Emerging-Market Multinationals in Developed Markets:
Exploring the Innovation Effects

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This study theoretically argues and empirically examines whether and to what extent emerging-market multinationals can capitalize on rich R&D resources in a host developed market through outward FDI to improve their proprietary R&D activeness at home –i.e., innovation effects on the parents. Specifically, there are two mechanisms to support such effects: the first is within-company technology transfer; the second is knowledge spillovers. Using a panel data of 493 emerging-market parents over 2000-2008, I find very supportive empirical evidences.

Key Words: emerging market, developed market, outward FDI, innovation, technology, R&D
JEL Codes: F21, F23, G11, G34, M16, O19, O31, O32, O33, O34, Y40

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Past few years have witnessed a new breed of ambitious multinationals from emerging markets (EMs) rising globally and penetrating into developed markets (DMs) through outward FDI (OFDI). Unlike their DM counterparts, many of them acquire R&D resources in host markets instead of exploiting their indigenous R&D competitiveness. In 2005, Chinese largest computer maker Lenovo acquired IBM PC Division and its patents for approximately $1.75 billion; in 2006, Chinese IT giant Huawei Technologies entered into a joint venture project with Nortel in Canada for developing ultra broadband access solutions; in 2009, Tata Consultancy, India's largest software services firm, acquired US Citigroup's global business process unit for $512 million; same year, Beijing Auto was entering a talk with GM for acquiring its technological assets of Saab models; in 2010, Chinese's Geely Auto acquired Ford's Volvo with all technological resources. After its acquisition, Geely's President Shufu Li says, the acquisition brings Geely not only 100% shareholdings, but more importantly all Volvo's trademarks, intellectual property rights, 10,963 patents, over ten new products under development and their production system, as well as over 3,800 R&D engineers and its innovation systems across more than 100 countries in the world (The People's Daily, 2010).

Observing this growing trend, business scholars argue for a technology-seeking view (Bertoni, Elia, & Rabbiosi, 2008; Braconier, Ekholm, & Knarvik, 2001; Makino, Lau, & Yeh, 2002; Luo & Tung, 2007; Rui & Yip, 2008; Peng, 2009). Specifically, the view argues that seeking for technology is the underlying motivation behind these EM to DM OFDIs (Mathews & Zander, 2007), and determines post-entry activities such as location choice (Buckley, Clegg, Cross, Liu, Voss, & Zheng, 2007) and entry mode (Bertoni, Elia, & Rabbiosi, 2008). For instance, Buckley et al. (2007) empirically find that *ceteris paribus* Chinese OFDIs are more likely to locate in a foreign market that has richer technological endowments; Bertoni et al. (2008) find that most OFDIs by BRIC markets (i.e., Brazil, Russia, India, and China) in DMs adopt horizontal acquisitions to access existing technology resources. Notwithstanding, a much deeper and more important question remains open –Can these technology-seeking OFDIs really bring innovativeness to the EM parents back in their homeland? In other words, although we have understood why and how EMs have OFDIs into DMs, we have little knowledge whether these flows really yield any post-entry innovation effects.

The purpose of this study is to examine whether, to what extent, and how EM multinationals may improve their proprietary R&D activeness through a host DM's rich R&D resources. Specifically, we unbundle R&D resources into output resources such as patents and input resources such as R&D workers and investment. The basic rationality is that patents and other output resources are well defined, codified, and traded publicly, and thus can be relatively easily acquired through alternative market transactions such as licensing, whilst input resources are relatively private, tacit, and unavailable through open market means (Keller, 2004). As a result, input resources' innovation effects through OFDI should be more significant than output resources'. My empirical analyses utilizing a 493-firm cross-country panel data between 2000 and 2008 yield very supportive results: EM parents investing in patent-richer DMs are not significantly more R&D-active than those investing in patent-poor DMs; however, EM parent firms that have OFDIs in input-richer DMs are consistently and significantly more R&D-active than those investing in intput-poor DMs, where we use both 3-digit SIC-level R&D employment and R&D investments as proxies to measure input-resource richness.

This study adds values on FDI literature and that focusing on EMs in particular. First, although we have posited and observed the innovation effects of FDIs on host markets (Globerman, 1979; Hejazi & Safarian, 1999; Kugler, 2006), very few have looked at the reverse direction –i.e., OFDI's innovation effects on the home-market parents. Second, this study extends the technology-seeking view of EM to DM OFDIs from a pre-entry- to a post-entry focus; in other words, most extant studies merely confine their discussions in EM multinationals' pre-entry issues such as location choice (e.g., Buckley et al., 2007) and entry mode (e.g., Bertoni et al., 2008), whist this paper opens discussions on the outcome of technology-seeking by focusing on the parent's proprietary R&D after OFDIs.

This study also provides new implications for practices relating to FDI and international technology outsourcing. On one hand, EM multinationals need to be aggressive to have physical investments in a R&D-rich markets, by not only focusing on their targeted investees but more importantly the richness of R&D resources surrounding their potential investees. An investee in an R&D-rich DM serves not only as a technology provider, but more importantly as a platform for an EM parent to seek for knowledge spillovers. On the other hand, compared to patents and other codified and traded R&D-output resources, it is the uncodified and tacit R&D-intput resources such as human resources and R&D specific capital that should be evaluated more seriously when judging the R&D climate of a host market. This is because unlike output resources, input resources are relatively difficult to be acquired through alternative market means.

