FDI spillovers and the effect of local firm's relational absorptive capacity for open innovation

Abstract

This paper explores absorptive capacity and its effect on the effectiveness of FDI technology spillovers on local firm's innovation performance. Given the increasingly salient role of a network-based approach to open innovation, we examine relational absorptive capacity relating to capabilities for local firms to manage network relationships and successfully search and acquire new external technologies from their business partners. We test a two–stage selection bias model to separate the effect of FDI spillovers under relational absorptive capacity from such effect after controlling local firm's decision to reduce the negative inertia from existing routines and capabilities. We find partial evidence illustrating strong relational absorptive capacity marked by breadth of network relationships help local firms gain from FDI technology spillovers. Capabilities building on depth of existing relationships do not provide the same moderating effect, and we believe this is because of negative inertia from depth of relationships. Our key contribution is to explore a specific type of absorptive capacity required for local firms to gain from FDI spillovers amid the salience of open innovation strategies, and show that local firms need to prevent negative inertia from creating organisational rigidities that impedes acquisition of foreign technologies.

Keywords
Technology spillovers, Foreign direct investment (FDI), Absorptive capacity, Relational absorptive capacity, Network

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Introduction

Innovation performance of a firm is influenced by a firm's interaction with the market (for incremental innovation) and non-market entities (for the radical innovation) (Freeman, 1995; Laursen & Salter, 2006). A systematic interaction with external source of innovation allows individual firms to capture greater values from 'collective creativity' residing in the outer innovation system (Chesbrough & M. Appleyard, 2007: 57). MNEs play an important role in local firm open innovation as their value-creating activities stretch across national innovation systems thereby transferring foreign technologies which an enclosed national innovation system otherwise would not generate autonomously (Acemoglu, 2012; Lall & Narula, 2004).

Foreign technologies are transferred through formal transactions and but also through informal conduits between local and foreign firms in the form of technology spillovers (Meyer & Sinani, 2004). Due to difficulties to transfer knowledge (Grant, 1996; Szulanski, 1996), local firms benefit from FDI spillovers when they interact with foreign firms through transactional linkages (Javorcik, 2004; Markusen & Venables, 1999), embedded network relationships (Spencer, 2008), and within the relevant network structure (Eapen, 2012). For local firms to successfully acquire foreign technologies through those linkages, absorptive capacity is a key condition, which refers to a key ability to identify, exploit and utilise external technologies including those from foreign-owned sources (Cohen & Levinthal, 1990).

Recently, more detailed definitions of absorptive capacity have been suggested. In the FDI spillover research absorptive capacity has been represented by existing technology stocks and intangible capitals such as human resources in local firms (e.g., Blalock & Gertler, 2009).

A new view is absorptive capacity should be understood as a platform for local firms to develop and manage network ties with foreign sources of technologies (e.g. Eapen, 2012). Re-conceptualisation of absorptive capacity's role in the FDI spillover process coincides with increasingly fine-grained conceptualisation of absorptive capacity, such as absorptive capacity as a linear learning process (Lane, Koka, & Pathak, 2006; Todorova & Durisin, 2007), absorptive capacity from the inter-firm relational perspective (Kale & Singh, 2007; Lichtenthaler & Lichtenthaler, 2009) and absorptive capacity as a bundle of routines and capabilities for internal and external knowledge processes (Lewin, Massini, & Peeters, 2011). In order to explore conditions of FDI spillover effect in the context of host-country open innovation, this paper focuses on abilities relating to the search and acquisition of foreign technologies in the process of open innovation and names this specific type of absorptive capacity as relational absorptive capacity. Whilst absorptive capacity theory has narrowly focused on the existing knowledge assets for internal exploitation, there has been lack of studies applying this new type of absorptive capacity for the assessment of FDI spillover effect.

Our key contribution is that we define and explain the role of relational absorptive capacity in the effectiveness of FDI spillovers from foreign sources to local recipients. We test evidence of relational absorptive capacity in two ways, in terms of local firms' the breadth of search activities and the depth of interactions with the source of external technologies (Eapen, 2012; Laursen & Salter, 2006). We examine how local firms with relational absorptive capacity benefit from MNE's innovation activities in the host country and improve innovation performance. We view relational absorptive capacity have dual roles: as the facilitator of search and transfer of foreign technologies and as the source of negative inertia to obstruct such processes. Using a two–stage selection bias model (Bourguignon, Fournier, & Gurgand, 2007), we minimise endogeneity bias involving the effect of absorptive

capacity on FDI spillover effective. Samples are limited to the repeated respondents from KIS 2002 and KIS 2005 but the data as a result is stronger than a cross-sectional data in terms of the reflection of various sources off heterogeneity.

