, Goldstein and Jiang, 2012; Foucault and Fresard, 2012). Therefore, it is possible that if stock prices reveal information about a firms' innovative projects, managers of firms that are exposed to knowledge spillovers can refer to their rival's stock price for information that will affect the managers decision to undertake a similar project. This allows managers of the follower firm to identify and absorb good projects.

From the shareholders' perspective, projects undertaken by firms that are exposed to knowledge spillovers should become more transparent. It is well documented that investment in knowledge creation by one party facilitates innovation by others (Jaffe et al., 2000). This is emphasized by the observation that most patents are cited by their peers' patents. The absorption of technology through knowledge spillovers reveals more information about the project than just the project itself. Technology spillovers provide shareholders with information for all previous patents and projects associated with those patents. This makes the project significantly more transparent to the shareholder as opposed to projects taken by firms with no knowledge spillovers. For example, if a firm is exposed to no knowledge leakages, the value of projects from the firm becomes more ambiguous as there are no references to previous projects.

Both perspectives suggest that technology spillover provides project transparency, such that under technology spillovers, managers can act as a bad project filter, while shareholders are provided with the more information to discriminate between good and bad projects. Since the main cause of crash risk is through earnings management when firms suffer from bad news such as poorly performing projects, if the manager or the market can already identify these projects then there is no incentive to absorb or manage earnings since all this information is already reflected in the stock price. These factors should all reduce the crash risk associated with bad projects (Bleck and Liu, 2007).

In support of our discussion, many studies find that there is a diffusion of information from technology spillovers. In particular, the diffusion process is frequently considered as a learning process, where the information associated with the diffusion process plays an essential role to the absorption of the innovation. For example, Griliches (1957) find that the diffusion of technology is faster for innovations that are more profitable. This suggests that firms use information on the profitability of a innovation to decide whether to absorb the diffusions from the rival firm. Similarly, McCardle (1985) show that the adoption decision by a firm is based on sequentially gathering of information, updating prior estimates of profitability in a Bayesian manner. Therefore, a firm sequentially gathers information on new technology and chooses to absorb technology spillovers as the uncertainties associated with the profitability decreases. However, this type of information is often not available within the firm and requires information from outside the firm. For example, Monjon and Waelbroek (1999) describes the sources of this information, in particular, they show that competitor's adoption of this technology is an important source of information for the firm's decision of absorption. In particular, if the market share of a competitor increases due to the use of this new technology or there is a large proportion of competitors that adopt this technology than this is a credible source of information that indicates that the innovation should be absorbed. Moreover, Mansfield (1968) suggests that there are other sources of information such as those disseminated by the producers through advertisements and salesman, reactions of users to the innovation, as well as informally through trade press. This suggests that firms use outside information that is also available to shareholders, which should reduce the information asymmetries between shareholders and managers and thus reduce crash risk.

Hypothesis 1b. Technology spillover is significant and negatively associated with crash risk.

Based on the discussion above, it is plausible that technology spillovers can either enhance crash-risk (risk-taking) or decrease crash-risk (information). In the following section, we discuss how technology spillovers can affect a firm's capital structure under both circumstances. In particular, technology spillovers are inherently associated with a firm's R&D spending and innovation (Bloom et al. 2013). Therefore, a firm with more technology spillovers will be incentivized to undertake such investments. However, theoretical models such as those by Nelson (1959) and Arrow (1962) provides evidence that it is inherently difficult to finance R&D and innovative activities due to the fact that it is difficult to keep knowledge secret and so the firm undertaking the innovative activities cannot fully capture the returns associated with the investment. As a result, it is difficult for firms to finance these investments, this is particularly prevalent when the source of funding is from external investors, which is the case with equity and debt. In particular, Arrow (1962) shows that there is an additional gap between private rate of return associated with R&D when the financing is by an external party. This suggests that firm's will only use their own retained earnings rather than external capital due to the costs of external capital being too high. This is frequently regarded as the motivation for policy makers to provide support for R&D through R&D tax incentives and encouragements of research partnerships. Moreover, Bernstein (2015) shows a causal effect of a firm going public on a firm's level of innovation. He finds that there is no effect on a firm's innovation, when a firm goes public. Specifically, he argues that this effect is due to the agency costs between shareholders and managers that arise when a firm goes public. Similarly Holmstrom (1982) shows that the high uncertainty associated with innovation will cause managers to avoid innovation. In particular, they model innovation as a highly uncertain event that on failure could mistakenly be attributed with managerial skill, which is detrimental to a manager's career. Similarly, Stein (1988) using a model of managerial myopia shows that shareholders are unable to evaluate investments in long-term innovative projects due to the asymmetric information and so markets will undervalue stocks of companies that are engaged in innovative activites. As a result, managers in this scenario will prefer to invest less in innovative projects that is difficult for shareholders to understand. Based on our discussion, if technology spillovers are associated with innovation, then the agency costs associated with innovation should have an insignificant effect on a firm's issuances of shares. In particular managers will prefer not to absorb these spillovers.

Hypothesis 2a. Technology spillover has an insignificant effect on the issuance of debt

Hypothesis 3a. Technology spillover has an insignificant effect on the issuance of equity

However, technology spillovers are inherently different from purely innovative activities. In support of this, Hall and Lerner (2009) suggests that the concept of imitating a new invention through technology spillovers will mitigate some of the underinvestment problems associated with innovative activities. In particular, based on our past discussion firms are able to gather much more information from competitor firms that allow them to assess the profitability of the new technology, reducing the uncertainties associated with the innovation (Griliches, 1957; McCardle, 1985;

Stoneman, 1995). This reduces the agency costs associated with a manager's career concern which should allow managers to more effectively absorb profitable technology spillovers. In addition to this, it has been shown that these firms rely on outside information rather than inside information to determine the profitability of these new technologies (Mansfield, 1968; Monjon and Waelbroek, 1999). However, this information isn't exclusive to the firm, it is also available to all market participants. Specifically, shareholders can also observe competitor firms and benefit from this information, this suggests that technology spillovers will help align the information between shareholders and managers. As a result, absorbing technology spillovers could lead to a reduction in information asymmetries and should have a positive effect on both the issuances of debt and equity. Based on our discussion we hypothesize that:

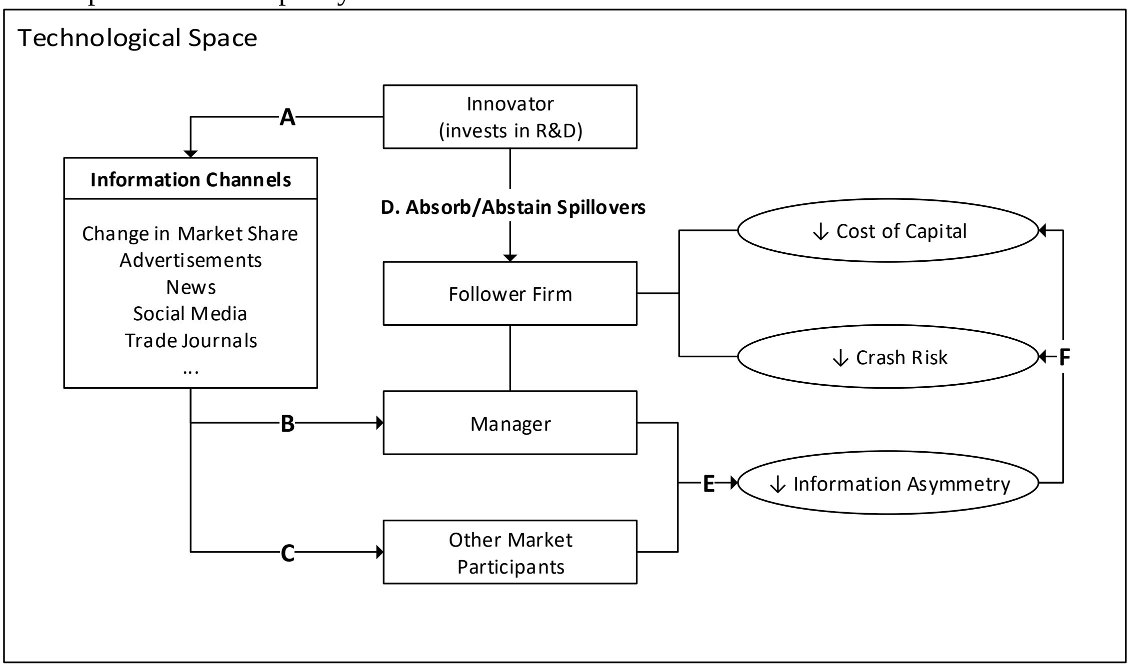
Hypothesis 2b. Technology spillovers significantly increases the issuance of debt.

Hypothesis 3b. Technology spillovers significantly increases the issuance of equity.

3.2.2. Framework

To provide further details, we illustrate the exact mechanisms of our hypothesis in Figure 3.1. Specifically, there are innovators and followers that exist in the same technological space. When an innovator decides to innovate by investing in R&D, public information regarding the innovation can potentially be transmitted through a variety of mediums into the market as suggested by Arrow A. Although we generalize the firm that invests in R&D initially as an innovator, the innovator in the process can just as easily be a follower firm. Both the manager of the follower firm and other market participant receive information regarding the innovation, which is represented by Arrow B and C respectively. The manager then decides on whether to absorb or abstain from absorbing the spillover as represented by Arrow D. However, in both scenarios, other market participants are afforded information that can allow them to evaluate the decision of the manager. The symmetrical public information regarding the spillovers between the manager and the other market participants will hypothetically reduce the information asymmetries associated with the managers decision making, represented by Arrow E. As a result, the manager's decision will also be theoretically affected by the fact that the manager is aware of the information being public. This reduction in the information asymmetries between the manager and other market participants regarding the firm's investment decisions will inherently affect the firm's crash risk and cost of capital, represented by Arrow F.

Figure 3.1: The Impact of Technology Spillover on Crash Risk and Corporate Financial Policy
This figure details the mechanisms for how technology spillovers can affect a firms' crash risk and corporate financial policy.



3.3 Empirical Model

To investigate how technology spillovers affect a firms' stock price crash risk, we estimate an unbalanced panel OLS regression:

$$CRASH_{i,t} = \beta_1 \ln\left(SPILL\_TECH_{i,t-1}\right) + \beta_2 \ln\left(SPILL_{SALE_{i,t-1}}\right) + \gamma' \mathrm{X}_{\mathrm{i,t-1}} + \tau_t + \varphi_k + \omega_j + \varepsilon$$

where *i*, *k*, *j*, and *t* refer to firm *i*, industry *k*, country *j*, and year *t*, respectively. *CRASH* is our crash-risk measures (NCSKEW, DUVOL, and COUNT). *SPILL_TECH* is our technology spillover measure, $SPILL\_SALE$ is our product market rivalry measure, *X* is a vector of constant terms and other firm-level control variables as discussed in subsection 3.4.4. We measure all explanatory variables in years *t-1*. The specification includes year fixed effects (τ), industry fixed effects (φ), country fixed effects (ω), and ε as the error term. Robust standard errors are clustered at the firm levels. If β_1 is positive (negative), then H1a (H1b) is supported.

In addition to crash risk, we also investigate the effects of information asymmetries from technology spillovers and a firms' corporate financial policy, we estimate an unbalanced panel OLS regression:

$$CFP_{i,t} = \beta_1 \ln\left(SPILL\_TECH_{i,t-1}\right) + \beta_2 \ln\left(SPILL_{SALE_{i,t-1}}\right) + \gamma' \mathrm{X}_{\mathrm{i,t-1}} + \tau_t + \varphi_k + \omega_j + \varepsilon$$

as before *i*, *k*, *j*, and *t* refer to firm *i*, industry *k*, country *j*, and year *t*, respectively. CFP is measure of a firms' corporate financial policy, which includes: (1) Leverage, which is total debt divided by book assets; (2) *DEBT_ISSUES*, which is the proceeds of new debt issues divided by assets (3) *EQ_ISSUES*, which is the proceeds of new secondary equity offerings divided by assets. As additional tests, we also evaluate the supply-side effects, which is the costs associated with each type of financing: (1) *COD*, which is the interest expense from debt divided by total debt; (2) *ICOC*, which is the average of the cost of capital deduced from four different models equating current stock price with expected future income; (3) *SEO_Underpricing*, which is the amount of underpricing associated with raising equity through seasoned equity offerings (SEOs). *SPILL_TECH* is our technology spillover measure, $SPILL\_SALE$ is our product market rivalry measure, X is a vector of constant terms and other firm-level control variables as discussed in subsection 3.4.4. We measure all explanatory variables in year *t-1*. The specification includes year fixed effects (τ), industry fixed effects (φ), country fixed effects (ω), and ε as the error term. Robust standard errors are clustered at the firm levels.

3.4 Data and Variable Construction

3.4.1 Data

Our investigation is based on the linkage between two main databases. The first source is the Derwent World Patent Index (DWPI) available in Thomson Innovation database, a dataset, in 2015, that details patent information for upwards of 63.3 million patent documents (29.4 million patent families) derived from 52 different sources worldwide (50 patent-issuing authorities and 2 journal sources). DWPI offers the world's most comprehensive database of enhanced patent documents. It is being used globally by thousands of organizations and over 40 patent offices. Expertly trained staff apply over 5,000 rules to normalize, standardize, correct and enhance patent records resulting in over 6,000 corrections each week, making it the world's most trusted and authoritative patent database.

We derive our fundamental data from the Datastream database. Datastream covers over 100,000 active equities plus over 103,000 inactive equities, covering 100 developed and emerging markets. For many markets, there is full coverage of all traded equity instruments with over 40 years of history. Data is sourced directly from exchanges, leading international and local suppliers, and published reports.

The key concern when using any patent data is the name matching between the patent database and the fundamental data. This process is both important and necessary because patent databases only provide us with the names of the assigned firms rather than stock identifiers. This process becomes increasingly complex in an international study because we require patent data available across every patent authority. On the surface, this may not seem like much of a problem, the problem arises when each patent authority can have completely different standards of recording firm names. For example, there are over 100 different spellings, misspellings, abbreviations, etc. for assignees of patents assigned to IBM. DWPI provides a remedy to this problem by providing standardized assignee names that we match to the names of the whole universe of firms available in the Datastream database[18]. The matching process can be described as both exact and fuzzy. For non-exact matches we manually search for information for the sample firms to confirm whether they matched up correctly in order to be included in our sample.

3.4.2 Sample

We construct our sample using all firms available in Datastream. Following previous studies, we exclude firms in heavily-regulated financial and utility industries. Through name matching between the Datastream and the DWPI index we only include firms in our sample that have at the minimum one published patent. We also impose the requirement that every economy must include at least 10 firms in the patent database to

[18] Appendix A provides more details regarding our name matching procedure.

be retained in our sample.[19] To preserve the consistency of our crash-risk measure, we require that there be no fewer than 26 weekly stock returns available for a firm-year. If any variable of interest is missing for a given year, we remove the firm-year observation. Our resulting sample consists of 5,696 public firms from 28 countries between 1999 and 2013.

3.4.3 Variable construction

3.4.3(i) Measuring spatial proximity

Following Bloom et al. (2013) we are able to distinguish a firm's technology space by identifying the firm-level patent distribution across different technology fields. Each firm's activity in a particular technology space is measured by its average share of patents granted in the DWPI technology classification across all years within our sample $T_i = (T_{i,1}, T_{i,2}, \dots, T_{i,291})$.[20]

To measure the technological proximity between two firms i and j we follow Jaffe (1986) in defining proximity as ω_{ij}, which is the uncentred correlation between every firm i, j pairing:

$$\omega_{ij} = T_i T_j' \Big/ \sqrt{T_i T_i' \times T_j T_j'}$$

Since we are dealing with an international sample we first define firm j as any firm operating in the same market as firm i. ω_{ij} , which is bounded between zero and one, which measures the technological proximity between firm i and j based on their

[19] The same exclusion does not hold for our final sample since we exclude additional firms based on missing variables.

[20] To be consistent we use the "current" provided DWPI classification for each patent. The total number of DWPI classifications may vary due to the updating of the DWPI classification. More information regarding the classifications are provided in Appendix B.

patent positioning across technological classes i.e. a large ω_{ij} close to one would suggest that the two firms are similarly distributed across technology classes.

In the construction of technological proximity, we pay special attention to three main issues. First, a firm can submit patent applications to and be granted patents by more than one patent authority. While they are considered different patents with different publication numbers, they are the same invention. If we consider these duplicate patents as unique patents then we will be overestimating a firms' share of patents in that particular technological space. The DWPI database classifies these types of patents as patent families. Therefore, we identify the patent family for each individual patent by using the International Patent Documentation (INPADOC), which is a database produced and maintained by the European Patent Office (EPO). We classify the patent with the earliest publication date as the basic patent in each patent family within our sample and delete all non-basic patents. This assures that we are not double counting any single invention.

Prior literature that explores the effect of technology spillovers tend to focus on data provided by the National Bureau of Economic Research (NBER) for patent name matching. The data that is provided is derived from the United States Patent and Trademark Office (USPTO), which focuses on patents that are issued in the United States. To be consistent with studies that use this data, we must determine the countries in which the invention for each basic patent is protected. To do this, we use both the INPADOC patent family as well as the designated states for each patent. For a basic patent which has coverage in a country in addition to the country in which it is initially filed in is then considered a patent for that country. This allows us to distinguish between technology spillovers that are protected by local authorities as well as those that are unprotected. This classification is also consistent with studies that use the NBER data.

A further issue is that patents can be classified into multiple DWPI classes. To address this issue we assume that the patent will equally contribute to each DWPI classification. While this may not be entirely accurate this issue arises with every classification system. This is an unavoidable limitation when using the technological classifications to construct the technological proximity between firms.

To account for the downsides associated with technological proximity between firms, we also construct a measure of their product market proximity between the firm pairings that we have identified through their share in technological space. The benefits associated with absorbing technology spillovers from rival firms can potentially be offset if they also share the same product market space. For each firm pairing we identify their product market proximity by their overlap in sales share across the four-digit SIC industries, therefore for each firm we construct the row vector $S_i = (S_{i,1}, S_{i,2}, \ldots)$. The k[th] element in the vector, $S_{i,k}$, is measured by the average of the reported sales share in that four-digit SIC industry per year over the sample period. The product market proximity between firm i and j is again calculated as an uncentred correlation between the firm i and j pairing:

$$\tau_{ij} = S_i S_j{}' / \sqrt{S_i S_i' \times S_j S_j{}'}$$

Similarly, τ_{ij}, is bounded between zero and one and measures the product market proximity between firm i and j based on their sales share across industries i.e. a large τ_{ij} close to one would suggest that the two firms have very similar operations in the product market.

3.4.3(ii) Measuring Firm-level Technology Spillover

Given this measure of technology proximity, we are interested in the outside technology pool that is available to firm i at any time t. We denote this outside technology pool as $Spill\_Tech_{it}$. $Spill\_Tech_{it}$ is computed as the weighted sum of all local competitors' R&D stock, denoted as G.

$$Spill\_Tech_{i,t} = \sum_{j \neq i} w_{ij} G_{jt} \qquad (2)$$

Following Bloom et al. (2013) and Hall, Jaffe and Trajtenberg (2005), we use the perpetual inventory method to construct R&D stock, G as $G_t = R_t + (1 - \delta)G_{t-1}$ where R_t is the R&D expenditure in year t and $\delta = 0.15$.[21] The perpetual inventory method is frequently used because while the firm's R&D expenditure in a particular period indicates the firm's commitment to knowledge production, the benefits and returns on these expenditures may last much longer.

By weighting on technological proximity, $Spill\_Tech_{it}$ can be interpreted as the total R&D stock in equivalent dollar value undertaken by competitors that is relevant to firm i's technology space. This value is then the potential knowledge spillovers that firm i can absorb (Qiu and Wan, 2015).

3.4.3(iii) Measuring Firm-level Product Market Rivalry

While technology spillover measures the outside technology pool available to the firm at any point in time, product market rivalry measures the technology induced competition when utilizing this pool of knowledge.

$$Spill\_Sale_{i,t} = \sum_{j \neq i} \tau_{ij} G_{jt}$$

[21] To construct R&D stock we use all R&D expenditure data available on Datastream.

The main difference between the two measures is the difference in weighting scheme, where technology spillover uses the spatial closeness in technology space and product market rivalry uses the spatial distance in product market space.

3.4.3(iv) Measuring Crash-Risk

Following previous studies (Chen, Hong, and Stein, 2001; Jin and Myers, 2006; Hutton et al., 2009; Kim et al., 2011a, b; An and Zhang, 2013), we construct three crash-risk measures: NCSKEW, DUVOL, and COUNT. First, following Jin and Myers (2006), we calculate the demeaned firm-specific continuously compounded weekly returns ($W_{i,t}$) for firm i in week t as the demeaned natural logarithm of one plus the residual from the expanded market model regression:

$$\begin{aligned} r_{i,t} = \alpha_i + \beta_{1,i} r_{m,j,t} + \beta_{2,i}\left[r_{U.S.,t} + EX_{j,t}\right] + \beta_{3,i} r_{m,j,t-1} + \beta_{4,i}\left[r_{U.S.,t-1} + EX_{j,t-1}\right] \\ + \beta_{5,i} r_{m,j,t-2} + \beta_{6,i}\left[r_{U.S.,t-2} + EX_{j,t-2}\right] + \beta_{7,i} r_{m,j,t+1} \\ + \beta_{8,i}\left[r_{U.S.,t+1} + EX_{j,t+1}\right] + \beta_{9,i} r_{m,j,t+2} + \beta_{10,i}\left[r_{U.S.,t+2} + EX_{j,t+2}\right] \\ + e_{i,t} \qquad (3) \end{aligned}$$

where: $r_{i,t}$ is the stock return for firm i in week t, $r_{m,j,t}$ is the local market return for country j in week t, $r_{U.S.,t}$ is the United States (U.S.) market return in week t, $EX_{j,t}$ is the change in country j's exchange rate vs. the U.S. dollar in week t.

The expanded market model includes two lead and lag terms to control for the non-synchronous trading that affects both the local market returns and U.S. market returns (Dimson, 1979). Individual stock returns that are not explained by the local and U.S. markets are considered firm specific and are captured by the residual term ($e_{i,t}$). We use such firm-specific returns to calculate the firm-specific continuously compounded weekly returns ($W_{i,t}$), which will be used to compute the three crash-risk measures below.

The first crash-risk measure, NCSKEW, is a measure of stock return asymmetry, which is the negative skewness of the firm-specific weekly return for a given year. This measure is computed by taking the negative of the third central moment of firm-specific weekly return scaled by the sample variance of firm-specific weekly return raised to the power of 3/2. We follow the literature by putting a minus sign in front of the skewness so that an increase in NCSKEW corresponds to higher crash risk (i.e., a more negatively skewed stock return distribution)(Chen et al., 2001). Specifically:

$$\mathrm{NCSKEW}_{i,t} = -\frac{n(n-1)^{\frac{3}{2}}\sum W_{i,t}^{3}}{(n-1)(n-2)\left(\sum W_{i,t}^{2}\right)^{\frac{3}{2}}} \qquad (4)$$

The second crash-risk measure, DUVOL, is also a measure of stock return asymmetry, computed by taking the natural logarithm of the ratio of the standard deviation on down weeks to the standard deviation on up weeks (Chen et al., 2001). Specifically:

$$\mathrm{DUVOL}_{i,t} = \log\left[\frac{(n_u-1)\sum W_{i_d,t}^{2}}{(n_d-1)\sum W_{i_u,t}^{2}}\right] \qquad (5)$$

A firm-week is considered an up (down)-week if the firm-specific weekly return is above (below) the annual mean weekly return. The convention is that a higher value of DUVOL indicates a more left-skewed distribution, thus higher crash risk.

The third crash-risk measure, COUNT, is computed in the following manner: we first detect crash (jump), which occurs when the firm-specific weekly return is 3.09 standard deviations below (above) its mean over the fiscal year,[22] we then compute COUNT as the number of crashes minus the number of jumps over the fiscal year (Hutton et al., 2009; Kim et al., 2011a,b; An and Zhang, 2013).

[22] We follow Hutton, Marcus, and Tehranian (2009) and choose 3.09 to generate top and bottom 0.1 percent in the normal distribution.

3.4.3(v) Measuring Technological Spillover Transparency

As a measure of the transparency of the knowledge stock from spillovers we measure the stock price informativeness of rival firms using commonly used measures from previous literature. Our measures for stock price informativeness includes: R^2 and $ANALYST$.

Our first measure, R^2, is a goodness-of-fit measure. Roll (1988) suggest that firm-level stock returns can be broken down into three different components: market related variations, industry related variations, and firm specific variations. The first two components are attributed to systematic variations. The proportion of stock return variations that are not attributed to systematic variations provide us with a measure of the level of private information being incorporated in stock prices. Firm-specific return variation is frequently adopted in literature as a proxy for stock price informativeness. This is estimated by $1 - R^2$, where R^2 is measured from the following regression:

$$r_{i,t} = \alpha_i + \beta_{1,i} r_{m,j,t} + \beta_{2,i} r_{ind,t} + \varepsilon_{i,t}$$

where: $r_{i,t}$ is the stock return for firm i in week t, $r_{m,j,t}$ is the local market return for country j in week t, $r_{ind,t}$ is the industry return in week t.

The second measure $ANALYST$, measures the number of financial analysts following a firm. The number of analysts and analyst information is expected to improve the overall information content of prices. The impounded information from analysts is expected to contribute to stock price informativeness.[23]

We measure the transparency of the knowledge stock by weighting our stock price informativeness measure of rival firm *j* by the proportion of the total spillover provided by firm j:

[23] From here onwards, R^2 refers to the weighted $1 - R^2$ and *ANALYST* refers to the weighted *ANALYST.*

$$Spill\_Info_{i,t} = \sum_{j \neq i} \frac{w_{i,j} G_{j,t}}{\sum_{j \neq i} w_{ij} G_{j,t}} \times INFO_{j,t}$$

This is expected to reflect the transparency of the knowledge stock since the transparency of rival firm j's investment decision in R&D results in spillovers that are more transparent to the market due to more informative stock prices.[24]

3.4.3(vi) Measuring Cost of Debt

Following prior literature, we construct cost of debt by using a firm's interest expense on financial debt divided by the average debt (short- and long-term) between the current and previous years (Pittman and Fortin, 2004; Francis et al., 2005; Minnis, 2011). As with prior literature, we find that this is a noisy proxy for cost of debt. The procedure most often used to deal with this issue by dropping extreme values (Dechow, 1994). Therefore, we truncate the variable at the 95th percentile.

3.4.3(vii) Measuring Cost of Equity

To construct a measure of cost of equity, we follow Hail and Leuz (2006), by using the average of four different implied cost of capital (ICOC) measures as a proxy for a firm's yearly cost of equity. The models used to estimate the ex-ante cost of capital are as follows:

- Gebhardt, Lee, and Swaminathan's (2001) residual income valuation model:

$$P_t = bv_t + \sum_{\tau=1}^{T} \frac{(\widehat{eps}_{t+\tau} - r_{GLS} \times bv_{t+\tau-1})}{(1 + r_{GLS})^{\tau}} + \frac{(\widehat{eps}_{t+T+1} - r_{GLS} \times bv_{t+T})}{r_{GLS}(1 + r_{GLS})^{T}}$$

where P_t is the price of the firm's stock at time t, $\widehat{eps}_{t+\tau}$ is the expected earnings per share for period $(t + \tau - 1, t + \tau)$, and $bv_{t+\tau-1}$ is the book value per share at time $t + \tau - 1$. The initial three years of expected future residual

[24] We use the backward average of our stock price informativeness measures due to the nature of the measure of R&D stock, since the transparency of R&D stock will be reflected in the transparency of R&D expenditure in previous periods.

income are extracted from the actual book values per share and the forecasted earnings per share for up to three years ahead. The future book values are imputed from current book values, forecasted earnings and dividends, assuming clean surplus, which is also the assumption adopted in Claus and Thomas's (2001) residual income valuation model. Dividends are set equal to the average of the past three years of payout ratios, which is defined in the same way for all four models. Beyond the initial three years, residual income is derived by assuming that the stream of residual income is linearly decreasing towards the accounting return on equity determined over the past three years. Firms are classified into industrial, service, and financial sectors. If the specific sector's annual median is negative, then it is replaced by the country annual median. Residual income is then assumed to be constant beyond the 12 years.

- Claus and Thomas's (2001) residual income valuation model

$$P_t = bv_t + \sum_{\tau=1}^{T} \frac{(\widehat{eps}_{t+\tau} - r_{CT} \times bv_{t+\tau-1})}{(1 + r_{CT})^{\tau}} + \frac{(\widehat{eps}_{t+T} - r_{CT} \times bv_{t+T-1})(1+g)}{(r_{CT} - g)(1 + r_{CT})^{T}}$$

The stream of expected future residual income is based on the actual book value per share and the forecasted earnings per share for up to five years ahead. For periods beyond five years, the nominal residual income is assumed to grow at a rate of g, which is equal to expected inflation. The expected inflation rate is based on the annualized median of a country's one-year ahead realized monthly inflation rates.