The rest of the paper proceeds as follows: Section Two reviews literature and develops theoretical hypotheses; Section Three discusses empirical method and results; Section Four concludes the paper by discussing its implications and potential future extensions.

LITERATURE REVIEW AND THEORY DEVELOPMENT

International Innovation Effects

The literature in international business and international economics has identified three major channels for international innovation effects. The first channel is technology licensing. Firms make royalty payments through market transactions for their use of patents, licenses, and copyrights and other definable and codified technology resources through market transaction (Baranson, 1970; Davidson & McFetridge, 1985). The second channel is international trade in intermediate goods (Rivera-Batiz & Romer, 1991; Grossman & Helpman, 1991; Eaton & Kortum, 2002), because “employing a foreign intermediate good in final-output production involves the implicit usage of the technology in embodied form” (Keller, 2004: 756). The third channel is FDI (De Mello, 1997; Liu, 2008; Saggi, 2002). Specifically, multinational parents transfer their technology across international borders to foreign affiliates to help them compete with other multinationals and local firms in host markets (Markusen, 2004); therefore, local companies may seek for technology externalities of these foreign technologies embedded in inward FDIs through *knowledge spillovers*, which describing "positive externalities that firms receive in terms of knowledge from the environment in which they operate" (Capello & Faggian, 2005: 75) because of "involuntary leakage of R&D-generated knowledge" in the host market (Rouvinen, 2002: 526). For instance, technology and its related know-how are usually spilled over through labour training and turnovers (e.g., Cheung & Lin, 2004; Görg & Strobl, 2005) or through supplies of high-technology intermediate inputs to local firms (Rodríguez-Clare, 1996).

OFDI and Innovation Effects

Most FDI literature argues for innovation effects on host-market companies through inward FDI only, whereas very few has posited the the reverse possibility, i.e., innovation effects on home-market companies through OFDI. Nevertheless, one may draw on some OFDI literature to indirectly posit such a proposition. For instance, Blomström and Kokko (1998) and Blomström, Globerman, and Kokko (1999) argue that OFDI typically allows the MNC (multinational corporation) to grow larger than what would otherwise be the case, which brings opportunities to benefit from economies of scale, both for the MNC itself and its local suppliers. Therefore, one may continue their discussions by arguing that R&D capacity in the home market may increase as a result of firm growth. In addition, Driffield and Love (2003) use productivity as an indicator for innovation improvement and UK manufacturing firms between 1984 and 1992 as the empirical sample, and find significant technical externalities from domestic firms to foreign-owned affiliates in UK. Their findings also imply the possibility of innovation effects on home markets if foreign-owned affiliates would presumably deliver their received externality resources to their home-market headquarters.

Notwithstanding, these few expections are insufficient to generate an conclusive understanding on innovation effects on the home-market companies. In particular, what Blomström and Kokko's (1998) and Blomström et al.'s (1999) suggest is indeed a consequence of the firm scale growth through OFDI rather than direct innovation effects, the latter of which should more specifically refer to improvement of proprietary R&D by the OFDI parent. Similarly, Driffield and Love (2003) fails to identify the R&D relationship between a host market and foreign parent either.

To address the literature gap specified above, the following discussions focus on the relationship between a parent's proprietary R&D and its host-market R&D resources. This focus is of particular relevance to EM to DM OFDIs. As a technology-seeking view has already pointed out, the most important distinction for EM-to-DM OFDIs from other OFDIs (e.g., EM-to-DM, DM-to-EM, and DM-to-DM) is their technology-driven nature (Bertoni et al., 2008; Braconier et al., 2001; Makino et al., 2002; Luo & Tung, 2007; Rui & Yip, 2008; Peng, 2009). Specifically, unlike conventional multinationals, which exploit their technology as a firm-specific advantage into a foreign host market (Dunning, 1981, 2001; Dunning & Lundan, 2008), EM multinationals explore technology and know-how as a direct objective to compensate their firm-specific disadvantage by investing to a DM (Tolentino, 1993; Mathews, 2002, 2006). Indeed, even before their OFDIs, many of EM multinationals have already grown to a large firm scale at home through comparative advantages compared to other home-market local companies, for instance through their government-backed monopoly (Child & Rodrgues, 2005) or benefiting from a massive regional market demand (Peng, 1997). Consequently, it is important to understand the direct linkage between host-market R&D resources and the EM parent's proprietary R&D activeness, while treating firm scale as a control variable.