The remainder of the paper is organised as follows: literature & theory introduces theoretical foundations of this paper. Then we hypothesise the influence of open innovation strategy on the effect of technology spillovers from FDI. Empirical section describes the empirical model, the two-stage estimation methods and data. Discussion will discuss the empirical results and Conclusion will make a conclusion, paired with key contributions, implications and reflection on limitations.

FDI Spillovers and Relational Absorptive Capacity

For local firms in host countries MNEs provide an easy access to foreign technologies. As opposed to formal routes such as joint venture and M&A, strategic alliance, buyer-supplier network and arm's lengthen transactions, FDI spillovers are informal routes to acquire foreign technologies that involve no market-based pricing. FDI spillovers are horizontally transferred through competition, demonstration and labour turnover to affect local rivals of MNE subsidiaries and vertically transferred through buyer-seller linkages to backwardly affect local supplier's upstream activities and forwardly affect local customer's downstream activities.

Evidence about FDI spillovers has been mixed. The effect of horizontal spillovers varies widely depending on types of activities taking place at MNE subsidiaries – employment, sales, capital investment and R&D. Recent studies support positive backward spillovers (Blalock & Gertler, 2008; Javorcik, 2004; Liu, Wang, & Wei, 2009; Marcin, 2008; Motohashi & Yuan, 2010). The positive effects of backward spillovers seem to be robust, even after controlling the possibility that MNEs hand-pick productive local suppliers (Javorcik & Spatareanu, 2008b). The effect of forward spillovers is ambiguous. Driffield & Love (Driffield, Munday,

& Roberts, 2002) posit evidence of positive forward spillovers, along with Schoors et al. (2002) and Liu et al. (2009), whilst Yudaeva et al. (2003) predicted negative forward spillovers, and there are more recent studies reporting that forward spillovers do not have a significant effect on local customers in the host country (Javorcik, 2004; Marcin, 2008; Motohashi & Yuan, 2010).

Mixed evidence indicates that adoption of external knowledge is not automatic, because learning is contingent on identification of values of external knowledge and for this existing internal knowledge matters. Therefore learning based on external knowledge demands relevant prior knowledge and experiences, the essence of which is summarised as absorptive capacity. Absorptive capacity commonly refers to the ability to identify and acquire valuable external knowledge, assimilate it through the process of interpreting the acquired knowledge and finally exploit it by combining it with existing internal knowledge (Brettel, Grève, & Flatten, 2011; Cohen & Levinthal, 1989).

Therefore absorptive capacity is a key condition for successful acquisition of FDI spillovers by domestic firms. To examine how far absorptive capacity matters for FDI spillovers, the extant literature has considered intangible assets of a local firm and R&D intensity (Liu, Siler, Wang, & Wei, 2000; Marcin, 2008), local investment in tangible assets and human capital (Meyer, 2004), comparison of the effect of absorptive capacity with productivity capability and the capability for marketing (Blalock & Simon, 2009), and being a sector leader (Javorcik & Spatareanu, 2008a).

However, existing technological asset alone cannot fully reflect required absorptive capacity for open innovation. In the context of open innovation, the source of competitive advantage is not fixed to ownership and control system. As learning can stretch across boundaries of firms that are involved in the process and as such rents are bound to the

relationship, not specific to any party, more complex forms of absorptive capacity emerge (Lichtenthaler & Lichtenthaler, 2009). Inter-organisational learning is a challenge as external knowledge comes from different organisational context (Grant, 1996; Spencer, 2008; Szulanski, 1996).

In this respect, more detailed definitions of absorptive capacity have been suggested in recent years. Absorptive capacity is described in the linear process of learning comprising exploration and exploitation (Lane, Koka, & Pathak, 2006; Todorova & Durisin, 2007). In the exploration stage a firm demands capabilities to develop routines for search and adoption across boundaries of the firm (Kale & Singh, 2007; Lichtenthaler & Lichtenthaler, 2009). Extant understanding pays less attention to the role of absorptive capacity how the search and adoption mechanism actually work (Eapen, 2012), especially in terms of social process (Todorova & Durisin, 2007). Compiling discussions underway under varying titles such as connectivity capacity, alliance capabilities, relational capabilities, we define *relational absorptive capacity* as a special type of absorptive capacity referring to a firm's ability to develop routines and related capabilities to manage search and acquisition of knowledge in inter-organisational learning process.