- Easton's (2004) PEG model

$$P_t = \frac{\left(\widehat{eps}_{t+2} + r_{PEG} \times \hat{d}_{t+1} - \widehat{eps}_{t+1}\right)}{r_{PEG}^2}$$

where $\widehat{eps}_{t+1}$ and $\widehat{eps}_{t+2}$ are the one-year and two-year ahead earnings per share forecasts, $\hat{d}_{t+1}$ is the one-year ahead expected dividends per share. This model assumes perpetual growth in abnormal earnings after the initial period.

- Ohlson and Juettner-Nauroth's (2005) abnormal earnings growth valuation model

$$P_t = \frac{\widehat{eps}_{t+1}}{r_{OJ}} \times \frac{(g_{st} + r_{OJ} \times \frac{\hat{d}_{t+1}}{\widehat{eps}_{t+1}} - g_{lt}}{\left(r_{OJ} - g_{lt}\right)}$$

where $\widehat{eps}_{t+1}$ and $\hat{d}_{t+1}$ are the one-year ahead forecasted earnings and dividends per share, g_{st} is the short-term growth rate estimated by the average of the forecasted percentage change in the first two years of earnings and the five-year growth forecast provided by financial analysts on I/B/E/S, and g_{lt} is the long-term earnings growth rate equal to the annualized country-specific median of one-year-ahead realized monthly inflation rates.

Financial and stock price information for constructing the ICOC, is obtained from Worldscope, while the analyst forecasts are obtained from the I/B/E/S database. We include firms based on the availability of data, in particular, when they have current stock price P_t, earnings forecast of one and two periods ahead, as well as either earnings forecast from three to five periods ahead, or a long-term earnings growth forecast. In all cases, we only include positive earnings forecasts. The analyst earnings forecasts are the based on the mean consensus analyst forecasts from I/B/E/S.

All analyst forecasts and stock prices are based on information released 10 months after the fiscal year ends, to ensure that all values are already reflected in the stock price that is used to estimate the implied cost of capital.

An iterative algorithm is used to back out the ICOC from each model, where the ICOC is constrained to be positive. The iterative procedure stops, when the imputed price from the models are within 0.001 of the actual price.

To complement our findings from ICOC, we also construct a measure of the underpricing of seasoned equity offerings (SEOs), which is a cost associated with issuing new shares. The advantage of using the SEO underpricing setting, is that the costs of raising equity capital can be directly and accurately measured. This is in comparison to the indirect measure of ICOC which relies on the assumption of various valuation models and inputs.

As defined in prior research, SEO underpricing is negative one times the return from the closing price prior to the offer date to the offer price i.e. a positive value is associated with underpricing where the offer price is below the prior day closing price. Safieddine and Wilhelm (1996) observe that the offer date that is reported in SDC is incorrect for offers where the offer takes place after the close of trading. To account for this, we follow prior research and use a volume based adjustment method to correct for any errors in offer date. Corwin (2003) observes there is a substantial spike in trading volume on the SEO offer date. Therefore, if the trading volume on the day after the SDC offer date is more than twice that on the SDC offer date and also more than twice the average daily trading volume for the previous 250 trading days prior to the SDC offer date, then the day following the SDC offer date is used as the actual offer date. Altinkilic and Hansen (2003) and Corwin (2003) finds that this approach is an accurate way to correct for the previously misclassified offers.

3.4.3(viii) Measuring Corporate Governance

We measure corporate governance using a number of country-level corporate governance measures. Based on our hypothesis we expect that the effect of knowledge spillovers will prevail in countries with more transparent information environments and stronger investor protection.

As measures of transparency of the information environment, we collect the Accounting Standards Index (ACCSTD), Credibility of Financial Accounting Disclosure (AUDIT), Analyst Followings (ANALYST), and the Prevalence of Disclosure (DISCL) from Bushman, Piotroski and Smith (2004). ACCSTD is an index that is created by examining and rating companies' annual reports based on their inclusion and omission of 90 different items. AUDIT measures the percentage of firms in a country audited by the big-five accounting firms. ANALYST is the number of analysts following the largest 30 companies in each country. DISCL is a ranking of answers based on questions associated with R&D, capital expenditure, subsidiaries, segment-product, segment-geographic, and accounting policy. Countries with higher values in these indices have higher credibility of financial accounting disclosure.

To measure country-level investor protection, we collect the Anti-Director Rights Index (ANTID) and the Anti-Self-Dealing Index (ANTISELF) sourced from Djankov, La Porta, Lopez-de-Silanes and Shleifer (2008). ANTID is an aggregate index formed to measure the level of shareholder rights, while ANTISELF is an index that captures the control of self-dealing. Further we collect the Strength of Investor Protection Index (INVPRO) from the Global Competitiveness Report 2008-2009. INVPRO measures the strength of investor protection in a country. As a general measure of corporate governance we also use an indicator variable that is equal to 1 if a country is considered to be developed and 0 otherwise.

3.4.4 Control variables

Following the literature on crash risk we include firm-level control variables that have been shown to significantly affect crash risk (Chen et al., 2001; Hutton et al., 2009; and Kim et al., 2011a, b). Specifically, we include the following firm-level control variables:

(1) De-trended average monthly stock turnover (DTURN) (i.e. the average monthly turnover minus the average monthly turnover from the previous year)—we expect stocks with higher turnover to be more negatively skewed;

(2) The standard deviation of firm-specific return (SIGMA), derived from the expanded market model (equation 1) (higher volatility of firm-specific return is expected to increase the crash risk of the firm);

(3) Average firm-specific weekly return (RET) (lower average firm-specific return indicates that a firm is more likely to experience more down weeks than up weeks, which should lead to more crash risk);

(4) Lagged three-year moving sum of the absolute value of discretionary accruals (OPACITY) (this is a measure of accrual manipulation and proxies for the ability of a manager to hide adverse information from the financial markets. This should increase a firm's crash risk, because when the threshold of bad news that the firm can sustain is higher, more extreme crashes are more likely);

(5) Leverage (LEVERAGE) (i.e. net debt over total assets. Higher leverage increases the probability of bankruptcy and crash risk);

(6) Profitability (ROA) (i.e. earnings before interest and tax over total assets—high profitability is expected to be associated with more stability and lower crash risk);

(7) Market-to-book ratio (MTB) (a higher market-to-book ratio has previously been shown to be associated with higher distress risks (Griffin and Lemmon, 2002), which are expected to lead to higher crash risk);

(8) The natural logarithm of the market value of equity in US dollar (SIZE);

(9) Lagged crash risk (lagged NCSKEW) (Kim et al., 2011a, b);

In our corporate financial policy regressions, we borrow control variables that have been shown to affect a firm's cash policy from Qiu and Wan (2015), specifically they are:[25]

(1) Book-to-market ratio (*Book-to-market*), which is the firm's ordinary(common) stock divided by a firm's market value.[26]
(2) Stock return (*STOCK_RET)*, which is the annual growth in stock returns
(3) Income Volatility (*INCOME_VOL)*, is measured as the standard deviation of ROA from year t to t-3.
(4) Sales growth (*SALESGROWTH*), is the annual growth in total sales

In both models, we also include country-year effects including:

(1) Growth in GDP (*GGDP*), which is the annual growth rate of GDP in constant 2005 U.S. $
(2) Market capitalization (*MCAP*), which is the stock market capitalization

[25] SIZE and ROA are also included in this regressions.
[26] This is just the inverse of the market-to-book ratio used in the crash risk regressions.

(3) GDP per capita (*GDPC*), defined as the GDP per capita in constant 2005 U.S. $

3.4.5 Summary statistics

Table 3.1 presents our summary statistics. Panel A reports the sample mean of our crash risk measure and technology spillover by economy. From our sample, we can see that United States has the largest number of firms with 1,751 firms, this is followed by Japan with 1,144 firms, South Korea with 629, and Taiwan with 396 firms. In terms of technology spillover, Japan experiences the most spillover of 20.583, followed by Korea with 20.200, United States with 17.137, and Taiwan with 16.828. On average, we can see that firms in emerging economies experience more knowledge spillovers of 17.198 compared to developed economies of 16.932.

Panel B in Table 3.1 presents the summary statistics of firm characteristics. On average, a firm in our sample has a market to book ratio of 2.284, return on assets ratio of 1.5%, and leverage ratio of 19.5%. Each firm has approximately 8 firm-year observations in our sample.

Table 3.1 Summary of Stock Price Crash Risk and Technology Spillover

This table reports the summary statistics for the 1999-2013 period. Panel A reports the means of stock price crash risk and technology spillover summary statistics by country. The Type of Economies column reports if the economies are considered as developed or emerging economies. # of Firms is the number of firms in our sample in each sample country. # of Firm-Years is the number of firm-year observations. NCSKEW is the negative skewness of firm specific returns. DUVOL is the natural logarithm of the ratio of standard deviation of down weeks on up weeks. COUNT is the number crashes minus the number of jumps. ln(SPILL_TECH) is the natural logarithm of the sum of R&D stock scaled by the technological proximity of all firms operating in the same country. ln(SPILL_SALE) is the natural logarithm of the sum of R&D stock scaled by product market proximity of all firms that share a similar technological space. Panel B reports the summary statistics of the firm related variables. Variable definitions are in Appendix C.

Panel A: Firm Stock Price Crash Risk and Technology Spillover by Country

				Crash Risk			Spillover	
Country	Type of Economies	# of Firms	# of Firm-Years	NCSKEW	DUVOL	COUNT	ln(SPILL_TECH)	ln(SPILL_SALE)
Australia	DEV	114	731	-0.098	-0.059	-0.031	10.620	3.206
Austria	DEV	16	100	-0.172	-0.102	-0.090	9.234	1.200
Belgium	DEV	27	225	-0.156	-0.090	-0.120	11.469	2.186
Brazil	EMG	17	79	-0.055	-0.020	-0.038	9.039	0.517
Canada	DEV	153	798	-0.145	-0.089	-0.074	12.376	3.314
China	EMG	32	211	-0.211	-0.119	-0.095	13.557	8.329
Denmark	DEV	32	272	-0.129	-0.079	-0.007	13.009	5.441
Finland	DEV	35	302	-0.125	-0.074	-0.043	12.949	4.394
France	DEV	146	1,246	-0.194	-0.114	-0.102	13.600	5.726
Germany	DEV	206	1,620	-0.161	-0.086	-0.109	14.398	6.544
Hong Kong	DEV	36	275	-0.184	-0.111	-0.087	11.300	2.863

Table 3.1 Panel A Cont.

Panel A Cont.: Firm Stock Price Crash Risk and Technology Spillover by Country								
				Crash Risk			Spillover	
Country	Type of Economies	# of Firms	# of Firm-Years	NCSKEW	DUVOL	COUNT	ln(SPILL_TECH)	ln(SPILL_SALE)
India	EMG	324	1,922	-0.281	-0.162	-0.131	14.457	8.168
Israel	EMG	39	159	-0.016	-0.028	0.031	12.712	0.653
Italy	DEV	68	502	-0.258	-0.137	-0.171	11.588	1.120
Japan	DEV	1,144	12,410	-0.183	-0.102	-0.097	20.583	15.294
Malaysia	EMG	12	81	-0.229	-0.125	-0.160	8.369	0.972
Netherlands	DEV	27	234	-0.166	-0.084	-0.115	12.129	3.730
Norway	DEV	26	148	-0.041	-0.026	0.027	12.187	1.855
Singapore	DEV	51	345	-0.175	-0.098	-0.078	9.702	0.394
South Africa	EMG	16	123	-0.079	-0.062	-0.033	10.192	0.695
South Korea	EMG	629	3,994	-0.222	-0.126	-0.109	20.200	10.238
Spain	DEV	26	171	-0.274	-0.151	-0.216	8.895	2.579
Sweden	DEV	60	481	-0.093	-0.062	-0.019	13.944	4.112
Switzerland	DEV	57	537	-0.160	-0.094	-0.063	13.293	4.563
Taiwan	EMG	396	3,174	-0.261	-0.148	-0.140	16.828	12.815
Turkey	EMG	15	121	-0.380	-0.204	-0.281	8.642	1.561
United Kingdom	DEV	241	1,882	-0.163	-0.094	-0.082	12.505	3.563
United States	DEV	1,751	11,245	-0.004	-0.021	0.021	17.137	8.247
Developed		4,216	33,524	-0.239	-0.137	-0.122	16.932	9.734
Emerging		1,480	9,864	-0.113	-0.070	-0.051	17.198	9.736
All Economies		5,696	43,388	-0.145	-0.087	-0.069	17.131	9.736

Table 3.1 Cont.

Panel B: Summary Statistics							
Variable	# of firms	# of Firm-Years	Mean	S.D.	25%	Median	75%
Crash Risk Variables							
NCSKEW	5,696	43,388	-0.145	0.664	-0.523	-0.149	0.215
DUVOL	5,696	43,388	-0.087	0.333	-0.309	-0.091	0.127
COUNT	5,696	43,388	-0.069	0.552	0.000	0.000	0.000
Corporate Financial Policy Variables							
LEVERAGE	5,696	43,388	0.234	0.244	0.036	0.185	0.348
DEBT_ISSUE	5,696	43,388	0.059	0.480	0.000	0.000	0.040
EQ_ISSUE	5,696	43,388	0.035	0.126	0.000	0.000	0.007
Cost of Debt and Equity Variables							
COD	5,696	43,388	0.068	0.108	0.0202	0.044	0.074
ICOC	4,710	26,156	0.091	0.038	0.067	0.083	0.106
SEO Underpricing	1,993	4,102	0.075	0.149	0.000	0.047	0.145
Spillover Variables							
ln(SPILL_TECH)	5,696	43,388	17.131	3.519	14.718	17.691	20.145
ln(SPILL_SALE)	5,696	43,388	9.736	3.561	7.661	10.306	11.364
Firm-Level Control Variables							
NCSKEW_LAG	5,696	43,388	-0.136	0.640	-0.508	-0.147	0.212
SIGMA	5,696	43,388	0.048	0.023	0.031	0.043	0.060
RET	5,696	43,388	-0.139	0.143	-0.175	-0.089	-0.047
SIZE	5,696	43,388	12.892	1.883	11.562	12.719	14.122
MTB	5,696	43,388	2.284	2.477	0.885	1.477	2.636
ROA	5,696	43,388	0.015	0.134	0.000	0.031	0.075
LEVERAGE_LAG	5,696	43,388	0.195	0.171	0.031	0.169	0.313
DTURN	5,696	43,388	-0.001	0.007	-0.001	0.000	0.001
OPACITY	5,696	43,388	0.726	1.217	0.215	0.348	0.632
INCOME_VOL	5,696	43,388	8.235	14.851	1.431	3.276	7.940
SALESGROWTH	5,696	43,388	0.133	0.422	-0.061	0.078	0.218
Ln(MV)	1,993	4,102	18.640	2.280	17.103	18.767	20.185
ROS	1,993	4,102	0.532	2.303	0.080	0.147	0.263
Ln(PRICE)	1,993	4,102	0.894	2.503	-0.691	1.080	2.662
CAR_NEGATIVE	1,993	4,102	0.538	0.499	0.000	1.000	1.000
CAR_POSITIVE	1,993	4,102	0.462	0.499	0.000	0.000	1.000
VOLATILITY	1,993	4,102	0.046	0.026	0.029	0.040	0.055
Country-level Control Variables							
GDPC	28	405	9.961	1.046	9.834	10.406	10.538
GGDP	28	405	2.983	3.324	1.341	2.825	4.555
MCAP	28	405	106.480	81.969	54.532	87.354	131.420

3.5 Results and Discussion

In this section, we study the impact of technology spillovers on a firms' stock price crash risk and the subsequent information asymmetry effects on a firm's corporate financial policy in terms of both equity and debt. Crash risk is generally considered a measure of information asymmetries between the firm and the shareholder. If we find a positive effect, this should result in increased costs for both equity and debt. However, if we find a negative effect, we should also see a reduction in costs for both equity and debt.

3.5.1 Baseline results

Table 3.2 reports our baseline regression results. Column 1 shows the impact of technology spillover on crash risk. The coefficient estimate of $ln(SPILL\_TECH)$ on NCSKEW is negative and significant at the 5% level. This suggests that more exposure to technology spillovers reduces the negative skewness in stock returns. In Column 2 we include the product market rivalry measure $\ln(SPILL\_SALES)$, which is an important inclusion because absorbing spillovers from firms' that operate in the same industry generates substantial competition. We find that our product market rivalry measure has an insignificant effect on crash risk across all crash risk specifications. In Columns 3 and 4 we use alternative measures of crash risk (DUVOL and COUNT) as dependent variables and we find that *ln(SPILL_TECH)* remains negative and significant at the 1% and 5% significance level respectively. This suggests that the effect of technology spillover on crash risk is robust to different specifications of our crash risk dependent variable.

Table 3.2 Technology Spillover and Crash Risk

This table reports the OLS estimation results of the following regression model: $CRASH_{i,t} = \beta_1 \ln(SPILL\_TECH_{i,t-1}) + \beta_2 ln(SPILL\_SALE_{i,t-1}) + \gamma' \mathrm{X}_{\mathrm{i,t-1}} + \tau_t + \varphi_k + \omega_j + \varepsilon$, where ln(SPILL_TECH) is the sum of R&D stock available to firm *j* scaled by technological proximity between firm *i* and *j* for all firms *j* operating in the same market as firm *i*, ln(SPILL_SALE) is the sum of R&D stock available to firm *j* scaled by product market proximity between firm *i* and *j* for all firms *j* that share a similar technological space, CRASH are our three measures of crash risk, and X is a vector including a constant and the control variables (firm characteristics). Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at firm level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are available in Appendix E.

Dependent Variable	NCSKEW [1]	NCSKEW [2]	DUVOL [3]	COUNT [4]
$ln(SPILL\_TECH)$	-0.005**	-0.005**	-0.003***	-0.004**
	(0.026)	(0.019)	(0.008)	(0.021)
$ln(SPILL\_SALE)$		0.000	0.000	0.000
		(0.373)	(0.622)	(0.642)
$NCSKEW\_LAG$	0.018***	0.018***	0.010***	0.010**
	(0.000)	(0.000)	(0.000)	(0.017)
$SIGMA$	0.900	0.898	0.213	0.680
	(0.276)	(0.279)	(0.588)	(0.221)
RET	-0.025	-0.026	-0.027	-0.053
	(0.858)	(0.849)	(0.682)	(0.579)
$SIZE$	0.048***	0.047***	0.024***	0.029***
	(0.000)	(0.000)	(0.000)	(0.000)
MTB	0.010***	0.010***	0.005***	0.006***
	(0.000)	(0.000)	(0.000)	(0.000)
ROA	0.050*	0.050*	0.026*	0.058**
	(0.099)	(0.098)	(0.073)	(0.035)
$LEVERAGE$	-0.025	-0.025	-0.016	-0.005
	(0.266)	(0.268)	(0.154)	(0.784)
$DTURN$	0.235	0.235	0.126	0.306
	(0.655)	(0.653)	(0.662)	(0.488)
$OPACITY$	0.003	0.003	0.001	0.001
	(0.262)	(0.261)	(0.367)	(0.776)
$GDPC$	-0.084	-0.084	-0.038	-0.109
	(0.436)	(0.436)	(0.565)	(0.122)
$GGDP$	0.007	0.007	0.003	0.006
	(0.280)	(0.280)	(0.380)	(0.103)
$MCAP$	0.001	0.001	0.000	0.001*
	(0.125)	(0.124)	(0.106)	(0.078)
Year-fixed effects	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES
Adj. R^2	0.050	0.050	0.052	0.026
N	43,388	43,388	43,388	43,388

In terms of economic significance, the coefficient of -0.005 on *ln(SPILL_TECH)* in Column 1 indicates that a one-standard-deviation increase in *ln(SPILL_TECH)* results in a 12 percent decrease in *NCSKEW* relative to its sample mean, given the standard deviation of *ln(SPILL_TECH)* is 3.519. This result supports Hypothesis 1b (H1b), which brings to light that technology spillovers may reduce the information asymmetries between shareholders and managers.

3.5.2 Technology Spillover Transparency and Crash Risk

To examine the channel between technology spillover and crash risk, we look at the transparency of the knowledge stock measured using the stock price informativeness (R^2 and $ANALYST$) of the rival stocks weighted by the magnitude of their respective spillovers. Table 3.3 reports our results when we utilize this measure by splitting our sample into three different subsamples[27] (low, medium, and high) based on the magnitude of the transparency of the knowledge stock. We find that the effect of technology spillover on stock price crash risk is only significant for high levels of transparency in the knowledge stock. The economic significance is also much larger when we are dealing with highly transparent knowledge stocks.

[27] For comparison, we only highlight the differences between the low and high subsamples.

Table 3.3 Technology Spillover Transparency and Crash Risk

This table reports the OLS estimation results of the following regression model:

$$CRASH_{i,t} = \beta_1 \ln\left(SPILL\_TECH_{i,t-1}\right) + \beta_2 ln(SPILL\_SALE_{i,t-1}) + \gamma' \mathrm{X}_{\mathrm{i,t-1}} + \tau_t + \varphi_k + \omega_j + \varepsilon,$$

where ln(SPILL_TECH) is the sum of R&D stock available to firm *j* scaled by technological proximity between firm *i* and *j* for all firms *j* operating in the same market as firm *i*, ln(SPILL_SALE) is the sum of R&D stock available to firm *j* scaled by product market proximity between firm *i* and *j* for all firms *j* that share a similar technological space, CRASH are our three measures of crash risk, and X is a vector including a constant and the control variables (firm characteristics). SPILL_INFO is our weighted measure of stock price informativeness of all rival firms. The sample has been split into three equal sized groups based on the magnitude of SPILL_INFO, where LOW refers to the lower third and HIGH refers to the upper third. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are available in Appendix E.

Spill Info	LOW R^2	HIGH R^2	LOW ANALYSTS	HIGH ANALYSTS
	[1]		[2]	
$ln(SPILL\_TECH)$	-0.005	-0.012**	0.002	-0.010*
	(0.346)	(0.019)	(0.649)	(0.068)
$ln(SPILL\_SALE)$	0.002***	-0.000	0.000	0.000
	(0.004)	(0.988)	(0.550)	(0.778)
Year fixed effects	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES
Adj. R^2	0.047	0.032	0.044	0.048
Observations	14,451	14,452	14,431	14,432

This indicates that the channel in which technology spillovers reduce crash risk is driven by the valuable information content that can be derived from a rival firm's R&D stock. The more transparent a firm's rival is, the stronger the signal of the absorption. A weak signal could weaken the benefits associated with technology spillovers. This provides preliminary support for Hypothesis 1b.

3.5.3 The Impact of Corporate Governance on Technology Spillovers and Crash Risk

To examine the impact of corporate governance on technology spillovers and crash risk we again split our sample into low and high levels based on country-level corporate governance.

We first examine the four country-level information environment variables: Accounting Standards Index (ACCSTD), Credibility of Financial Accounting Disclosure (AUDIT), Analyst Followings (ANALYST), and the Prevalence of Disclosure (DISCL). As shown in Table 3.4, we find that more transparent information environments supplement the effect of technology spillovers on crash risk. The more transparent the information environment the stronger the signal associated with technology spillovers. This supports the view that technology spillover acts as a signal providing the market with valuable information regarding the investment decisions or projects being undertaken by the firm.

Table 3.4 Information Environment

This table reports the OLS estimation results of the following regression model:

$$CRASH_{i,t} = \beta_1 \ln\left(SPILL\_TECH_{i,t-1}\right) + \beta_2 ln(SPILL\_SALE_{i,t-1}) + \gamma' X_{i,t-1} + \tau_t + \varphi_k + \omega_j + \varepsilon,$$

where ln(SPILL_TECH) is the sum of R&D stock available to firm *j* scaled by technological proximity between firm i and j for all firms j operating in the same market as firm i, ln(SPILL_SALE) is the sum of R&D stock available to firm *j* scaled by product market proximity between firm i and j for all firms j that share a similar technological space, CRASH are our three measures of crash risk, and X is a vector including a constant and the control variables (firm characteristics). The sample has been split into three equal sized groups based on the magnitude of different information environment indices, where LOW refers to the lower third and HIGH refers to the upper third. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at both the firm -level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are available in Appendix E.

Information Environment	LOW_ACCSTD	HIGH_ACCSTD	LOW_DISCL	HIGH_DISCL
	[1]		[2]	
$ln(SPILL\_TECH)$	0.001	-0.008**	0.004	-0.008**
	(0.804)	(0.020)	(0.487)	(0.046)
$ln(SPILL\_SALE)$	0.000	-0.000	-0.001	0.002***
	(0.904)	(0.884)	(0.540)	(0.007)
Control Variables	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES
Adj. R^2	0.055	0.037	0.058	0.043
N	11,745	16,965	10,093	21,328

Information Environment	LOW_AUDIT	HIGH_AUDIT	LOW_ANALYST	LOW_ANALYST
	[3]		[4]	
$ln(SPILL\_TECH)$	0.002	-0.010***	0.006	-0.010*
	(0.735)	(0.000)	(0.219)	(0.094)
$ln(SPILL\_SALE)$	-0.000	0.001	-0.001	0.001
	(0.690)	(0.424)	(0.468)	(0.615)
Control Variables	YES	YES	YES	YES
Year-fixed effects	YES	YES	YES	YES
Industry-fixed effects	YES	YES	YES	YES
Country-fixed effects	YES	YES	YES	YES
Adj. R^2	0.061	0.042	0.057	0.037
N	11,646	31,531	10,752	14,612

Further, we examine a general country-level corporate governance measure and three different country-level investor protection measures: Dummy variable that equals to 1 when the country is considered developed (DEVELOPED), the Anti-Director Rights Index (ANTID), the Anti-Self-Dealing Index (ANTISELF), and the Strength of Investor Protection Index (INVPRO). Table 3.5 shows that investor protection also has a similar complementary effect on technology spillovers on crash risk.

In summary, we find that corporate governance complements the effect of technology spillovers on crash risk through managerial and investor perception of the knowledge stock.

Table 3.5 Other Governance Measures and Investor Protection

This table reports the OLS estimation results of the following regression model:

$$CRASH_{i,t} = \beta_1 \ln(SPILL\_TECH_{i,t-1}) + \beta_2 ln(SPILL\_SALE_{i,t-1}) + \gamma' X_{i,t-1} + \tau_t + \varphi_k + \omega_j + \varepsilon,$$

where ln(SPILL_TECH) is the sum of R&D stock available to firm *j* scaled by technological proximity between firm *i* and *j* for all firms *j* operating in the same market as firm *i*, ln(SPILL_SALE) is the sum of R&D stock available to firm *j* scaled by product market proximity between firm *i* and *j* for all firms *j* that share a similar technological space, CRASH are our three measures of crash risk, and X is a vector including a constant and the control variables (firm characteristics). The sample has been split into three equal sized groups based on the magnitude of different investor protection indices, where LOW refers to the lower third and HIGH refers to the upper third. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at firm -level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are available in Appendix E.

Investor Protection	DEVELOPING	DEVELOPED	LOW_ANTID	HIGH_ANTID
	[1]		[2]	
$ln(SPILL\_TECH)$	0.003	-0.009***	-0.003	-0.007*
	(0.703)	(0.000)	(0.409)	(0.058)
$ln(SPILL\_SALE)$	-0.001	0.001	0.000	0.001
Control Variables	YES	YES	YES	YES
Year-fixed effects	YES	YES	YES	YES
Industry-fixed effects	YES	YES	YES	YES
Country-fixed effects	YES	YES	YES	YES
Adj. R^2	0.060	0.042	0.054	0.043
N	10,959	32,429	13,279	16,705

Investor Protection	LOW_ANTISELF	HIGH_ANTISELF	LOW_ANTISELF	HIGH_ANTISELF
	[3]		[4]	
$ln(SPILL\_TECH)$	-0.005	-0.007**	-0.005	-0.007**
	(0.105)	(0.048)	(0.105)	(0.048)
$ln(SPILL\_SALE)$	0.000	0.000	0.000	0.000
Control Variables	YES	YES	YES	YES
Year-fixed effects	YES	YES	YES	YES
Industry-fixed effects	YES	YES	YES	YES
Country-fixed effects	YES	YES	YES	YES
Adj. R^2	0.051	0.030	0.051	0.030
N	10,009	15,586	10,009	15,586

3.5.4 Technology Spillover Transparency in Developing/Developed Countries and Crash Risk

The previous result casts doubt on whether the transparency of the knowledge stock still applies to firms in developing countries. To test this, we split the sample into low and high weighted R^2 followed by a split based on developing and developed countries.[28] As shown in Table 3.6, we find that the significance of technology spillover still holds for both developing and developed countries when the firm's knowledge stock is more transparent.

[28] This assures that the weighted R^2 split is comparable in the regressions between developed and developing countries.

Table 3.6 Technology Spillover Transparency in Developing/Developed Countries

This table reports the OLS estimation results of the following regression model:
$CRASH_{i,t} = \beta_1 \ln(SPILL\_TECH_{i,t-1}) + \beta_2 ln(SPILL\_SALE_{i,t-1}) + \gamma' X_{i,t-1} + \tau_t + \varphi_k + \omega_j + \varepsilon,$
where ln(SPILL_TECH) is the sum of R&D stock available to firm j scaled by technological proximity between firm *i* and *j* for all firms *j* operating in the same market as firm *i*, ln(SPILL_SALE) is the sum of R&D stock available to firm *j* scaled by product market proximity between firm *i* and *j* for all firms *j* that share a similar technological space, CRASH are our three measures of crash risk, and X is a vector including a constant and the control variables (firm characteristics). SPILL_INFO is our weighted measure of stock price informativeness of all rival firms. The sample has been split into three equal sized groups based on the magnitude of SPILL_INFO, where LOW refers to the lower third and HIGH refers to the upper third. A further split is made for whether a country is considered to be developed or developing. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are available in Appendix E.

