Can Foreign Firms Inhibit Knowledge Spillover to Local Firms? The Role of Innovation Capabilities and Tacit Knowledge

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Abstract

To date, the literature on knowledge spillover has tended to focus on how the presence of foreign firms affects the productivity of local firms. While knowledge spillover is beneficial to local firms, it is generally harmful to foreign firms. Foreign firms thus should devote significant attention to the prevention of knowledge spillover. Incorporating research on knowledge spillover and the knowledge-based view, this study examines the question of whether foreign firms' innovation capabilities and tacit knowledge can reduce the amount of knowledge spillover. Examining 102 Taiwanese manufacturing firms operating in China, this study finds that innovation capabilities have an inverted U-shaped relationship with knowledge spillover, while tacit knowledge has a negative relationship. Additionally, while locating within agglomerations can lead to access to valuable local resources, it may also serve to accelerate knowledge spillover to local firms. This study suggests that the positive relationship is stronger when innovation capabilities is intermediate; however, the positive relationship is likely to weaken when innovation capabilities is high. Finally, tacit knowledge leads to a lessening of the positive relationship between agglomeration and knowledge spillover.

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1   Introduction

Recent studies on knowledge spillover have highlighted the presence of foreign firms in contributing to the productivity of local firms in emerging economies[1]. Although knowledge spillover is regarded as beneficial to a host country, it can have extremely negative consequences for a foreign firm.   Such knowledge spillover from foreign firms to local competitors occurs as a result of knowledge absorption by local competitors directly, or knowledge diffusion through local suppliers indirectly[2]. When local competitors catch up with foreign firms, they would likely hurt foreign firms' competitiveness, substitute foreign firms' market positions, and finally expel foreign firms out of a host country.   Thus, determining which factors can inhibit foreign firms' knowledge spillovers is an issue of significant.

Most studies examining the topic of knowledge spillover have simply looked at the number of foreign firms to predict the improvement of local productivity.   Not surprisingly, then, some studies have found that the presence of foreign firms has a positive impact on the economies of host countries (e.g., Sanna-Randaccio and Veugelers[3], Wei and Liu[4]).   Often, such studies link the growth in a host country's economic productivity to the phenomenon of knowledge spillover.   Other studies, however, have found the opposite to be true[5].   We wonder if such inconsistent findings are resulted from an (incorrect) assumption that each foreign firm has a uniform effect on knowledge spillover.   Specifically, such an assumption does not take into account firm heterogeneity.   According to the knowledge-based view (KBV), the stocks (i.e., innovation capabilities) and the characteristics (i.e., tacitness) of knowledge are two critical factors shaping firm heterogeneity.   Such innovation capabilities and tacitness are likely to influence the extent of knowledge transfer within firms, as well as to spill over to firms in a host country[6].

Innovation capabilities are a firm's capacity to adopt or implement new ideas, processes, or products successfully[7].   Typically, a more robust innovation capacity might well mean more valuable knowledge and resources, which would attract imitation by local rivals, especially in emerging economies where local firms have a significant motivation to catch up with their foreign counterparts[8].   However, when innovation capabilities move beyond a certain level, they serve to reduce the degree of knowledge spillover because of their stickiness and firm-specificity.   Specifically, high innovation capabilities are likely to create technology gaps between local firms and foreign firms. Such gaps will lead local firms to be difficults to fully absorb the latest value of innovation capabilities of foreign firms.   Accordingly, we expect that innovation capabilities will have an inverted U-shaped relationship with knowledge spillover to local firms; that is, there will be a positive relationship until a minimum level of innovation capability is reached, and a negative relationship thereafter.

Tacit knowledge relating to implicit and/or non-codified skills seems to act as another sort of barrier to imitation by local firms[9].   Tacit knowledge often develops from the transfer of context-specific knowledge embedded in non-standardized and tailored processes, thus generating causal ambiguity[10].   Accordingly, greater tacitness might result in a lesser degree of knowledge spillover.

While most studies have examined the extent of knowledge spillover at the national level[11], the variance of knowledge spillover is likely to emerge across regions within a country.   In particular, knowledge spillover would be received first by the geographically proximate firms in the same or related industries (i.e., members within an

agglomeration) before they diffuse to other, more distant firms[12]. Research on agglomeration is another stream that highlighting the issue of knowledge spillover. However, it takes into account that foreign firms choose to agglomerate is to acquire the complementary resources within agglomeration without considering the negative spillover from foreign firms to local firms. Indeed, in China, foreign firms operating within agglomerations of firms, intentionally or unintentionally, diffuce much valuable knowledge to local firms, and in turn, these local firms gradually catch up with foreign firms and threat their survival[13]. Therefore, the contention that agglomeration facilitates negative knowledge spillover requires an examination of how foreign firms choosing to locate within agglomerations are able to reduce the amount of knowledge spillover. We propose that the positive relationship between agglomeration and knowledge spillover is the strongest when the innovation capabilities are intermediate. Subsequently, the positive relationship between agglomeration and knowledge spillover becomes weak when the innovation capabilities are high. Additionally, the moderating role of tacit knowledge on the relationship between agglomeration and knowledge spillover seems to suggest an alternate set of hypotheses. According to the economic geography literature, agglomeration serves to facilitate the sharing of tacit knowledge, thereby increasing knowledge dissemination[14]. Conversely, drawing from the KBV, tacitness associated with the difficulty of disentangling firm knowledge would likely act to protect firm-specific knowledge, thus decreasing knowledge spillover in situations of agglomeration[9]. The unresolved tension between these arguments demands further empirical research.