Relational absorptive capacity has two dimensions: breadth of search channels and depth of interactions in network relationships. The first paired with knowledge exploration and the second being the combined process of knowledge exploitation and retention (Lichtenthaler & Lichtenthaler, 2009). Breadth of open innovation strategy indicate ability of the local firm to handle a wide variety of administrative heritages of network partners (Laursen & Salter, 2006). Breadth of network-relationships alludes to how far the local firm focuses on the search of new technology from a number of external channels. Meanwhile, depth of open innovation strategy corresponds to the capability of the local firm to build and sustain intense interactions with network partners (Laursen & Salter, 2006). Therefore, depth of network

relationships concerns how far the local firm develops an inter-organisational learning process for continuously successful acquisition and integration of new technology from its existing foreign partners.

In sum, we highlight inter-organisational learning process and tease out the under-studied dimension of local firms' active selection of different open innovation strategy building on absorptive capacity. Relational absorptive capacity merits equal emphasis as internal absorptive capacity, given the nature of FDI spillovers. And relational absorptive capacity of a local firm can be reified into the firm's ability to develop and manage either breadth or depth of network relationships (See Figure 1).

-- Insert Figure 1 about here --

Based on the realisation that FDI spillovers occur in the context of inter-firm network ties that requires capabilities relating to relation-specific learning and rent generation, the next section further discusses how relational absorptive capability works as a condition of FDI spillover effect.

Hypotheses Development

This section starts by discussing how relational absorptive capacity works to faciliate inter-organisational informal technology flows. Firstly, relational absorptive capacity includes partnering skills for the search process. Network is a channel to reach external knowledge resources, and through network experiences a domestic firm develop skills to establish links with external knowledge sources and secure access to them (Lichtenthaler & Lichtenthaler, 2009). This partnering skills should be dynamic enough to survive different phases of network relationships (Kale & Singh, 2007). Secondly, relational absorptive capacity includes ability to learn from inter-firm ties by bridging the gap between different organisational routines and

to manage inter-firm relationships (Dyer & Singh, 1998; Lane & Lubatkin, 1998; Lewin, Massini, & Peeters, 2011). Thirdly, beyond mutual knowledge exchange, both foreign and local firms develop represent joint gains in the network and jointly develop network capabilities (Kogut, 2000). In this context, strong relational capabilities of a domestic firm to govern network relationships with foreign MNEs improve the chance to successfully acquire positive technology spillovers from FDI. Overall, strong relational absorptive capacity benefit domestic firms by establishing and managing network relationships with MNEs and this increases the likelihood of transfer of complex knowledge by reducing challenges of tacit knowledge transfer (Hansen, 1999; Lane & Lubatkin, 1998).

Previously absorptive capacity has been reduced to past experiences concerning managing high switching costs and learning curves in adding new entries into the portfolio of search channels (Burnham, Frels, & Mahajan, 2003). However, past experiences of successful identifying, utilising and commercially benefiting from network-based knowledge does not necessarily point to the extent to which a firm has relevant partnering skills, its functional unit developed capabilities to handle inter-organisational learning, and the learning process is embedded in its organisational structure (Kale, Dyer, & Singh, 2002; Kale & Singh, 2007).

Relational absorptive capacity for breadth in particular concerns the ability to manage the travel of technology spillovers by addressing the organisational distance between local firms and MNE subsidiaries with diverse organisational backgrounds. Therefore local firms with strong relational absorptive capacity to manage breath of search channels are more likely to benefit from positive FDI technology spillovers. For this reason, the moderating effect of relational absorptive capacity will be positive on relationship between FDI spillovers and local firm's innovation performance.

Hypothesis 1: *Horizontal technology spillovers from FDI have a positive effect on innovation performance of local firms with strong relational absorptive capacity for breadth of network relationships.*

Not all relational absorptive capacity is complementary to the effectiveness of FDI spillovers, however. This is the case if there is a fundamental cultural, institutional, and psychic distance between foreign and local firms. Routines and capabilities local firms have developed in the local open innovation network may not be compatible with those required for foreign technology adoption from foreign MNE subsidiaries. This is because local firms may experience negative inertia from extant domestic network for open innovation. Depth of extant network relationships is likely to raise organisational inertia. Therefore,

Hypothesis 2: *Horizontal technology spillovers from FDI have a positive effect on innovation performance of local firms with strong relational absorptive capacity for depth of network relationships.*

Methodology

Model

The analysis aims to disentangle the pure moderating effect of open innovation strategy by controlling selection bias: a local firm's decision on how to implement innovation within the corporate organisation and another decision on the use of network potentially bias the relationship between relational absorptive capacity and innovation performance change. In this case the relationship between relational absorptive capacity and innovation performance is to a certain extent predicted by local firms, albeit not pre-determined, and for this reason a structural model without handling the selection bias may mix up self-selected outcomes and pure effect of FDI spillovers.