	DEVELOPING		DEVELOPED	
$Spill\ info$	LOW R^2	HIGH R^2	LOW R^2	HIGH R^2
	[1]		[2]	
$ln(SPILL\_TECH)$	-0.002	-0.025**	-0.002	-0.010*
	(0.834)	(0.029)	(0.841)	(0.065)
$ln(SPILL\_SALES)$	0.001	-0.008**	0.003***	0.000
	(0.625)	(0.042)	(0.000)	(0.835)
Year-fixed effects	YES	YES	YES	YES
Industry-fixed effects	YES	YES	YES	YES
Country-fixed effects	YES	YES	YES	YES
Adj. R^2	0.060	0.071	0.048	0.029
N	5,471	667	8,980	13,785

First, this suggests that developing countries can benefit from increased transparency in the knowledge stock. Second, an external shock to transparency of a single firm in a market can potentially have industry wide effects due to the increased transparency of the knowledge stock. This transparency affects all technological rival firms which suggests that a spillover effect of information can reduce the information asymmetries between shareholders and managers in developing countries.

3.5.5 Technology spillover and Leverage

Column 1 of Table 3.7 shows the impact of technology spillover on a firm's choice of leverage. The coefficient estimate of $ln(SPILL\_TECH)$ on *Leverage* is negative and significant at the 1% level. A firm exposed to more technology spillovers will reduce their overall exposure to debt. In Column 2 we include only the product market rivalry measure $\ln(SPILL\_SALES)$, we find that the product market rivalry is also significantly negative at the 1% significance level. In Column 3 we include both the technology spillover and product market rivalry measure and find that both measures have a significantly negative effects on a firms choice of leverage. In Column 4 we use an alternative leverage measure *ln(Leverage)* due to the skewness associated with the levels of leverage. We find that the negative effect of technology spillovers continues to hold. Similarly, product market rivalry is also consistently negative across all specifications. This is not surprising however, as studies tend to find an inverse relationship between product market rivalry and firm leverage (Guney, Li, Fairchild, 2011; Chevalier, 1995).

Table 3.7 Technology Spillover and Leverage

This table reports the OLS estimation results of the following regression model:

$$LEVERAGE_{i,t} = \beta_1 \ln\left(SPILL\_TECH_{i,t-1}\right) + \beta_2 ln(SPILL\_SALE_{i,t-1}) + \gamma' \mathrm{X}_{\mathrm{i,t-1}} + \tau_t + \eta_i + \varepsilon,$$

where ln(SPILL_TECH) is the sum of R&D stock available to firm *j* scaled by technological proximity between firm i and j for all firms j operating in the same market as firm *i*, ln(SPILL_SALE) is the sum of R&D stock available to firm *j* scaled by product market proximity between firm i and j for all firms *j* that share a similar technological space, Leverage is measured as the ratio of book value of debt scaled by book value of assets, and X is a vector including a constant and the control variables (firm characteristics). Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are available in Appendix E.

Variables	*LEVERAGE* [1]	*LEVERAGE* [2]	*LEVERAGE* [3]	*Ln(LEVERAGE)* [4]
Ln(SPILL_TECH)	-0.010***		-0.008***	-0.040***
	(0.000)		(0.000)	(0.000)
Ln(SPILL_SALES)		-0.005***	-0.004***	-0.010***
		(0.000)	(0.000)	(0.001)
SIZE	0.015***	0.014***	0.015***	0.095***
	(0.000)	(0.000)	(0.000)	(0.000)
BTM	-0.045***	-0.045***	-0.046***	-0.135***
	(0.000)	(0.000)	(0.000)	(0.000)
STOCK_RET	0.016***	0.015***	0.016***	0.038***
	(0.000)	(0.000)	(0.000)	(0.000)
ROA	-0.002***	-0.002***	-0.002***	-0.010***
	(0.000)	(0.000)	(0.000)	(0.000)
INCOME_VOL	0.002***	0.002***	0.002***	0.006***
	(0.000)	(0.000)	(0.000)	(0.000)
SALESGROWTH	0.003	0.003	0.003	-0.007
	(0.312)	(0.326)	(0.294)	(0.701)
GDPC	-0.007	-0.025**	-0.003	0.171**
	(0.555)	(0.042)	(0.831)	(0.021)
GGDP	0.000	0.000	0.000	-0.006
	(0.852)	(0.787)	(0.892)	(0.178)
MCAP	0.000	0.000	0.000	0.000
	(0.563)	(0.688)	(0.490)	(0.964)
Year-fixed effect	YES	YES	YES	YES
Industry-fixed effect	YES	YES	YES	YES
Country-fixed effect	YES	YES	YES	YES
Adj. R^2	0.155	0.154	0.155	0.098
N	43,388	43,388	43,388	37,896

3.5.6 Technology spillover and Debt Issuance

In this section we look at the effect of technology spillover and a firm's choice of annual long-term debt issuances. As expected we find that the effect of technology spillover on debt issuances is similar to the effect of technology spillover on a firm's overall leverage. We find in Table 3.8, Column 1 that technology spillover has a negative and significant effect at the 1% level on long-term debt issuances similar to that of product market rivalry. This continues to hold in Columns 2 and 3. In Column 4, we find that while technology spillover on net debt issuances continues to have a significantly negative effect on net debt issues at the 10% level, product market rivalry is no longer associated significantly with net debt. This suggests that product market rivalry has a positive effect in terms of either reductions in long-term debt or increases in short-term borrowings.

Table 3.8 Technology Spillover and Debt Issuance

This table reports the OLS estimation results of the following regression model:
$DEBT\_ISSUE_{i,t} = \beta_1 \ln(SPILL\_TECH_{i,t-1}) + \beta_2 ln(SPILL\_SALE_{i,t-1}) + \gamma' \mathrm{X}_{\mathrm{i,t-1}} + \tau_t + \eta_i + \varepsilon,$
where ln(SPILL_TECH) is the sum of R&D stock available to firm *j* scaled by technological proximity between firm *i* and *j* for all firms *j* operating in the same market as firm *i*, ln(SPILL_SALE) is the sum of R&D stock available to firm j scaled by product market proximity between firm i and j for all firms j that share a similar technological space, $DEBT\_ISSUE$, is the issuance of long-term debt scaled by total assets, and X is a vector including a constant and the control variables (firm characteristics). Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are available in Appendix E.

Variables	*DEBT_ISSUE* [1]	*DEBT_ISSUE* [2]	*DEBT_ISSUE* [3]	*NET_DEBT_ISSUE* [4]
Ln(SPILL_TECH)	-0.002***		-0.002***	-0.003*
	(0.000)		(0.000)	(0.068)
Ln(SPILL_SALES)		-0.001***	-0.001***	0.000
		(0.000)	(0.000)	(0.701)
SIZE	0.008***	0.008***	0.008***	0.002***
	(0.000)	(0.000)	(0.000)	(0.001)
BTM	-0.006***	-0.005***	-0.006***	-0.012***
	(0.000)	(0.000)	(0.000)	(0.003)
STOCK_RET	0.003***	0.003***	0.003***	0.008*
	(0.002)	(0.002)	(0.002)	(0.067)
ROA	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
INCOME_VOL	0.000***	0.000***	0.000***	0.002***
	(0.000)	(0.000)	(0.000)	(0.001)
SALESGROWTH	0.002*	0.002*	0.002*	-0.006
	(0.074)	(0.076)	(0.070)	(0.563)
GDPC	0.031***	0.028***	0.033***	-0.026
	(0.001)	(0.003)	(0.001)	(0.296)
GGDP	0.000	0.000	0.000	0.000
	(0.287)	(0.273)	(0.301)	(0.617)
MCAP	-0.000**	-0.000**	-0.000**	0.000
	(0.034)	(0.029)	(0.040)	(0.383)
Year-fixed effect	YES	YES	YES	YES
Industry-fixed effect	YES	YES	YES	YES
Country-fixed effect	YES	YES	YES	YES
Adj. R^2	0.096	0.096	0.096	0.014
N	43,388	43,388	43,388	43,388

3.5.7 Technology spillover and Equity Issuance

Overall, we have found consistent evidence that firms reduce their leverage and overall use of debt when financing technology spillovers. We follow up by looking at the alternative forms of financing through equity issuances. In Table 3.9, Column 1, we observe that the effect of technology spillover alone has a positive and significant effect at the 1% level, while product market rivalry in Column 2 has no significant effect on equity issuances. This effect is also observed in Column 3 when we include both spillover measures. In Column 4, we look at the net equity issuances, which accounts for equity issuances net of repurchases. Technology spillover continues to load positively and significantly at the 1% level on net equity issuances. This suggests that firms issue more equity when there are increased technology spillovers. This coupled with our results from Table 3.7 and 3.8, provides preliminary support that firms primarily finance these technology spillovers through equity. This suggests that the information asymmetry associated with equity is reduced when a firm has technology spillovers. This provides support for Hypothesis 3b.

Table 3.9 Technology Spillover and Equity Issuance

This table reports the OLS estimation results of the following regression model:
$EQUITY\_ISSUE_{i,t} = \beta_1 \ln\left(SPILL\_TECH_{i,t-1}\right) + \beta_2 ln(SPILL\_SALE_{i,t-1}) + \gamma' \mathrm{X}_{\mathrm{i,t-1}} + \tau_t + \eta_i + \varepsilon$, where ln(SPILL_TECH) is the sum of R&D stock available to firm *j* scaled by technological proximity between firm i and j for all firms j operating in the same market as firm *i*, ln(SPILL_SALE) is the sum of R&D stock available to firm *j* scaled by product market proximity between firm *i* and *j* for all firms *j* that share a similar technological space, $EQUITY\_ISSUE$ is the issuance of common and preferred equity scaled by total assets, and X is a vector including a constant and the control variables (firm characteristics). Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are available in Appendix E.

Variables	*EQ_ISSUE* [1]	*EQ_ISSUE* [2]	*EQ_ISSUE* [3]	*EQ_ISSUE* [5]
Ln(SPILL_TECH)	0.002***		0.002***	0.002***
	(0.000)		(0.000)	(0.000)
Ln(SPILL_SALES)		0.000	-0.000	-0.000
		(0.381)	(0.373)	(0.205)
SIZE	-0.007***	-0.006***	-0.007***	-0.008***
	(0.000)	(0.000)	(0.000)	(0.000)
BTM	-0.016***	-0.016***	-0.016***	-0.015***
	(0.000)	(0.000)	(0.000)	(0.000)
STOCK_RET	0.021***	0.021***	0.021***	0.021***
	(0.000)	(0.000)	(0.000)	(0.000)
ROA	-0.002***	-0.002***	-0.002***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
INCOME_VOL	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
SALESGROWTH	0.019***	0.019***	0.019***	0.021***
	(0.000)	(0.000)	(0.000)	(0.000)
GDPC	-0.004	0.003	-0.003	0.001
	(0.302)	(0.400)	(0.330)	(0.645)
GGDP	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.002)
MCAP	-0.000***	-0.000***	-0.000***	-0.000**
	(0.002)	(0.004)	(0.002)	(0.020)
Year-fixed effect	YES	YES	YES	YES
Industry-fixed effect	YES	YES	YES	YES
Country-fixed effect	YES	YES	YES	YES
Adj. R^2	0.398	0.398	0.398	0.405
N	43,388	43,388	43,388	43,388

3.5.8 Technology spillover and Cost of Debt

Although we observe that technology spillover has an overall negative effect on debt and positive effect on equity issuances, this only provides us with half the story. For the full story, we also look at the supply-side effects by evaluating how spillovers affect the costs associated with financing. In Column 1 of Table 3.10, we find that technology spillover has a positive and significant effect at the 5% level on the cost of debt, which is measured as the interest on debt divided by total debt. Product market rivalry on the other hand, has an insignificant effect on the cost of debt as shown in Column 2. In Column 3, when both spillover measures are included, the results remain consistent, that is, technology spillovers increase the cost of debt. This suggests that the reduction in leverage and debt issuance is driven by the increase in the costs associated with debt financing. The firms choose to use less debt because the market demands a higher cost for raising such debt.

Table 3.10 Technology Spillover and Cost of Debt

This table reports the OLS estimation results of the following regression model:

$$COD_{i,t} = \beta_1 \ln\left(SPILL\_TECH_{i,t-1}\right) + \beta_2 ln(SPILL\_SALE_{i,t-1}) + \gamma' \mathrm{X}_{\mathrm{i,t-1}} + \tau_t + \eta_i + \varepsilon,$$

where ln(SPILL_TECH) is the sum of R&D stock available to firm *j* scaled by technological proximity between firm *i* and *j* for all firms *j* operating in the same market as firm *i*, ln(SPILL_SALE) is the sum of R&D stock available to firm *j* scaled by product market proximity between firm *i* and *j* for all firms *j* that share a similar technological space, *COD* is our cost of debt measure, and X is a vector including a constant and the control variables (firm characteristics). Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are available in Appendix C.

Variables	*COD*	*COD*	*COD*
	[1]	[2]	[3]
Ln(SPILL_TECH)	0.001**		0.001**
	(0.011)		(0.020)
Ln(SPILL_SALES)		0.000	0.000
		(0.307)	(0.615)
SIZE	-0.004***	-0.004***	-0.004***
	(0.000)	(0.000)	(0.000)
BTM	-0.001**	-0.001**	-0.001*
	(0.049)	(0.038)	(0.051)
STOCK_RET	0.000	0.000	0.000
	(0.663)	(0.639)	(0.666)
ROA	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
INCOME_VOL	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
SALESGROWTH	0.002	0.002	0.002
	(0.204)	(0.201)	(0.205)
GDPC	-0.003	-0.001	-0.003
	(0.454)	(0.774)	(0.439)
GGDP	-0.000	-0.000	-0.000
	(0.332)	(0.310)	(0.334)
MCAP	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)
Year-fixed effect	YES	YES	YES
Industry-fixed effect	YES	YES	YES
Country-fixed effect	YES	YES	YES
Adj. R^2	0.214	0.214	0.214
N	43,388	43,388	43,388

3.5.9. Technology spillover and Cost of Equity

For the costs associated with equity financing, we look at both the implied cost of capital and the underpricing in seasoned equity offerings. In Column 1 of Table 3.11, we find that technology spillover is negative and significant at the 1% level, while in Column 2 of Table 3.11, product market spillover is insignificant at every level. These results are consistent when both spillovers are included concurrently in Column 3 of Table 3.11. Similarly, when we measure the cost of equity based on underpricing of individual SEOs in our sample, we find that technology spillover also loads negatively on SEO underpricing at the 1% level, which suggests that firms exposed to more technology spillovers are less heavily discounted when issuing equity to absorb spillovers. In Column 2 of Table 3.12, product market rivalry remains insignificant similar to the findings in Column 2 of Table 3.11.

Both the results from Table 3.11 and 3.12 using implied cost of capital and SEO underpricing respectively provides us with similar results, which strongly supports the hypothesis that technology spillover reduces the costs associated with raising equity. This suggests that firms issue more equity from technology spillovers due to a reduction in the cost of equity. This supports our hypothesis that technology spillovers plays an important informationational role in reducing the information asymmetries between shareholder and managers that allows the firm to issue more equity at a cheaper cost. Interestingly, in both scenarios, firms are neither compensated nor penalized due to product market rivalries, which suggests that the firms are only rewarded for the upside of spillovers. This provides further support for Hypothesis 3b.

Table 3.11 Technology Spillover and Cost of Equity

This table reports the OLS estimation results of the following regression model:

$$ICOC_{i,t} = \beta_1 \ln\left(SPILL\_TECH_{i,t-1}\right) + \beta_2 ln(SPILL\_SALE_{i,t-1}) + \gamma' \mathrm{X}_{\mathrm{i,t-1}} + \tau_t + \eta_i + \varepsilon,$$

where ln(SPILL_TECH) is the sum of R&D stock available to firm *j* scaled by technological proximity between firm *i* and *j* for all firms *j* operating in the same market as firm *i*, ln(SPILL_SALE) is the sum of R&D stock available to firm *j* scaled by product market proximity between firm *i* and *j* for all firms *j* that share a similar technological space, *ICOC* is the average of the cost of capital deduced from four different models equating current stock price with expected future income, and X is a vector including a constant and the control variables (firm characteristics). Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are available in Appendix C.

Variables	*ICOC* [1]	*ICOC* [2]	*ICOC* [3]
Ln(SPILL_TECH)	-0.001***		-0.001***
	(0.000)		(0.000)
Ln(SPILL_SALES)		0.000	0.000
		(0.894)	(0.132)
SIZE	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)
BTM	0.013***	0.014***	0.013***
	(0.000)	(0.000)	(0.000)
STOCK_RET	-0.008***	-0.008***	-0.008***
	(0.000)	(0.000)	(0.000)
ROA	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
INCOME_VOL	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
SALESGROWTH	0.007***	0.007***	0.007***
	(0.000)	(0.000)	(0.000)
GDPC	0.032***	0.029***	0.032***
	(0.000)	(0.000)	(0.000)
GGDP	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
MCAP	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Year-fixed effect	YES	YES	YES
Industry-fixed effect	YES	YES	YES
Country-fixed effect	YES	YES	YES
Adj. R^2	0.234	0.234	0.234
N	26,156	26,156	26,156

Table 3.12 Technology Spillover and SEO Underpricing

This table reports the OLS estimation results of the following regression model: $SEO\_Underpricing_{i,t} = \beta_1 \ln\left(SPILL\_TECH_{i,t-1}\right) + \beta_2 ln(SPILL\_SALE_{i,t-1}) + \gamma' \mathrm{X}_{\mathrm{i,t-1}} + \tau_t + \eta_i + \varepsilon$, where ln(SPILL_TECH) is the sum of R&D stock available to firm *j* scaled by technological proximity between firm *i* and *j* for all firms *j* operating in the same market as firm *i*, ln(SPILL_SALE) is the sum of R&D stock available to firm *j* scaled by product market proximity between firm *i* and *j* for all firms *j* that share a similar technological space, *SEO Underpricing* is underpricing associated with Seasoned Equity Offerings (SEO), and X is a vector including a constant and the control variables (firm characteristics). Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are available in Appendix C.

Variables	*SEO Underpricing* [1]	*SEO Underpricing* [2]	*SEO Underpricing* [3]
Ln(SPILL_TECH)	-0.007***		-0.007***
	(0.001)		(0.001)
Ln(SPILL_SALES)		-0.001	0.000
		(0.417)	(0.850)
Ln(MV)	0.001	0.001	0.001
	(0.520)	(0.657)	(0.533)
ROS	0.001	0.001	0.001
	(0.500)	(0.536)	(0.503)
Ln(PRICE)	0.005**	0.005**	0.005**
	(0.016)	(0.016)	(0.016)
CAR_NEGATIVE	-0.098***	-0.094***	-0.098***
	(0.000)	(0.000)	(0.000)
CAR_POSITIVE	-0.070***	-0.066***	-0.071***
	(0.000)	(0.000)	(0.000)
VOLATILITY	0.332**	0.338**	0.331**
	(0.020)	(0.019)	(0.020)
GDPC	-0.085	-0.092	-0.085
	(0.034)	(0.020)	(0.034)
GGDP	-0.004	-0.003	-0.004
	(0.011)	(0.011)	(0.011)
MCAP	-0.000	-0.000	-0.000
	(0.554)	(0.558)	(0.552)
Year-fixed effect	YES	YES	YES
Industry-fixed effect	YES	YES	YES
Country-fixed effect	YES	YES	YES
Adj. R^2	0.114	0.112	0.114
N	4,102	4,102	4,102

3.5.10 Technology spillover, Cost of Debt, and Creditor Rights

Based on previous results, we find that technology spillovers significantly reduces the firm's leverage and debt issuances, while increasing the firm's cost of debt. In this section we attempt to reconcile the effects of technology spillovers on debt issuances and cost of debt. We hypothesize that there are atleast two possible reasons why a reduction in information asymmetry could lead to a reduction in debt issuance and firm leverage. First, it is possible that the reductions in information asymmetries could reduce the cost of equity in such a way that the firm would always prefer to issue equity rather than debt. However, if this is was the case, we would not observe that there is an increase in the cost of debt. Another possible reason is that technology spillovers are associated with the absorption of innovative activities, which are intangible assets that are intellectual rather than physical. This poses an issue for raising debt, since intellectual capital comes with high valuation risk and poor collaterizability. Due to the poor collaterizability of innovative activities, these firms may experience increased costs associated with debt if technology spillovers leads to a reduction in information asymmetry.

To investigate this effect, we follow Mann (2018), who shows that stronger creditor rights is associated with increased access to debt financing. More importantly, Mann (2018) shows that when creditor rights are strong, creditors are able to enforce their rights against patents like other tangible asset classes. Therefore, stronger creditor rights increases the effectiveness of patents as collateral for debt. If we observe this effect for technology spillovers than this suggests that the reason it increases the cost of debt and reduction of debt issuances is due to the poor collaterizability associated with technology spillovers. In this section, we measure creditor rights by collecting the Creditor Rights Index from La

Porta et al. (1998). We then interact this term with our measure of technology spillover measure.

Table 3.13 Technology Spillover and Creditor Rights

This table reports the OLS estimation results of the following regression model:

$DEBT_{i,t} = \beta_1 \ln(SPILL\_TECH_{i,t-1}) + \beta_2 \ln(SPILL\_TECH_{i,t-1}) * CR + \beta_3 ln(SPILL\_SALE_{i,t-1}) + \gamma' \mathrm{X}_{i,t-1} + \tau_t + \eta_i + \varepsilon,$

where ln(SPILL_TECH) is the sum of R&D stock available to firm *j* scaled by technological proximity between firm *i* and *j* for all firms *j* operating in the same market as firm *i*, ln(SPILL_SALE) is the sum of R&D stock available to firm *j* scaled by product market proximity between firm *i* and *j* for all firms *j* that share a similar technological space, DEBT is a variety of debt related measures we have used previously including *LEVERAGE*, *DEBT_ISSUE*, and *COD*, CR is the creditor rights index, and X is a vector including a constant and the control variables (firm characteristics). Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions and data sources are available in Appendix C.

	Debt		
Variables	*LEVERAGE* [1]	*DEBT_ISSUE* [2]	*COD* [3]
Ln(SPILL_TECH)	-0.017***	-0.007***	0.002***
	(0.000)	(0.000)	(0.007)
$Ln(SPILL\_TECH) \times CR$	0.005***	0.003***	-0.001**
	(0.000)	(0.000)	(0.036)
Ln(SPILL_SALES)	-0.004***	-0.001***	0.000
	(0.000)	(0.000)	(0.632)
Controls Variables	YES	YES	YES
Year-fixed effect	YES	YES	YES
Industry-fixed effect	YES	YES	YES
Country-fixed effect	YES	YES	YES
Adj. R^2	0.156	0.097	0.214
N	43,388	43,388	43,388

Our results are presented in Table 3.13. In Columns 1 and 2 of Table 3.13, we find that the interaction between technology spillover and creditor rights are positive and significant at the 1% significance level. This suggests that the usage of debt for technology spillovers increases in countries with stronger creditor rights. Alternatively, in Column 3 of Table

3.13, we find that the effect of the interaction term between technology spillover and creditor rights on cost of debt is negative at the 5% significance level. This suggests that the positive effect of technology spillover on cost of debt decreases with the strength of creditor rights. Therefore, a firm's reliance on debt for absorbing spillovers are strongly dependent on the strength of creditor rights. Overall, this shows that our previous results are driven primarily by the fact that absorbing spillovers produces patents which are in general poor collateral for debt rather than capturing the effect associated information asymmetries. This suggests that firms operating in countries with strong creditor rights are able to benefit from the information asymmetry reductions associated with technology spillovers.

3.6 Conclusion

The importance of promoting technological innovation is well documented in previous studies. Technological spillover is frequently called upon as a motivator for firms to innovate. Although this is the primary role of technology spillovers, the benefits associated with it has mainly been linked with aspects related to R&D productivity and market value. The information value of technology spillover through mechanisms of investment transparency has been largely unexplored.

In this study we investigate the effect of investment transparency through technology spillover on a firm's stock price crash risk. Using a sample containing 5,696 firms across 28 countries in the 1999-2013 period, we find that there is a negative relationship between technology spillovers and a firm's stock price crash risk. Moreover, this negative effect is shown to have both an economic and statistical significance on crash risk. The effect remains robust when we use alternative crash risk measures. This result demonstrates that technology spillovers can provide information, but more importantly absorbing technology spillovers reduces the risks associated with innovation, which is evidenced by prior literature regarding R&D productivity. This risk reduction effect should reduce the crash risk associated with innovation.

To find the channel for this effect, we examine the overall information content in rival firm's knowledge stock provided through spillovers and find that only firms with a transparent knowledge stock can effectively reduce crash risk. This evidence is supplemented by investigating how a firm's corporate governance environment affects this relationship. We find that firms operating in better information and investor protection environments complement this effect. This shows that the effect is driven by the informativeness of the knowledge signal and how the market and managers interpret this signal.

Given the information asymmetry benefits associated with technology spillovers, we also investigate the effect of technology spillovers on a firms' corporate financial policy. We find that firms that have more technology spillovers are able to raise more equity at a cheaper cost. This result stems from the fact that the costs of raising equity increases with the level of information asymmetry. The reduction in information asymmetry as shown by the reduction in crash risk reduces the agency costs associated with raising equity. As a result, firms that have more technology spillovers rely less on financial leverage. In particular, we find that firms with more technology spillovers actually experience an increase in the cost of raising debt, a potential explanation for this is that patents are a poor form of collateral, which reduces the appeal of technology spillovers for debtholders.

Overall, the evidence draws attention to the unique role of technology spillover in improving investment transparency and reducing the propensity of managers to manage earnings by improving the transparency of the knowledge stock. This reduction allows the firm to rely less on financial leverage, since a significant cost associated with raising equity is associated with the information asymmetry between managers and shareholders. A reduction in the information asymmetry between managers and shareholders through technology spillovers enables the firm to be less financially constrained and raise more equity capital to finance these positive externalities.

Chapter 4

Cross-Border Acquisitions and International Technology Spillovers

4.1 Introduction

China has seen extraordinary growth over the last 30 years with an annual average gross domestic product (GDP) growth rate of nearly 10% a year, as of 2018. As a result of this unprecedented expansion, China is now considered the second largest economy in terms of GDP and the largest economy after adjusting for purchasing power parity (PPP). This unparalleled growth stems from China's extensive market reforms in 1978, which shifted China's policies towards attracting foreign direct investments (FDI). Although there are many potential benefits associated with inward FDI, technology transfers from FDI is frequently considered as the most important contributor to China's economic growth (Dees, 1998; Tuan, Ng, and Zhao, 2009; Chen, 2011; Xu and Sheng, 2012; Chen, 2017). Explicitly, Holmes, McGrattan, Prescott (2015) estimates that in 2010, more than half of all technology owned by Chinese firms was obtained from foreign firms. As a result, anecdotal evidence suggests that economic growth in emerging countries can be facilitated by international technology transfers. However, technology transfers doesn't necessarily require direct government intervention, in particular, past literature supports this by showing that technological innovation can arise from technology spillovers. More specifically, a technology spillover can occur when a firm discloses or implements innovative technology and as a consequence valuable information is revealed to rival firms creating knowledge spillovers. The benefactors of these positive externalities are then able to acquire new technology at a cheaper cost than what is required to invent it, which results in improved productivity and innovative capabilities (Jaffe, 1986, 1988). Therefore, international technology spillovers to emerging countries can theoretically lead to global economic growth through cross-country convergences in growth rates (Findlay, 1978; Howitt, 2000; Wang and Blomstrom, 1992).

However, the empirical evidence on the role of Foreign Direct Investment (*FDI*) in facilitating international technology spillovers is mixed. On one hand, studies find that international technology spillovers can bring substantial productivity gains by reducing the marginal cost of production for local markets (Xu, 2000; Coe and Helpman, 1995; Haskel, Pereira, and Slaughter, 2007; Keller and Yeaple, 2009b). On the other hand, without the existence of technology spillovers, FDI can have an adverse effect on the local economy by promoting productivity gains in the target which damages rival firms as they suffer from a reduction in market share due to increased competition (Aitken and Harrison, 1999; Blalock and Gertler, 2008; Bwalya, 2006; Djankov and Hoekman, 2000; Görg and Greenaway, 2004; Guadalupe, Kuzmina, and Thomas, 2012; Haddad and Harrison, 1993; Hanson 2001; Konings, 2001; Javorcik and Spatareanu 2008; Tao, Lu and Zhu, 2017; Rodrik 1999). More importantly, most studies that successfully demonstrate a positive technology spillover effect have either focused their analysis at the macro-level or at a micro-level in developed economies (Haskel, Pereira, and Slaughter, 2007; Keller and Yeaple, 2009b). Thus, whether FDI can facilitate international technology spillovers in emerging markets remains an important empirical question that sheds new light on whether FDI is beneficial or detrimental for less developed markets.