Our study seeks to make several contributions to the literature on knowledge spillover. First, integrating the research on knowledge spillover and the KBV, this study infers that firm heterogeneity, rather than the mere presence of a foreign firm, may be the most important factor influencing the degree of knowledge spillover. Second, given that foreign firms may choose to locate within agglomerations for reasons having to do with economic externalities, this study investigates whether foreign firms within agglomeration can reduce negative knowledge spillovers. Specifically, we investigate whether their innovation capabilities and tacit knowledge can lead to a decrease in knowledge dissemination or not.

2   Literature Review

Foreign firms investing in emerging economies are often regarded as holders of advanced knowledge; this knowledge, in turn, typically seeps—to greater or lesser extent—into local environments, where alert local firms absorb and/or imitate its contents[15]. Specifically, knowledge spillover is the phenomenon by which foreign firms' particular inventory of self-generated knowledge leaks out to local firms, rather than being appropriated through formal means. Since knowledge assets are often used by foreign firms to compete with local firms, knowledge dissemination should be actively inhibited, especially by foreign firms from newly industrialized economies (NIEs) operating in emerging economies. Foreign firms from NIEs typically possess more labor-intensive skills than foreign firms based in developed countries[16]. Such skills, to some extent, indicate a relatively small knowledge gap between local firms in emerging economies and foreign firms from NIEs. In such cases, it is much more likely to attract local firms to first learn the knowledge skills embedded within foreign firms from NIEs. Further,

given the fact that the increasing entry of foreign firms has put significant pressure on domestic firms in emerging economies to catch up and upgrade their technological capabilities[11], foreign firms should pay more attention to the threat of knowledge spillover.

Existing studies have helped to increase understanding of the issues associated with knowledge spillover by using the economic productivity of a host country at the macro level as a proxy for the consequences of knowledge spillover.   A positive estimate for foreign presence suggests the occurrence of knowledge spillover from foreign to domestic firms[17].   FDI (foreign direct investments) is regarded as an important and effective means of infusing capital, equipment, technology, and marketing or managerial skills into indigenous firms[4].   Specifically, such spillovers often occur as a by-product of the flow of skilled staff, as well as from the simple demonstration of certain skills or knowledge[1].   Spillover resulting from the movement of skilled staff suggests that a foreign firm's knowledge may in fact be spread throughout their skilled employees, whose capabilities are the result of the foreign firm's training.   Spillover resulting from demonstration shows that a foreign firm's superior production and managerial capabilities might leak out merely as a result of its arm's length relationships.   Skills associated with production and managerial practices might also be inadvertently shared through common suppliers and customers[18].   Several studies examining knowledge spillover in China have found that the presence of foreign firms has a positive impact on domestic productivity, suggesting that there are indeed real effects associated with knowledge spillover[19].   Surprisingly, other studies have found the opposite to be true[20].

Some scholars have explained such contradictory empirical findings as the result either of the various datasets employed[1], or of incomplete and overly simple proxies gleaned from the observation of aggregated dependent variables[21].   Such explanations are likely true, at least to some extent, as the studies in question may have focused on macroeconomic growth, or have assumed that foreign firms' positive impact on local productivity could be very simply equated to knowledge spillover.   However, knowledge spillover may well be a construct within the mid-term process of the enhancement of local productivity.   Indeed, the reasons for knowledge diffusion remain largely unknown. Further, such incongruous findings may be the result of an assumption of homogeneity among foreign firms.   This might be the case as the sheer number of foreign firms is increasing, at the same time that local productivity is increasing[19].   Several studies on knowledge spillover have begun to examine the effects of firm heterogeneity in investment motivation[22], tangible or intangible assets[21], country of origin[22] and local firms' absorptive capacity[23]   However, these studies have generally evaluated the consequences of local productivity, rather than the level of knowledge spillover experienced by foreign firms.   In sum, most studies on knowledge spillover have not taken firm heterogeneity into account, nor have they adopted direct measurements.   To fill such a research gap, Kaiser [24] has started to directly evaluate the organizational perception of knowledge spillover and found that the direct perceptional measurement of knowledge spillover is significantly related to several aggregated proxies.   A foreign firm's perception of knowledge spillover, for instance, is often quite reliable, because such firms are keenly aware of the damage that can be caused by knowledge spillover. This indicates a need for further empirical effort toward determining the causes of knowledge spillover.

Recently, Sanna-Randaccio and Veugelers [3] inferred, conceptually, that technology-specific factors associated with the capacity for innovation, and the associated

tacit knowledge, will influence the degree of knowledge spillover. Building on their work, this study takes the perspective of foreign firms to explore the effect that innovation capabilities and tacit knowledge have on the extent of knowledge spillover.

Innovation capabilities are associated with the generation and implementation of new ideas, processes, products or services[25]. Given that this is the case, the relative value and abundance of the innovative capabilities possessed by a foreign firm is likely to increase domestic firms' opportunities to learn from foreign firms. In a sample of foreign manufacturing firms investing in China, Wei and Liu [4] further suggested that the effectiveness of knowledge spillover, at least in part, depended on the technical capabilities of the foreign firm. Similarly, Arrow [26] asserted that a portion of the knowledge generated from proprietary investment in innovation capabilities invariably leaks out into the public domain. However, taking the KBV, innovation capabilities may be regarded as a function of organization members' ability to combine and exchange knowledge, which produce well-established and sticky organizational routines. Further, innovation capabilities are related to organizing principles and firm-specific logics available to organizations to elaborate and conform[27]. In this way, innovation capabilities are accumulated through "learning-by-doing," and have a path-dependent character. Thus, firms' idiosyncratic knowledge would create a barrier to potential imitation that would be difficult to diffuse or transfer through markets[28]. In light of the contradictory arguments drawn from these two paradigms, there may be an inverted U-shaped relationship between innovation capabilities and knowledge spillover of foreign firms. As foreign firms' innovation capabilities increase from low to moderately high, it is likely to attract local firms to absorb valuable and digestible knowledge of foreign firms. However, as innovation capabilities increase from intermediate to high, the technology gap between local and foreign firms is enlarged, and therefore knowledge spillover is less likely to occur. Facing these different arguments, this study intends to examine the true relationship between innovation capabilities and knowledge spillover.