The two-stage selection bias model comprises the first-stage decision model and the second-stage outcome model. The common decision model assumes determinants of two outcomes and is estimated by the probit model. By contrast, we consider four combinations of a decision on the use of network and a decision on the establishment of research centres or teams in the organisational structure. We estimate this decision function by means of multinomial logit and generate four Inverse Mills Ratios following a STATA procedure based on Bourguignon et al. (2007). Each combination is represented by integers of 1,2,3, and 4. Four outcomes are predicted by four firm-level **Control**$_i$, profit margin, age, appropriability concerns and perceived competitive pressures. The latter two are measured by the six-point Likert scale:

$$\Pr(Decisions_i) = a_0 + \boldsymbol{a_1 Control1}_i + \varepsilon_i, \text{ where } \quad Decisions_i = 1,2,3,4$$

The outcome model is about determinants of the percentage of innovative products sales in a local firm. Technology spillovers from FDI is inserted as one determinant. Four IMRs derived from the decision model are plugged into this second-stage outcome model as follows:

$$\begin{aligned} \boldsymbol{InnovationSales}_{it} \\ &= b_0 + b_1 FDI_{it} + b_2\, \boldsymbol{RAC}_{it} + b_3\, \boldsymbol{RAC}_{it}^2 \\ &+ \; b_4\, \boldsymbol{FDI}_{it} \times \boldsymbol{RAC}_{it} + b_5 \boldsymbol{Control2}_{it} + b_6 \boldsymbol{IMR}_{it} + \; \mu_{it} \end{aligned}$$

$\boldsymbol{FDI}_{it}$ is horizontal FDI spillovers diffused through competition, demonstration and labour turover effect. $\boldsymbol{RAC}_{it}$ is a vector of relational absorptive capacity, depending on breadth and depth. Following Laursen & Salter (2006) we enter quadratic terms in order to allow the curvilinear relationship between open innovation strategy and innovation performance. $\boldsymbol{Control2}_{it}$ is a vector of control variables representing industry and firm heterogeneity, such as average size of the firm in the industry, average R&D intensity of the

industry, the usage of intra-firm network for search, perceived risk constraint of innovation, type of firms in arm's lengthen relationships, and technology level of the firm's industry in OECD's industry classification system. The error term is μ_{it}. We test the model in two ways. Firstly, we estimate by means of the tobit model, as the dependent variable varies between 0 and 100. Then we estimate the quantile regression, to compare the effect of RAC on local firms in the 25^{th}, inter-quantile, and 75^{th} percentile of the innovation sales ratio. Finally the same model is replicated on the alternative dependent variable, the log transformation of patent application counts.

Data and variables

Our data come from micro-data of Korean Innovation Survey collected by the Science and Technology Policy Institute (STEPI) in South Korea. The questionnaire is designed under the direction of the Oslo Manual of the OECD, and cases are randomly sampled from the same population as nations' annual manufacturing survey.

There are a few context-specific factors in South Korea that may be shared with other newly industrialised Asian economies. Firstly, the South Korean economy has strong technological capability to entice competence-creating subsidiaries. Therefore, a significant impact by MNE subsidiaries attracted by strong locational technology assets can be a unique aspect of FDI spillovers in countries like South Korea. Secondly, South Korean markets are characterised by rapid change in consumer demand, competition and technological change. This unique business environment may influence the behaviour and performance of both MNE investors and host-country firms. Thirdly, South Korea has technologically competitive domestic firms in both upstream and downstream sectors, including leading multinationals in the manufacturing sector. This indicates a generally strong internal absorptive capacity among

host-country firms, motivating us to test the effect of variances in relational absorptive capacity.

Including repeated respondents, each cross-sectional wave conducted in years 2002 and 2005 contain 32,551 and 29,617 observations, respectively. Among them, 421 firms repeatedly participated in the innovation survey in 2002 and 2005. We use each cross-sectional data to compute the FDI spillover proxy. Then we estimate the regression model with the repeated respondents across both years of survey to explain factors of innovation performance of the repeated respondents, which is further explained in the next section.

In the second-stage outcome model, our dependent variable is the log transformation of international and domestic patent counts of a local firm. We focus on patenting as patent counts indicate the level of new-to-the-market knowledge that is open to the public and therefore deemed a contribution to the public-knowledge pool in a national innovation system (Furman, Porter, & Stern, 2002: 918).