Mechanisms

We argue that EM-to-DM OFDI helps improve parent's proprietary R&D activeness through mainly two mechanisms. The first, following transaction cost theory (Hennart, 1988; Ostrom, 2000; Williamson, 1979), is through within-company technology transfer by DM affiliates to EM parents. Transaction cost theory suggests that a parent-affiliate relationship enables transfer of tactic resources such as technology, skills, and knowledge, which are not codified, quantified, and thus non-tradable through open markets. This argument is also consistent with some other generic FDI theories such as internationalization theory (Rugman, 1985) and ownership-location-internalization (OLI) paradigm (Dunning, 1981), which draw similar arguments. Such a way specifically includes not only DM affiliate directly licensing the EM parent (Shan & Song, 1997), but more indirect ways (Saggi, 2002). For instance, the EM parent possesses technology in an embodied form through within-company imports of high-technology intermediate products made by its DM affiliates (Javorcik, 2004); the EM parent can also have DM affiliate R&D researchers to train home-market employees, or directly re-appoint former affiliate researchers to serve in its EM headquarter (Cheung & Lin, 2004; Görg & Strobl, 2005); besides, the EM parent may also regularly send its home-market researchers to the DM affiliate to observe, analyze, and learn R&D knowledge, experiences, and skills (Liu & Buck, 2007).

The second mechanism, following knowledge spillovers literature (e.g., Atkinson & Stiglitz, 1969; Globerman, 1979; Koizumi & Kopecky, 1977), is through R&D spillovers or, more specifically, the leakages of technology and know-how from external R&D leaders in the DM host-land. The literature has suggested that knowledge spillovers are spatially bounded in nature: knowledge spillovers are more likely to take place within a certain region than beyond, because most technology-generating facilities and resources such as labs, equipment, and researchers are location-specific, and R&D workers' communications and turnovers are accommodated by regional networks (Jaffe, Trajtenberg, & Henderson, 1993; Griliches, 1994; Globerman, Shapiro, & Vining, 2005). Therefore, to benefit from these R&D spillovers, an EM company should actually present in such regions that are rich in R&D resources, and hence embed itself in the regional technological networks (Almeida & Kogut, 1999). Specifically, in terms of how technology and knowledge spilled over to the EM parent, the first possibility is through local supply chain in a DM; that is, R&D spillovers are associated with purchases and usage of high-technology intermediate products made by local suppliers (Javorcik, 2004). In addition, employing its foreign affiliate as a legitimate platform, the EM parent may collect, analyze, and learn technologies and other R&D-generated resources by interacting with local R&D leaders including scientists and engineers of other local companies, external research labs, and local universities (Mansfield & Romeo, 1980; Almeida & Kogut, 1999). Besides, by presenting itself in the region, the EM parent has a chance to recruit high-quality graduates in local universities and hunt potential R&D employees from local labour market turnovers (Møen, 2005).

The purpose of our previous discussions is to identify two simutenous possibilities of innovation effects on the parents instead of trying to distinguish between them. Conceptually, two mechanisms are different, because in the spillover mechanism, the EM parent may directly contact and interact with the DM local organizations outside its affiliate. In practice however, both ways occur simultaneously and are difficult to be disentangled from each other. For instance, the DM affiliate may first engage in local supply chain of high-technology intermediate products, and then exports them across the border to the EM parent; similarly, spilled over knowledge and newly hired researchers and engineers may first be integrated in the DM affiliates before being delivered to the EM parents.

METHOD

Data

Major data source for collecting EM parent information is Bureau van Dijk (BvD) Orbis, which records global parent-affiliate relations and financial statements of over 60 million companies across the world. Major data sources for industry- and country-level information are SourceOECD, the World Bank WDI, and KPMG. In addition, data for distance measure between countries are collected from CEPII of France. Based on BvD Orbis database, my first screening is to keep only EM parent companies following the EM classifications from various sources, including Hoskisson, Eden, Lau, & Wright's (2000) review paper on emerging economies, MSCI Barra, and FTSE Group. The final list including 57 markets (Albania, Argentina, Armenia, Azerbaijan, Bangladesh, Belarus, Bosnia & Herzegovina, Botswana, Brazil, Bulgaria, Chile, China, Colombia, Cote d'Ivoire, Croatia, Czech Republic, Ecuador, Egypt, Estonia, Georgia, Ghana, Hungary, India, Indonesia, Israel, Jamaica, Jordan, Kazakhstan, Kenya, Kyrgyzstan, Latvia, Lithuania, Macedonia, Malaysia, Mauritius, Mexico, Moldova, Morocco, Nigeria, Pakistan, Peru, Philippines, Poland, Romania, Russia, Saudi Arabia, Slovenia, South Africa, South Korea, Sri Lanka, Taiwan, Tajikistan, Thailand, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Ukraine, Uzbekistan, Venezuela, and Zimbabwe). The criteria for being an EM *parent* company include being registered in an EM and being an ultimate global owner. Because the focus of this paper is on R&D activeness, my second screening is to keep only companies that engage in R&D activities, describing that a selected company should report R&D spending for at least one year across the whole sample period, between 2000 and 2008. Those which persistently did not report any R&D spending are presumed to be uninterested in R&D resources, and are thus excluded. After these two screenings, there are in total 9,953 EM parents (hereafter referred to as the larger EM sample). The larger EM sample will be used to calculate industry-specific R&D measure in a home market as a control variable to control for potential home-market technological externalities. My last screening is to keep only those that have foreign affiliates in DMs, where DMs refer to high-income OECD countries as of 2010.