Tacit knowledge associated with a foreign firm's technological capabilities enables a foreign firm to effectively control knowledge transfer within its own boundaries, but not beyond those boundaries. In a series of recent papers, tacitness has been linked to difficulties with knowledge transfer in strategic alliances, supply chains, international joint ventures, and intra-firm networks[29]. However, few studies have examined the effect that tacitness has on knowledge spillover in the context of a host country. Recently, Tian [21] implicitly explored the issue and found that the presence of foreign firms producing goods with well-known standard manufacturing processes is positively related to the productivity of domestic firms. He suggested that standard production skills are much easier to observe—i.e. the associated knowledge is inherently less tacit— and thereby a more likely candidate for knowledge spillover. In contrast, the tacitness inherent to a particular production process would, to some extent, limit the degree of knowledge spillover.

Another research stream associated with economic geography has asserted that agglomeration is likely to induce knowledge spillover to firms located in geographic proximity to one another. However, the majority of the empirical evidence associated with agglomeration is either built upon macro-level studies focusing on regional productivity[30], or upon firm-level research emphasizing organizational performance[31]. Their major concern holds that agglomeration can attract a pool of specialized suppliers and qualified employees for production and demand enhancement[32]. In fact, agglomeration also offers local firms better access to foreign

firms' resources and knowledge, when it comes to engendering both informal and formal interactions, as well as to their internal communications. Boari, Odorici, and Zamarian [2] have conceptually posited that comparison with rivals inside the cluster is deeper than with rivals outside the cluster. Some studies have shown that technology and management practices are transferred from foreign firms to nearby domestic ones[33], while others have shown little evidence of knowledge spillover in geographically proximate inter-firm relationships[34]. Given these contradictory findings, the existing body of research may be said to be inconclusive. This study intends to clarify the effect that geographical agglomeration has on knowledge spillover for foreign firms operating in emerging economies.

While some cluster knowledge and resources are regarded as part of the "public good," the acquisition of foreign firms' valuable resources and knowledge may be less than straightforward, owing to the technology gap between foreign and local firms. Innovation capabilities and tacit knowledge might also play significant roles in creating a technology gap, so as to have substantial moderating effects on the relationship between agglomeration and knowledge spillover. Sophisticated innovation capabilities would likely form isolating mechanisms, acting to reduce local firms' absorptive capacity or to enlarge the knowledge gap[35]. Additionally, while knowledge diffusion might be weakened by knowledge tacitness, it might also be strengthened by agglomeration. Some firms might reason that the benefits of tacitness and the costs of agglomeration are likely to cancel one another out, and may therefore choose to accept a certain amount of knowledge spillover, while others might choose to focus on protecting knowledge within an agglomeration through tacitness. Bearing in mind these two lines of thought, we choose to examine the distinct moderating effect that tacitness has on the relationship between agglomeration and knowledge spillover, as described below.

3   Hypotheses

3.1 Innovation Capabilities, Tacit Knowledge and Agglomeration

Intuitively speaking, foreign firms' innovation capabilities— which include their combinative technological capabilities to create new applications or develop new products[7], and their accumulated know-how associated with market responsiveness—are the most obvious target for imitation by local competitors in a host country. Further, given that China's institutional environment is characterized by weak property rights protections, foreign firms' innovation capabilities may be easily disseminated to domestic firms through the flow of staff, by outsourcing or imitation, or as a result of reverse engineering[36]. Interestingly, Buckley, Clegg, and Wang [18] found that a foreign firm's lack of sufficient or superior knowledge stock was likely to result in a reduced incidence of knowledge spillover to local firms. Given these realities, the valuable innovation capabilities possessed by a particular foreign firm are likely to positively influence the extent to which knowledge is spilled over to local firms, even when each foreign firm is located in the same host country.

However, as innovation capabilities move beyond a certain level, they become idiosyncratic, hard-to-copy resources. This is because innovation capabilities are related to an organization as an entire system, including its structures and routines for developing cutting-edge technology or unique services, and thus resulting in firm-specific, inimitable

knowledge[37]. Further, the high complexity of innovation capabilities exert a positive impact on innovation value appropriability[38]. In such cases, the marginal costs of potential imitation may be offset by the marginal benefits of innovation capabilities, thereby reducing the speed with which imitation occurs. Recognizing that innovation capabilities may have their own set of benefits and costs, we expect that the spillover effects of innovation capabilities would initially be strong, but that past some level of innovation, the effects begin to decrease.

Hypothesis 1. A foreign firm's innovation capabilities will have a quadratic (inverted U-shaped) relationship with the amount of knowledge the firm spills over to local firms in a host country.

Tacit knowledge develops from firm-specific production processes, forming characteristics of non-codification, non-teachability, and complexity[9]. Tacitness also drives causal ambiguity between core technical know-how and its outcome products as a result of the transfer process[29], acting as a substantial barrier to knowledge spillover. Further, tacit knowledge is partially embodied in the skills of a firm's employees[24]. Nonaka, Toyama, and Nagata [6] have suggested that tacit knowledge is non-transferable without the exchange of key personnel and all the systems that support them. Even when domestic competitors have every intention of absorbing knowledge, tacit knowledge may reduce the speed with which knowledge can be disseminated. Specifically, external tacit knowledge is likely to be unrelated to local competitors' existing knowledge domains. The transfer of knowledge that is not completely understood becomes especially difficult[39].