Horizontal technology spillovers from FDI are measured by the ratio of MNE subsidiaries in a 'j^{th}' industry's R&D expenditures. A firm is identified as a MNE subsidiary if it has at least 20% of foreign ownership (Haskel, Pereira, & Slaughter, 2007; Marin & Bell, 2006). The industry is based on the two-digit NACE industry classification. The base year for all three types of R&D spillovers is the last year of the three-year period covered by each survey.

$$Horizontal_j = \sum_{i \in j} RDExpenditure_i^{Foreign} \Big/ \sum_{i \in j} RDExp_i^{All}$$

Relational absorptive capacity in terms of breadth of search channel is measured based on Laursen & Salter (2006). An indicator of search breadth was based on the innovation survey questionnaire asking the importance of external knowledge sources for innovation

performance as measured in the Likert scale. Technology spillovers from FDI is relevant to domestic firms' network ties with customers, suppliers and rivals, as MNE subsidiaries act either as downstream customers, upstream suppliers and rivals within the same market. Therefore, we consider a combination of those three network relationships only, instead of all network relationships as reported in the innovation survey. The recoding process is summarised in Table 1. Firstly a binary variable is generated (0 for no use and 1 for using the given network relationship) and secondly to add up those scores. A firm with the most extensive network relationships will be assigned three, and a firm with no relationships will be zero.

For relational absorptive capacity concerning depth of network relationships, we again follow Laursen & Salter (2006).[1] Using the same question, firms reporting the highest importance from the concerned network relationship is coded as 1 and otherwise 0. Then individual scores of a firm are added up. A firm with the greatest depth of network relationships with all given three sources will gain three, and a firm with the greatest depth of relationships with no given source will gain zero. Limitation of this data is that the mode of access to those external technologies is not distinguished (Dahlander & Gann, 2010).

-- Insert Table 1 about here --

Table 2 summarises the result of coding. Through t-test, it is confirmed that breadth and depth have scores different mean scores, although Chi-square test hints at inter-dependence

[1] Previously, relational absorptive capacity is measured in some studies by the technological fit among associated partners (Dyer & Singh, 1998; Phene & Almeida, 2008), and in others by a firm's experience as a proxy (Kale, Dyer, & Singh, 2002). Past experiences of successful identifying, utilising and commercially benefiting from network-based knowledge is related to the extent to which a firm has relevant partnering skills, has established a functional unit dedicated to inter-organisational learning, and how well the learning process is embedded in its organisational structure (Kale & Singh, 2002, 2007). In line with the second group of studies, we measure relational absorptive capacity by the significance of network-based knowledge-acquiring experiences for a local firm's innovation.

between two scores. Cronbach alpha for reliability is 0.67 and internal consistency is at an acceptable level.

-- Insert Table 2 about here --

Empirical Results

Table 3 reports three models. Models 1, 2 and 3 are about determinants of innovation sales of local firms. Model 1 is estimated by the tobit panel model. Models 2 and 3 are the quantile regression, which allows us to investigate in which part of the sample the hypothesised effect may appear mostly. Model 2 is tested on local firms between 25 and 75 percentiles of innovation sales ratio distribution in the sample. Model 3 is tested on local firms in the 75 percentiles of the concerned distribution. We tested with the 25 percentiles but we do not report the result as we failed to estimate the model. Furthermore, Model 4 is about determinants of the log-transformed value of local firms' patent application counts. The estimation method is the mixed model for linear dependent variable and includes two random effects addressing time-specific and firm-specific heterogeneity respectively. Model 4 allows us to corroborate results of Models 1 to 3.

-- Insert Table 3 about here --

Before we begin, key independent variables, $FDI^{horizontal}$, $RAC^{Breadth}$ and RAC^{Depth}.RAC are analysed. In Models from 1 to 3 the coefficient for $FDI^{horizontal}$ is positive and significant. This means local firms benefit from horizontal technology spillovers from their foreign rivals. This result is consistent with existing studies about general productivity spillovers from FDI in South Korea (e.g., Kim & Kang, 2012) and findings in some other countries at the similar stage of economic development (e.g., Meyer & Sinani, 2009). In both Models 1 and 2,

$RAC^{Breadth}$ is positive and significant, while $RAC^{Breadth}$ ^2 is negatively significant. This shows the inverted U-shaped relationship between $RAC^{Breadth}$ and innovation sales. RAC^{Depth} is either not significant or even negative in Model 3. The curvilinear effect of $RAC^{Breadth}$ was identical as Laursen &Salter (2006) and also indirectly related to Girma (2005) observing the inverted U-shaped effect of absorptive capacity. This means $RAC^{Breadth}$ is a key factor of open innovation activities in the network involving foreign firms as well as a generic national open-innovation network. RAC^{Depth} is not significant for the reason that it is either a source of negative inertia or developed mainly to address inter-organisational learning between firms with narrow cultural and institutional distances. Therefore RAC^{Depth} is not exactly compatible for local firm's learning from the network relationships with foreign firms from different cultural and institutional backgrounds.