To explore the role of FDI in facilitating international technology spillovers, we focus on cross-border acquisitions by acquirors from developed countries of target firms in emerging markets. To understand why we focus on cross-border acquisitions we must understand the motivation behind a cross-border acquisition. One of the underlying incentives for a firm to undertake a cross-border acquisition as opposed to other forms of geographic expansion is often associated with the barriers to entry into foreign markets, however acquiring an existing business allows the acquiror to overcome some of these barriers by obtaining existing customers, local networks in the form of suppliers, distributors, as well as approval from government officials (Hitt, Ireland, and Hoskisson, 2003). As a result, cross-border acquisitions are vehicles that firms typically use to rapidly establish a presence in foreign markets. Moreover, the performance of cross-border acquisitions depends critically on how well an acquiring firm can exploit their tangible and intangible assets in an international market (Hymer, 1976; Leonard, 1998; Nonaka, 1994). On that note, many studies show that knowledge transfers between the acquiror and target firm is an important source of competitive advantage that contributes to cross-border acquisition performance (Björkman et al., 2007; Bresman, Birkinshaw, & Nobel, 1999; Capron, 1999; Zou and Ghauri, 2008). Empirical evidence provides support for this claim by showing that domestic firms which have been acquired by foreign acquirers are not only more productive but also more likely to innovate due to better access to foreign technologies (Aitken and Harrison, 1999; Guadalupe, Kuzmina, and Thomas, 2012; Branstetter, Fisman, and Foley, 2006; Bloom, Sadun, and Reenen, 2012).

There is substantial evidence to suggest that cross-border acquisitions facilitate knowledge transfers from the acquiror to the target firm. However, it is unclear why knowledge that has been transferred to the target firm does not disseminate into the local markets in emerging countries since there are various channels for technology spillovers to occur in the local market that should not be exclusive to developed countries. In particular, it has been shown that international technology spillovers can occur through international trade in the form of imports (Keller, 2010; Coe and Helpman, 1995; Pavcnik, 2002; Amiti and Konings, 2007; Acharya and Keller, 2008). This suggests that market expansions of a firm's products through cross-border acquisitions can facilitate technology spillovers simply by exposing the firm's products to the local market. Firms operating in a similar industry can then learn about the foreign firm's technology from the foreign product allowing them to potentially create similar products at a lower cost. Alternatively, if the foreign acquiror requires complementary resources, whether it is labour or intermediate inputs, there is also evidence to suggest that technology spillovers can occur through vertical linkages. Foreign acquirors may also be incentivised to transfer technology to local firms in upstream sectors to benefit from higher quality inputs (Javorcik, 2004; Blalock and Gertler, 2008; Javorcik and Spatareanu, 2008). This can facilitate horizontal technology spillovers because firms that operate in a similar industry can also benefit from the higher quality inputs. In terms of labour, evidence suggests that technology spillovers can occur through labour turnover. Several studies have shown that foreign firms are more likely to provide training programs for their existing employees as opposed to domestic firms (Edfelt, R.B., 1975; Gonclaves, R., 1986; Stiglitz, 2000). This result should be particularly prevalent when there are new production technologies or processes being utilized by the foreign firm. Although it has been shown that a significant determinant of acquisition performance is the retention of firm employees, there is no doubt that in the long-term there is significant turnover of employees after an acquisition (Ranft and Lord, 2002; Walsh, 1988; Krug, 2003; Buchholtz, Ribbens, and Houle, 2003). Moreover, this effect is stronger in cross-border acquisitions due to both national and organizational cultural differences (Sarala and Vaara, 2010). Workers who change jobs will bring their ideas with them which can facilitate technology spillovers to other domestic firms. Therefore, given the various channels for technology spillovers, it remains unclear why FDI would not facilitate international technology spillovers through horizontal linkages in emerging countries.

To investigate the role of FDI in facilitating international technology spillovers, we employ a sample of 483 cross-border acquisitions to 18 emerging countries between the years 1998 to 2012. Specifically, we focus on controlling cross-border acquisitions where the acquiror seeks to gain control of the target firm. We then examine the response of non-target rival firms to these acquisitions. By utilizing measures derived from Bloom, Schankerman, and Van Reenen (2013), we attempt to disentangle the two potential competing effects associated with the utilization of an acquiror's tangible and intangible assets in a cross-border acquisitions i.e. technology spillovers and product market rivalry. This is important because past literature tends to focus on the aggregated effect of FDI, which could lead to the conclusion that there are no technology spillovers, if the negative effects outweigh the positive. By disentangling the technology spillovers associated with FDI, we show that there is indeed technology transfers in cross-border acquisitions.

We begin by showing that non-target rivals experience positive cumulative abnormal returns (CARs) based on the potential technology spillovers from the acquiror at the announcement of a cross-border acquisition. Moreover, we show that technology spillovers have a lasting effect apart from the initial CARs on the acquisition date. In particular, the potential technology spillovers from the acquiring firm is positively associated with firm-value in terms of Tobin's Q (ln(Q)), productivity measured by Total Factor Productivity (ln(TFP)), as well as Innovation in terms of patent count (ln(1+COUNT)) and citations (ln(1+CITE)). Furthermore, the positive association of technology spillovers depends critically on the foreign acquiror's mode of entry, namely, through horizontal or non-diversifying cross-border acquisitions. Additionally, using an index of intellectual property rights (IPR), we show that the effect of technology spillovers is potentially driven by the willingness of the foreign acquirors to disclose their tangible and intangible assets rather than through the supposed imitation effect. Finally, we confirm that the positive effect of technology spillovers depends critically on a non-target rival firm's absorptive capacity.

This paper contributes to the existing literature in several ways. First, we contribute to the ongoing debate of whether there are FDI spillovers at all. Our paper shows that there is a positive impact of technology spillovers from cross-border acquisitions on a non-target rival firms' CARs, performance, productivity and innovation. Past literature tends to have concluded that there is almost no evidence for any substantial FDI spillovers (Görg and Greenaway 2004, Hanson 2001). By disentangling the effect of FDI into the technological component, we find that technology spillovers from FDI does have predictive power on a variety of non-target rival's firm performance measures beyond the productivity measure. Moreover, the type of FDI matters. Those that bring proprietary assets in a horizontal cross-border acquisitions are more likely to provide technology spillovers due to their intention to replicate their production facilities overseas. However, we do not detect any horizontal spillovers associated with non-horizontal cross-border acquisitions, which are primarily driven by the need for inputs that facilitate their production back at home (Caves, 1971).

Second, our paper contributes to the literature on the ongoing debate regarding the role of intellectual property rights on international technology spillovers. While one could argue that stronger intellectual property rights may harm emerging countries because it increases the cost of imitation (Glass and Saggi, 2002; Falvey, Greenaway, and Foster-

McGregor, 2006; Parello, 2008). Our results suggests that intellectual property rights facilitates international technology spillovers from cross-border acquisitions. In particular, it has been shown in a theoretical model by Dinopoulos and Segerstrom (2010) that stronger intellectual property rights in developing countries leads to an increase in technology transfer to the developing countries. Studies that support this role of intellectual property rights suggests that this effect is primarily driven by foreign acquirors rather than domestic firms. Specifically, stronger intellectual property rights increases the incentive for foreign acquirors to disclose their innovative activities through licensing or patenting their inventions, which facilitates knowledge spillovers (Yang and Maskus, 2001; Anton and Yao, 2004).

Third, we contribute to the literature on absorptive capacity. We show that absorptive capacity matters even in our sub-sample of more innovative firms. Therefore, policies that help build up the absorptive capacity in a country is vital to facilitating technological diffusion and hence economic growth. In particular, we show that firms that hire more skilled employees, build up their R&D stock, and are less financially constrained are more likely to benefit from international knowledge diffusions originating from cross-border acquisitions.

The remainder of the paper is organized as follows. Section 4.2 provides hypotheses development. Section 4.3 presents the empirical model. Section 4.4 describes the data and the construction of our sample in detail. Sections 4.5 presents our empirical results, and Section 4.6 concludes the paper.

4.2 Hypothesis Development

4.2.1 Cross-border Acquisitions and International Spillovers

Ever since the introduction of the neoclassical growth models pioneered by Solow (1956), there has been an abundance of interest in the dynamics that lead to cross-country convergences in growth rates (e.g. Barro, 1991; Barro and Sala-i-Martin, 1992; Abel and Bernanke 2005; Mankiw, Romer, and Weil, 1992; Caggiano and Leonida, 2009; Petrakos and Artelaris, 2009). The theory of unconditional convergences that stems from the model introduced by Solow (1956) suggests that there is diminishing returns to capital, whether it is in terms of physical or human capital. The implication of this theory to cross-country convergences is that a small capital investment for poor countries will have a larger effect on productivity than for rich countries with substantial amounts of capital investments (Mankiw et al., 1992). As a result, poor countries have the potential to grow at a faster rate than rich countries and all economies will eventually converge in terms of per capita income.

Apart from capital investments, cross-country knowledge spillovers have frequently been regarded as another contributing factor to cross-country convergences (Griffith, Redding, and Van Reenen, 2004; Keller, 2004). Specifically, cross-country knowledge spillover occurs when innovations in one country is built on knowledge that was created by innovations in another country. Theoretically, Howitt (2000) demonstrates that cross-country technology spillovers can lead to cross-country conditional convergence of growth rates using Schumpeterian growth models. In Howitt (2000)'s model he shows that a country with greater divergence from the global technology frontier can grow faster than a country that is closer to the global technology frontier. If a country is further away from the global technology frontier, cross-country knowledge spillovers can result in a larger leap in technological advancement than for a country that is closer to the technology frontier. This suggests that cross-country knowledge spillovers may be more beneficial for poorer countries.

International trade and FDI are commonly considered as the two major sources of cross-country knowledge spillovers. Although stronger evidence exists for the role of international trade (both imports and exports) in facilitating cross-country knowledge spillovers, the empirical evidence surrounding the role of FDI in facilitating cross-country horizontal knowledge spillovers in developed and developing countries is mixed.

While the theoretical work by Findlay (1979) and Wang and Bloomstrom (1992) suggests that FDI is an important channel for cross-country knowledge spillovers, the empirical evidence suggests otherwise especially for less developed countries. For example, Xu (2000) finds that outward FDI into 40 countries from 1966 to 1994 by US multinational enterprises at the country-level provided technology transfers to advanced but not less developed countries. Other studies also find that there are statistically significant horizontal FDI spillovers in developed countries, such as Haskel, Pereira, and Slaughter (2007) as well as Keller and Yeaple (2009) who studies the effect of horizontal FDI spillovers on productivity growth in the UK and US respectively.

Further, empirical evidence using micro-data specific to less developed countries suggests that there are either insignificant or negative horizontal FDI spillovers. For example, Aitken and Harrison (1999) who investigates the effect of FDI in a sample of Venezuelan factories, find that foreign equity facilitates productivity benefits for the recipient firm but damages the productivity of domestically owned firms in the same industry. They hypothesize that foreign firms with the advantage of lower marginal costs have the incentives to increase production capacity which reduces the demand for products of other firms in the domestic market. The overall effect is that domestic firms will cut production due to their smaller market share leading to a reduction in productivity. Therefore, they suggest that the competition from foreign direct investment dominates any positive technology spillovers effects. Consistent with these findings, Djankov and Hoekman (2000) using firm-level data in Czech Republic between 1992 and 1996 finds that FDI has significant productivity effect on the recipient firm but tends to be either negative or insignificant for firms without foreign partnerships. Bwalya (2006) in a study on manufacturing firms in Zambia find that there is little evidence for any inter-industry spillovers. These findings are consistent with many other studies in this area (Guadalupe, Kuzmina, and Thomas, 2012; Haddad and Harrison, 1993; Hanson 2001; Javorcik, 2004; Konings, 2001; Tao, Lu and Zhu, 2017). Based on this discussion we hypothesize that:

Hypothesis 1a (H1a)*: Technology spillovers from cross-border acquisitions has an insignificant effect on non-target rival firms.*

However, it is unclear why horizontal knowledge spillovers in these studies don't operate in less developed countries. In terms of horizontal linkages, we have briefly summarized in the introduction why technology spillovers should still occur in developing countries. We will now reiterate in further detail with literature that focuses on less developed countries. First, there is significant evidence that there is international technology diffusion through imports. For example, Coe, Helpman and Hoffmaister (1997) finds that there is a positive and economically large effect of import-weighted R&D on productivity from highly industrialized countries to less developed countries. Amiti and Konings (2007) using a sample of Indonesian manufacturing firms from 1991 to 2001 provides evidence that even the import of final goods can facilitate productivity improvements. This suggests that exposing a firm's products in an international market could allow other firms to learn about the firm's technology, which suggests that cross-border acquisitions should atleast have this effect. Second, technology spillovers can also occur through vertical linkages. The primary focus in this area of the literature is on technology spillovers originating from FDI to upstream sectors, where multinationals may have the incentives to transfer technology to their intermediate input suppliers to benefit from higher quality inputs. More importantly, these findings are consistent across studies that focus on less developed countries such as samples of Romanian (Javorcik and Spatareanu, 2008) and Indonesian firms (Blalock and Gertler, 2008). Indeed, this would suggest that in terms of horizontal linkages a firm that shares the same industry as the multinational affiliate may benefit from this technology transfer if they also share the same intermediate inputs.

Blalock and Gertler (2008) also provides evidence that there are horizontal technology spillovers amongst upstream firms. In particular, they find that domestic firms that are upstream to the multinational affiliate but are not immediate suppliers of the multinational affiliate also experience improved productivity. This suggests that technology transfers from FDI can have a horizontal spillover effect even in developing countries. Third, the role of labour turnover in facilitating technology spillovers has also been examined extensively. For example, Poole (2013), using an establishment-working database from Brazil for years 1996 through 2001, finds that there are positive multinational wage spillovers through labour mobility. Specifically, they find that workers from multinationals that are subsequently rehired by domestic firms earn higher wages, which is consistent with the role of worker mobility as a source of technology spillovers. Similarly, Masso and Vahter (2016) shows in a sample of employer-employee level data from Estonia, that domestic firms experience productivity increases based on the level of hired employees who have multinational enterprise experience. Gorg and Strobl (2005) using data on 200 Ghanaian firms also show that entrepreneurs with previous training at foreign-owned affiliates, for firms that belong in the same industry, provide productivity benefits. Therefore, Gorg and Strobl (2005) provides evidence that horizontal technology spillovers can occur through labour turnover.

Therefore, individual studies on the channels seem to show that there are horizontal technology spillovers associated with FDI. Amongst the many studies, albeit less, there are also studies that do find that there is a positive effect of FDI on less developed countries. For example, Amann and Virimani (2014) in their country-level study, find that there is significant productivity growth associated with FDI from R&D intensive developed countries into 18 emerging countries, during the 1990 to 2010 period. There are also studies using micro panel data that find positive horizontal technology spillovers such as Liu (2008) who finds that FDI has a negative effect on productivity in the short-term but increases productivity growth in the long-term for a sample of Chinese firms. Alternatively, Abebe, McMillan, Serafinelli (2017) investigates the impact of a large FDI plant being added to local Ethiopian districts. Using an event study design around the entrance of these large FDI plants, they find that there is a 13% increase in the productivity of domestic plants. In their study, they also provide survey data on the possible channels of technology spillovers confirming those in previous studies such as the adoption of production processes through observation of foreign plants in the same industry, employment of workers from foreign plants, as well as the acquisition of technologies from FDI customers and suppliers. Based on the discussion above we hypothesize that:

Hypothesis 1b (H1b)*: Technology spillovers from cross-border acquisitions has positive effect on non-target rival firms.*

Our study, much like Abebe, McMillan, Serafinelli (2017) focuses on an event study. But rather than an establishment of a large FDI plant, we focus on controlling cross-border acquisition of a target firm in an emerging country by an acquiror from a developed country, which is presumably closer to the technology frontier. The main motivations that firms have for acquiring a foreign business is either due to differences in production costs across countries, foreign market access, or access to country specific assets (Helpman, 2006). Amongst the theoretical trade models, the motivation of foreign market access is generally considered the most important motive for cross-border acquisitions (Helpman, Melitz, and Yeaple, 2004). Specifically, this type of market seeking FDI, is a "horizontal" investment where a firm intends to produce the same line of products that they intend to produce in their home markets (Caves, 1971). In comparison, "vertical" investments, which is more in line with the motivation to access country specific assets, is usually associated with the intention to produce abroad a raw material or other intermediary inputs to facilitate their production at home (Caves, 1971; Helpman, 2006). Using a model by Melitz (2003), Helpman (2006) explains that firms that choose the horizontal investment route will tend to be more productive than firms that choose to export. This finding is confirmed in Helpman et al. (2004), who finds that in 1996, U.S. firms who chose the FDI route was 15% more productive in terms of labour productivity than firms that only engaged in exports. Similarly, Frésard, Hege, and Phillips (2015) using a sample of horizontal acquisitions announced between 1990 and 2010 finds that acquirers from more specialized industries are more likely to acquire foreign targets that are less specialized in the same industry. Moreover, they find that this is particularly strong in horizontal cross-border acquisitions. They link their findings to the internalization theory, which suggests that if a firm possesses mobile proprietary knowledge, firms can benefit by internalizing the knowledge by performing a controlling foreign acquisition and exploiting their proprietary knowledge in their own production facilities worldwide rather than risking knowledge leakages to other firms through contractual agreements such as the licencing (Hymer, 1976; Caves, 1971). This type of proprietary knowledge can include technological know-how, marketing knowledge, management expertise, as well as human capital, which are all significant drivers of a firm's cross-border acquisition decision (Caves, 2007). Moreover, this type of cross-border acquisition is more likely to occur through a horizontal acquisition due to proprietary knowledge being industry specific, synergies associated with the targets' immobile productive assets, as well as the capacity to remove a local competitor. Therefore, horizontal cross-border acquisitions could potentially be more beneficial in terms of technology spillovers due to the industry specific intangibles that FDI brings to the market. However, this can also be offset by the acquirors desire to internalize and reduce knowledge leakages. Based on our discussion, we hypothesize that:

Hypothesis 2a (H2a)*: Technology spillovers from horizontal cross-border acquisitions are beneficial to non-target rival firms.*

Hypothesis 2b (H2b): *Technology spillovers from horizontal cross-border acquisitions has an insignificant effect on non-target rival firms.*

In addition to the mode of entry, we also investigate the role of intellectual property rights in facilitating international technology transfers from cross-border acquisitions. There are two prevailing views associated with intellectual property rights literature in less developed countries. For example, Parello (2008) suggests that stronger intellectual property rights may damage technology transfers to less developed countries due its negative impact on the long-run imitation rates. Similarly, in a theoretical model by Glass and Saggi (2002), they show that stronger intellectual property rights forces less developed countries to spend more resources on imitation which reduces the resources that is required for production. Falvey, Greenaway, and Foster-McGregor (2006) on the other hand show that improvements in intellectual rights can increase technology flows to low-income countries but may damage middle-income countries due to the losses associated with reduced scope of imitation. Overall, this strand of literature supports the view that stronger intellectual property rights makes imitation more costly which reduces the role of international technology transfers to these countries. This is particularly important because imitation is frequently considered a primary source of international technology transfers for less developed countries. As a result, improvements in intellectual property rights will hamper international technology spillovers.

On the other hand, there is also literature that encourages the improvements in intellectual property rights in less developed countries. For example, it has been shown that improvements in intellectual property rights is associated with more inward FDI activity and improved synergies (Awokuse and Yin, 2010; Alimov and Officer, 2017). Similarly, Dinopoulos and Segerstrom (2010) find that stronger intellectual property rights raises the rate of international technology transfer. Moreover, the internalization theory suggests that the primary reason firms want to internalize markets rather than licence their proprietary assets is due to the fear that firms operating in a country with poor intellectual property rights or contractual enforcement would not honour contractual agreements (Caves, 1971; Hymer, 1976). Similarly, Yang and Maskus (2001) shows that stronger intellectual property rights increases the incentives of firms to innovate and license advanced technologies. This suggests that an improvement in intellectual property rights can facilitate knowledge diffusion as foreign acquirers will place more trust in contractual agreements between other firms operating in the same market, facilitating cooperation and improved cross-border knowledge diffusion. Additionally, there is also evidence to suggest that rather than licensing, even obtaining a patent is sufficient disclosure to allow for technology diffusion. Xu and Chiang (2005) shows that an improvement in intellectual property rights protection affects economic growth by attracting flows of foreign patents. While, Anton and Yao (2004) suggests that in a country with poor intellectual property rights, the disclosure through the act of obtaining a patent is offset by the threat of imitation. Therefore, in countries with weaker intellectual property rights a firm may prefer the secrecy route rather than patenting and disclosing information about their innovations. This view is supported Cohen, Nelson, and Walsh (2000) who finds that secrecy is more important than patenting for the protection of a firm's product innovations. As a result, acquirors will disclose less information about their innovations in countries with weaker intellectual property rights. Based on our discussion, we hypothesize that:

Hypothesis 3a (H3a): Intellectual property rights facilitates international technology spillovers.

Hypothesis 3b (H3b): Intellectual property rights reduces the imitating capabilities of a domestic firm which reduces their abilities to absorb international technology spillovers.

4.2.2 Framework

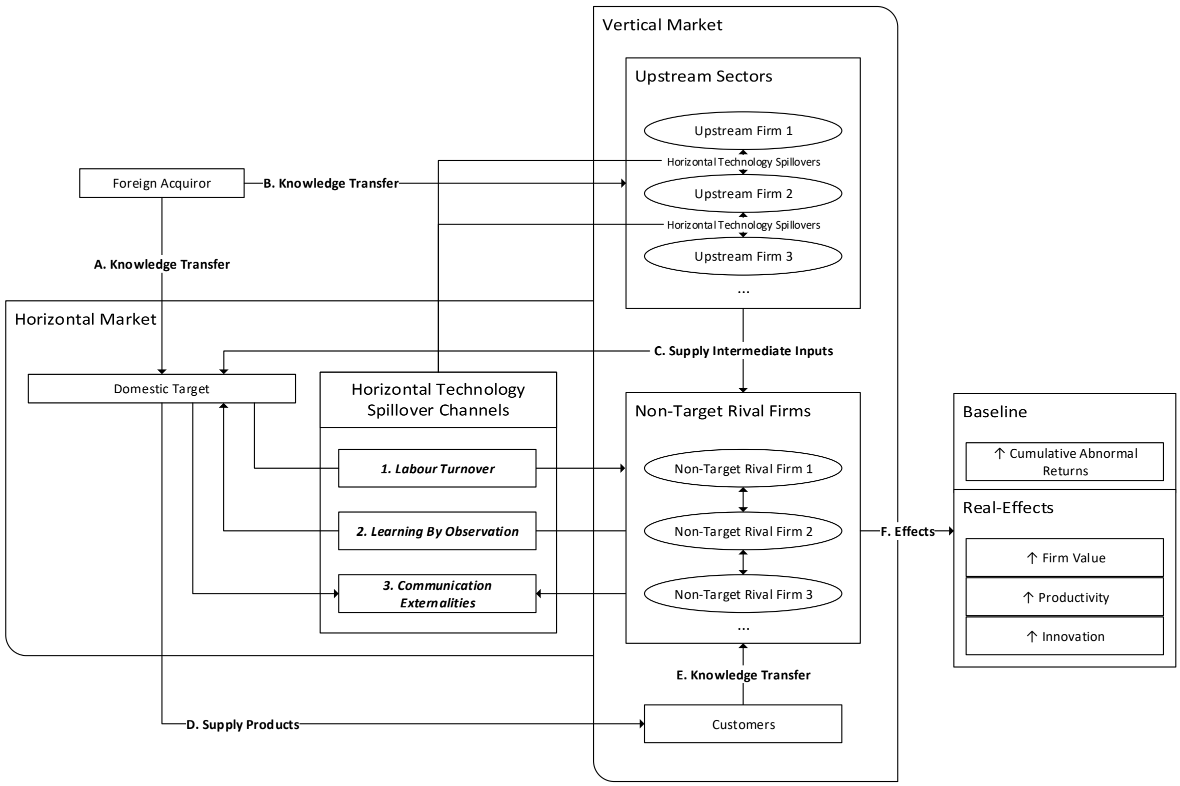
Based on the discussion in the previous section, we detail the mechanisms that allow for technology spillovers to accrue to non-target rival firms from cross-border acquisitions in Figure 4.1. Technology spillovers can generally be classified as either horizontal or vertical. In this paper, we focus on horizontal technology spillovers, which is when knowledge is transferred from the target firm to non-target firms within in the same industry.

As suggested by the internalization theory, an international investment such as a cross-border acquisition occurs when a firm has information or knowledge based intangible assets that they can exploit in international markets. As shown by Arrow A, when a domestic firm is acquired, the foreign acquiror has an incentive to transfer these intangible assets to improve acquisition performance. Horizontal technology spillovers from the target firm to non-target rivals can then occur in a number of different ways. First, as shown by Arrow 1, technology spillovers can occur through labor turnover, which describes the process of employees bringing their accumulated knowledge from the domestic target firm to other domestic firms. Second, as shown by Arrow 2, domestic non-target rival firms can learn from the target firm through observation. For example, the foreign acquiror can introduce new products, production technology, marketing technique, managerial technique, organizational form, or even export markets that was previously unknown to domestic firms. The knowledge can then be potentially assimilated by other domestic firms through observation and imitation. Third, as shown by Arrow 3, knowledge transfers can also occur through communication externalities, which are any interactions between skilled employees from the target and non-target rival firms. These interactions can include in-person meetings, word-of-mouth communications, conferences and trade conventions.

Alternatively, horizontal technology spillovers from the target firms can also occur through vertical linkages. Vertical linkages refer to the linkages between the target and its customer and suppliers which are referred to as forward and backward linkages respectively. Amongst forward and backward linkages, the literature tends to focus primarily on backward linkages as shown by Arrow B. Technology spillovers from backward linkages can occur because foreign acquirors have the incentive to transfer technology to the target firm's intermediate suppliers to improve input quality and production efficiency in order to boost the target firm's profits. In this case, firms that operate in the same industry as the target can benefit naturally from improved common intermediate inputs, as shown by Arrow C. Technology spillovers can also occur through forward linkages, as shown by Arrow D. It is plausible that the domestic target firm could introduce new products to customers by engaging in product demonstration and or installations, which have the potential for knowledge transfers to other domestic rival firms, as shown by Arrow E.

Overall, the literature suggests that there are a multitude of avenues for knowledge transfers from cross-border acquisitions to non-target rival firms. As shown by Arrow F, we hypothesize that these avenues will inherently affect how the market reacts to these cross-border acquisitions in terms of cumulative abnormal returns. These knowledge transfers are also expected to have a lasting effect on non-target rival firms in terms of firm value, productivity, and innovation.

Figure 4.1: Cross-border Acquisitions and International Spillovers
This figure details the mechanisms on how cross-border acquisitions can lead to international technology spillovers.



4.3 Empirical Design

4.3.1 Empirical model

This paper investigates the impact of technology spillovers from cross-border acquisitions. We begin by conducting an event study around the announcement of the cross-border acquisition, specifically, we regress the CARs of non-target rivals on the potential technology spillover and product market rivalry from the acquiring firm. Our empirical model is as follows:

$$CARs_{i,d} = \beta_1 \ln\left(SPILLTECH_{i,d-365}\right) + \beta_2 \ln\left(SPILLSALES_{i,d-365}\right) + \beta_3 CROSSVAL_{i,d-11} + \gamma' \mathrm{X}_{\mathrm{i,t-1}} + \tau_t + \eta_i + \varepsilon_{i,t}$$

where *i* and *d* refer to firm *i* and announcement date *d*, respectively. *CARs*, is defined as the cumulative abnormal returns of the non-target rival firm in the target nation over the event window (-2, 2) around announcement date d of the cross-border acquisition. ln($SPILLTECH$) is the natural logarithm of our technology spillover measure, ln($SPILLSALES$) is our product market rivalry measure, $CROSSVAL_{i,d-11}$ is the value of the acquisition scaled by the aggregate market value of the firm i's industry 11 days prior to the acquisition date *d*. *X* is a vector of constant terms and other deal-, firm- and country-level control variables that will be discussed in subsection 4.3.4. The specification includes year (τ) and firm-fixed effects (η). ε is the error term. Robust standard errors are clustered at the firm-level.

In addition to the event study methodology, we also examine the effects of technology spillovers from cross-border acquisitions on annual performance measures of non-target rivals. More specifically, we run a regression that aggregates the FDI activity and technology spillovers to a firm-year panel regression:

$$Performance_{i,t} = \beta_1 \ln\left(SPILLTECH_{i,t-1}\right) + \beta_2 \ln\left(SPILLSALES_{i,t-1}\right) + \beta_3 FDI_{i,t-1} + \gamma' \mathrm{X}_{\mathrm{i,t-1}} + \tau_t + \eta_i + \varepsilon_{i,t}$$

where $Performance_{i,t}$ includes a number of performance measures from Bloom et al. (2013) for firm i in year t such as: (1) Tobin's Q, which is a measure of the firm's performance; (2) Productivity, which is measured by the firm's total factor productivity; (3) Innovation, which is a measure of the firm's innovation output in terms of patent count and citations; and $CROSSVAL_{i,t-1}$ is the aggregated deal value of cross-border acquisition in firm *i's* country-industry as a percentage of the total market value of the country-industry in year *t-1*; *X* is a vector of constant terms and other firm-level control variables as discussed in subsection 4.3.4. Like our event-study methodology, we include year (τ) and firm-fixed effects (η). ε is the error term. Robust standard errors are also clustered at the firm-level.