By contrast, a foreign firm's more tangible knowledge assets are more likely to be released to local firms, as such knowledge might easily be copied either as a result of observation or reverse engineering[40]. Although such intellectual property protections as patents and copyrights are well known means of protecting knowledge from imitation, their perceived ineffectiveness is particularly serious in emerging economies. Therefore, tacit capabilities, because they are difficult to appropriate, become an extremely important means for reducing the extent of knowledge spillover to local firms.

Hypothesis 2. The tacitness associated with a foreign firm's technological capabilities is negatively related to the amount of knowledge the firm spills over to local firms in a host country.

In addition to internal factors, an external factor—agglomeration—might play a key role in influencing variations in knowledge spillover[41]. Firms' geographic proximity to one another provides incumbent firms with more opportunities to access competitors' strategic behavior[32]. Specifically, a foreign firm's knowledge assets may well leak to indigenous firms through the observation of others' behavior, as well as through shared customers and suppliers and the movement of well-informed and skilled staff. This is particularly the case for domestic firms in emerging economies (like China in this study), because they are eager to catch up with foreign firms[42]. Given the fact that China is a large and unevenly developed country, not each region provides similar conduits for the acquisition of valuable information and knowledge. Regions with industrial agglomerations will increase both communication and observations, which help local firms to access and imitate the capabilities of foreign firms. Foreign firm's knowledge, thus, is much more likely to be disseminated among geographically dispersed competitors. We thus offer the following hypothesis:

Hypothesis 3. Agglomeration is positively related to the amount of knowledge that foreign firms spill over to local firms in a host country.

3.2 The Moderating Roles of Innovation Capabilities and Tacit Knowledge

Foreign firms within the same agglomeration will not necessarily disseminate the same amount of knowledge to members of geographically proximate groups[43].   While agglomeration facilitates knowledge spillover from foreign firms to local firms, foreign firms' innovation capabilities vary which will effect local firms' knowledge absorption and then knowledge spillover from foreign firms to local firms.   We propose that the positive relationship between agglomeration and knowledge spillover is the strongest when innovation capabilities are intermediate, compared with when innovation capabilities are either too small or too large.

We suggest this quadratic moderating effect because innovation capabilities affect absorption capacity of local firms within agglomeration to digest foreign firms' innovative knowledge.   First, when innovation capabilities are too small, agglomeration has a relatively weak impact on knowledge spillovers.   It indicates that such knowledge diffusion, these knowledge elements of foreign firms have little value to local firms. Second, when innovation capabilities become superior, technologies practices brought by foreign firms certainly represent advanced, external knowledge for the domestic firms to learn, thus increasing the potential of knowledge spillovers.   Third, beyond the inflection point, when the innovation capabilities of foreign firms is too advanced, local firms may not have the capacity to absorb the advanced technologies and management practices brought by foreign firms.   Further, when the technology gap is large, the technology and management practices of foreign firms represent significant isolating mechanisms—and isolating mechanisms, in this case, generate the asymmetries in knowledge stock[44] that allow foreign firms in situations of agglomeration to limit the speed of knowledge dissemination.   We thus propose the following hypothesis:

Hypothesis 4. There is the strongest positive relationship between agglomeration and the amount of knowledge the firm spills over to local firms in a host country, when a foreign firm's innovation capabilities are intermediate.

As mentioned earlier, tacit knowledge is an indication of how well a foreign firm is able to regulate the dispersion of its knowledge.   However, given that close geographical proximity increases both communication and observation, a greater intensity of local firms would cause tacit knowledge to spill over to a greater extent[45].   With respect to this concern, we expect that—when it comes to a foreign firm's technological capabilities—the efficacy of tacitness in eliminating knowledge spillover may be overcome by a situation of agglomeration.   In particular, when organizational domains between foreign and local firms do not completely overlap, local firms do not have the capacity to recognize the value content of the tacit knowledge[46].   Further, a foreign firm's tacit knowledge is not only tied closely to the identity of the firm's production processes, but is also influenced by the home country's institutional environment[47]. Along these lines, it increases the technology gap with local firms, thus acting as an impediment to imitation.   Therefore, the marginal knowledge spillover associated with agglomeration decreases as a function of knowledge tacitness.   We therefore derive the following hypothesis:

Hypothesis 5. The tacitness of a foreign firm's technological capabilities reduces the positive relationship between agglomeration and the amount of knowledge the firm spills over to local firms in a host country.

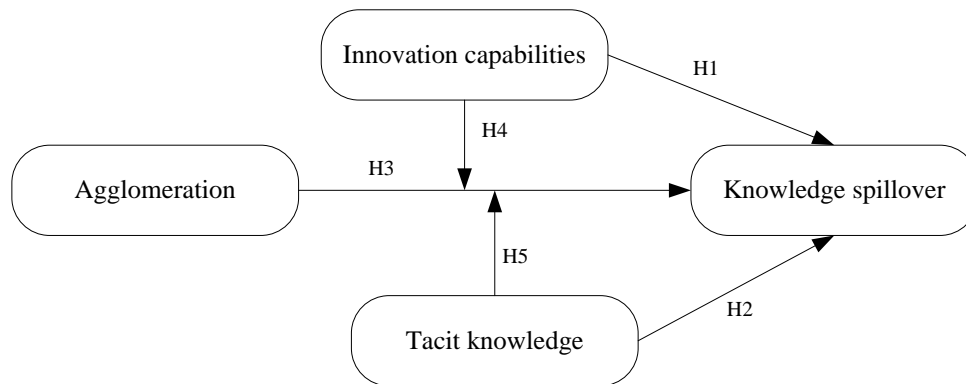Figure 1 shows our research framework for this relationship.