The final sample is a panel of 493 EM multinational parents between the years 2000 and 2008， representing 20 different EMs with significant concentration in Taiwan, Turkey, and Israel, 43 different industries (based on 2-digit US SIC codes) with concentration in sectors of electronic and other electric equipment, industrial machinery and equipment, and chemicals and allied products, and 27 different host DMs, showing that most of the EM parents in sample invested in Germany, Netherlands, United Kingdom, and the United States.

Variables

Dependent Variables

EM parent's proprietary R&D activeness Following existing literature (Baysinger & Hoskisson, 1989; Markides & Ittner, 1994; Hundley, Jacobson, & Park, 1996), this variable is measured as the annual R&D spending by the EM multinational parent. This information is available in each parent's financial statements from BvD Orbis.

Independent Variables

The literature has argued that R&D activities are largely industry-specific. Specifically, R&D activities are product-scoped and heavily directed by a company's core business (Nelson, 1982; Porter, 2006). Therefore, R&D knowledge and specialty embedded in researchers and R&D-required plants, equipment, and other investments are used for certain industry sectors, and thus the related technology formation and R&D-generated outputs are largely industry scoped (Griliches, 1994; Pater & Pavitt, 1997). Following this feature, we use industry-level measures rather than national aggregates to capture R&D-resource richness of a DM host, where empirically industry-level refers to 3-digit SIC following existing literature on horizontal and related industries (e.g., Bertoni et al., 2008).

Measure 1 – Host DM's Number of R&D Workers industry-level (3-digit SIC) number of R&D workers including researchers and technicians in a DM. This measure can approximate such R&D inputs as human capitals, R&D expertise, and specialized knowledge.

Measure 2 – Host DM's Dollar Value of R&D Investments industry-level (3-digit SIC) dollar value of R&D investments in a DM territory. This can approximate such R&D inputs as research plant investment, administration, and other efforts devoted to R&D activities (Gornik-Tomaszewski & Millan, 2005). Information for both measures is available in SourceOECD.

Measure 3 – Host DM's Number of Patents Applied industry-level (3-digit SIC) number of patents applied by both residents and non-residents of a DM. This information is available in SourceOECD.

Because many EM parents in the sample held affiliates in multiple DM hosts, both R&D resource measures may take multiple values. To address this problem, we calculate both average- and the summation values to construct the independent variables. For robustness check, we also construct composite values for independent variables weighted by host DM's market size and the distance between host and home markets.

Control Variables

First of all, as previously discussed, we control *firm size*, measured as total assets, because larger firm scale allows a parent to be more capable in investing in R&D activities. The second company-level control variable is *firm age*, measured as number of years since incorporation, suggesting a company's experience and business circle. The other two firm-level control variables are *firm current ratio*, calculated as the ratio of current assets to current liabilities, to control for short term liquidity stress, and *firm solvency ratio*, calculated as the ratio of total assets to total liabilities, to control for long term solvency stress. All these information are available in financial statements from BvD Orbis. To control for relative home-market R&D resource richness to the DM host, we further include an indicator *home R&D advantage*, measured as the logarithm amount of industry-level (3-digit SIC) R&D investment in the EM homes over mean among all EM homes by year (each value added by an fixed amount to a positive value before taking logarithm).

In addition, we want to control for the potential bilateral economic relations between the host- and home markets, which may affect the cross-border innovation effects. According to Gravity model, both markets' sizes and the distance between them collectively determine the two markets' potential bilateral economic flows of trade, capital, and foreign aid among others (Bergstrand, 1985). Consequently, we further control three national-level variables, including *home market size* and *host market size*, both measured as real GDPs compiled by World Bank's WDI database, and *weighted geographic distance* between home and host markets, which is measured as a composite of geographic distances between two markets' major metropolis cities weighted by each city's population, and can be found from CEPII of France.

Related, *home tax burden*, measured as effective corporate tax rate, is controlled for to measure the heterogeneity of parents' taxation pressure in different home markets. This is collected from KPMG Global Tax Survey. In addition, we include a dummy variable *common official language*, measured as value 1 if both home and host countries share the same official language and 0 otherwise, to control for linguistic and communication barriers.

Lastly, to control for period- and country-specific effects, we include a series of dummies for year, home countries, and host countries. Table A1 in the Appendix lists detailed descriptions and data sources for all variables.

Econometric Specification

Instead of using original values, we use natural logarithm values for flow- and stock-based variables (i.e., all variables except current- and solvency ratios, tax burden, and dummies). There are four rationalities for this transformation. First, in mathematics logarithm suggests the change or growth, instead of original quantity, of the value of a flow- or stock-based variable (e.g., Godfrey, McAleer, & McKenzie, 1988). This can reduce the possibly of a potential endogenous problem caused by the relation of the technology scale and quantity of an EM parent to those of its selection of host markets. In other words, there might be such a relationship between two measures' scale and quantity, but it is less so between their growths. Second, as previously discussed, an EM parent's proprietary R&D activeness is largely determined by the collection and accumulation of R&D knowledge developed through productions (e.g., intermediate products) in a DM host. Following Cobb-Douglas production function, Either (1982) and Keller (2002, 2004) derived the linear expression of the degree of accumulation of R&D knowledge as a log-log function of all production resources, which in this paper referring to total assets, firm experience measured as age, and host market R&D resources. Third, potential economic relation between two markets, which is controlled for, is also expressed as a log-log function of both markets' sizes and their distance following Gravity model (Bergstrand, 1985). Last but not the least, parameter estimates in a log-log econometric model directly tell us the scale-free marginal effects of an independent variable on dependent variable (Greene, 2004). For example, a 0.3 marginal effect by the DM's industry-level number of R&D workers on the EM parent's R&D spending directly suggests that 1% increase in the former will result in 0.3% increase in the latter.