4.3.2 Variable Construction

4.3.2(i) Cumulative Abnormal Returns (CARs)

To construct the CARs of industry linked rival firms, we follow the standard event study methodology by assuming that the returns follow the standard market model:

$$R_{i,t} = \alpha + \beta R_{m,t} + e_{i,t}$$

where $R_{i,t}$ is the return of the industry linked rival firm *i* on day *t* and $R_{m,t}$ is the market return on day *t*. Firm and market returns are constructed from the firm return index and Datastream market return index. Following Lee (2011), we also screen the return index.[29] The coefficients of the standard market model are estimated using an event window consisting of 300 to 91 trading-days prior to the announcement of the cross-border

[29] Since the return index is reported to the nearest tenth in Datastream, daily returns calculated from the return index will inherently exaggerate the proportion of zero-return days. Therefore, if the return index is less than 0.01, we set the return index to missing. Additionally, we also set the calculated daily returns to be missing if any daily return is above 100% and reverses within one day i.e. if the returns of either days *t* and *t-1* are greater than 100% and $(1 + R_{i,t})(1 + R_{i,t-1}) \leq 0.5$ then both $R_{i,t}$ and $R_{i,t-1}$ are set to be missing.

acquisition. We further specify that there must be at least 100-trading-day returns in each estimation window. The CARs are then calculated as the sum of the returns in excess of the returns predicted by the market model over the event window (-2,+2).

4.3.2(ii) Tobin's Q

We construct our Tobin's Q measure following Griliches (1981), which has been applied in many studies in this area (Hall et al., 1999; Lanjouw and Schankerman, 2004; Bloom et al., 2013). Specifically, it is measured as firm value scaled by the book value of capital. We measure firm value as the sum of common equity, preferred equity, total debt minus current assets. The book value of capital is the sum of net plant, property, and equipment, inventories, investments in unconsolidated subsidiaries, and intangibles other than R&D. The logic underlying the measure is that the current market value of a firm depends on how well a firm utilizes its conventional and unconventional assets. By scaling firm value by the firm's conventional assets, the right-hand side captures the contribution of the unconventional assets such as knowledge capital to firm value.

4.3.2(iii) Productivity

We construct a measure of total factor productivity at the firm-level following the methodology outlined by both Blalock and Gertler (2009) and Schoar (2002). Specifically, they model total factor productivity as the residual from the Cobb Douglas production function as:

$$TFP_{it} = \exp\left(\ln(OUTPUT_{it}) - \beta_0 \ln\left(CAPITAL_{i,t}\right) - \beta_1 \ln(LABOR_{it}) - \beta_2 \ln\left(MATERIALS_{it}\right)\right)$$

Where the coefficients associated with the returns to the capital inputs are determined by the regression:

$$\ln(OUTPUT_{it}) = \beta_0 \ln(CAPITAL_{it}) + \beta_1 \ln(LABOR_{it}) + \beta_2 \ln(MATERIALS_{it}) + \omega_{it} + \varepsilon_{it}$$

The issue with estimating this regression using OLS is that ω_{it}, which represents a productivity shock will be observed by the firm and so the input choices will be influenced by ω_{it}. Therefore, we would get inconsistent estimates when we estimate the returns associated with capital inputs. To address this concern, we follow Levinsohn, Petrin, Poi (2004), who provides a Stata command (levpet.do) to estimate the returns to the capital inputs. Specifically, we proxy for the firm's output and inputs using total sales as the output, gross property, plant, and equipment as the capital input, the number of employees as the labour input and raw materials as the materials input. We use the revenue method and estimate the coefficients at the 2-digit SIC industry-level to allow for the returns to capital to vary by industry.

4.3.2(iv) Innovation

As a measure of a firm's innovativeness, we construct two different measures of innovation output from the Thomson Innovation Database. Specifically, we construct measures of a firm's patent count (COUNT) and citations (CITE). For both measures we use the application year rather than the publication year because the application year is a more appropriate measure of when the innovation takes place. The first measure, COUNT, represents the firm's innovation quantity, which is measured as a scaled number of patent applications that are eventually granted for a firm in a year. We scale the measure in several ways. First, for patents with multiple assignees, we scale the patent count measure assuming equal ownership or contribution to the creation of the patent. Second, to create a more accurate measure of a firm's innovativeness, we scale a firm's patent count by the average patent count for firms that share a DWPI technology class in that year.[30] This provides a more accurate measure of a firm's innovativeness because a firm's patent count depends on the technology class they operate in. For example, it is difficult to distinguish the innovativeness of two firms if a firm applies for a single patent in semi-conductors, which is one of the most frequently patented technology classes (103,025 total published patents in the USPTO as of 2015) and another firm applies for a single patent in heating systems (1,170 total published patents in the USPTO as of 2015), which is one of the least patented technology classes. If we simply compare the two firms based on patent count, we would reach the incorrect conclusion that these two firms are equally innovative.

The second measure, CITE, is a measure of the firm's innovation quality, which is measured by the scaled number of citations received by a firm's patents. The prevailing assumption is that a patent with more citations is more innovative. An issue with using patent citations however is that we only observe a patent's citations up to the date of when the patent data is collected. As a result, citations of patents that are published earlier will be biased upwards compared to the patents that are published later. Therefore, it is difficult to compare the innovativeness of patents across years. To address this truncation issue in citations, we follow Hall, Jaffe, and Trajtenberg (2001) by scaling a patents citation count

[30] We use the narrowest classification of DWPI technology classes with 291 total technology classes as described in Appendix C.

by the average number of citations of patents that share the same technology class in the same application year.

By construction, both these measures are right-skewed as documented in previous literature (Tian and Wang, 2014). We address this by winsorizing at the 99th percentile and then taking natural logarithm of both measures. However, since taking the natural logarithm will eliminate all firm-years with zero patent applications, we add one to both measures before we take the natural logarithm. This makes sense economically because both these measures are zero in these years.

4.3.2(v) Spatial Proximity Measures

We measure technological proximity by following Bloom et al. (2013). Specifically, we determine a firm's technology space by utilizing a firm's patent distribution across technology classifications. Given the differences in technology classifications across patent offices, we utilize the DWPI classification system, which provides a unique classification system that is consistently applied to all patents in the database. More precisely, patents are divided into 21 broad subject areas or sections, with each section further subdivided into classes.[31] To determine the firm's technology space, we construct the average share of patent applications within a technology class across each year in our sample as $T_{i,k}$ for firm i in technology class k. The firm's average shares of patent applications for each technology class is then aggregated as a vector $T_i = (T_{i,1}, T_{i,2}, \dots, T_{i,N})$, where $N = 291$ is the total number of DWPI technology classes. [32]

[31] More information regarding the classifications are provided in Appendix C.
[32] To be consistent we use the "current" provided DWPI classification for each patent. The total number of DWPI classifications may vary due to the updating of the DWPI classification. As of the date of the data collection we find that there are 291 total DWPI classes.

Following Jaffe (1986), we construct the technological proximity between two different firms i and j as ω_{ij}, which is the uncentered correlation between firm i and j:

$$\omega_{ij} = T_i T_j' / \sqrt{T_i T_i' \times T_j T_j'}$$

For each cross-border acquisition deal, we calculate the technological proximity between the acquiror firm *i* and non-target rival firms *j* that operate in the target nation. The measure ω_{ij}, is bounded between zero and one, and measures the technological proximity in terms of patenting position across technology classes. A technological proximity ω_{ij} closer to one would suggests that both acquiror and non-target rivals are similarly distributed across technology classes. Non-target rival firms that are similarly distributed across technology classes with the acquiror will potentially benefit more from technology knowledge diffusion from the acquiror.

Past studies suggest that there are several issues that should be addressed when using patent data. First, the same invention can be applied and granted by multiple national patent offices. Therefore, if we use the raw patent applications, multiple applications of the same invention will exaggerate the firm's share of patents in particular technology classes. The DWPI database provides information on patent families, which are applications for the same invention. To address this issue, we collect all patent families during our sample period from the DWPI database and classify the patent with the earliest application date as the basic patent. To construct our technological proximity measure, we only consider basic patents with application dates within our sample period.

Second, there is inherently a truncation issue with patent application and publication dates. Specifically, a patent application is only visible in the DWPI database after the application is granted and published by the patent office. Past studies on the USPTO data suggests that there is on average a lag of 2 years between the application and publication year. This issue is particularly prevalent in the later years of our patent data because the number of patent publication doesn't truly reflect the actual number of patent applications. The suggested method to address this issue is to neglect patent data with applications dates that occur within the last 2 years of when the patent data is collected. However, because we are using patent data from patent offices beyond the USPTO, we delete patents with application dates within the last three years. Subsequently, our patent sample only includes patents with application dates between 1998 and 2013.

Finally, a single patent can have multiple assignees as well as multiple DWPI technology classifications. In both cases, we assume equal share i.e. a patent with two assignee firms and two technology classifications will only contribute one quarter to each technology classification for each firm in the calculation of a firm's patent share. This is an issue that is shared by past studies that calculate technological proximity using the NBER patent data, which uses the International Patent Classification (IPC).

Although cross-border acquisitions can lead to positive externalities in the form of technological knowledge diffusion amongst non-target rival firms, there can also be negative externalities in the form of product market rivalry with firms that operate in similar product markets. In particular, a key contribution by Bloom et al. (2013) is that they are able to successfully disentangle the positive and negative externalities associated with R&D expenditure. Following Bloom et al. (2013), we also consider the negative externalities by constructing a measure of product market proximity between acquiror and non-target rival firm.

To do this, we identify each firm's product market space by using the firm's sales share across each of their product segments. Explicitly, we construct the average share of reported sales within four-digit SIC industry codes over the same sample period as our patent data as $S_{i,k}$ for firm *i* in each of the firm's four-digit SIC industry *k*. The firm's product market space is then represented by a vector containing the firm's average sales share across each four-digit SIC industry as $S_i = (S_{i,1}, S_{i,2}, \ldots, S_{i,N})$, where N is the total number of four-digit SIC industry codes in our entire sample.

Like our technological proximity measure, we measure product market proximity as the uncentered correlation between firm *i* and *j*'s product market space:

$$\tau_{ij} = S_i S_j{}' / \sqrt{S_i S_i' \times S_j S_j{}'}$$

Similarly, τ_{ij} is also bounded between zero and one and represents the degree of overlap of firm *i* and *j* in product market space. Therefore, a large τ_{ij} indicates that the two firms operate in similar product markets.

An issue with using Jaffe (1986)'s proximity measure is that we assume each technology class or four-digit SIC industry code is completely unrelated. However, in reality, different technology classes or four-digit SIC industry codes can be highly related and facilitate spillovers across classifications. Following Bloom et al. (2013), we address this issue using the Mahalanobis (1936) distance metric. The logic underlying this metric is that other than the proximity in technology and product market space between firm *i* and *j*, we also need to include a measure for the relatedness across classifications. We measure the relatedness across classifications by accounting for how often these classifications arise within the same firm. For example, if two technology classes are frequently filed together within the same firm, these two technology classes are highly related and assigned a weight of one. By including this measure, we can account for the spillovers that can occur across classifications.[33]

4.3.2(vi) Technology Spillover and Product Market Rivalry

We are interested in the relevant technology pool that an acquiror firm *i* brings to a non-target rival firm *j* in a target nation. Although technology and product market proximity provide a measure for the relevance in technology and product market space, respectively. The size of the potential leakages is also an important determinant towards the benefits that an acquiror can bring. To construct the relevant technology pool from the acquiror, we compute $SPILLTECH_{j,t}$ as the weighted R&D stock of the acquiror, as:

$$SPILLTECH_{j,t} = \sum_{i} w_{ij} G_{it}$$

where *i* is the acquiror firm and *j* is the non-target rival firm. When there is only a single acquiror, as is the case for the event study, the measure only includes a single acquiror. For the size of the technology pool of the acquiror, we use the perpetual inventory method to construct R&D stock of the acquiror, $G_{i,t}$ as $G_{i,t} = R_{i,t} + (1 - \delta)G_{i,t-1}$, where $R_{i,t}$ is the R&D expenditure of acquiror i in year t and $\delta = 0.15$.[34] While the R&D

[33] This calculation of this measure is mathematically involved. For more details on the calculations refer to Bloom et al. (2013).
[34] R&D capital is assumed to depreciate at 15 percent per year, which is described by Hall (2007) as the consensus depreciation rate.

expenditure in current period *t* reflects the commitment to knowledge production in period *t*, it doesn't reflect the size of the acquiror firm's accumulated knowledge or technology pool in period *t*. However, the benefits associated with investments in knowledge deteriorates over time, therefore, a depreciation δ is included in the construction of R&D stock (Bloom et al., 2013; Jaffe et al., 2005).

In addition to technology spillovers from the acquiror, we also account for the technology induced competition in the form of product market rivalries introduced by the acquiror in a cross-border acquisition. The measure of product market rivalry is constructed for each non-target rival firm *j* as:

$$SPILLSALES_{j,t} = \sum_{i} \tau_{ij} G_{it}$$

The primary difference between the two measures, is the weighting scheme applied to the R&D stock i.e. technology spillover utilizes the spatial closeness in technology space, while product market rivalry uses the spatial closeness in product market space.

4.3.2(vii) Intellectual Property Rights

To measure Intellectual Property Rights (IPR), we utilize a measure that has been widely adopted in the economics literature when investigating intellectual property rights (Alimov and Officer, 2017; Branstetter et al., 2006). Specifically, we utilize an index of patent rights protection that was originally created by Ginarte and Park (1997). In this study, we use the updated version by Park (2008). The index is constructed based on statutory patent law and their enforcement for 122 countries from 1960 to 2005. The index ranges from 0 to 5, with larger values associated with stronger intellectual rights protection.

The scores are based on five different components associated with patent-law i.e. the extent of patent coverage, membership in international agreements, provisions for loss of protection, enforcement mechanisms, as well as the duration of protection. According to Maskus (2000), the patent rights index provides us with a consistent and objective measure of the strength of intellectual property rights that are comparable across countries and over time.

An issue with IPR is that it only provides data on intellectual property rights at 5-year intervals. Following Alimov and Officer (2017), we match each cross-border acquisition to the closest year.

4.3.3(i) Absorptive Capacity Measures

According to Cohen and Levinthal (1990) a firm's absorptive capacity is defined as the firm's ability "to recognize the value of new, external information, assimilate it, and apply it to commercial ends". Therefore, a firm's absorptive capacity is the mechanism that allows a firm to identify and utilize technology spillovers. Furthermore, Blalock and Gertler (2009) empirically finds that firms that are more innovative, have highly skilled employees, and a larger technology gap will have greater benefits from international technology spillovers. To empirically study the role of absorptive capacity, we consider measures of: (1) Innovativeness; (2) Human Capital; (3) Financial constraints. In the following section, we explain how each of these relate to absorptive capacity and how we measure them.

4.3.3(ii) Human Capital

According to Howitt and Mayer-Foulkes (2005), a country's convergence depends highly on the country's stock of skilled workers. In their study, they highlight the role of human capital in allowing firms in poorer countries to use more productive modern methods of technological investments. Other studies have also recognized the role of human capital as a component of absorptive capacity (Minbaeva et al., 2003; Vinding, 2006; Blalock and Gertler, 2009; Lopez-Garcia and Montero, 2011). Human capital plays a vital role in absorptive capacity, in particular, these studies tend to consider human capital as an additional proxy for absorptive capacity. The role of human capital in terms of Cohen and Levinthal (1990)'s definition of absorptive capacity provides a firm with the ability to both recognize the value of external knowledge as well as assimilating and integrating this knowledge into the firm's products. Therefore, a firm with more skilled human capital should have stronger capabilities to absorb technology spillovers from cross-border acquisitions.

Due to the lack of firm-level data on employee skill, we follow previous studies and approximate the employee skill by using data on a firm's number of employees as well as salary and benefits expenses. We divide the firm's salary and benefits expenses by the firm's number of employees, which provides us with a measure of the firm's average wage levels. The assumption that we use for this measure is that firms with higher average wage levels in the same country-industry will also have higher skilled employees.

4.3.3(iii) Innovativeness

To measure how innovativeness affects the non-target rival firm's absorptive capacity, we follow Blalock and Gertler (2009) and classify a firm's innovativeness based on the firm's R&D expenditure. However, we deviate from their indicator variable of R&D expenditure and focus on the non-target rival firm's R&D stock. Specifically, it provides us with an aggregate measure of the investments to R&D considering the recency of their

R&D expenditure by incorporating a depreciation rate as shown in Section 4.3.2. This is consistent with the insights on absorptive capacity by Cohen and Levinthal (1989), who proposes that a firm's investments in R&D plays a learning role that increases a firm's absorptive capacity.

4.3.3(iv) Financial Constraints

In a study by Aghion, Howitt, and Mayer-Foulkes (2005), they introduce the role of imperfect creditor protection in a Schumpeterian growth model. They demonstrate theoretically and empirically at the country-level that financial constraints in poor countries hinders their ability to take full advantage of technology transfers. They recognize that absorbing technology transfers isn't costless. In particular, a firm is required to invest in technological knowledge in order to assimilate and adapt foreign technologies to the local environment, which is consistent with past findings (Cohen and Levinthal, 1989; Griffith et al., 2004). In more recent literature, Qiu and Wan (2015) shows that firms facing greater technology spillovers domestically will hold more cash, which confirms the need for further investments to absorb technology spillovers. Therefore, if a firm is more financially constrained they will have to face more difficulties when assimilating and integrating technology spillovers from cross-border acquisitions.

To investigate the role of financial constraints we use the Size-Age (SA) index constructed by Hadlock and Pierce (2010). In particular, in their study they use several leading indices that measure the degree of financial constraints. A firm is considered financially constrained if a firm faces a wedge between internal and external costs of funds. A firm becomes more financially constrained as the wedge between the costs increases. As a result, firms which are more financially constrained will experience difficulties when trying to raise funds to finance their investments. We construct the SA index as:

$$SA_t = -0.737 \times Size_t + 0.043 \times Size_t^2 - 0.040 \times Age_t$$

where $Size$ is equal to the natural logarithm of total book assets and Age is the number of years between when the firm is first listed in Datastream and the year at time t.

4.3.4 Control variables

Our controls differ between our event study and aggregated firm-year regressions. For the event study, we use variables that are frequently used in the event study literature (Golubov, Yawson, and Zhang, 2015). In particular, we include:

(1) Tobin's Q, which is measured as the sum of market capitalization and total liabilities divided by the sum of common stock and total liabilities.

(2) Runup, which is the market-adjusted buy-and-hold returns for the non-target rival firm over a 200-day window relative to the announcement date (-210, -11).

(3) Sigma, which is the standard deviation of the market-adjusted daily returns over a 200-day window relative to the announcement date (-210,-11).

(4) Industry, which is an indicator that equals one if the acquiror and target operate in the same primary two-digit SIC code.

(5) Leverage, which is the firm's total debt divided by total assets.

(6) $Ln(MV)$, which is the natural logarithm of the firm's market value 11 days prior to the prior to the announcement date in U.S. $.

The firm-year measures, which include Tobin's Q and Leverage are lagged by 1 year when included in our CARs regression.

For our aggregated firm-year regression, we borrow control variables from Albuquerque, Brandão-Marques, and Ferreira (2019), who also studies the non-target rival effects at the firm-year levels. Specifically, the control variables include:

(1) ROA, which is constructed as net income before extraordinary items plus interest expense scaled by total assets.

(2) LEVERAGE, which is the firm's total debt divided by total assets.

(3) SIZE, which is the natural logarithm of total assets denominated in U.S. $.

(4) CAPEX, which is the capital expenditure expense divided by total assets.

(5) PPE, which is the firm's Net property, plant, and equipment expense divided by total assets.

(6) CASH, is calculated as cash and short-term investments divied by total assets.

(7) R&D, is the firm's R&D expenditure scaled by total assets.

(8) SALESGROWTH, which is the annual growth in a firm's total sales.

(9) FSALES, is the proportion of total sales from foreign operations.

(10) ANALYSTS, the number of analysts that follows a firm measured by the number of analysts that provide an estimate of the firm's earnings per share in the next period.

(11) CLOSE, the number of shares held by insiders as a fraction of the number of shares outstanding.

For both event-study and aggregated firm-year regressions we also include some standard country-year variables:

(4) GGDP, which is the annual growth rate of GDP in constant 2005 U.S. $

(5) MCAP, which is the stock market capitalization

(6) GDPC, defined as the GDP per capita in constant 2005 U.S. $

(7) IR, which is a measure of the countries interest rates

4.4 DATA AND SAMPLE

4.4.1 *Data*

The data in this study is constructed using several different sources, which ultimately combines information for cross-border mergers and acquisitions, patent data, stock price and returns, and accounting data.

First, cross-border mergers and acquisitions data is collected from the Securities Data Corporation (SDC) Platinum Mergers and Acquisitions database. We impose a number of restrictions to our initial sample, which includes: (1) the acquisition is completed; (2) Datastream code for the acquiror must be available (3) the acquisition must be a cross-border mergers and acquisition; (4) the acquiror must own less than 51% of the equity prior to the acquisition and greater than 50% after (5) the deal value must exceed $1 million USD; (6) the announcement date is between January 1, 1998 and December 31, 2012.

Second, we collect patent data from the Derwent World Patent Index (DWPI) available in the Thomson Innovation database. The DWPI offers the world's most comprehensive database of enhanced patent documents. For example, in 2015, DWPI provided patent information for upwards of 63.3 million patent documents consisting of 29.4 million patent families from 50 patent-issuing authorities as well as 2 journal sources. More importantly, expertly trained staff apply over 5,000 rules to normalize, standardize, correct and enhance patent records resulting in over 6,000 corrections each week.

Third and finally, we collect the remaining data from several sources. Stock price and return data is collected from Datastream. Accounting data is collected from Worldscope. Country-level data is sourced from World Development Indicators.

A primary concern with using patent data is that the DWPI database only provides us with the names of the assignee firms rather than stock identifiers. To address this concern, we follow procedures specified by the National Bureau of Economics Research (NBER) patent database. Specifically, we collect from the DWPI database the DWPI standardized assignee names for all patents with application date after 1998, as well as all current and past names for the primary quotes of major securities on Worldscope. We use the programs provided by the NBER patent website to standardize both the DWPI assignee names as well as the Worldscope firm names. The assignee names and firm names are then matched following Bena et al. (2017) by using a combination of the Bigram string comparison algorithm and the Levenshtein distance metric.[35] The matching process can be described as both exact and fuzzy. For non-exact matches we manually search for information for the sample firms and the matched patent to confirm whether they matched up correctly in order to be included in our sample.

4.4.2 Sample

Our initial patent sample contains 24,600,239 patent documents with application dates between 1998 and 2016 available from the DWPI database. The NBER patent database provides us with separate standardization routines for both assignee and firm names. After standardizing assignee names from the DWPI database, we are left with 1,706,447 unique assignee names. Similarly, after standardizing the past and present firm

[35] More details of the matching procedure is provided in Appendix C.

names, we have 112,404 unique firm names from Worldscope. We match standardized assignee names and standardized firm names by splitting each name into their individual bigrams. The bigrams between the assignee names and standardized firm names are then matched and aggregated by assignee-firm pairs.[36] By requiring that the bigram score for each assignee-firm pairing must be greater than or equal to 0.5, we have a total of 329,953,629 possible matches. We further restrict this sample by requiring that the cost measured using the Levenshtein distance metric is no greater than 500, resulting in 14,346,128 matches. By creating a metric based on both bigram score and Levenshtein distance, we further restrict this sample to a manageable number of 52,070. Amongst these 52,070 matches, we have 16,727 exact matches and 35,343 non-exact matches. For non-exact matches we manually search for information for both the firm and the matched patent associated with the assignee name based on various factors such as address, website, type of technology amongst other factors. Out of the non-exact matches we find that 22,237 are correctly matched. We then utilize the Assignee DWPI code, which provides unique codes for common patenting entities. Out of the 7,489 common patenting entities, our initial matching routine captures 2,587 of these patenting entities. For the remaining 4,902 common patenting entities, we match them manually to firms in Worldscope. Using these two methods, we match 9,601,475 out of the 24,600,239 total patent documents. To account for the fact that these 9,601,475 patents aren't necessarily different inventions, we use the INPADOC patent family to determine the patent with the earliest application date. After deleting the patents that share a patent family with other patents we find that there are

[36] There are cases where there are multiple identical bigrams in an assignee (firm) name. If identical bigrams can be matched to a single bigram in the firm (assignee) name, the bigram score can be larger than one. Therefore, for each assignee-firm pairing we allow only one match for each individual bigram.

8,944,533 basic patents. We then address the truncation issue associated with patent data by deleting all basic patents with application dates after 2013, which results in a final sample of 7,736,304 basic patents matched to 19,794 firms from Worldscope. Therefore, our patent sample consists of 19,794 firms for years between 1998 and 2013.

To allow for a one-year lag for the independent variables, we gather cross-border acquisitions between 1998 and 2012. We briefly note how we arrive at our sample. First, we collect all completed M&A with deal values exceeding $1 million USD between 1998 to 2012, which provides us with a total of 178,691 M&A during the sample period. We begin by deleting all observations without acquiror Datastream codes (92,158).[37] The observations where the Datastream of the acquiror is the same as the target are also deleted (87,338). Deals that are not considered cross-border M&As are deleted (25,745). Observations where the percentage acquired, or the percentage owned after are missing are deleted (24,999). Further, we require that the cross-border acquisition represents a change in control, therefore we require that the acquiror previously owned less than 51% and the amount owned afterwards is 51% or greater (18,995). We then delete any observations associated with acquisitions of assets or buy-backs which are not associated with equity ownership (9,086). Acquisitions between financial and utility firms i.e. SIC codes between 6900-6999 (Financial) and 4900-4999 (Utility) are deleted from our sample (7,172). Next, we delete all deals that are not between developed acquiror and emerging target countries pairs (1,266).[38] We then require that we can compute the technological proximity and product market rivalry measures, which results in a final sample of 483 cross-border acquisitions, which covers approximately 38.15% of the developed-emerging pairs based

[37] The number of deals remaining after we perform these steps are reported in brackets.
[38] Developed and emerging countries are defined based on the MSCI classification.

on our filtering. To match the acquisition deals to non-target rivals, we use the 2-digit primary SIC code of the target provided by SDC platinum for each deal. This is then matched to the 2-digit primary SIC codes provided by Worldscope.[39]

Table 4.1 reports the sample distribution of cross-border acquisitions by year. Columns 1 and 2 report the number of cross-border acquisitions and the percentage weights relative to our entire sample. We identify a total of 483 cross-border acquisitions between the years 1998 and 2012. There is an increasing trend in regards to the number of cross-border acquisitions relative to the sample year. This is expected as it represents the increasing trend for FDI worldwide.

[39] The SIC codes are generally scarcer than ICB classification codes on Worldscope. For those that we do not observe a SIC code, but we do observe ICB codes, we map them back to the appropriate 2-digit SIC code using all the available SIC-ICB pairs available on Worldscope.

Table 4.1: Cross-border Acquisitions by Year

The sample (by year): This table reports our entire sample of cross-border acquisitions for each year between 1998 and 2012.

Year	N.O. of Cross-border Acquisitions [1]	Percentage [2]
1998	24	4.97%
1999	30	6.21%
2000	29	6.00%
2001	31	6.42%
2002	21	4.35%
2003	30	6.21%
2004	32	6.63%
2005	36	7.45%
2006	41	8.49%
2007	31	6.42%
2008	37	7.66%
2009	30	6.21%
2010	33	6.83%
2011	44	9.11%
2012	34	7.04%
Mean	32.20	6.67%
Median	31.50	6.52%
Std. Dev.	5.85	1.21%
Min	21	4.35%
Max	44	9.11%
Total	483	100.00%

Table 4.2 reports the sample distribution of cross-border acquisitions by country. In our sample there are 18 countries, which are identified as emerging countries. As shown in Column 2, the weights of cross-border acquisitions range from as little of 0.21% in Peru to 30.43% in China. Columns 4 and 5 provides us with the total deal value of our cross-border acquisitions. We find that the smallest deal weight is associated with Philippines (220 million U.S. $ (0.32%)) and the largest in our sample is Brazil (15,480 million U.S. $ (22.82%)). The number of rivals for each country is reported in Columns 6-8, specifically the average number of rivals is 27.11 across all countries.

Table 4.2 Sample Distribution of Cross-Border Acquisitions by Country

The sample (by country): This table reports the number of cross-border acquisitions, the average and total deal values, and the average, minimum, maximum number of rival firms for each country.