Figure 1: Conceptual Model

4 Methodology

4.1 Survey Procedure and Samples

To test its hypotheses, this study examines a sample group of Taiwanese manufacturing firms investing in China[48] . The sample is confined to manufacturing industries because the experience and knowledge within the manufacturing sector are quite different from those in the service sector. Taiwanese manufacturing firms operating in China are treated as foreign manufacturing firms from an NIE, and China is treated as an emerging-economy host country for three reasons. First, China is continuing to aggressively attract FDI for (at least in part) the purpose of absorbing knowledge embedded within foreign firms' products and manufacturing processes. Second, since China is characterized by an incomplete protection of intellectual property rights, the various factors that facilitate or inhibit knowledge spillover have caught scholars' and managers' attention. Third, recent research has begun to pay increasing attention to international expansion in China on the part of firms based in NIEs, such as Taiwan [14]. Notably, Taiwan recently ranked as China's eighth largest foreign investor[49]. Even though China and Taiwan enjoy significant cultural similarity and are geographically proximate, Orru, Biggart, and Hamilton [50] found significant variation in technology development and management practices across the two countries. Firms from NIEs that have experience with economic policies similar to those that characterized China's (former) planned economy may become the target of imitation by indigenous firms. At the same time, they may also be skilled in protecting their own know-how in the context of an emerging economy (i.e., China). Additionally, Taiwan, a fast-growing economy, has been accumulating more and more innovation capabilities from the private sector. Some Taiwanese firms have been successful in closing the technological gap between themselves and their counterparts in developed countries, while others have retained traditional labor-intensive production methods[51]. In such situations, an examination of the determinants of knowledge spillover for Taiwanese firms might provide some insight for other foreign investors with operations in China.

An investigation into the number of Taiwanese firms investing in China yields two significantly different figures. One comes from data tracking Taiwanese FDI in China, which is drawn from a report on *Taiwanese firms investing in China* 2005[52]. This report gives a figure of 2308 organizations. The second figure comes from official data

drawn from the *China Statistical Yearbook* 2006[53]. This report claims that more than 68,000 such projects exist. According to Taiwanese government officials, part of the reason that these two numbers are so different is that Taiwanese firms often engage in FDI privately or informally. Therefore, this study sacrifices some degree of external validity by contacting firms through two banks providing foreign-exchange and banking services to Taiwanese firms with operations in China[54]. This lack of external validity is especially the case when it comes to those firms not shown in the Taiwanese governmental list.

By means of systematic sampling, this study selected 450 firms from the list of *Taiwanese firms investing in China* 2005[52], and then mailed questionnaires directly to the manufacturing firms' executives. A total of forty-five usable questionnaires were retained for analysis, for an effective usable response rate of 10%. Additionally, we collect the data through banks' foreign exchange and banking service counters which have greater acces to Taiwanese manufacturers investing in China. From this part of survey, 57 responses were useful, out of 67 questionnaires. In total, this study collected a total of 102 usable questionnaires. Additionally, the two groups of respondents were compared across the constructs of our study. No significant differences (p > .05) were observed, implying that the responses of the two groups did not differ significantly. This study further compared groupings of respondents with non-respondents according to the size of their organizations (based on the data provided by the Investment Commission), and no significant differences emerged. In this study, Taiwanese investments presented wide geographic coverage throughout China, consisting of Beijing, Fujian, Guangdong, Hainan, Hubei, Jiangsu, Liaoning, Shaanxi, Shandong, Shanghai, Tianjin, and Zhejiang.

4.2 Measurements

Based upon a review of the literature and in-depth interviews with nine executives, this study developed measures for its related constructs. To further confirm the appropriateness of the terminology and response formats, the questionnaires were tested again with two Taiwanese manufacturing firms. This study measures the constructs using a 7-point Likert scale,ranging from 1 (strong disagreement) to 7 (strong agreement).

Knowledge spillover. This study followed Kaiser's [24] approach to measuring the perceived extent of knowledge spillover, using five items: (1) after providing assistance designed to improve our suppliers' overall product quality and reliability, we found that local firms showed similar gains in the reliability and quality of components provided by these suppliers (KS1); (2) local firms can easily acquire our product and marketing know-how through our shared suppliers (KS2); (3) local firms can easily gain our product and marketing know-how through our shared customers (KS3); (4) local firms can gain access to knowledge about our products and technological assets by recruiting our staff (KS4); and (5) local firms can gain access to knowledge about our managerial practices, including human resource management and/or manufacturing strategies, by recruiting our staff (KS5). This paper used the mean answer-value to represent knowledge spillover.

Innovation capabilities. Following Hurley and Hult [7], this study measured innovation capabilities according to a four-item scale, by asking survey participants to respond to the following statements: (1) We have innovation capabilities associated with developing new products to respond to market needs quickly in the host country (IC1); (2) We have innovation capabilities relating to convert new ideas into new products quickly in the host country (IC2); (3) We have innovation capabilities relating to improve manufacturing

processes quickly in the host country (IC3); (4) We have innovation capabilities accumulated through research and developments (IC4). This article calculated innovation capabilities as the average of the responses to these items.

Tacit knowledge. In accordance with Simonin's [29] work, this study asked participants to respond to three statements regarding tacit knowledge: (1) our technology is not easily codifiable (TA1); (2) our process know-how is not easily codifiable (TA2); and (3) our technology/process know-how could not be written down, and is not easily transferable to new employees (TA3). The mean of responses to these items represented tacit knowledge.