Another concern is the time lag between DM's R&D measures and EM parent's proprietary R&D activeness. In other words, technology diffusions among organizations and cross borders including both technology transfer and spillovers take time, and thus innovation effects take time. Using American firms, Mansfield and Romeo (1980) find that the time lag for US multinationals to leak their technology to a foreign host market is on average 4 years, including about 1 year (6 to 18 months) for local market diffusion (Mansfield, 1985). Therefore, in main result table (Table 3), we report results using 4 years of time lags. Scholars have argued that time of technology diffusions between parties is very different depending on the parties' absorptive capacity, information barriers, and many other random factors, and tends to be "stochastic" (Keller, 2004: 755). Therefore, for robustness check, we replicate regressions using all other possible year lags (i.e., 0, and 5 to 7) between the dependent variable and independent variables. In addition, allowing for a relatively long time lag can largely ensure the causation direction –i.e., the long historical industry-level R&D resources in a DM is not likely to be determined by the future unknown firm-level R&D spending in a foreign EM.

The last concern is the non-negative nature and a large proportion (about 12%) of zero values for dependent variable; that is, there was no R&D spending for some firms in some years. This suggests that we cannot use a linear regression model because the dependent variable is latent and, more specifically (McDonald & Moffitt, 1980), non-negative. Following Tobin (1958), we adopted a Tobit model. Specifically, the dependent variable is expressed as a non-negative latent variable as follows,

$$\ln\left(\textbf{R\&D spending}_{i,t}\right)^{*} = \begin{cases} \mathbf{0}, & if\ \textbf{R\&D spending}_{i,t} = \mathbf{0} \\ \ln\left(\textbf{R\&D spending}_{i,t} + \mathbf{1}\right), & if\ \textbf{R\&D spending}_{1,t} > \mathbf{0} \end{cases}.$$

In terms of panel regressions, we adopt random effect rather than fixed effect because firstly fixed effect would drop time-invariant variables such as distance between markets and home dummies, and secondly fixed effect is technically not available in non-linear models such as Tobit (Greene, 2004).

In summary, the econometric specification is

$$\ln(\mathbf{R\&D\ spending}_{\mathbf{i,t}})^{*} = \boldsymbol{\alpha} + \boldsymbol{\beta}\ln(\mathbf{DM's\ richness\ in\ R}\&D\ resources_{\mathbf{i,t-r}}) + \sum_{\mathbf{m}} \boldsymbol{\gamma}_{\mathbf{m}} \ln(\mathbf{the}\ m\mathrm{th}\ \mathbf{flow\ or\ stock\ based\ control\ var}$$

,

where *i* stands for EM parent *i*, *t* stands for year *t* (from 0 to 8), and *r* stands for numbers of year lags, taking from 0 to 7.

Hausman Test for Exogeneity

As illustrated in the previous section, adopting a logarithm-logarithm equation and allowing for large year lags can largely reduce potential endogenous problem. Before starting running regressions, we test for exogeneity of the econometric specification using Hausman Test to ensure the robustness of the model (Hausman, 1978). Specifically, in step 1, we regress three independent variable measures respectively on an instrumental variable (IV), which is correlated with host-market R&D activities but independent of the EM parent firm's R&D activities. In step 2, we include the residual term from the step 1 into the main econometric specification, and test for the null hypothesis that the parameter estimate for the residual is zero –if the estimate is significantly different from zero, there is endogeneity. The IV we use is the effective corporate tax rate of the host market, which has no direct effects on a foreign parent firm that is registered under its home-market tax legislation but largely determines host-market economic activities and thus R&D spending. Table 1A reports the first step results, and Table 1B reports the second step results with the T-test for the significance of residual's parameter estimate. Results suggest that the IV is significant correlated with all three measures for the independent variable (as suggested in step 1 result), whilst in step 2 the parameter estimates for residuals collected in step 1 are not significantly different from zero, and thus the original econometric specification has no concerns of endogeneity.

we also replicate the tests by using summation measures for the host market and by using different year lags, and receive similar results.

[Insert Table 1A here]
[Insert Table 1B here]

Regression Results and Interpretations

Table 2 presents summary statistics and correlation matrix for all variables, which suggest no severe multi-collinearity problems. Table 3 reports regression results using three different measures for independent variable.