Market	N.O. of Cross-border Acquisitions	Percentage	Deal value (million U.S. $)			N.O. of Rivals		
			Mean	Total	Percentage	Mean	Min	Max
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Brazil	61	12.63%	254	15,480	22.82%	5.93	1	16
Chile	9	1.86%	471	4,238	6.25%	2.44	1	4
China	147	30.43%	76	11,202	16.51%	152.62	2	539
Czech Republic	15	3.11%	316	4,747	7.00%	2.27	1	4
Egypt	2	0.41%	25	50	0.07%	1.00	1	1
Hungary	2	0.41%	9	17	0.03%	2.00	2	2
India	55	11.39%	86	4,715	6.95%	59.11	2	80
Indonesia	11	2.28%	137	1,510	2.23%	2.00	1	3
Malaysia	25	5.18%	139	3,482	5.13%	6.88	1	12
Mexico	19	3.93%	175	3,333	4.91%	3.95	1	6
Peru	1	0.21%	470	470	0.69%	2.00	2	2
Philippines	5	1.04%	44	220	0.32%	1.60	1	2
Poland	34	7.04%	45	1,525	2.25%	17.74	1	47
Russian Fed	11	2.28%	283	3,113	4.59%	2.55	1	4
South Africa	20	4.14%	198	3,956	5.83%	6.80	1	12
Taiwan	32	6.63%	118	3,767	5.55%	209.53	3	395
Thailand	18	3.73%	76	1,368	2.02%	4.50	1	9
Turkey	16	3.31%	290	4,640	6.84%	5.00	1	9
Mean	26.83	5.56%	178	3,769	5.56%	27.11		
Median	17	3.52%	138	3,407	5.02%	4.22		
Std. Dev.	34.40	7.12%	142	3,935	5.80%	58.41		
Min.	1	0.21%	9	17	0.03%	1		
Max.	147	30.43%	471	15,480	22.82%	209.53		
Total	483	100.00%	3,212	67,833	100.00%	487.91		

Panel A of Table 4.3 presents the summary statistics associated with our firm-, deal-, and country-level variables for 5,868 rival-years in our event study. The mean of $Ln(SPILLTECH)$, which represents our technology spillover is 6.999. If we take the exponential, we have an approximate 1,095,537 U.S $ of related R&D stock (units are in 000's). The equivalent Mahalanobis measures of technology spillovers and product market rivalries are generally larger due to taking account the relatedness between technological and product market classifications.

Our event study naturally represents a sub-sample of our entire rival-year sample due to potential contamination issues associated with the calculation of CARs. Therefore, we also report the full sample that represents annual aggregated values when testing the real effects (Tobin's Q, Total Factor Productivity, and Innovation) in Panel B. Our measures of innovation is most complete due to the use of patent data to measure the spatial proximity for rival firms. We then match on our measures of Tobin's Q, as well as Total Factor Productivity.

Table 4.3 Summary Statistics Associated with Firm, Deal, and Country-Level Variables

In panel A, we report the summary statistics for the sub-sample associated with our event study around a cross-border acquisition deal. In panel B, we report the summary statistics for the variables after aggregating all deal related variables to the firm-year level. The table presents the descriptive statistics of firm-, deal-, and country-level variables.Variable definitions are provided in Appendix F.

Panel A: Event Study

	N	Mean	Std. Dev.	Min	Median	Max
	[1]	[2]	[3]	[4]	[5]	[6]
$CAR(-2,+2)$	5,868	0.006	0.062	-0.142	-0.000	0.214
$Ln(SPILLTECH)$	5,868	6.999	4.461	0.000	8.249	15.000
$Ln(SPILLTECH_{MAH})$	5,868	8.753	4.257	0.000	10.047	15.929
$Ln(SPILLSALES)$	5,868	1.749	4.163	0.000	0.000	15.454
$Ln(SPILLSALES_{MAH})$	5,868	4.682	4.469	0.000	5.074	15.460
$CROSSVAL$	5,868	0.001	0.003	0.000	0.000	0.021
$RUNUP$	5,868	0.035	0.502	-0.914	-0.056	2.099
$SIGMA$	5,868	0.028	0.009	0.012	0.027	0.060
$Ln(MV)$	5,868	5.296	1.761	1.185	5.333	9.551
$TOBIN'S\ Q$	5,868	1.866	1.331	0.584	1.410	7.870
$LEVERAGE$	5,868	0.238	0.177	0.000	0.230	0.687
$SALESGROWTH$	5,868	0.168	0.344	-0.543	0.132	1.658
$INDUSTRY$	5,868	0.604	0.489	0.000	1.000	1.000
$GGDP$	5,868	6.554	3.923	-10.510	6.117	14.162
$MCAP$	5,868	101.351	50.556	7.722	100.349	291.275
$GDPC$	5,868	8.262	1.163	6.228	7.868	9.758
IR	5,868	7.468	7.451	2.797	5.310	86.363

Table 4.3 Cont.

Panel B: Real Effects						
	N	Mean	Std. Dev	Min	Median	Max
	[1]	[2]	[3]	[4]	[5]	[6]
$Ln(Q)$	13,075	-0.006	0.642	-2.194	-0.047	1.877
$Ln(TFP)$	12,525	5.458	1.541	2.513	5.251	9.301
$Ln(1 + COUNT)$	13,183	0.608	0.945	0.000	0.111	4.099
$Ln(1 + CITE)$	13,183	1.392	1.905	0.000	0.000	6.958
$Ln(SPILLTECH)$	13,183	9.085	4.193	0.000	10.214	15.166
$Ln(SPILLTECH_{MAH})$	13,183	10.781	3.663	0.000	11.678	15.905
$Ln(SPILLSALES)$	13,183	2.397	4.592	0.000	0.000	15.413
$Ln(SPILLSALES_{MAH})$	13,183	6.488	3.909	0.000	6.809	15.422
$CROSSVAL$	13,183	0.002	0.004	0.000	0.001	0.026
ROA	13,183	0.073	0.080	-0.255	0.070	0.300
$LEVERAGE$	13,183	0.227	0.174	0.000	0.213	0.714
$SIZE$	13,183	12.357	1.410	9.173	12.258	16.346
$CAPEX$	13,183	0.062	0.058	0.000	0.045	0.282
PPE	13,183	0.313	0.179	0.016	0.287	0.769
$CASH$	13,183	0.184	0.145	0.004	0.145	0.672
$R\&D$	13,183	0.012	0.027	0.000	0.000	0.158
$SALESGROWTH$	13,183	0.173	0.334	-0.533	0.129	1.829
$FSALES$	13,183	8.815	21.905	0.000	0.000	98.640
$ANALYSTS$	13,183	1.735	3.757	0.000	0.000	20.000
$CLOSE$	13,183	23.935	28.546	0.000	4.260	92.540
$GGDP$	13,183	7.870	3.467	-10.510	9.082	14.162
$MCAP$	13,183	89.896	50.658	11.834	80.311	291.275
$GDPC$	13,183	8.150	1.024	6.271	7.962	9.776
IR	13,183	6.951	6.553	2.603	5.810	86.363

4.5 Empirical Results

4.5.1 Baseline Results

We begin by employing an event study for industry-linked rivals in the target nation around a controlling cross-border acquisition. We perform this event study, because it provides us with the distinct effects associated with a single cross-border acquisition event, which may not be the case if we aggregate effects at an annual level. However, one issue with performing an event study is that we require that estimations of the CARs are not contaminated by another event. Specifically, observations are only included if there isn't another cross-border acquisition within the CAR estimation window. Therefore, this event study represents a subsample of the entire set of cross-border acquisitions that we intend to analyse in the later sections. We include both firm and year fixed effects in each regression as well as control variables that have frequently been used in event studies around M&As.

Our results are presented in Table 4.4. As shown in Column 1, we find that $CROSSVAL$ has an insignificant effect on the CARs, however a p-value of 0.109 suggests that it is close to being significant at the 10% level, which provides some support for the competition effect from Aitken and Harrison (1999). However, the effect of $Ln(SpillTech)$ is positive and significant at the 1% level. This suggests that the potential technology diffusions from the acquiror is associated with a highly positive market response. In terms of the economic significance, this tells us that a 1% increase in our technology spillover measure is associated with about a 0.18% increase in cumulative abnormal returns relative to the mean. In Column 2 of Table 4.4, we investigate whether there is a product market rivalry effect. Indeed, it is plausible if rivals can learn by replicating products and creating it at a cheaper cost we would expect this effect to be positive and significant. On the other hand, if the cross-border acquisition is export driven and they compete with the rival firm in the product market, then we expect this effect to be negative and significant. However, we find that this is insignificant at all conventional significance levels. In Column 3 of Table 4.4, we include both technology spillover and product market rivalry and the results remain consistent with those from Column 1 and 2. Next we investigate the Mahalanobis measures introduced by Bloom et al. (2013), we find that in Column 4 and 5 of Table 4.4, the results are again consistent with those in Column 1 and 2 even after accounting for correlations within technological or product market proximity linkages. However, in Column 6, when we include both Mahalanobis measures, the product market rivalry measure is now significantly negative. This is most likely driven by the higher correlations associated with the Mahalanobis measures, since the product market rivalry measure on its own does not appear to have any explanatory power. Therefore, the CARs are mainly driven by the technological rather than any product market linkages, which provides some preliminary support for Hypothesis 1b.

Table 4.4: Technology Spillovers and Cumulative Abnormal Returns of Non-Target Rival Firms

This table reports an event study around a controlling cross-border acquisition and the effects of technology spillovers and product market rivalry on cumulative abnormal returns on the non-target rival firm. The dependent variable is CAR(-2,+2) is the CARs of non-target rivals over the (-2,+2) period around the announcement date of a cross-border acquisition. The main independent variable is the natural logarithm of our technology spillover and product market rivalry. All regressions include a full set firm and year fixed effects. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix F.

	$CAR(-2,+2)$					
	[1]	[2]	[3]	[4]	[5]	[6]
$Ln(SPILLTECH)$	0.001***		0.001***			
	(0.000)		(0.000)			
$Ln(SPILLSALES)$		0.000	-0.000			
		(0.413)	(0.646)			
$Ln(SPILLTECH_{MAH})$				0.001***		0.002***
				(0.000)		(0.000)
$Ln(SPILLSALES_{MAH})$					0.000	-0.001***
					(0.740)	(0.000)
$CROSSVAL$	-0.033	-0.020	-0.033	-0.035	-0.020	-0.039*
	(0.109)	(0.230)	(0.108)	(0.109)	(0.237)	(0.076)
$RUNUP$	-0.012***	-0.012***	-0.012***	-0.012***	-0.012***	-0.012***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$SIGMA$	-0.260	-0.238	-0.260	-0.278	-0.238	-0.296
	(0.160)	(0.197)	(0.160)	(0.134)	(0.198)	(0.111)
$Ln(MV)$	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.314)	(0.151)	(0.318)	(0.362)	(0.160)	(0.321)
$TOBIN'S\ Q$	-0.005***	-0.005***	-0.005***	-0.005***	-0.005***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$LEVERAGE$	-0.013	-0.012	-0.013	-0.013	-0.012	-0.014
	(0.216)	(0.250)	(0.213)	(0.220)	(0.245)	(0.178)
$SALESGROWTH$	0.003	0.003	0.003	0.002	0.003	0.002
	(0.426)	(0.353)	(0.426)	(0.443)	(0.350)	(0.485)
$INDUSTRY$	-0.000	0.000	-0.000	-0.000	0.001	0.000
	(0.888)	(0.874)	(0.932)	(0.925)	(0.808)	(0.896)
$GGDP$	-0.001**	-0.001**	-0.001**	-0.001*	-0.001*	-0.001*
	(0.043)	(0.049)	(0.047)	(0.054)	(0.054)	(0.062)
$MCAP$	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$GDPC$	0.035***	0.033***	0.035***	0.036***	0.033***	0.037***
	(0.002)	(0.004)	(0.002)	(0.002)	(0.004)	(0.001)
IR	-0.001*	-0.001	-0.001*	-0.001*	-0.001*	-0.001*
	(0.077)	(0.110)	(0.071)	(0.085)	(0.095)	(0.069)
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
$Adj. R^2$	0.188	0.185	0.188	0.188	0.185	0.190
N	5,868	5,868	5,868	5,868	5,868	5,868

4.5.2 Real Effects

In this section, we investigate the real effects associated with cross-border technology spillovers and product market rivalry on Tobin's Q, Productivity and Innovation. Specifically, we aggregate all variables at the annual-level and focus only on the rival firm-years where there is at least one cross-border acquisition associated with the rival. We expect that the market response i.e. the positive CARs associated with technology spillovers will carry on having real effects on a firm at the annual level.

4.5.2(i) Tobin's Q

In Table 4.5, we report the annual-level aggregated effects of technology spillovers from cross-border acquisitions on the Tobin's Q of rival firms. As expected the aggregated effect of technology spillover is like those reported in our CAR results in Table 4.5, since Tobin's Q is also a market related measure. Specifically, the aggregated technology spillovers are positive and significant at the 1% level. The product market rivalry measure in Column 2 of Table 4.5 is now almost negatively significant at the 10% level, which suggests that there could be some negative effects for rival firms if they share the same product market as the acquiror. In both Column 3 and 4 in Table 4.5. the product market rivalry measure becomes significant when included with our technology spillover measure. This would suggest that rival firms can benefit if they can learn from the acquiror's technology, but there is an offsetting effect associated with product market rivalries.

Table 4.5: Technology Spillovers and Tobin's Q of Non-Target Rival Firms

This table reports an OLS estimation of the aggregated technology spillover, product market rivalry, and deal value at the non-target rival firm-year level. Firm-years are only included if another firm within the same industry was acquired during that year. The dependent variable is the logarithm of Tobin's Q. The main independent variable is the natural logarithm of our technology spillover and product market rivalry measures. All regressions include a full set firm and year fixed effects. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix F.

		$Ln(Q)$		
	[1]	[2]	[3]	[4]
$Ln(SPILLTECH)$	0.003***		0.004***	
	(0.002)		(0.000)	
$Ln(SPILLSALES)$		-0.001	-0.002**	
		(0.139)	(0.016)	
$Ln(SPILLTECH_{MAH})$				0.004***
				(0.001)
$Ln(SPILLSALES_{MAH})$				-0.002**
				(0.021)
$CROSSVAL$	-0.510	0.586	-0.533	-0.586
	(0.631)	(0.564)	(0.615)	(0.576)
ROA	0.930***	0.935***	0.929***	0.928***
	(0.000)	(0.000)	(0.000)	(0.000)
$LEVERAGE$	-0.733***	-0.732***	-0.734***	-0.735***
	(0.000)	(0.000)	(0.000)	(0.000)
$SIZE$	-0.015	-0.015	-0.015	-0.015
	(0.477)	(0.471)	(0.473)	(0.458)
$CAPEX$	-0.386***	-0.391***	-0.383***	-0.382***
	(0.000)	(0.000)	(0.000)	(0.000)
PPE	-0.304***	-0.304***	-0.304***	-0.304***
	(0.000)	(0.000)	(0.000)	(0.000)
$CASH$	0.669***	0.665***	0.669***	0.669***
	(0.000)	(0.000)	(0.000)	(0.000)
$R\&D$	-0.040	0.000	-0.034	-0.049
	(0.919)	(1.000)	(0.932)	(0.901)
$SALESGROWTH$	-0.051***	-0.051***	-0.051***	-0.052***
	(0.001)	(0.001)	(0.001)	(0.001)
$FSALES$	-0.000	-0.000	-0.000	-0.000
	(0.306)	(0.351)	(0.305)	(0.317)

Table 4.5 Cont.

	$Ln(Q)$			
	[1]	[2]	[3]	[4]
$ANALYSTS$	0.003*	0.003	0.003*	0.003*
	(0.095)	(0.106)	(0.099)	(0.092)
$CLOSE$	-0.000	-0.000	-0.000	-0.000
	(0.821)	(0.795)	(0.841)	(0.851)
$GGDP$	-0.003	-0.003	-0.003	-0.003
	(0.234)	(0.189)	(0.174)	(0.185)
$MCAP$	0.000	0.000	0.000	0.000
	(0.314)	(0.315)	(0.219)	(0.212)
$GDPC$	-0.164**	-0.170***	-0.158**	-0.150**
	(0.011)	(0.009)	(0.015)	(0.022)
IR	0.004	0.003	0.004	0.004
	(0.165)	(0.204)	(0.182)	(0.189)
Year-fixed effects	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES
$Adj. R^2$	0.741	0.741	0.741	0.741
N	13,075	13,075	13,075	13,075

4.5.2(ii) Productivity

The literature on technology spillovers mainly focus on how FDI can affect a rival firm's productivity. In this section, we return to that notion and find that there is indeed a significant negative effect associated with FDI on domestic productivity. As shown in Column 1 of Table 4.6, we find that $CROSSVAL$ is negative and significant at the 5% level. However, by disentangling the effect of technology spillovers from FDI, we can see that technology spillovers from cross-border acqusitions continue to have a significantly positive effect on a firm's total factor productivity at the 5%. Moreover, this is consistent in Column 3 of Table 4.6 and is stronger when taking into account the inter-related technology classes with the Mahalanobis measure in Column 4 of Table 4.6.

Table 4.6: Technology Spillovers and Total Factor Productivity of Non-Target Rival Firms

This table reports an OLS estimation of the aggregated technology spillover, product market rivalry, and deal value at the non-target rival firm-year level. Firm-years are only included if another firm within the same industry was acquired during that year. The dependent variable is the logarithm of Tobin's Q. The main independent variable is the natural logarithm of our technology spillover and product market rivalry measures. All regressions include a full set of firm and year fixed effects. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix F.

	$Ln(TFP)$			
	[1]	[2]	[3]	[4]
$Ln(SPILLTECH)$	0.005**		0.005**	
	(0.022)		(0.019)	
$Ln(SPILLSALES)$		0.000	-0.001	
		(0.916)	(0.526)	
$Ln(SPILLTECH_{MAH})$				0.009***
				(0.008)
$Ln(SPILLSALES_{MAH})$				-0.004
				(0.211)
$CROSSVAL$	-6.939**	-5.184*	-6.949**	-7.497**
	(0.015)	(0.066)	(0.015)	(0.010)
ROA	0.957***	0.963***	0.956***	0.951***
	(0.000)	(0.000)	(0.000)	(0.000)
$LEVERAGE$	-0.038	-0.036	-0.038	-0.040
	(0.751)	(0.760)	(0.750)	(0.738)
$SIZE$	0.106***	0.106***	0.106***	0.105***
	(0.001)	(0.001)	(0.001)	(0.001)
$CAPEX$	-0.259	-0.271	-0.258	-0.259
	(0.127)	(0.111)	(0.130)	(0.128)
PPE	-0.915***	-0.913***	-0.915***	-0.915***
	(0.000)	(0.000)	(0.000)	(0.000)
$CASH$	-0.092	-0.098	-0.092	-0.091
	(0.439)	(0.415)	(0.441)	(0.444)
$R\&D$	-3.206***	-3.210***	-3.197***	-3.199***
	(0.000)	(0.000)	(0.000)	(0.000)
$SALESGROWTH$	0.286***	0.287***	0.286***	0.285***
	(0.000)	(0.000)	(0.000)	(0.000)
$FSALES$	0.001**	0.001**	0.001**	0.001**
	(0.039)	(0.034)	(0.039)	(0.038)
$ANALYSTS$	0.005	0.005	0.005	0.005
	(0.228)	(0.239)	(0.230)	(0.214)
$CLOSE$	-0.018***	-0.018***	-0.018***	-0.018***
	(0.000)	(0.000)	(0.000)	(0.000)
$GGDP$	-0.058***	-0.058***	-0.058***	-0.058***
	(0.000)	(0.000)	(0.000)	(0.000)

Table 4.6 Cont.

	$Ln(TFP)$			
	[1]	[2]	[3]	[4]
$MCAP$	0.007***	0.007***	0.007***	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)
$GDPC$	-0.742***	-0.750***	-0.739***	-0.726***
	(0.000)	(0.000)	(0.000)	(0.000)
IR	0.003	0.002	0.002	0.003
	(0.820)	(0.862)	(0.826)	(0.807)
Year-fixed effects	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES
$Adj. R^2$	0.839	0.839	0.839	0.839
N	12,525	12,525	12,525	12,525

4.5.2(iii) Innovation

Finally, we investigate whether technology diffusion from cross-border acquisitions leads to increased innovation by the non-target rival firms. In Column 1 of both Panel A and B of Table 4.7, we find that the technology spillovers are positive and significant at the 1% level for both innovation quantity ($Ln(1 + COUNT)$) and innovation quality ($Ln(1 + CITE)$). Moreover, this effect is not affected by the inclusion of product market rivalry or the use of the Mahalanobis spillover measures as shown in Columns 3 and 4 of Table 4.7, respectively.

Table 4.7 Technology Spillovers and Innovation of Non-Target Rival Firms

This table reports an OLS estimation of the aggregated technology spillover, product market rivalry, and deal value at the non-target rival firm-year level. Firm-years are only included if another firm within the same industry was acquired during that year. The dependent variable in Panel A is the natural logarithm of 1 plus our scaled patent count measure. The dependent variable in Panel B is the natural logarithm of 1 plus our scaled citations measure. The main independent variable is the natural logarithm of our technology spillover and product market rivalry measures. All regressions include a full set of firm and year fixed effects. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix F.

	Panel A			
	$Ln(1 + COUNT)$			
	[1]	[2]	[3]	[4]
$Ln(SPILLTECH)$	0.004***		0.004***	
	(0.001)		(0.000)	
$Ln(SPILLSALES)$		-0.000	-0.002	
		(0.688)	(0.189)	
$Ln(SPILLTECH_{MAH})$				0.008***
				(0.000)
$Ln(SPILLSALES_{MAH})$				-0.003*
				(0.080)
$CROSSVAL$	0.542	1.737	0.525	0.149
	(0.601)	(0.105)	(0.613)	(0.886)
ROA	0.268***	0.274***	0.267***	0.263***
	(0.004)	(0.003)	(0.004)	(0.005)
$LEVERAGE$	0.033	0.034	0.033	0.031
	(0.696)	(0.687)	(0.701)	(0.715)
$SIZE$	0.157***	0.157***	0.157***	0.156***
	(0.000)	(0.000)	(0.000)	(0.000)
$CAPEX$	-0.058	-0.065	-0.056	-0.057
	(0.625)	(0.580)	(0.636)	(0.628)
PPE	0.325***	0.326***	0.325***	0.326***
	(0.002)	(0.002)	(0.002)	(0.002)
$CASH$	0.144	0.139	0.144	0.144
	(0.117)	(0.130)	(0.116)	(0.115)
$R\&D$	2.466***	2.466***	2.477***	2.472***
	(0.000)	(0.000)	(0.000)	(0.000)
$SALESGROWTH$	-0.040***	-0.039***	-0.040***	-0.040***
	(0.009)	(0.010)	(0.009)	(0.008)
$FSALES$	-0.001**	-0.001**	-0.001**	-0.001**
	(0.038)	(0.047)	(0.038)	(0.039)
$ANALYSTS$	0.017***	0.017***	0.017***	0.017***
	(0.000)	(0.000)	(0.000)	(0.000)
$CLOSE$	-0.001***	-0.001***	-0.001***	-0.001***
	(0.001)	(0.000)	(0.001)	(0.001)

Table 4.7 Panel A Cont.

	$Ln(1+COUNT)$			
	[1]	[2]	[3]	[4]
$GGDP$	-0.006**	-0.006**	-0.006***	-0.006**
	(0.014)	(0.012)	(0.010)	(0.014)
$MCAP$	0.001***	0.001***	0.001***	0.001***
	(0.001)	(0.002)	(0.001)	(0.001)
$GDPC$	1.669***	1.661***	1.673***	1.683***
	(0.000)	(0.000)	(0.000)	(0.000)
IR	-0.012***	-0.013***	-0.012***	-0.012***
	(0.001)	(0.000)	(0.001)	(0.001)
Year-fixed effects	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES
$Adj. R^2$	0.799	0.799	0.799	0.799
N	13,183	13,183	13,183	13,183

Panel B

	$Ln(1+CITE)$			
	[1]	[2]	[3]	[4]
$Ln(SPILLTECH)$	0.009***		0.010***	
	(0.001)		(0.000)	
$Ln(SPILLSALES)$		-0.001	-0.004	
		(0.558)	(0.115)	
$Ln(SPILLTECH_{MAH})$				0.015***
				(0.000)
$Ln(SPILLSALES_{MAH})$				-0.006
				(0.136)
$CROSSVAL$	-0.064	2.603	-0.105	-0.647
	(0.979)	(0.287)	(0.965)	(0.788)
ROA	0.662***	0.676***	0.661***	0.654***
	(0.000)	(0.000)	(0.001)	(0.001)
$LEVERAGE$	0.257	0.259	0.256	0.253
	(0.110)	(0.107)	(0.112)	(0.116)
$SIZE$	0.282***	0.282***	0.282***	0.280***
	(0.000)	(0.000)	(0.000)	(0.000)
$CAPEX$	-0.167	-0.183	-0.162	-0.166
	(0.475)	(0.432)	(0.487)	(0.475)
PPE	0.353*	0.354*	0.353*	0.355*
	(0.069)	(0.069)	(0.069)	(0.068)
$CASH$	0.177	0.166	0.178	0.178
	(0.294)	(0.326)	(0.291)	(0.292)
$R\&D$	4.496***	4.498***	4.522***	4.505***
	(0.000)	(0.000)	(0.000)	(0.000)
$SALESGROWTH$	-0.084***	-0.083***	-0.084***	-0.085***
	(0.005)	(0.006)	(0.005)	(0.005)

Table 4.7 Panel B Cont.

	$Ln(1 + CITE)$			
	[1]	[2]	[3]	[4]
$FSALES$	-0.001	-0.001	-0.001	-0.001
	(0.296)	(0.341)	(0.296)	(0.307)
$ANALYSTS$	0.021***	0.021***	0.021***	0.021***
	(0.002)	(0.002)	(0.002)	(0.001)
$CLOSE$	-0.002**	-0.002**	-0.002**	-0.002**
	(0.016)	(0.014)	(0.017)	(0.018)
$GGDP$	-0.011*	-0.011**	-0.012**	-0.011*
	(0.051)	(0.045)	(0.039)	(0.052)
$MCAP$	0.001**	0.001**	0.001**	0.001**
	(0.019)	(0.026)	(0.013)	(0.016)
$GDPC$	3.386***	3.369***	3.396***	3.413***
	(0.000)	(0.000)	(0.000)	(0.000)
IR	-0.020***	-0.021***	-0.020***	-0.020***
	(0.002)	(0.001)	(0.002)	(0.002)
Year-fixed effects	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES
$Adj. R^2$	0.789	0.789	0.789	0.789
N	13,183	13,183	13,183	13,183

Overall, the real effects of technology spillovers, which include Tobin's Q, Total Productivity, and Innovation provides us with a justification for why the market reacts positively to a controlling cross-border acquisition. This provides further evidence to support Hypothesis 1b.

4.5.3 Horizontal vs Non-Horizontal

Past literature frequently distinguishes between two forms of cross-border acquisitions, namely, horizontal and vertical cross-border acquisitions. The two forms differ significantly and represents different strategies for the acquiring firm. Specifically, horizontal cross-border acquisitions are usually associated with the acquiror's desire to gain market access and replicate their production process abroad. While vertical cross-border acquisitions are associated with the acquiror's desire to access a complementary resource to facilitate their production process at home (Caves, 1971; Head and Ries, 2003; Herger and

McCorriston, 2016). More importantly, the internalization theory surrounding international expansions suggests that firms can create value through cross-border acquisitions by expanding the use of their proprietary assets internationally rather than contracting or licensing their proprietary assets. Moreover, their proprietary assets are likely to be industry specific, therefore a horizontal cross-border acquisition is more likely to be associated with the intention to deploy their proprietary assets worldwide. The results are reported in Table 4.8. In Column 1 of Table 4.8, we interact our $INDUSTRY$ indicator variable, which is equal to one when the target and the acquiror operates in the same 2-digit primary SIC code. We find that the interaction term $(Ln(SPILLTEC) \times INDUSTRY)$ captures almost entirely the positive effect of technology spillovers on CARs and is significant at the 1% level. Similarly, when we interact our product market rivalry with the $INDUSTRY$ indicator variable, we find that the interaction term $(Ln(SPILLSALES) \times INDUSTRY)$ is negative and significant at the 10% level. This result is notably different from Column 3 of Table 4.4., where $Ln(SPILLSALES)$ isn't significant at any conventional significance level. This suggests that our product market rivalry is capturing some of the negative effects associated with the competition that is induced by a firm that internalizes their proprietary assets across borders. However, in terms of the sample mean of technology spillovers and product market rivalry, we can see that our technology spillover measures at the natural logarithm level is at least 4 times the size of our product market rivalry measure. This result suggests that at means the benefits associated with technology spillovers far outweigh any of the costs associated with product market rivalry. The structure of our model differs in Columns 2-5 of Table 4.4, due to the fact that Column 1 represents a single deal, while Columns 2-5 represents multiple deals in a year. To investigate the effect of horizontal deals, we aggregate our technology spillover measure for all horizontal and non-horizontal deals separately during a firm-year and include both measures as independent variables. In Columns 2-5 of Table 4.4., we find results that are similar to those in Column 1, in particular, the aggregated spillovers associated with horizontal cross-border acquisitions always captures all the significance as opposed to non-horizontal cross-border acquisitions. Based on our results, this suggests that the technology spillovers in cross-border acquisitions are associated with horizontal cross-border acquisitions i.e. when an acquiror replicates or operates their production processes in the local market. This provides support for Hypothesis 2a.