Agglomeration. Agglomeration was measured in accordance with Appold [55] and Kukalis [31], who looked at how foreign firms form groups with geographically proximate competitors, customers, and suppliers. A four-item scale assessed the degree to which (1) We have agglomerated with many competitors in a particular area (AG1); (2) We are part of an agglomeration with many suppliers in the same geographical area (AG2); (3) We are co-located with many customers in the same geographical area (AG3); and (4) We are co-located with many suppliers providing a complete range of components in a particular area (AG4). The value of agglomeration was the average of the responses to these statements.

Several control variables, involving characteristics at both the firm level and the industry level, are likely to affect knowledge spillover. While providing no formal hypotheses regarding these factors, this study controlled for their respective impacts in the model. First, *firm size and length of operation* are related to knowledge spillover to local firms. Firm size was captured by the number of employees (in the ordinal scale of 5 levels: fewer than 100 employees, 101-500 employees, 501-1000 employees, 1001-1500 employees, and, more than 1501 employees). Length of operation was measured as the number of years foreign firms have operated in the host country. Second, *export intensity* was captured as the ratio of export sales to total firm sales. Foreign firms characterized by high export intensity usually have significant knowledge of international marketing, advanced technological know-how, and distribution networks[4]. We used a logarithm transformation of length of operation and export intensity as the variables in our regressions because of their high degree of skewness. Third, this article used a dummy variable to represent the *electronics industry*, which is characterized by cutting-edge knowledge.

We used confirmatory factor analysis (CFA) to examine the adequacy of the measurement model. The results show that the CFA model reaches a reasonable level of fitness for knowledge spillover, innovation capabilities, tacit knowledge, and agglomeration ($\chi2(98)=159.29$, $p < 0.00$, GFI=0.84, NFI=0.84, NNFI= 0.91, RMSEA=0.05). An examination of the individual item loading appears to be both large and significant, indicating the existence of convergent validity (see Table 1). With respect to the reliability of the scales, the levels of Cronbach α for all multi-item constructs exceeded the necessary 0.70 level. Moreover, the measurement model appears to reach discriminant validity, because the confidence interval of the correlation between any two latent constructs (in the phi-matrix) did not include 1.

Table 1: Final measurement model

		Standardized factor loading	t-value	Reliability
Knowledge spillover	KS1	0.88	10.44**	0.82
	KS2	0.66	7.03**	
	KS3	0.77	8.70**	
	KS4	0.62	5.23**	
	KS5	0.62	5.29**	
Innovation capabilities	IC1	0.81	9.38**	0.85
	IC2	0.88	10.47**	
	IC3	0.67	7.21**	
	IC4	0.60	6.09**	
Tacit knowledge	TA1	0.87	10.94**	0.89
	TA2	0.99	14.18**	
	TA3	0.94	12.49**	
Agglomeration	AG1	0.65	7.02**	0.88
	AG2	0.84	10.03**	
	AG3	0.91	11.23**	
	AG4	0.60	5.95**	

Note: ** Significant at 0.05.

Since common method bias is of concern when collecting multiple measures from the same survey instrument, this study used Harman's one-factor test to make sure that such bias was not a factor. A principal-components factor analysis of the measurement items generated four factors with eigenvalues greater than one, which together accounted for 72.45 percent of the variance in the data. Because this analysis yielded multiple factors, rather than only one, and because the first factor did not explain the majority of the variance (only 19.54%), these results did not suffer from serious problems of common method bias.

5   Results

Table 2 summarizes the descriptive statistics and correlation matrix pertaining to all variables involved in this study. The study used hierarchical regression analysis calculated by ordinary least squares (OLS) to estimate the coefficients for all explanatory variables (see Table 3). In addition, to minimize the distortion caused by multicollinearity, each scale constituting an interaction term was mean-centered. In Table 3, this study reported the control variables in Model 1; it then introduced the independent variables and the quadratic term of innovation capabilities in model 2; and finally, it added the interaction variables in models 3 and 4. Model 1 was not significant, but both models 2, 3 and 4 were significant (at the 0.01 level), indicating the extent to which knowledge spillover can be explained by independent and interaction variables.

Table 2: Descriptive statistics and pearson correlation matrix

	1	2	3	4	5	6	7	8
1. Knowledge spillover	1.00							
2. Innovation capabilities	0.27**	1.00						
3. Tacit knowledge	-0.28**	0.09	1.00					
4. Agglomeration	0.18	0.39**	0.21*	1.00				
5. Firm size	-0.15	0.15	0.09	0.03	1.00			
6. Length of operation	0.02	-0.11	0.18	0.08	0.23*	1.00		
7. Export intensity	-0.14	-0.05	-0.07	-0.25*	0.26*	-0.08	1.00	
8. Industry	-0.01	0.24*	-0.04	0.00	0.09	-0.35**	0.08	1.00
Mean	4.03	4.98	4.29	4.35	2.92	2.10	1.65	0.45
S.D.	1.14	1.21	1.54	1.48	1.38	0.59	0.51	0.50

** Significant at 0.05   * Significant at 0.10.

Table 3: Hierarchical regression analysis for knowledge spillover

	Model 1	Model 2	Model 3	Model 4
Control variables				
Firm size	-0.13(0.11)[a]	-0.15(0.06)*	-0.16(0.05)*	-0.14(0.06)*
Length of operation	0.05(0.34)	0.12(0.11)	0.13(0.11)	0.11(0.12)
Export intensity	-0.11(0.15)	-0.06(0.27)	-0.05(0.30)	-0.05(0.28)
Industry	0.03(0.39)	0.03(0.40)	0.02(0.42)	0.03(0.39)
Independent variables				
Innovation capabilities		0.19(0.05)**	0.21(0.04)**	0.22(0.03)**
Innovation capabilities^2(H1)		-0.22(0.02)**	-0.19(0.04)**	-0.14(0.09)*
Tacit knowledge (H2)		-0.33(0.00)***	-0.34(0.00)***	-0.24(0.01)**
Agglomeration (H3)		0.14(0.08)*	0.15(0.07)*	0.29(0.01)**
Interaction				
Agglomeration* Innovation capabilities			-0.08(0.19)	-0.11(0.12)
Agglomeration* Innovation capabilities^2(H4)				-0.18(0.09)*
Agglomeration* Tacit knowledge (H5)				-0.29(0.00)***
F-value	0.87	4.17***	3.78***	4.51***
R^2	0.03	0.26	0.27	0.36
Adjusted R^2	-0.01	0.20	0.20	0.28
Δ Adjusted R^2		0.23	0.01	0.09
Hierarchical F-value		7.24***	0.75	5.97***