[Insert Table 2 here]
[Insert Table 3 here]

Regresson results show supportive evidences: parameters for measures 2 (host-market number of R&D workers) and 3 (host-market dollar value of R&D investments) are positive and significant. As discussed, the results for logarithmed variables directly report marginal effects: for instance, econometrically the number of industry-level R&D workers in a DM host market increases by 1%, then R&D spending in EM parent of the same industry increases by 0.17% in the same year, 0.19% the next year, 0.21% the third year, 0.13% the fourth year, and so on; if the dollar value of industry-level R&D investments in a DM host market increases by 1%, then the R&D spending of the EM parent of the same industry increase by 0.46% in the same year, 0.29% in the second year, 0.27% in the third year, 0.22 in the fourth year, and so on. In addition, the overall explanation power of the econometric specification is strong –Chi squares (goodness of fit test comparable to F-test in linear models) for all models 1 to 4 are very high and P-values (probability to reject the significance of all variables) are consistently close to 0 for all models.

However, results using measure 3 (host-market R&D number of patents applied) suggest that an EM parent with affiliates in a patent richer DM is not significantly more R&D active than others. Here is my explanation as follows. One key advantage of using FDI to diffuse technology over alternative market transactions such as licensing is FDI's capability of delivering tacit resources such as knowledge and experiences, where the term "tacit" is in contrast to "codified" (Keller, 2004). Specifically, codified resources are those well defined, quantified, and transferrable through demonstrations and instructions (David, 1992); on the contrary, tacit resources are private, under-quantified, and thus requiring intense inter-personal contacts and physical examples to transfer between parties (Polanyi, 1958). Because of its good codification and quantification, codified resources are relatively easy to be priced and traded in markets (Keller, 2004). In contrast, tacit resources are difficult to be priced and not available in open markets due to their privateness and under-quantification (Grabowski, 1968; Griliches, 1984). Following these concepts, R&D-intput resources such as patents, trademarks, copyrights, and licenses well fall into the codified resource category, because all these resources are well defined, quantified, evaluated, and tradable in open markets, while R&D-intput resources such as human capital, R&D knowledge, techniques and skills, and experiences are largely tacit and hard to be precisely priced. For instance, although a registered patent generated through a series of R&D experiments can be priced either by its R&D expense or by its application value, the skills employed, the knowledge generated, and the lessons learned from the whole R&D process is very difficult to be quantified and priced; therefore, one can trade the registered patent, but can not trade the related skills, knowledge, and lessons learned. Consequently, innovation effects by different R&D resources are expected to yield different significance. Specifically, the codification nature of R&D outputs allows an EM multinational to obtain these resources in numerous alternative means, for example through market transactions and international technology licensing. On one hand, given the large sunk cost in physical investments in a foreign market, seeking for R&D outputs using OFDI is not necessarily more efficient and economical than negotiating a fair market price. On the other hand, one who can obtain patents and other traded R&D outputs can also find a way to purchase these resources in the markets.

Results for control variables are also worth discussions. First, home R&D advance's consistently positive and significant parameter suggests that an R&D-active environment at home accommodates home parent's firm-level R&D activeness.

Second, parameter estimates for home- and host market sizes and weighted distance suggest that both home and host markets' sizes have positive effects while the distance between them have a negative effect. However, the effect by home market size is more significant than that of host market size, suggesting that an EM parent's R&D activeness is more exposed to the home market's economic environment than to the host market's.

Among all firm-level control variables, firm size is the only variable that is consistently significant in all regressions; its significant and positive parameter estimates suggest that large-scaled firms are more engaged in R&D activities. Besides, firm age is a significantly negative variable in most regressions, suggesting that younger firms are more active in R&D. In addition, tax burden at home is a negative factor, but is not significant when more lagged independent variables are included. Lastly but interestingly, sharing of a common official language is not a significant factor, which can be explained by the fact that most researchers and technicians, particularly those working in multinationals, can use English fluently as their working language no matter what their official languages are.

Robustness Check

First, as discussed previously, we release the assumption of 4-year time lag for technology diffusion as Mansfield and Romeo (1980) argue. Instead, we use all possible numbers of year lags (i.e., all numbers between 0 and 7). Tables 4 to 6 show the results for all lagged models. Same findings in Table 3 hold consistently in all the lag models.

[Insert Table 4 here]
[Insert Table 5 here]
[Insert Table 6 here]

Second, we re-construct the independent variables as a composite weighted average of original values if there are multiple host markets. The first weight we use is host market size, measured as real GDP. The underlying assumption is that an EM multinational tends to focus more on a larger economy as there are potentially more economic opportunities, and thus R&D resources in a larger economy would draw more attention by the parent. The second weight we use is home-host geographic distance. The underlying assumption is that it is relatively easier for an EM parent to travel in a closer foreign country for any R&D related collaborations and interactive activities, and thus there might be more frequent chances for an EM parent to access to R&D resources in a closer place. Table 7 shows the results for these alternative independent variables, which are very similar to and the previous regression results.