Table 4.8 The Effect of Horizontal vs Non-Horizontal Cross-border Acquisitions

In Column 1, this table reports an event study around a controlling cross-border acquisition and the effects of technology spillovers and product market rivalry interacted with an industry indicator variable on cumulative abnormal returns on the non-target rival firm. The main independent variable is the natural logarithm of our technology spillover measure interacted with the industry indicator variable. Columns 2-4 reports an OLS estimation of the aggregated technology spillover, product market rivalry, and deal value on $Ln(Q), Ln(1 + COUNT), and\ Ln(TFP)$ at the non-target rival firm-year level. Firm-years are only included if another firm within the same industry was acquired during that year. The main independent variable is the natural logarithm of our technology spillover and product market rivalry measures that have been aggregated based on whether a cross-border acquisition is considered horizontal or non-horizontal (horizontal deals occur when the 2-digit primary SIC code between the acquiror and the target is equal, and are non-horizontal otherwise). All regressions include a full set of firm and year fixed effects. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix F.

	$CAR(-2,+2)$ [1]	$Ln(Q)$ [2]	$Ln(1 + COUNT)$ [3]	$Ln(TFP)$ [4]
$Ln(SPILLTECH)$	0.000			
	(0.302)			
$Ln(SPILLTECH) \times INDUSTRY$	0.001***			
	(0.001)			
$Ln(SPILLSALES)$	0.000			
	(0.357)			
$Ln(SPILLSALES) \times INDUSTRY$	-0.001*			
	(0.068)			
$Ln(SPILLTECH_{INDUSTRY})$		0.002***	0.004***	0.010***
		(0.005)	(0.000)	(0.000)
$Ln(SPILLSALES_{INDUSTRY})$		-0.003***	-0.003**	-0.003
		(0.009)	(0.021)	(0.207)
$Ln(SPILLTECH_{NON-INDUSTRY})$		0.001	0.001	0.002
		(0.217)	(0.395)	(0.130)
$Ln(SPILLSALES_{NON-INDUSTRY})$		0.000	0.000	-0.002
		(0.850)	(0.770)	(0.191)
Year-fixed effects	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES
$Adj. R^2$	0.189	0.740	0.799	0.838
N	5,868	13,075	13,183	12,525

4.5.4 The Role of Patent Protection

To address the concern on whether the imitation effect or the the internalization theory dominates in our sample, we include the Intellectual Property Rights Index (IPR) in our regression as well as it's interaction with technology spillovers. In general, our results in Table 4.9. suggests that the interaction between our technology spillover and IPI is significant except for in our Tobin's Q measure in Column 2 of Table 4.9. Notably, the average value of IPR is approximately 3.7, with a minimum of approximately 2.27. Our results suggests that at the minimum level of IPR, the effect of technology spillovers are negative, which suggests that our measure of technology spillover is not driven by the imitation effect associated with poor intellectual property rights. It is more likely that the IPR measure affects how the cross-border acquiror interacts with the market. For example, Alimov and Officer (2017) shows that IPR increases the amount of inbound M&A after IPR reforms, which results in improved synergy gains. This result suggests that cross-border acquirors are more likely to disclose their technology, whether it is through licensing or patenting, when there are stronger intellectual property rights.[40] This result supports Hypothesis 3a.

[40] In unreported results, we find that the interaction of IPR and CROSSVAL is positive and significant on a non-target rival firm's productivity. Moreover, the effect of IPR dominates the negative effect of CROSSVAL at means, which suggests that improvements in IPR would reduce the aggregate negative effect of FDI in aggregate in cross-border acquisitions.

Table 4.9 Technology Spillover and Patent Protection

In Column 1, this table reports an event study around a controlling cross-border acquisition and the effects of technology spillovers and product market rivalry on the cumulative abnormal returns on the non-target rival firm. The main independent variable is the natural logarithm of our technology spillover measure interacted with the Intellectual Property Rights Index (IPR). Columns 2-4 reports an OLS estimation of the aggregated technology spillover, product market rivalry, and deal value on $Ln(Q), Ln(1 + COUNT), and\ Ln(TFP)$ at the non-target rival firm-year level. Firm-years are only included if another firm within the same industry was acquired during that year. The main independent variable is the natural logarithm of our technology spillover interacted with IPR. All regressions include a full set of firm and year fixed effects. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix F.

	(1) $CAR(-2, +2)$	(2) $Ln(Q)$	(3) $Ln(1 + COUNT)$	(4) $Ln(TFP)$
$Ln(SPILLTECH)$	-0.005***	-0.009	-0.055***	-0.055***
	(0.004)	(0.335)	(0.000)	(0.001)
$Ln(SPILLTECH) \times IPR$	0.002***	0.003	0.016***	0.017***
	(0.000)	(0.158)	(0.000)	(0.000)
IPR	-0.019**	-0.018	-0.524***	0.483***
	(0.026)	(0.705)	(0.000)	(0.000)
$Ln(SPILLSALES)$	-0.000	-0.002**	-0.001	-0.002
	(0.521)	(0.017)	(0.421)	(0.377)
Year-fixed effects	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES
$Adj. R^2$	0.191	0.740	0.801	0.839
N	5,868	13,075	13,183	12,525

4.5.6 Absorptive Capacity

Previous literature tends to provide evidence that the spillovers from FDI depends on the local firm's absorptive capacity. The firm's absorptive capacity is defined by Cohen and Levinthal (1990) as the capabilities of the firm "to recognize the value of new, external information, assimilate it, and apply it to commercial ends". Most empirical literature tend to measure the effect of how absorptive capacity might affect the role of FDI as a whole. In this study, we disaggregate the FDI effect into the technological component and specifically analyse the role of absorptive capacity on the potential technology spillovers itself. In particular, we analyse the rival firm's absorptive capacity by looking at three different components of absorptive capacity, namely, a firm's human capital, innovativeness, and financial constraints.

To investigate the effect of human capital, we match a firm's average employee wage, which is the salary and benefits expense divided by the number of employees, at *t-1*. For each country-industry-year, we find the median average wage. We then split the sample based on high (low) average wage levels if the firm has average wage above (below) the median wage level. We then estimate the sample separately for CARs, Tobin's Q, Innovation, and Total Factor Productivity. In Panel A of Table 4.10, we show that the technology spillover measure is generally more significant both statistically and economically when a firm has higher average wage levels. The only measures that remain statistically significant in the low average wage sub-sample is the market related measures in Columns 5 and 6 of Table 4.10 Panel A, however they are both statistically less significant than the high average wage sub-samples presented in Columns 1 and 2 of Table 4.10 Panel A. While for both innovation and total productivity measures, we find that only the high average wage samples are statistically significant in Columns 3 and 4 of Table 4.10 Panel A. Our results support the idea that employee skill influences how much a firm can benefit from technology spillovers from cross-border acquisitions.

Next, we follow Blalock and Gertler (2009) by classifying a firm's innovativeness based on their spending on R&D. Past literature suggests that R&D plays an important role in a firm's absorptive capacity. In particular, Cohen and Levinthal (1990) recognized that R&D plays an important role in learning and is a way for firms to build up their absorptive capacity because it allows the firm to assimilate the knowledge created by competitors in their environment. To test this avenue, we use the non-target rival firm's R&D stock based on the perpetual inventory method that we have discussed in the previous section. We focus on R&D stock because R&D expenditure in the past can contribute to learning, however at a decreasing rate, which is accounted for by using a depreciation rate of 15%. After splitting the sample into high and low R&D stock sub-samples based on the median at the country-industry-year level, we find that the effect of technology spillovers has a positive and significant effect on CAR, Tobin's Q, Innovation, as well Total Factor Productivity in Columns 1 to 4 of Table 4.10 Panel B. However, the effect of technology spillovers on each of the dependent variables are insignificant at all conventional significance levels in rival firms with low R&D stock as shown in Columns 5 through 8 in Table 4.10 Panel B. Therefore, non-target rival firms that build up their R&D stock provides these firms with more capabilities to adapt the knowledge spillovers from cross-border acquisitions.

As an alternative measure for absorptive capacity, we also consider a non-target rival firm's financial constraint. Specifically, there are costs associated with absorbing technology spillovers as discussed earlier, therefore financial constraints could reduce the ability of non-target rival firms when absorbing technology spillovers. As a measure of financial constraint, we use the SA index, where a higher value of the SA index indicates that a firm is more financially constrained. The results are presented in Table 4.10 Panel C. We find that for market related measures, CARs and Tobin's Q, technology spillovers are statistically significant for both financially constrained and unconstrained firms. In particular, in Columns 1 and 2 of Table 4.10 Panel C, we find that technology spillovers for financially unconstrained firms are positive and significant at 1% on both CARs and Tobin's Q. However, for financially constrained firms, in Columns 5 and 6 of Table 4.10 Panel C, technology spillovers are still significant but at the 5% level. Although, there is some evidence that financial constraints matter in terms of technology spillovers it does not appear to be that different in terms of market related measures. Alternatively, for measures of Innovation and Total Factor Productivity, there appears to be a significant difference between financially constrained and unconstrained firms. For innovation, Column 3 of Table 4.10 Panel C, shows that the effect of technology spillovers for financially unconstrained firms is significant at the 1% level, while in Column 7 of Table 4.10 Panel C, technology spillovers are only significant at the 10% level. A similar result is presented for Total Factor Productivity in Column 4 and 8 of Table 4.10 Panel C. Specifically, technology spillovers for financially unconstrained firms are significant at the 1% level, while it is insignificant at all conventional significance levels for financially constrained firms.

Table 4.10 Absorptive Capacity of Technology Spillovers

In Panel A, we report the median split at the country-industry-year level of the non-target rival firms into those that pay a high average wage from Columns 1 to 4, and low average wage from Columns 5-8. In Panel B, we report the median split of the non-target rival firms into those that have a high R&D stock from Columns 1 to 4, and low R&D stocks from Columns 5-8. In Panel C, we report the median split at the country-industry-year level of the non-target rival firms into those that have a low SA Index from Columns 1 to 4, and high SA Index from Columns 5-8.The dependent variables are CAR(-2,+2), Ln(Q), Ln(1+COUNT), and Ln(TFP) from left to right. Beneath each coefficient estimate is the p-value in parentheses based on robust standard errors clustered at the firm-level. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix F.

Panel A : Human Capital

	High Average Wage			
	$CAR(-2,+2)$	$Ln(Q)$	$Ln(1+COUNT)$	$Ln(TFP)$
	[1]	[2]	[3]	[4]
$Ln(SPILLTECH)$	0.001***	0.005***	0.006***	0.007**
	(0.008)	(0.000)	(0.001)	(0.012)
$Ln(SPILLSALES)$	-0.000	-0.004***	-0.003	-0.003
	(0.211)	(0.004)	(0.120)	(0.226)
Year-fixed effects	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES
$Adj.R^2$	0.178	0.756	0.823	0.835
N	2,905	6,465	6,511	6,197
	Low Average Wage			
VARIABLES	$CAR(-2,+2)$	$Ln(Q)$	$Ln(1+COUNT)$	$Ln(TFP)$
	[5]	[6]	[7]	[8]
$Ln(SPILLTECH)$	0.001**	0.003*	0.003	0.003
	(0.019)	(0.084)	(0.107)	(0.391)
$Ln(SPILLSALES)$	0.000	-0.001	-0.000	0.000
	(0.757)	(0.454)	(0.969)	(0.840)
Year-fixed effects	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES
$Adj.R^2$	0.195	0.731	0.762	0.849
N	2,787	6,350	6,386	6,100

Table 4.10 Cont.

	Panel B: Innovative			
	High R&D Stock			
	$CAR(-2,+2)$	$Ln(Q)$	$Ln(1+COUNT)$	$Ln(TFP)$
	[1]	[2]	[3]	[4]
$Ln(SPILLTECH)$	0.001***	0.003**	0.003**	0.006**
	(0.000)	(0.022)	(0.013)	(0.027)
$Ln(SPILLSALES)$	-0.000	-0.002*	-0.001	0.001
	(0.839)	(0.072)	(0.327)	(0.707)
Year-fixed effects	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES
$Adj.R^2$	0.271	0.743	0.797	0.838
N	4,051	10,448	10,522	10,106
	Low R&D Stock			
	$CAR(-2,+2)$	$Ln(Q)$	$Ln(1+COUNT)$	$Ln(TFP)$
	[5]	[6]	[7]	[8]
$Ln(SPILLTECH)$	0.000	0.005	-0.002	-0.001
	(0.725)	(0.147)	(0.211)	(0.874)
$Ln(SPILLSALES)$	-0.001	-0.006**	0.001	-0.004
	(0.420)	(0.030)	(0.711)	(0.340)
Year-fixed effects	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES
$Adj.R^2$	0.012	0.741	0.796	0.890
N	1,522	2,283	2,338	2,142

Table 4.10 Cont.

Panel C: Financial Constraints				
Low SA Index (Financially Unconstrained)				
	$CAR(-2,+2)$	$Ln(Q)$	$Ln(1+COUNT)$	$Ln(TFP)$
	[1]	[2]	[3]	[4]
$Ln(SPILLTECH)$	0.001***	0.004***	0.007***	0.009***
	(0.008)	(0.007)	(0.001)	(0.004)
$Ln(SPILLSALES)$	-0.000	-0.003**	-0.002	-0.004
	(0.883)	(0.034)	(0.206)	(0.145)
Year-fixed effects	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES
$Adj. R^2$	0.169	0.737	0.823	0.834
N	2,695	6,353	6,387	6,023
High SA Index (Financially Constrained)				
	$CAR(-2,+2)$	$Ln(Q)$	$Ln(1+COUNT)$	$Ln(TFP)$
	[5]	[6]	[7]	[8]
$Ln(SPILLTECH)$	0.001**	0.003**	0.002*	0.005
	(0.046)	(0.025)	(0.071)	(0.115)
$Ln(SPILLSALES)$	0.000	-0.002	-0.001	-0.000
	(0.843)	(0.119)	(0.420)	(0.855)
Year-fixed effects	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES
$Adj. R^2$	0.200	0.778	0.773	0.856
N	2,748	6,360	6,428	6,144

4.6 Conclusion

The importance of international technology spillovers in emerging countries plays a vital role in facilitating global economic growth through conditional convergences in growth rates. Theory suggests that international technology spillovers for these countries are particularly valuable due to the existence of a technology gap. However, past literature tends to find that there are either zero FDI spillovers or very little at best. Therefore, it is necessary to examine when international knowledge diffusion occurs in these countries.

Using a sample of 483 cross-border acquisitions in 18 emerging countries between the years 1998 to 2012, we show that the potential technology spillovers brought by the acquiring firm increases the CARs of non-target rival firms in the same industry. Moreover, this effect translates into multiple dimensions such as Tobin's Q, Total Factor Productivity, as well as Innovation. To investigate when technology diffusion occurs, we investigate whether our technology spillover measures are influenced by the mode of entry i.e. how horizontal or non-horizontal cross-border acquisitions affect the international diffusion of knowledge. We find that the positive technology spillovers we find are primarily driven by horizontal cross-border acquisitions, which are usually conducted by acquirors wishing to exploit their tangible and intangible assets overseas (Caves, 1971; Hymer, 1976; Leonard, 1998; Nonaka, 1994). In addition to the mode of entry, we also investigate the role of intellectual property rights. We find that the effect of technology spillovers increases with intellectual property rights, which brings into question whether the increase in the costs of imitation is the primary source of international technology transfers in these countries. An alternative explanation for this effect is that it is plausible that the improvements in intellectual property rights mainly affects the foreign acquirors. Based on the literature, foreign acquirors are more likely to disclose their innovative activities in countries with stronger intellectual property rights. Therefore, our results suggests that the willingness of foreign acquirors to disclose their innovative activities is more important than the imitation costs associated with non-target rival firms (Yang and Maskus, 2001; Anton and Yao, 2004). Other than the mode of entry and intellectual property rights, we also explore the role of absorptive capacity. In general, we find evidence that absorptive capacity plays a role in learnings and adapting external knowledge from cross-border acquisitions.

Overall, our results have broad policy implications. In particular, we show that there are technology spillovers from cross-border acquisitions, which provides support for the liberalization of markets around the world. The type of FDI also matters, those that replicate their production processes abroad through horizontal cross-border acquisitions are primarily the ones that facilitate the transmission of cross-country technology spillovers. Also, absorptive capacity matters, improvements in education infrastructure and quality can accelerate the development of skilled labour, which would in turn lead to increased research and development and allow for more cross-country knowledge spillovers. Improvements in the country's capital markets reduces financial constraints which would also foster a firm's absorptive capacity. And finally, stronger enforcement of intellectual property rights is an important factor that could give foreign acquirors the confidence to disclose their innovations, which would lead to increased knowledge spillovers.

Chapter 5

Conclusion

In this thesis we present three independent studies that relate to institutional ownership and technology spillovers. Specifically, the second chapter investigates the role of foreign institutional ownership on corporate risk-taking in an international context, the third chapter investigates the role of technology spillovers on a firm's stock price crash risk and corporate financial policy and the fourth chapter investigates the role of cross-border acquisitions in facilitating international technology spillovers. The common theme in each of the chapters is how to promote economic growth in developing and emerging countries.

Chapter 2 investigates whether foreign institutional ownership, particularly foreign portfolio investors, promotes risk-taking around the world and more importantly what are the channels. This provides an extension to previous papers that investigate whether foreign ownership promotes risk-taking in a privatization setting as well as studies related to foreign direct investment. We find that foreign institutional ownership promotes risk-taking in terms of volatility of income which captures the uncertainties of the income stream as well as various risk-taking measures such as the inputs and outputs of innovation as well as M&A intensity around the world through a number of different indirect channels: (1) Monitoring channel; (2) Disclosure channel; (3) Insurance channel; (4) Financing channel; (5) Human capital channel; (6) International diversification channel; and the (7) Internationalization channel. Additionally, these effects tend to be stronger in weaker corporate governance countries, which shows that foreign institutional ownership is a substitute for corporate governance. To address endogeneity concerns of our main hypothesis, we consider various techniques such as first difference, firm-fixed effects, instrumental variable regression as well as the difference in difference approach. In particular, we use the MSCI ACWI as an instrumental variable since it has been shown in previous studies that foreign institutional investors rely on the MSCI ACWI as a portfolio benchmark and as a result the inclusion attracts more foreign capital (Ferreira and Matos, 2008; Leuz et al., 2009). However, the inclusion in the MSCI ACWI is unlikely to be related to corporate risk-taking as it depends solely on the firm's free-float adjusted market capitalization. Therefore, we use a difference-in-difference estimation around stock additions (deletions) to (from) the MSCI ACWI as an exogenous shock to foreign ownership. Using this approach, we find that foreign institutional ownership increases (decreases) due to stock additions (deletions) to (from) the MSCI ACWI which leads to a subsequent increase (decrease) in corporate risk-taking. As a robustness test for our results, we use an event study to confirm that cross-border mergers and acquisitions have a similar effect on risk-taking. Our results support the view that foreign institutional investors play a vital role in promoting risk-taking and economic growth around the world, however they have a stronger effect in developing countries. In addition, this effect is stronger when the foreign institutional investor is from a developed country, more independent, have longer investment horizons, and are more internationally diversified.

Chapter 3 investigates the benefits of domestic technology spillovers in an international context. It has been shown in previous studies that firms readily absorb technology spillovers, subsequently technology spillovers represent an investment opportunity for the firm. While past literature tends to investigate the effects of technology spillovers on firm value, productivity, or innovation, we investigate whether technology spillovers provide valuable information to market participants. Our findings suggest that domestic technology spillovers significantly reduce the stock price crash risk of a firm. Specifically, crash risk refers to an extreme decline in firm specific stock returns, which is associated with information asymmetries between shareholders and managers. We show in our study, that technology spillovers reduce the information asymmetries associated with the firm's investment decision. To demonstrate that the reduction in crash risk is driven by investment transparency, we show that the reduction in crash risk is driven by more transparent technological R&D stock from technological rivals. In addition, we show that this effect is more apparent in transparent institutional environments, which supports the information transparency role of technology spillovers. Moreover, this effect does not dissipate in weaker institutional environments if a firm has more transparent technological R&D stock from technological rivals, which suggests that a disclosure shock to technologically linked rivals can reduce the information asymmetries for all technologically linked firms in a country. This suggests that a reduction in information asymmetries can travel through the technology spillover channel. Furthermore, we find that technology spillovers has practical implications in terms of firm’s financial policy. In particular, technology spillover reduces information asymmetries which allows the firm to raise more equity capital at a cheaper cost. This provides further support for the reductions in information asymmetries between shareholders and managers, since information asymmetries is primarily associated with cost of equity capital. In addition, we also examine the effect of technology spillovers on leverage, debt issuances and cost of debt. We find that technology spillovers are associated with an decreases in both leverage and debt, due to an increase in the cost of debt. Past literature suggests that a reduction in information asymmetries should also lead to a reduction in the cost of debt. We reconcile this result by showing that the effect is primarily due to the poor collaterizability of innovative activities associated with technology spillovers, which is only prevalent in countries with poor creditor rights protection.

In Chapter 4 we extend a new measure that has been further developed by Bloom et al. (2013) to an international context. This allows us to investigate the effects of international technology spillover on a domestic firm in an emerging market. We find that there are indeed technology spillovers that occur from cross-border acquisitions. In particular, we find that non-target rivals experience cumulative abnormal returns on the announcement of a cross-border acquisition. Furthermore, this effect is positive and significant on a non-target rival firm’s Tobin’s Q, Total Factor Productivity, and Innovation. Moreover, this effect is stronger for acquirers undertaking a horizontal cross-border acquisition due to their intentions to exploit their proprietary assets in the foreign market. In addition, we also explore the effects of patent protection on technology spillovers from cross-border acquisitions. We find that the effect of technology spillovers from cross-border acquisitions increases with improvements in intellectual property rights. This suggests that effect of intellectual property rights on the disclosure of foreign acquiror’s innovative activities is stronger than the effect of increased cost of imitation for firms in emerging countries. Finally, we investigate the role of absorptive capacity on a non-target firm’s absorption of international technology spillovers. The evidence suggests that absorptive capacity plays a role in facilitating international technology spillovers, particularly, in the dimensions of skilled labor, R&D expenditures, and financial constraints.

Overall, the chapters in this thesis provides a thorough examination of two areas that can lead to global economic growth in the form of foreign institutional ownership and technology spillovers. For example, in chapter 2, we show that foreign institutional ownership can increase the risk-taking in domestic firms especially in developing countries, which suggests that foreign institutional ownership can be a channel for economic growth in these countries. While in chapter 3, we show that firms can gain informational benefits through technological rivals, which suggests that a foreign shock to technological rivals can provide an information transfer in the form of technology spillovers to technologically linked firms. In chapter 4, we directly investigate this effect by showing that FDI from cross-border acquisitions can provide benefit in the form of technology spillovers to non-target rival firms by exposing their technology to the market, even in emerging markets. This disclosure of technology by FDI can provide a multitude of benefits to all technologically linked firms in the target nation, leading to a potential global convergence in growth rates.

Appendix A. Variable Definitions – Chapter 2

Variable	Acronym	Definition	Source
Panel A: Corporate Risk-Taking			
Earnings Volatility	*RISK1*	$RISK1 = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}\left(ROA_{i,t} - \frac{1}{T}\sum_{t=1}^{T} ROA_{i,t}\right)^2}$, where $ROA_{i,t} = \frac{EBIT_{i,t}}{Assets_{i,t}}$. T is over the year (0 to +4).	Worldscope
Earnings Range	*RISK2*	$RISK2 = Max(ROA_{i,t}) - Min(ROA_{i,t})$, where $ROA_{i,t} = \frac{EBIT_{i,t}}{Assets_{i,t}}$. T is over the year (0 to +4).	Worldscope
Earnings Volatility (Adjusted by country)	*RISK3*	$RISK3 = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}\left(ROA_{i,c,t} - \frac{1}{T}\sum_{t=1}^{T} ROA_{i,c,t}\right)^2}$, where $ROA_{i,c,t} = \frac{EBIT_{i,c,t}}{Assets_{i,c,t}} - \frac{1}{N_{c,t}}\sum_{k=1}^{N_{c,t}} \frac{EBIT_{k,c,t}}{Assets_{k,c,t}}$, $N_{c,t}$ indexes the firms within country *c* and year *t*. T is over the year (0 to +4).	Worldscope
Earnings Volatility (Adjusted by country and industry)	*RISK4*	$RISK4 = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}\left(ROA_{i,c,d,t} - \frac{1}{T}\sum_{t=1}^{T} ROA_{i,c,d,t}\right)^2}$, where $ROA_{i,c,d,t} = \frac{EBIT_{i,c,d,t}}{Assets_{i,c,d,t}} - \frac{1}{N_{c,d,t}}\sum_{k=1}^{N_{c,d,t}} \frac{EBIT_{k,c,d,t}}{Assets_{k,c,d,t}}$, $N_{c,d,t}$ indexes the firms within country *c*, industry *d*, and year *t*. T is over the year (0 to +4).	Worldscope

Stock Return Volatility	*SRVOL*	The standard deviation of the monthly stock returns over the year (0 to +1).	Datastream
Panel B: Institutional Ownership			
Foreign Institutional Ownership	*FIO*	The aggregate equity holdings of foreign institutions scaled by the firm's market capitalization.	FactSet
Domestic Institutional Ownership	*DIO*	The aggregate equity holdings of domestic institutions scaled by the firm's market capitalization.	FactSet
Panel C: Control Variables			
Return on Assets	*ROA*	The ratio of earnings before interest and taxes to the book value of assets.	Worldscope
Financial Leverage	*LEVERAGE*	The ratio of book value of debt to the book value of assets.	Worldscope
Firm Size	*SIZE*	The natural logarithm of total sales denominated in U.S. dollars.	Worldscope
Sales Growth	*SALESGROWTH*	The annual sales growth rate.	Worldscope
Capital Expenditure	*CAPEX*	The ratio of capital expenditures to the book value of assets.	Worldscope
GDP Growth	*GDPGROWTH*	The annual GDP growth rate, at constant 2005 U.S. dollars.	WDI
Economic Freedom Index	*ECONFREEDOM*	A measure of the degree to which the policies and institutions of countries are supportive of economic freedom. The cornerstones of economic freedom are personal choice, voluntary exchange, freedom to compete, and the security of privately owned property. The index is constructed by using 42 variables in five broad areas, including (1) size of government; (2) legal system and property rights; (3) sound money; (4) freedom to trade internationally; and (5) regulation.	Economic Freedom of the World
GDP per Capita	*GDP*	The natural logarithm of GDP per capita, at constant 2005 U.S. dollars.	WDI
Real Interest Rate	*IR*	The real interest rate.	WDI

Panel D: Country-Level Corporate Governance			
Financial Transparency	*FINTRA*	A measure of the availability of financial information due to disclosure, interpretation, and dissemination of financial information by firms, financial analysts, and media reporters.	Bushman et al. (2004)
Financial Analysts	*ANALYST*	The number of analysts following the largest 30 companies in each country in 1996.	Bushman et al. (2004)
Overall Transparency Score	*OTSCO*	A measure of the institutional transparency and political transparency.	Bellver and Kaufmann (2005)
Disclosure Requirements Index	*DISREQ*	An index of disclosure that equals the arithmetic mean of (1) prospects; (2) compensation; (3) shareholders; (4) inside ownership; (5) irregular contracts; and (6) transactions.	La Porta et al. (2006)
Liability Standard Index	*LIASTA*	An index of liability standards that equals the arithmetic mean of (1) the liability standard for the issuer and its directors; (2) the liability standard for the distributor; and (3) the liability standard for the accountant.	La Porta et al. (2006)
Legal Origin	*LEGCOM*	Dummy variable that equals one if a country adopts a common law system and zero otherwise.	La Porta et al. (1998)

Anti-Director Index	*ANTID*	An index aggregating shareholder rights. This index is calculated by adding one when (1) the country allows shareholders to mail their proxy vote to the firm; (2) shareholders are not required to deposit their shares prior to the general shareholders' meeting; (3) cumulative voting or proportional representation of minorities in the board of directors is allowed; (4) an oppressed minorities mechanism is in place; (5) the minimum percentage of share capital that entitles a shareholder to call for an extraordinary shareholders' meeting is less than or equal to 10 percent (the sample median); or (6) shareholders have preemptive rights that can be waived only by a shareholders' vote.	La Porta et al. (1998)
Corporate Governance Index	*CGI*	The percentage of firms in country that give satisfactory ratings to questions regarding minority shareholders protection, training quality, willingness to delegate authority, nepotism, and corporate governance.	Kaufmann (2004)
Control of Corruption	*COC*	The perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as the "capture" of the state by elites and private interests.	Kaufmann et al. (2009)
Panel E: Deal-Level Variables			
Foreign Block Purchases	*FBP*	The number of common shares acquired in the transaction scaled by the total number of shares outstanding.	SDC Platinum
Acquisition Premium	*PREMIUM*	Bid price as a percentage of the closing price of target four weeks prior to the announcement.	SDC Platinum
All-Cash Bid	*ALLCASH*	Dummy variable that equals one if the acquisition is entirely paid in cash and zero otherwise.	SDC Platinum