Now moving on to the main hypothesis test, we focus on the coefficient of $FDI^{Horizontal}$_ $RAC^{Breadth}$ and $FDI^{Horizontal}$_ RAC^{Depth} in Models 1,2, and 3. In Model 1 on the overall sample and Model 2 on the interquantiles $FDI^{Horizontal}$_ $RAC^{Breadth}$ is not significant. However the quantile regression shed some light: the same interaction term is positive and significant for the 75 percentiles of local firm's innovation sales (Model 3) but not significant for the interquantile samples.

Likewise, the effect of $FDI^{Horizontal}$_RAC^{Depth} is only found in the sample of the 75 percentiles. The coefficient is negative to indicate the negative moderating effect of RAC^{Depth}. Overall, RAC appears insignificant in the overall sample but have significant effects on the part of the sample. Hypothesis 1 is only partially confirmed and hypothesis 2 is not accepted.

Model 4 outlines the determinants of local firms' patenting activities. Here $FDI^{Horizontal}$ is not significant. The standalone effects of $RAC^{Breadth}$ and RAC^{Depth} are also not significant. However, the interaction term $FDI^{Horizontal}$_ $RAC^{Breadth}$ is positive and significant, and this is a

partial evidence supporting the positive moderating effect of $RAC^{Breadth}$. $FDI^{Horizontal}$_RAC^{Depth} is not significant. All in all, Model 4 provides consistent insights as Models 1,2, and 3.

Our finding leads a few thoughts. Firstly, the ability to handle wide range of relationships in the past facilitates the local firm's initial joining process into the industrial network involving foreign firms, as they already have related knowledge and experiences and even have a dedicated team of people and process embedded in the organisational structure of the firm. However such ability is not available for any local firms. Therefore, our second thought is that only aggressive innovators can enjoy a breadth of network relationships. As evidence is found in a certain range of innovation sales, we say that the positive moderating effect of $RAC^{Breadth}$ is only for firms that are selling innovative products aggressively. On the other hand, the ability to address organisational distance with new network partner may cause negative inertia, given that the past knowledge and experiences of managing network-based learning with existing partners for a prolonged period of time work as disincentive or even myopia of managers. Therefore, our third thought is local firms' RAC^{Depth} is a source of negative inertia and disincentive therefore does not facilitate FDI spillover effect.

Finally, we check the presence of the bias caused by the firm's decisions on the mode of innovation and the use of network for innovation activities. Those two decisions can cause an endogeneity bias potentially exaggerating effect of RAC. The source of such bias is captured in four IMRs. IMRs are statistically significant in Models 1,2 and 4, justifying the usefulness of estimation based on the two-stage selection model.

Discussion

This research investigates conditions under which MNE activities impact upon innovation performance in host-country firms, motivated by incongruence in existing evidence (Crespo & Fontura, 2007; Gorg & Strobl, 2001; Lipsey & Sjöholm, 2005; Smeets, 2008). Despite a

large volume of research, there remain missing conceptual links concerning the FDI spillover process, which has been assumed as a rather automatic process (Acemoglu, 2012). In this regard, absorptive capacity of a local firm has been pointed out as a key factor, which fills this conceptual void and establishes a condition of positive effect of technology spillovers from FDI.

Extending the extant understanding of the role of absorptive capacity in FDI spillovers, this paper discussed that current conceptualisation of absorptive capacity in the FDI spillover context only partially exploits the multidimensional definition of the original concept. Un-packing the multidimensionality of absorptive capacity merits attention, since different types of absorptive capacity can be in demand across host countries with different macro and micro-business environment interacting with, especially if we consider FDI spillovers in different contexts marked by income levels and technological competencies. So far, the literature has assumed that theorisation based on developing host countries can be generalisable to all other host countries, despite different stages of economic development. That would not be the case, as Meyer & Sinani (2009) demonstrated, as there is a curvilinear relationship between the impact of FDI spillovers and the income level of the host country. Extending their observation, this research explains how the impact of FDI spillovers in newly industrialised countries may demand more refined reification as opposed to what is already known from developing host-country cases. Therefore, scrutiny of absorptive capacity is necessary to further elucidate unique conditions of FDI spillover in a technologically capable host country in East Asia, South Korea.

Building on latest studies about absorptive capacity, this paper identified the under-studied dimension of absorptive capacity and labelled it as relational absorptive capacity. Relational absorptive capacity was further divided into one for breadth of network relationships and the other for depth of such relationships. To test this new variable, this

research drew on a new dataset documenting firm-level organisational capabilities in replace of the economic data recording the status of internal tangible resources within the firm.

Our empirical finding confirmed that a local firm needs strong relational absorptive capacity with regard to breadth of network relationships in order to benefit from technology spillovers from FDI. There is no evidence of how far strong relational absorptive capacity concerning depth of network relationship matters as a condition of successful FDI spillovers.