[Insert Table 7 here]

DISCUSSION

This paper targets a rising new trend of FDIs –EM to DM OFDIs driven by technology seeking. Although a technology-seeking view has well been recognized by scholars to explain such flows' motivations, our understandings of whether, to what extent, and how such OFDI flows can really generate innovation effects on the EM investors remain limited and inconclusive. The purpose of this study is to enrich our knowledge in these areas. In particular, the empirical results suggest that only the relatively tacit and non-traded R&D inputs can create significant innovation effects through OFDI, but codified and tradable R&D outputs such as patents are irrelevant if we control a series of company-, firm- and bilateral level factors. These findings provide two key implications for practices relating to FDI and international technology outsourcing. On one hand, EM multinationals need to be aggressive to have physical investments in a R&D-rich markets, by not only focusing on their targeted investees but more importantly the richness of R&D resources and the technology networks surrounding their potential investees –an investee in an R&D-rich DM serves not only as a technology provider, but more importantly as a platform for an EM parent to seek for knowledge spillovers. On the other hand, compared to patents and other codified and traded R&D-output resources, it is the un-codified and tacit R&D-input resources such as human resources and R&D specific capital that should be evaluated more seriously when judging the R&D climate of a host market. This will require an OFDI multinational to go beyond the performance of an investee and other local technology providers such as research labs and universities, and obtain deeper market intelligence relating to the host market's endowment in human resources, advanced education and academic research systems, and local firms' effort in investing in R&D activities.

Although beyond the scope of this study, audiences may ask why R&D output richness is not consistent with the R&D input richness (e.g., different significance in my regressions). The reason is that the objectives for R&D inputs are much broader than producing R&D outputs such as patents and inventions; indeed, in most cases, firms spend human resources, time and capital in R&D activities to experiment new ideas, to train and learn new techniques and skills, and to identify new models for improving overall productivity and organizational efficiency –not all of these will eventually turn into a codified and registerable outcome. In practice, this is also how firms classify their expenses into the R&D categories in their financial statements (Gornik-Tomaszewski & Millan, 2005). Statistically, a very low correlation between patent richness and R&D-input richness as reported in Table 1 tells the same story.

One potential extension of this paper is to identify the factors that can moderate the innovation effects. Based on existing literature in innovation, these factors may be company-level such as an EM parent's absorptive capacity and business diversification (Cohen & Levinthal, 1990; Griffith, Redding, & van Reenen, 2003), industry-level such as industry competition (Sakakibara, 2002), and country-level such as capacity of host-market innovation networks and technology-related institutions such as IP protection (Muller & Zenker, 2001; Zhao, 2006). Furthermore, as parent-affiliate interactions vary by entry modes, another potential extension is to investigate questions such as whether the degree of innovation effects differs between wholly-owned affiliate-parent relationship and joint ventures, or between springboard investments and mergers & acquisitions (M&As). However, these questions largely rely on the availability of data that may thoroughly trace very detailed corporate activities, for which our data is insufficient to do so.

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Table 1A
Hausman Test for Exogeneity: Step 1 Results

	Measure 1	Measure 2	Measure 3
Effective corporate tax rate of host market	410.81**	-3.64*	802.16***
Constant	-6581.37	2625.38***	-98690.68***
Sigma u	16692.12***	6271.37***	155433.92***
Sigma e	17296.17***	1547.47***	3748.89***
Year dummies	included		
Statistics			
Number of left-censored obs.	3	1	0
Number of Obs.	1321	1057	1360
Chi-square	26.53	17.33	103.12
P-value	0.00	0.00	0.00

* p<0.1, ** p<0.05, *** p<0.01

Table 1B
Hausman Test for Exogeneity: Step 2 Results

	Measure 1	Measure 2	Measure 3
Residual from step 1	0.01	0.05	0.09
Host R&D measure	-0.08	1.10	-0.01
Firm age	37797.97*	43109.53*	35175.15*
Firm size	0.00***	0.00	0.00***
Current ratio	-2076.04	-1370.50	-1846.82
Solvency ratio	28.36	38.30	35.71
Home R&D advantage	1.66***	2.05***	1.65***
Home market size	8951.79	10188.24	8038.31
Host market size	12616.60*	3262.57	5247.68
Home tax burden	-862.61	-573.26	-941.92
Weighted geographic distance	-1589.55	-2953.21	-629.85
Common official language	-6321.55	3934.85	-2739.67
Constant	-604162.27**	-387801.72	-383753.47
Sigma u	77389.85	83103.46	76555.37
Sigma e	60735.54	66505.32	59970.17
Statistics			
Number of obs.	850	686	871
Number of left-censored obs.	41	28	41
Chi-square	259.84	213.04	265.72
P-value	0.00	0.00	0.00