[a] : Standardized regression coefficients (β) with ' *** ' indicating significant at 0.01, ' ** ' indicating significant at 0.05, and ' * ' indicating significant at 0.10.

Hypothesis 1 predicts a quadratic (inverted U-shaped) relationship between the innovation capabilities and the amount of knowledge spillover. The coefficient for innovation capabilities is positive and significant (β= 0.19, p < 0.05 in Model 2), and the coefficient for innovation capabilities squared is negative and significant (β= -0.22, p < 0.05 in Model 2). These findings provide strong support for Hypothesis 1. We further provide the graph of the quadratic associations, which suggest that once a foreign firm possesses a high level of innovation capabilities, the negative effect of innovation capabilities will become dominant over the positive effects on knowledge spillover. Tacit knowledge was negatively and significantly related to knowledge spillover (β= -0.33, p < 0.01 in Models 2), thereby supporting H2. The association between agglomeration and knowledge spillover also emerged as being significant (β= 0.14, p < 0.10 in Model 2); therefore, H3 was also supported.

Model 3 adds the interaction of agglomeration and innovation capabilities (β= -0.08, n.s. in Model 3). Model 4 adds the interaction of agglomeration and the squared term of innovation capabilities, which is negative and significant (b = -0.18, p < 0.10 in Model 4). The result suggests that the relationship between agglomeration and knowledge spillover varies across different levels of innovation capabilities in a quadratic manner which is shown in Figure 2.

Following the approach used by Zhang, Li, Li, and Zhou [23], we plotted this significant interaction effect in Figure 3. The plot shows how the relationship between agglomeration and knowledge spillover varies across different levels of innovation capabilities. To create this plot, the regression equation predicting knowledge spillover was examined at different levels of innovation capabilities. The vertical axis of the graph represents values for the standardized regression coefficient for agglomeration predicting knowledge spillover, and the horizontal axis represents values for innovation capabilities. As show in the figure, there is an inverted U-shaped relationship between agglomeration and knowledge spillover across increasing levels of innovation capabilities. The coefficient is the highest when innovation capabilities are at the intermediate level compared with when the innovation capabilities are either too small or too large. The results thus support H4.

The moderating effect of tacit knowledge carried a significantly negative sign (β= -0.29, p <0.01 in Model 4), meaning that H5 was supported. Similarly, to facilitate interpretation, tacit knowledge took the value of one standard deviation below and above the mean. Figure 4 reveals that if the tacitness level is high, foreign firms in situations of agglomeration will demonstrate lower levels of knowledge spillover.
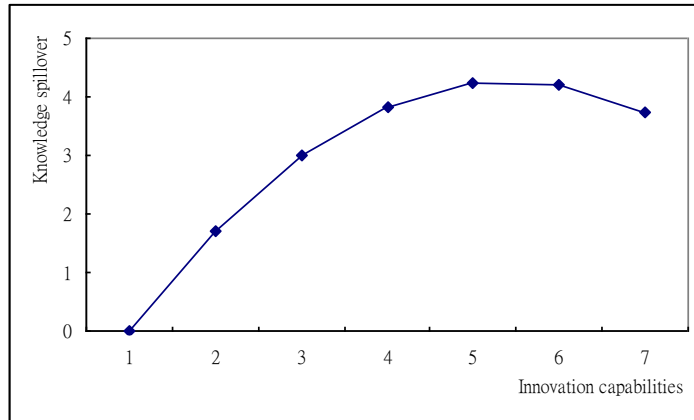
Figure 2: Knowledge spillover and innovation capabilities
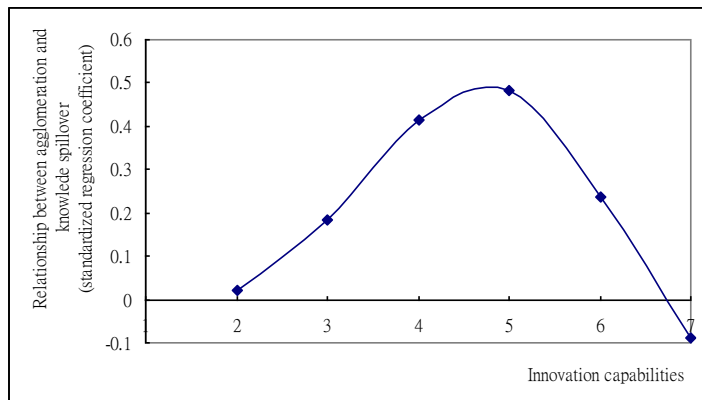