This finding indirectly indicates that in addition to in-house technology stocks and past innovation performance, a local firm requires new source of innovation from outside its boundary and FDI is a useful source of diversification. To access foreign technology informally transferred through FDI, however, the local firm with experiences of extensive search seems to have acquired the ability to handle wide organisational differences and such an ability is particularly essential for it to explore and access foreign technology that is nurtured from unfamiliar organisational context. By comparison, the ability to develop deep ties may not be critical, if technological environment changes so dynamically in developed host countries that returns from extant relationships are diminishing while costs of sustaining such relationships surmount.

Therefore, our key contribution lies in extended conceptualisation of absorptive capacity which has been widely considered as a key condition of successful FDI spillovers. Latest debates about multidimensionality of absorptive capacity concept into FDI spillover analysis merits attention, as there have been limited views about FDI spillovers in developed host countries as opposed to cases in developing host countries. In the developed countries, what matters are often not only internal resources but also organisational capabilities and technological competencies that help the firm to sail through stiff competition and sustain its

competitive advantages, and one of essential capabilities is related to the ability to manage and exploit network relationships.

In this context, this paper shows that in the Korean scenario of FDI spillovers, there is a part that cannot be explained based on the models developed from developing countries. Also, South Korean context cannot be comparable with the experiences of some developed countries where the domestic manufacturing sectors have gradually been losing competitiveness. Therefore, understanding of South Korean case requires a new conceptualisation involving a novel mediator, such as relational absorptive capacity, and this paper demonstrates that specification of new conditions help documenting FDI spillovers in this less studied context. Relational absorptive capacity, in terms of breadth and depth, is therefore suggested as key conditions to assess the current status of FDI spillovers uniquely in developed host countries and future conditions of justifying long-term effect of FDI promotion policy in many developed host countries.

This research has a few limitations. We have placed FDI spllovers in a new research context, and also sought methodological newness, as measurements in this research are based on a new type of innovation survey series which records a firm's innovation activities and in turn is contrasted with economic data focusing on the status of tangible inputs in a firm, overlooking organisational capabilities. Therefore, some suggestions in this paper represent an initial step towards the investigation of new theoretical concepts, and further research is required to strengthen the validity of proposed measurements through cross-tabulation. One of those limitations concerns the dependent variable: performance change due to FDI spillovers is confined to a limited stage of new product development. It is unknown how far innovation activities, reflected in a firm's patents, are related to overall performance change in a firm, whatever the definition of 'performance' may be. As a result, the implications of this paper are limited to this single aspect of a firm's performance. Future research may consider

merging economic data on internal resources and firm-level survey data on organisational capabilities so as to overcome this limitation.

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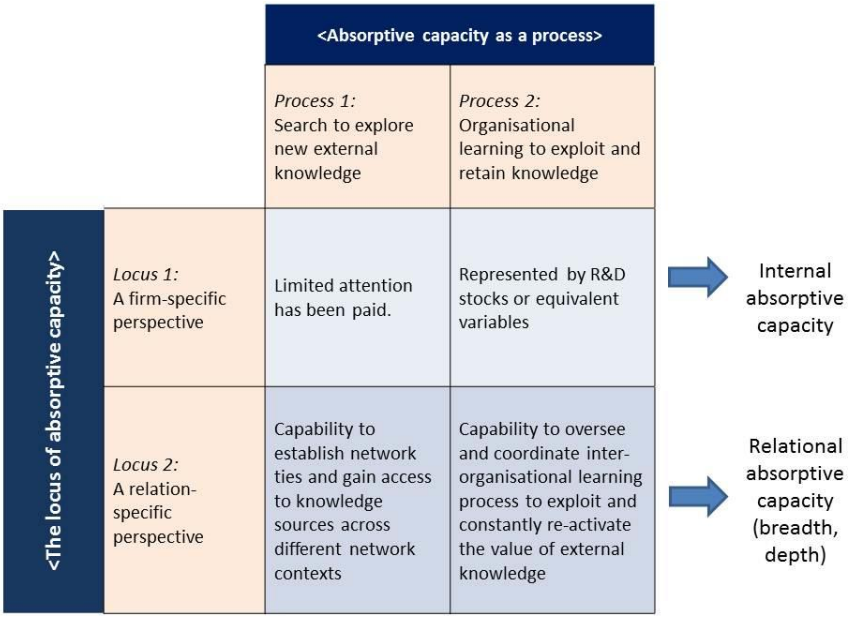
Appendix

Figure 1. Re-conceptualisation of absorptive capacity in the FDI spillover context



Note: Based on author's analysis of literature.