Friendly Bid	*FRIENDLY*	Dummy variable that equals one if the bid is classified as a friendly bid and zero otherwise.	SDC Platinum
Same Industry	*INDUSTRY*	Dummy variable that equals one if the target and acquirer firms share the same two-digit SIC code.	Datastream
Same Continent	*CONTINENT*	Dummy variable that equals one if the target and acquirer firms are from the same continent and zero otherwise.	The World Factbook
Same Language	*LANGUAGE*	Dummy variable that equals one if the target and acquirer firms use the same official language and zero otherwise.	The World Factbook
Panel F: Direct Channels			
R&D Expenses	*R&D*	The average R&D ratio (i.e., the ratio of R&D expenses to the book value of assets) over the year (0 to +4).	Worldscope
Patent Count	*LnPatent*	The natural logarithm of one plus the total number of patents granted to a firm in each year, scaled by the mean of patent applications filed in that year for the same technology group.	Thomson Innovations
Patent Citations	*LnCitePat*	The natural logarithm of one plus the total number of citations made to a firm's patents in each year, scaled by the mean of citations received by each patent in that year for the same technology group.	Thomson Innovations
Net Asset Acquisitions	*ACQ_ASSETS*	The average net asset acquisitions ratio (i.e., the ratio of the net acquisition expense to the book value of assets) over the year (0 to +4).	Worldscope
Number of Acquisitions	*ACQ*	The annual number of acquisition made that are classified as mergers, acquisitions, acquisitions of majority interest, acquisitions of partial interest, acquisitions of remaining interest, acquisitions of assets, or acquisitions of certain assets.	SDC Platinum

Value of Acquisitions	*ACQ_VALUE*	The total value of acquisition made in a year scaled by the book value of assets.	SDC Platinum
Panel G: Indirect Channels			
Total Accruals	*TA*	$TA_{i,t} = \frac{\Delta CA_{i,t} - \Delta CL_{i,t} - \Delta CASH_{i,t} + \Delta STD_{i,t} - DEP_{i,t}}{A_{i,t-1}}$, where $\Delta CA_{i,t}$ is the change in current assets between year *t-1* and *t*, $\Delta CL_{i,t}$ is the change in current liabilities between year *t-1* and *t*, $\Delta CASH_{i,t}$ is the change in cash and cash equivalents between year *t-1* and *t*, $\Delta STD_{i,t}$ is the change in short-term debt between year *t-1* and *t*, $DEP_{i,t}$ is the depreciation and amortization expense in year *t*, and $A_{i,t-1}$ is the total assets in year *t-1*.	Worldscope
Discretionary Accruals	*DA*	The residuals from the following model: $TA_{i,t} = \alpha_1\left(\frac{1}{A_{i,t-1}}\right) + \alpha_2\left(\Delta REV_{i,t} - \Delta REC_{i,t}\right) + \alpha_3\left(PPE_{i,t}\right) + \epsilon_{i,t}$ where $\Delta REV_{i,t}$ is the change in revenues between year *t-1* and *t*, ΔREC_t is the change in net receivables between year *t-1* and *t*, and $PPE_{i,t}$ is gross property plant and equipment in year *t*.	Worldscope
Big 4 Auditor	*BIG4*	Dummy variable that equals one if the firm hires a Big 4 audit firm in a year and zero otherwise.	Worldscope
CEO Turnover	*CEO_TURN*	Dummy variable that equals one if the top executive at the end of year is different from the top executive in the previous year and zero otherwise.	Capital IQ
Change in CEO Cash Compensation	ΔCEO_CASH	The change in annual cash compensation, including salary, bonuses, and other cash compensation.	Capital IQ

Change in CEO Total Compensation	ΔCEO_TOTAL	The change in annual total compensation, including salary, bonuses, equity, long-term incentive plans, options, and other compensation.	Capital IQ
Equity Issuance	*EQ_ISSUE*	Sale/issue of common and preferred equity scaled by total assets.	Worldscope
Net Equity Issuance	*NET_EQ_ISSUE*	Sale/issue of common and preferred equity minus common and preferred redeemed, retired, or converted equity scaled by total assets.	Worldscope
Debt Issuance	*DEBT_ISSUE*	Long-term borrowings scaled by total assets.	Worldscope
Net Debt Issuance	*NET_DEBT_ISSUE*	Long-term borrowings minus the reduction in long-term debt plus the increase/decrease in short-term borrowings scaled by total assets.	Worldscope
Implied Cost of Capital	*ICOC*	The average of four different implied cost of capital measures.	I/B/E/S
Annual Stock Return	*STOCK_RET*	The percentage change in the stock price over a one-year period.	Datastream
SEO Underpricing	*SEO_UNDERPRICE*	Negative one times the return from the closing price on the day prior to the offer date to the offer price.	SDC Platinum
Cost of Debt	*SPREAD*	At-issue yield spreads on corporate bonds over treasury bonds with comparable maturity.	SDC Platinum
Number of Employees	$LABOR$	The natural logarithm of the number of employees.	Worldscope
Average Salary	AV_STAFF_COST	The natural logarithm of salary expenses scaled by the number of employees.	Worldscope
Labor Efficiency	$LABOR\_EFF$	The net profit excluding salary expenses scaled by salary expenses.	Worldscope
Cross-Listing	*CROSSLIST*	Dummy variable that equals one in the year *t* when a firm is cross-listed in a foreign country and zero otherwise.	Worldscope

Geographic Expansion	*GEO_EXP*	*GEO_EXP* equals one when the number of geographic segments the firm operates in increases, equals negative one when a firm decreases the number of geographic segments it operates in and zero otherwise.	Worldscope
Panel H: The Optimal Risk-Taking			
Tobin's Q	*Tobin's Q*	The market value of equity plus the book value of debt scaled by the book value of assets.	Worldscope
Asset Growth	*ASSETGROWTH*	The annual asset growth rate.	Worldscope
Annual Stock Return Volatility	*VOLATILITY*	The standard deviation of weekly stock returns.	Thomson Innovations
Negative Skewness	*NCSKEW*	$$NCSKEW_{i,t} = -\frac{n(n-1)^{\frac{3}{2}}\sum W_{i,t}^{3}}{(n-1)(n-2)\left(\sum W_{i,t}^{2}\right)^{\frac{3}{2}}}$$ where $W_{i,t}$ is the firm-specific weekly return of firm *i* in year *t*.	Datastream
Return Asymmetries	*DUVOL*	$$DUVOL_{i,t} = log\left[\frac{(n_u - 1)\sum W_{i_d,t}^{2}}{(n_d - 1)\sum W_{i_u,t}^{2}}\right]$$ Where $W_{i_u,t}$ and $W_{i_d,t}$ are the firm-specific weekly returns for the up and down weeks respectively; n_u and n_d are the number of up and down weeks respectively.	Datastream
Crashes Minus Jumps	*COUNT*	The number of crash weeks minus the number of jump weeks over the year. A crash (jump) week occurs when the firm-specific weekly return is 3.09 standard deviations below (above) its mean over the year.	Datastream
Sigma	*SIGMA*	The standard deviation of the firm-specific weekly returns of the year.	Worldscope

Return	*RET*	The mean of the firm-specific weekly returns of the year.	Worldscope
Detrended Turnover	*DTURN*	The average monthly share turnover in the current year minus the average monthly share turnover in the previous year, where monthly share turnover is calculated as the monthly trading volume divided by the number of shares outstanding.	Worldscope
Earning Opacity	*ACCM*	The sum of the absolute value of discretionary accruals over the prior three years, where discretionary accruals are estimated using the modified Jones model.	Worldscope
Market to Book Ratio	*MTB*	The market value of equity divided by the book value of equity.	Worldscope
Market Capitalization	*MCAP*	The natural logarithm of market capitalization.	WDI
Optimal Risk-Taking	*OPTIMAL_RISK*	The negative absolute value of the residuals from a regression between *RISK1* and all control variables as well as the fixed effects from the baseline regression.	Worldscope

Appendix B. Implied Cost of Capital

Following Hail and Leuz (2006), we construct four different *ICOC* measures and use their average as a proxy of firms' cost of capital. The models used to estimate the *ex-ante* cost of capital for each of the four measures are described below:

Gebhardt et al. (2001) residual income valuation model:

$$P_t = bv_t + \sum_{\tau=1}^{T} \frac{(\widehat{eps}_{t+\tau} - r_{GLS} \times bv_{t+\tau-1})}{(1 + r_{GLS})^{\tau}} + \frac{(\widehat{eps}_{t+T+1} - r_{GLS} \times bv_{t+T})}{r_{GLS}(1 + r_{GLS})^{T}}$$

where P_t is the share price at time t, $\widehat{eps}_{t+\tau}$ is the expected earnings per share for period $(t + \tau - 1, t + \tau)$, and $bv_{t+\tau-1}$ is the book value per share at time $t + \tau - 1$. The initial three years of expected future residual income are extracted from the actual book values per share and the forecasted earnings per share for up to three years ahead. The future book values are imputed from the current book values, forecasted earnings and dividends, assuming clean surplus, which is also the assumption adopted in Claus and Thomas's (2001) residual income valuation model. The dividends are set equal to the average of the past three years of payout ratios, which is defined in the same way for all four models. Beyond the initial three years, residual income is derived by assuming that the stream of residual income is linearly decreasing towards the accounting return on equity determined over the past three years. The firms are classified into industrial, service, and financial sectors. If a specific sector's annual median is negative, then it is replaced by the country's annual median. Residual income is then assumed to be constant beyond 12 years.

Claus and Thomas's (2001) residual income valuation model:

$$P_t = bv_t + \sum_{\tau=1}^{T} \frac{(\widehat{eps}_{t+\tau} - r_{CT} \times bv_{t+\tau-1})}{(1 + r_{CT})^{\tau}} + \frac{(\widehat{eps}_{t+T} - r_{CT} \times bv_{t+T-1})(1 + g)}{(r_{CT} - g)(1 + r_{CT})^{T}}$$

The stream of expected future residual income is based on the actual book value per share and the forecasted earnings per share for up to five years ahead. For periods beyond five years, the nominal residual income is assumed to grow at a rate of g, which equals expected inflation. The expected inflation rate is based on the annualized median of each country's one-year-ahead realized monthly inflation rates.

Easton's (2004) PEG model:

$$P_t = \frac{\left(\widehat{eps}_{t+2} + r_{PEG} \times \hat{d}_{t+1} - \widehat{eps}_{t+1}\right)}{r_{PEG}^{2}}$$

where $\widehat{eps}_{t+1}$ and $\widehat{eps}_{t+2}$ are the one-year and two-year ahead earnings per share forecasts, respectively, and $\hat{d}_{t+1}$ is the one-year ahead expected dividends per share. This model assumes perpetual growth in abnormal earnings after the initial period.

Ohlson and Juettner-Nauroth's (2005) abnormal earnings growth valuation model:

$$P_t = \frac{\widehat{eps}_{t+1}}{r_{OJ}} \times \frac{(g_{st} + r_{OJ} \times \frac{\hat{d}_{t+1}}{\widehat{eps}_{t+1}} - g_{lt}}{\left(r_{OJ} - g_{lt}\right)}$$

where $\widehat{eps}_{t+1}$ and $\hat{d}_{t+1}$ are the one-year ahead forecasted earnings and dividends per share, respectively; g_{st} is the short-term growth rate estimated by the average of the forecasted percentage change in the first two years of earnings and the five-year growth forecast provided by financial analysts; and g_{lt} is the long-term earnings growth rate that equals the annualized country-specific median of one-year-ahead realized monthly inflation rates.

We include firms based on the availability of data on the current stock price, P_t, the earnings forecast of one and two periods ahead, and either the earnings forecast from three to five periods ahead, or a long-term earnings growth forecast. In all cases, we include only positive earnings forecasts. The analyst earnings forecasts are based on the mean consensus analyst forecasts. All analyst forecasts and stock prices are based on information released 10 months after the fiscal year ends to ensure that all values have already been reflected in the stock price that is used to estimate the *ICOC*. An iterative algorithm is used to back out the *ICOC* from each model, where the *ICOC* is constrained to be positive. The iterative procedure stops when the imputed prices from the models are within 0.001 of the actual price.

Appendix C. Matching Patent Data to Datastream Firms

We collect patents data from the Derwent World Patents Index (DWPI) available from the Thomson Innovation database. Our initial data only includes the name of the assigned organization at the issuance of the patent.

A key complication when using the data is then how we would match these assignee names back to the names in Datastream. In most previous studies they focus on a large sample of US firms, the process then becomes much more complex when dealing with a large international sample.

We conduct the name matching by following the NBER patent data project where the matching is performed through a multi-step procedure. First, we collected the names of all equities available in Datastream. It is important here to note that what we have in Datastream is equity-level data and not entity-level data. We require data at an entity level, because patents assigned to subsidiaries are usually reassigned to the parent company. Parent companies can also choose to publish patents through their subsidiaries. It is therefore evident that to evaluate the true patent ownership share we require all the data at the entity-level. The alleviate this issue, we only collect the current and past names of equities that are both primary listings and major securities on Datastream. This does not alleviate all the issues, especially for parent and subsidiary relationships. However, we do not have access to a mapping for this available to us. Using the program supplied by the NBER patent database we cleaned and standardized the names from both assignee names from DWPI as well as equity names from the Datastream database. Specifically, the program standardizes common abbreviations and removes designators of corporate form. By simply cleaning the names of both databases, we identified a large number of cases where the standardized assignee name exactly matched the standardized firm name.

For the standardized assignee and firm names that did not match up, we follow Bena et al. (2017) by using a combination of the Bigram string comparison algorithm and the Levenshtein distance metric. In particular, we required that for each combination of assignee-firm pair they have a Bigram score larger than 0.5. After that filtering, we required that each assignee-firm pair to have a Levenshtein distance cost less than 500. We then standardized both Bigram score and the Levenshtein costs and filtered the top matches to find a manageable amount of matches to manually check. In total, we manually checked 35,343 non-exact matches based on factors such as website, patented technology and address amongst other factors.

Appendix D: DWPI Classification System

DWPI categorizes patent documents using a simple classification system for all technologies. These unique classifications are consistently applied to all patents. Patents are divided into three broad areas: Chemical, Engineering, and Electronic and Electrical Engineering. Each of these are then divided into "Sections", which describe the technical area, or areas, covered by the patent. There are currently 21 such sections, with A-M for Chemical, P-Q for Engineering, and S-X for Electronic and Electricals. These sections are further broken into classes amounting to a total of 291 unique classifications.

	Broad Areas	
Chemical	**Engineering**	**Electronic and Electrical Engineering**
A - Polymers and Plastics	**P1 -** Agriculture, Food, Tobacco	**S -** Instrumentation, Measuring and Testing
B – Pharmaceuticals	**P2 -** Personal, Domestic	**T -** Computing and Control
C - Agricultural Chemicals	**P3 -** Health, Amusement	**U -** Semiconductors and Electronic Circuitry
D - Food, Detergents, Water Treatment and Biotechnology	**P4 -** Separating, Mixing	**V -** Electronic Components
E - General Chemicals	**P5 -** Shaping Metal	**W** – Communications
F - Textiles and Paper-Making	**P6 -** Shaping Non-metal	**X -** Electric Power Engineering
G - Printing, Coating, Photographic	**P7 -** Pressing, Printing	
H – Petroleum	**P8 -** Optics, Photography, General	
J - Chemical Engineering		
K - Nucleonics, Explosives and Protection	**Q1 -** Vehicles in General	
L - Refractories, Ceramics, Cement and Electro(in)organics	**Q2 -** Special Vehicles	
M – Metallurgy	**Q3 -** Conveying, Packaging, Storing	
N – Catalysts	**Q4 -** Buildings, Construction	
	Q5 - Engines, Pumps	
	Q6 - Engineering Elements	
	Q7 - Lighting, Heating	
	Number of Classes	
138	**103**	**50**

Appendix E: Variable Definitions – Chapter 3

Variable	Acronym	Definition	Data Source
Panel A: Stock Price Crash Risk			
Negative Skewness	***NCSKEW***	$$NCSKEW_{i,t} = -\frac{n(n-1)^{\frac{3}{2}}\sum W_{i,t}^{3}}{(n-1)(n-2)\left(\sum W_{i,t}^{2}\right)^{\frac{3}{2}}}$$ where $W_{i,t}$ is firm-specific weekly return of firm *i* in year *t*.	Datastream
Return Asymmetries	***DUVOL***	$$DUVOL_{i,t} = log\left[\frac{(n_u - 1)\sum W_{i_d,t}^{2}}{(n_d - 1)\sum W_{i_u,t}^{2}}\right]$$ $W_{i_u,t}$ and $W_{i_d,t}$ are firm-specific weekly return for up and down weeks respectively; n_u and n_d are the number of up and down weeks respectively.	Datastream
Crashes Minus Jumps	***COUNT***	The number of crash weeks minus the number of jump weeks over the year. A crash (jump) week occurs when the firm-specific weekly return is 3.09 standard deviations below (above) its mean over the year.	Datastream
Panel B: Corporate Financial Policy Variables			
Leverage	***LEVERAGE***	The ratio of book value of debt scaled by book value of assets.	Worldscope
Equity Issuance	***EQ_ISSUE***	Sale/issue of common and preferred equity scaled by total assets.	Worldscope
Net Equity Issuance	***NET_EQ_ISSUE***	Sale/issue of common and preferred equity minus common and preferred redeemed, retired, or converted equity scaled by total assets.	Worldscope
Debt Issuance	***DEBT_ISSUE***	Long-term borrowings scaled by total assets.	Worldscope

Net Debt Issuance	***NET_DEBT_ISSUE***	Long-term borrowings minus the reduction in long-term debt plus the increase/decrease in short-term borrowings scaled by total assets.	Worldscope
Cost of Debt	***COD***	The firm's interest expense on financial debt divided by the average debt (short- and long-term) between the current and previous year.	Worldscope
Implied Cost of Capital	***ICOC***	The average of four different implied cost of capital measures.	I/B/E/S
SEO Underpricing	***SEO_UNDERPRICE***	Negative one times the return from the closing price on the day prior to the offer date to the offer price.	SDC Platinum
Panel C: Spillover Variables			
Technology Spillover	***Ln(SPILL_TECH)***	Natural logarithm of the sum of R&D stock of firm *j* scaled by technological proximity between firm *i* and *j* for all firms *j* that operate in the same country as firm *i*.	Thomson Innovations
Product Market Rivalry	***Ln(SPILL_SALES)***	Natural logarithm of the sum of R&D stock of firm *j* scaled by product market proximity between firm *i* and *j* for all firms *j* that share a technological space with firm *i* and operate within the same country as firm *i*.	Thomson Innovations
Panel D: Firm-Level Control Variables			
Return on Assets	***ROA***	The ratio of earnings before interest and taxes scaled by book value of assets.	Worldscope
Leverage	***LEVERAGE***	The ratio of book value of debt scaled by book value of assets.	Worldscope
Firm Size	***SIZE***	The natural logarithm of total sales denominated in U.S. dollar.	Worldscope
Sigma	***SIGMA***	The standard deviation of firm-specific weekly returns of the year.	Worldscope
Income Volatility	***INCOME_VOL***	The standard deviation of ROA from t to t-3	Worldscope
Return	***RET***	The mean of the firm-specific weekly returns of the year.	Worldscope
Stock Return	***STOCK_RET***	The annual change in stock price	Datastream

Detrended Turnover	***DTURN***	The average monthly share turnover in the current year minus the average monthly share turnover in the previous year, where monthly share turnover is given by the monthly trading volume divided by the number of shares outstanding.	Worldscope
Earning Opacity	***OPACITY***	The sum of the absolute value of discretionary accruals over the prior three years, where discretionary accruals are estimated from the Modified-Jones model.	Worldscope
Market Capitalization	***MCAP***	The natural logarithm of market capitalization.	Worldscope
Market to Book Ratio	***MTB***	Market value of equity divided by the book value of equity.	Worldscope
Sales Growth	***SALESGROWTH***	The annual change in total sales	Worlscope
Relative Offer Size	***ROS***	The number of offered shares divided by total outstanding shares prior to offer	SDC Platinum Datastream
Price	***Ln(PRICE)***	The closing price on the day prior to the offer.	SDC Platinum
Market Value	***Ln(MV)***	The closing price on the day prior to offer multiplied by the total shares outstanding.	SDC Platinum Datastream
Positive CAR	***CAR_POSITIVE***	Cumulative market adjusted returns over the five days prior to the offer are calculated. If there are positive cumulative market adjusted returns during this period the indicator variable is equal to one and zero otherwise.	Datastream
Negative CAR	***CAR_NEGATIVE***	Cumulative market adjusted returns over the five days prior to the offer are calculated. If there are negative cumulative market adjusted returns during this period the indicator variable is equal to one and zero otherwise.	Datastream
Panel E: Country-Level Control Variables			
GDP Growth	***GGDP***	The annual GDP growth rate, at constant 2005 U.S. dollars.	WDI

GDP per Capita	***GDP***	The natural logarithm of GDP per capita, at constant 2005 U.S. dollars.	WDI
Stock Market Capitalization	***MCAP***	The natural logarithm of a country's stock market capitalization	WDI
Panel F: Country-Level Information Environment			
Accounting Standard	***ACCSTD***	Index created by examining and rating companies' 1995 annual reports on their inclusion or omission of 90 items. These items fall into seven categories (general information, income statements, balance sheets, funds flow statement, accounting standards, stock data and special items). A minimum of 3 companies in each country were studied.	Bushman et al. (2004)
Prevalence of Disclosure	***DISCL***	Average ranking of the answers to the following questions: A6g (R&D), B3f (Capital expenditure), Ca (subsidiaries), Cb (segment-product), Cc (segment-geographic), and D1 (accounting policy).	Bushman et al. (2004)
Auditing Standard Index	***AUDIT***	Variable indicating the percentage of firms in the country audited by the Big 5 accounting firms. AUDIT equals 1, 2, 3 or 4 if the percentage ranges between [0,25%], (25%,50%], (50%, 75%] and (75%, 100%], respectively.	Bushman et al. (2004)
Financial Analysts	***ANALYST***	A number of analysts following the largest 30 companies in each country in 1996.	Bushman et al. (2004)
Panel G: Country-Level Investor Protection			
Anti-Director Rights Index	***ANTID***	Aggregate index of shareholder rights. The index is formed by summing: (1) vote by mail; (2) shares not deposited; (3) cumulative voting; (4) oppressed minority; (5) pre-emptive rights; and (6) capital to call a meeting.	Djankov et al. (2008)
Anti-self-dealing index	***ANTISELF***	Average of ex-ante and ex-post private control of self-dealing.	Djankov et al. (2008)

Strength of investor protection	***INVPRO***	Measures the strength of investor protection. The index is scaled from 1 (worst) to 10 (best).	Global Competitiveness Report 2008-2009. Section 8.06.
Developed (General Measure)	***DEVELOPED***	Dummy variable that equals to 1 when a country is considered developed and 0 otherwise.	International Monetary Fund (IMF)
Panel H: Country-level Creditor Rights Index			
Creditor Rights Index	***CR***	An index aggregating different creditor rights. The index is formed by adding 1 when (1) the country imposes restrictions, such as creditors' consent or minimum dividends to file for reorganization; (2) secured creditors are able to gain possession of their security once the reorganization petition has been approved (no automatic stay); (3) secured creditors are ranked first in the distribution of the proceeds that result from the disposition of the assets of a bankrupt firm; and (4) the debtor does not retain the administration of its property pending the resolution of the reorganization. The index ranges from zero to four.	La Porta et al. (1998)
Panel H: Stock Price Informativeness			
Weighted Market Synchronicity Measure	$\boldsymbol{R^2}$	The sum of $1 - R^2$ of firm j weighted by the magnitude of firm *j*'s spillovers to firm *i* divided by the total spillovers of all possible firm j. R^2 is measured using a market model including market and industry returns.	Datastream
Weighted Number of financial analysts	***ANALYSTS***	The sum of the number of financial analysts following firm *j* weighted by the magnitude of firm *j*'s spillovers to firm *i* divided by the total spillovers of all possible firm *j*.	I/B/E/S

Appendix F: Variable Definitions – Chapter 4

Variable	Acronym	Definition	Data Source
Panel A: Dependent Variables			
Cumulative Abnormal Returns	***CAR(-2,+2)***	The sum of the returns in excess of the returns predicted by the standard market model for a non-target rival firm in the target nation over the event window (-2,+2) around the announcement of a cross-border acquisition. The returns are calculated using the standard market model with the Datastream Market Index (TOTMK) as the benchmark i.e. for a Brazilian non-target rival firm we use TOTMKBR. The parameters of the standard market model are estimated over the (-300, -91) trading days prior to the announcement. The daily returns are calculated from the return index (RI#S) for both the firm and corresponding Datastream Market Index.	Datastream
Tobin's Q	***Ln(Q)***	Market value of equity plus debt (WC03501+WC03451+WC03255-WC02201) divided by the stock of fixed capital (WC02501+WC02101+WC02256+WC02649).	Worldscope
Total Factor Productivity	***Ln(TFP)***	Total Factor Productivity is constructed using the gross revenue method from Levinsohn and Petrin (2003). It is constructed using total sales (WC01001) as the output and number of employees (WC07011), capital stock (WC02301), and raw materials (WC02097) as inputs. Following previous studies, we estimate separate production functions by industry.	Worldscope
Patent Count	***Ln(COUNT)***	The number of patent applications filed in a year scaled by the mean number of applications by firms that operate in the same technology classes in the same year.	Thomson Innovations
Patent Citations	***Ln(CITE)***	The number of citations received by the patent application filed in a year scaled by the mean number of citations received by patents in the same technology class in the same year.	Thomson Innovations
Panel B: Spillover Measures			

Technology Spillover	***Ln(SPILLTECH)***	Natural logarithm of the R&D stock (constructed from WC01201) of acquiror firm *j* multiplied by technological proximity between acquiror firm *i* and non-target rival firm *j*.	Thomson Innovations Worldscope
Product Market Rivalry	***Ln(SPILLSALES)***	Natural logarithm of the R&D stock (constructed from WC01201) of acquiror firm *j* multiplied by product market proximity between acquiror firm *i* and non-target rival firm *j*.	Thomson Innovations Worldscope
Value of Cross-Border Acquisition Deal	***CROSSVAL***	Value of the cross-border acquisition divided by the market value of all industry-linked firms of the target in the target nation.	SDC Platinum Datastream
Panel C: Control Variables (Event Study)			
Market value of Equity	***Ln(MV)***	The natural logarithm of the market value (MV) of the technologically linked rival firm 11 days before the announcement date in $US dollars.	Datastream
Tobin's Q	***TOBIN'S Q***	Measured as the sum of market capitalization (WC08001) and total liabilities (WC03351) divided by the sum of common stock (WC03501) and total liabilities (WC03351).	Worldscope
Market-Adjusted Buy and Hold Returns	***RUNUP***	The market-adjusted buy and hold returns of the non-target rival firm over a 200-day window (-210, -11).	Datastream
Standard Deviation of Market-Adjusted Daily Returns	***SIGMA***	The standard deviation of the market-adjusted daily returns of the non-target rival firm over a 200-day window (-210,-11).	Datastream
Horizontal Acquisition	***INDUSTRY***	A dummy variable that equals to one if the acquiror and target shares a 2-digit primary SIC code, and zero otherwise.	SDC Platinum
Panel D: Control Variables (Annual)			
Return on Assets	***ROA***	Net income before extraordinary items (WC01551) plus interest expense (WC01151) divided by total assets (WC02999).	Worldscope
Leverage	***LEVERAGE***	Total debt (WC03255) divided by total assets (WC02999).	Worldscope

Firm Size	***SIZE***	The natural logarithm of the total assets (WC02999) in $US dollars.	Worlscope
Capital Expenditure	***CAPEX***	Capital expenditures (WC04601) divided by total assets (WC02999).	Worldscope
Property, Plant, and Equipment	***PPE***	Property, Plant, and Equipment (WC02501) divided by total assets (WC02999).	Worldscope
Cash	***CASH***	Cash and short-term investments (WC02001) divided by total assets (WC02999).	Worldscope
Research and Development Expenditure	***R&D***	Research and Development Expense (WC01201) divided by total assets (WC02999).	Worldscope
Annual Sales Growth	***SALESGROWTH***	The annual growth rate in sales (constructed from WC01001).	Worldscope
Foreign Sales	***FSALES***	International sales (WC07101) divided by total sales (WC01001).	Worldscope
Number of Financial Analysts	***ANALYSTS***	The number of analysts (EPS1NET) that follow a firm	IBES
Closely-held shares	***CLOSE***	Total number of closely held shares (NOSHCH)	Worldscope
GDP Growth	***GGDP***	The annual GDP growth rate, at constant 2005 U.S. dollars.	WDI
GDP per Capita	***GDP***	The natural logarithm of GDP per capita, at constant 2005 U.S. dollars.	WDI
Stock Market Capitalization	***MCAP***	The natural logarithm of a country's stock market capitalization	WDI
Real Interest Rates	***IR***	The real interest rates.	WDI

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