Figure 3: The relationship between agglomeration and knowledge spillover as a function of innovation capabilities
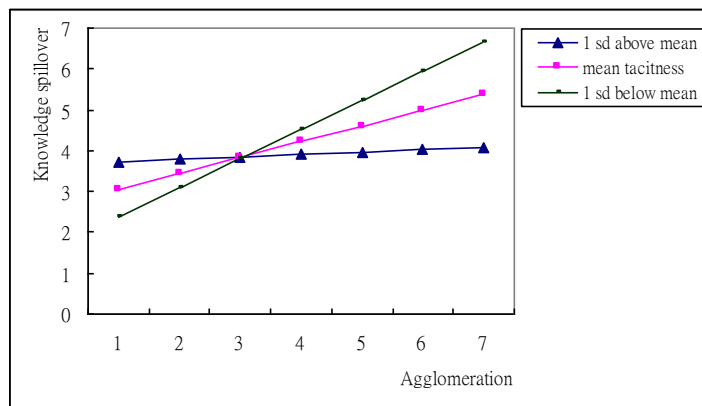

Figure 4: Knowledge spillover and agglomeration by tacit knowledge

6   Discussion and Conclusions

The purpose of our study was to explore how foreign firms can inhibit knowledge spillover to local firms.   To achieve this aim, we incorporated research on knowledge spillover and the KBV.   Operating from the basic assumption that both firms and locations are heterogeneous, innovation capabilities and tacit knowledge, along with agglomeration, are included in the study for the purpose of explaining issues related to knowledge spillover.   We found evidence supporting our arguments as follows: First, the knowledge spillover literature has explained the dissemination of knowledge with the general idea that richer innovation capabilities lead to a greater amount of knowledge diffusion.   However, consistent with the logic offered by the KBV, as foreign firms' innovation capabilities cross a given threshold, substantial barriers to imitation emerge, reducing the amount of knowledge spillover.   Second, due largely to its hard-to-articulate and non-codified nature, tacitness associated with foreign firms' technological capabilities would inhibit knowledge dissemination.   Third, in order to overcome foreignness liabilities and acquire local resources, foreign firms would likely choose to locate within agglomerations.   However, agglomeration is a two-sided coin: Locating in geographic proximity to other firms will increase the amount of knowledge spillover.   Fourth, we argue that the heterogeneity in foreign firms' innovation capabilities can affect the extent of knowledge spillovers within agglomeration.   Our findings suggest that there is a quadratic moderating effect of innovation capabilities of foreign firms.   Specifically, it is at the intermediate level of innovation capabilities that agglomeration will facilitate the greatest amount of knowledge spillover.   Fifth, knowledge tacitness can limit the speed of knowledge spillover within an agglomeration, as the benefits of tacitness will outweigh the harmful effects of agglomeration on knowledge spillover, in keeping with the arguments of the KBV.   In sum, regarding the tension between the knowledge spillover literature and the KBV, our findings show complementarities when it comes to explaining variances in knowledge spillover.

Regarding the theoretical implications, this study is to advance our understanding of knowledge spillover.   Several streams of research—examining such topics as agglomeration, the presence of FDI, and entry mode—have attempted to deconstruct the issue of knowledge spillover.   However, most studies neither consider the heterogeneity of firms, nor use a detailed measure as a proxy for the spillover effect.   Although some studies of entry mode have suggested that the tendency of firm-specific know-how to be disseminated might encourage foreign firms to engage in exporting rather than FDI, many foreign firms were likely eager to invest in China because of its potentially huge markets and abundant natural resources.   We have chosen to use foreign firms with operations in China as our research sample, and have focused on a firm's heterogeneity, bringing the knowledge-based perspective together with the economic geography research to explore this topic.   In our empirical observations, innovation capabilities, tacitness, and agglomeration all provide a theoretical model for knowledge spillover; this, in turn, may explain why previous research has produced such inconsistent findings.

This issue is not only important to the extension of theory, but also has critical implications for managers.   First, although the exploitation motive for foreign firms from NIEs operating in emerging economies has long been dominant (Makino et al., 2002), it requires that such firms continuously improve their innovation capabilities.   Foreign firms' innovation capabilities will attract local firms to imitate.   However, accumulating innovation capabilities beyond some threshold, foreign firms are enable to build barriers

to imitation as well as to create organizational competitiveness[38]. Second, emerging economies are characterized by insufficiently developed intellectual property rights, and their domestic firms often undertake aggressive catch-up efforts. Tacit knowledge increases the amount of time—as well as the costs—associated with technology's transfer and full utilization by local competitors. Third, although agglomeration may increase some benefits, locating close by to others will lead foreign firms to increase their exposure to potential spillover. Further, in general a foreign firm cannot prevent the relocation by other firms, nor can it inhibit the location decisions in situations of agglomeration by new entrants. Thus, with the increasing innovation capabilities of foreign firms, agglomeration is likely to facilitate a greater extent of knowledge spillover. Yet, extremely innovation capabilities would likely exacerbate the challenges for local firms to absorb and digest. That is, when innovation capabilities accumulated to a certain high level, it will lead to a weakening positive effect of agglomeration on knowledge spillover from foreign to local firms. Finally, in order to lessen the competitive pressure and the degree of knowledge spillover, tacit knowledge may be well protected from imitation by domestic firms.

6.1 Limitations

Our research is not without limitations. First, our study focuses on the degree of knowledge spillover without differentiating among competitors according to their strategic or resource endowments. Within external environments, for instance, competitors with greater resources might be better able to absorb the diffused knowledge from foreign firms. Although our aim was to measure degrees of knowledge spillover, rather than to identify which type of local counterpart might receive more knowledge from such spillover, the data in this study would have been far richer and more objective if the study had had access to the views of all the parties in question (i.e., both foreign and indigenous firms). Second, although this cross-sectional research survey demonstrates the importance of innovation capabilities and tacit knowledge in understanding knowledge spillover, this approach fails to consider the dynamic nature of such spillover. For example, certain economic development policies in a host country might influence knowledge spillover effects. In the future, researchers might wish to develop a longitudinal research design to investigate this issue.

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