Table 1. Recoding original data into BREADTH and DEPTH variables

	Original value	Converted for BREADTH
None	0	0
Less important	1	1
↑	2	1
	3	1
↓	4	1
Very important	5	1

	Original value	Converted for DEPTH
None	0	0
Less important	1	0
↑	2	0
	3	0
↓	4	0
Very important	5	1

Table 2. Descriptive statistics of open innovation strategy

	Breadth score	Observations	Total breadth score	
Rival	0	442	Mean	1.402
	1	393	Standard deviation	1.378
Supplier	0	462	Min	0
	1	372	Max	3
Customer	0	429	Observations	834
	1	407		
	Depth score	Observations	Total depth score	
Rival	0	736	Mean	0.368
	1	89	Standard deviation	0.732
Supplier	0	766	Min	0
	1	68	Max	3
Customer	0	683	Observations	834
	1	153		

Source: Author's calculation based on the Korean Innovation Surveys 2002 and 2005.

Table 3. Relational absorptive capacity and FDI spillovers

	Innovation sales						Patenting	
	Tobit panel		Quantile regression				Mixed model With two random effects	
	(1) Overall		(2) Interquantiles (25 to 75 percentiles)		(3) 75 percentiles		(4) Overall	
	Coef. (z)		Coef. (t)		Coef. (t)		Coef. (z)	
FDI and RAC								
$FDI^{Horizontal}$	40.248 (3.600)	***	17.799 (0.840)		17.799 (6.770)	***	0.192 (1.120)	
$RAC^{Breadth}$	23.367 (3.280)	***	27.917 (3.170)	***	27.917 (14.490)	***	0.143 (1.170)	
RAC^{Depth}	0.447 (0.060)		-7.284 (-1.030)		-7.618 (-3.750)	***	0.133 (1.010)	
$RAC^{Breadth}$^2	-6.971 (-3.250)	***	-9.080 (-3.270)	***	-9.080 (-15.500)	***	-0.039 (-1.020)	
RAC^{Depth}^2	2.296 (0.910		2.477 (0.860)		2.811 (4.040)	***	-0.053 (-1.170)	
$FDI^{Horizontal}$_ $RAC^{Breadth}$	-0.091 (-0.020)		15.813 (1.890)	*	15.813 (10.130)	***	0.207 (2.040)	**
$FDI^{Horizontal}$_ RAC^{Depth}	-19.193 (-1.420)		-10.756 (-0.480)		-10.756 (-2.360)	**	0.227 (0.870)	
Firm characteristics								
Ln(RDStaff)	1.865 (1.270)		0.087 (0.040)		0.087 (0.230)		0.161 (6.380)	***
Ln(RDExpenditures)	3.586 (5.100)	***	2.150 (2.170)	**	2.150 (11.740)	***	0.051 (4.470)	***
DUMMY of group information	-1.802 (-0.430)		-2.896 (-0.570)		-2.896 (-2.540)	**	0.265 (3.470)	***
Risk constraint	3.053 (2.160)	**	2.573 (2.000)	**	2.573 (6.580)	***	0.021 (0.880)	
DUMMY OF Arm's length partner type	Included							
Industry characteristics								
Average size	0.000 (-0.150)		0.000 (0.230)		0.000 (0.450)		0.000 (1.210)	
Average R&D intensity	13.804 (0.390)		16.589 (0.520)		16.589 (1.810)	*	-0.008 (-0.010)	
DUMMY OF Technology type	Included							
Selection bias								
IMR_D1	10.053 (4.300)	***	1.007 (0.670)		1.007 (2.360)	**	-0.051 (-1.610)	
IMR_D2	5.296 (4.060)	***	1.713 (1.180)		1.713 (4.370)	***	-0.023 (-1.020)	
IMR_D3	1.493 (1.420)		1.151 (1.330)		1.151 (4.090)	***	-0.009 (-0.480)	

IMR_D4	2.018	*	-0.019	-0.019		-0.012	
	(1.710)		(-0.020)	(-0.080)		(-0.700)	
Constant	94.914	***	24.952	24.952	***	-0.878	*
	(3.510)		(1.100)	(3.420)		(-1.950)	
No. of observations	715		715	715		737	
No. of groups	408					412	
Log likelihood	1960.620					835.241	
Wald chi2 (d/f)	172.81 (23)	***				331.32 (23)	***
Pseudo R2, 0.75			0.195	0.195			
Pseudo R2, 0.25			0.0002				

1. Figures in parentheses are z-statistics.
2. * Significant at 10% level; ** at 5% level; *** at 1% level.
3. (3) includes two random effects, to address firm-specific and time (year)-specific heterogeneity.