* p<0.1, ** p<0.05, *** p<0.01

Table 2
Summary Statistics and Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) Proprietary R&D activeness (log)	1.00																
(2) Host 3SIC # of patent (log, mean)	0.11	1.00															
(3) Host 3SIC $ of investments (log, mean)	0.03	0.12	1.00														
(4) Host 3SIC # of R&D workers (log, mean)	0.07	0.34	0.39	1.00													
(5) Host 3SIC # of patent (log, sum)	0.20	0.88	0.06	0.31	1.00												
(6) Host 3SIC $ of investments (log, sum)	0.19	0.10	0.40	0.17	0.26	1.00											
(7) Host 3SIC # of R&D workers (log, sum)	0.35	0.27	0.20	0.74	0.38	0.40	1.00										
(8) Firm size (log)	0.23	0.09	0.00	0.03	0.23	0.15	0.14	1.00									
(9) Firm age (log)	0.04	-0.10	0.05	0.03	0.04	0.12	0.13	0.17	1.00								
(10) Firm current ratio	-0.03	0.00	0.01	0.05	-0.02	-0.02	0.03	0.01	-0.01	1.00							
(11) Firm solvency ratio	0.04	-0.03	0.01	-0.02	-0.05	-0.01	-0.02	-0.01	0.06	0.33	1.00						
(12) Home R&D advantage (log)	0.37	0.02	0.00	0.02	0.03	0.02	0.03	0.04	0.01	0.00	0.02	1.00					
(13) Home market size (log)	0.00	0.01	0.08	0.04	-0.01	0.00	0.01	0.10	-0.15	0.03	-0.09	-0.06	1.00				
(14) Host market size (log)	0.11	0.91	0.09	0.35	0.80	0.08	0.28	0.09	-0.06	0.03	-0.01	0.01	-0.02	1.00			
(15) Weighted geographic distance (log)	-0.01	0.37	-0.01	0.20	0.45	0.06	0.20	0.29	0.10	0.02	-0.03	0.02	0.03	0.32	1.00		
(16) Home tax burden	-0.09	0.14	0.01	0.07	0.21	0.04	0.08	-0.04	0.08	0.05	-0.03	0.04	-0.03	0.11	0.44	1.00	
(17) Common official language	-0.01	0.30	0.02	0.14	0.34	0.07	0.17	0.15	0.22	0.06	-0.07	0.03	-0.05	0.26	0.54	0.46	1.00
Number of obs.	1721	2721	2644	2172	2721	2644	2172	2550	2721	2551	2551	2630	2721	2721	2721	2721	2721
Mean	19894.16	10.30	9233.23	2770.66	11.06	33977.12	13031.52	11.63	1.43	2.24	47.70	12.05	26.36	27.97	8.43	30.96	0.24
St. Dev.	87878.52	1.46	21510.11	6701.25	1.95	125786.70	39377.69	3.44	0.30	4.12	26.62	0.25	0.73	1.02	0.66	5.92	0.37

Table 3
Panel Tobit Regression Results
(Dependent Variables Lagged by 4 Years)

	Measure 1		**Measure 2**		**Measure 3**	
	mean	**sum**	**mean**	**sum**	**mean**	**sum**
	1	**2**	**3**	**4**	**5**	**6**
Independent Variable						
Host DM's R&D Measure (Lagged by 4 Years)	0.20***	0.22***	0.10*	0.11*	-0.06	-0.05
Control Variables						
Firm size	0.31***	0.28***	0.36***	0.32***	0.33***	0.30***
Firm age	-0.53	-0.91*	-1.04*	-1.45***	-0.95*	-1.30**
Current ratio	-0.51	-0.08	-12.36**	-11.66**	-11.92**	-11.29**
Solvency ratio	-0.82*	-0.74	-0.41	-0.39	-0.38	-0.36
Home R&D advantage	1.15***	1.12***	0.71***	0.64***	0.68***	0.62***
Home market size	0.45***	0.37***	0.54***	0.43***	0.53***	0.49***
Host market size	-0.16	-0.11	-0.14	-0.12	-0.14	-0.11
Weighted geographic distance	-0.33	-0.50	-0.67**	-0.81***	-0.58**	-0.73**
Home tax burden	0.79	0.38	0.77	0.22	0.25	-0.14
Common official language	-0.63	-0.76	0.39	0.43	0.42	0.42
Constant	-2.87	-0.06	-2.55	1.80	-1.74	0.58
Sigma u	2.09***	2.01***	2.19***	2.14***	2.24***	2.20***
Sigma e	1.21***	1.21***	1.38***	1.37***	1.35***	1.35***
Year Dummy Home Dummy Host Dummy	included		included		included	
Statistics						
Number of Left-Censored Observations	35	35	53	53	53	53
Number of Observations	853	853	1053	1053	1084	1084
Chi-Square	106.33	132.15	110.15	130.74	105.98	124.50
P-Value	0.00	0.00	0.00	0.00	0.00	0.00

* p<0.1, ** p<0.05, *** p<0.01

Table 4
Robustness Check: More Panel Tobit Regression Results using Measure 1

Measure 1	Using Host-Measure Means							Using Host-Measure Summations						
	7	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
	(No lag)	**(Lag 1)**	**(Lag 2)**	**(Lag 3)**	**(Lag 5)**	**(Lag 6)**	**(Lag 7)**	**(No lag)**	**(Lag 1)**	**(Lag 2)**	**(Lag 3)**	**(Lag 5)**	**(Lag 6)**	**(Lag 7)**
Independent Variable														
Host DM's industry-level $value of R&D investments	0.46***	0.29***	0.27***	0.22***	0.21***	0.34***	0.31***	0.46***	0.29***	0.29***	0.25***	0.22***	0.34***	0.31***
Control Variables														
Firm size	0.26***	0.23***	0.20***	0.18***	0.36***	0.72***	0.73***	0.25***	0.22***	0.19***	0.16***	0.31***	0.62***	0.59***
Firm age	-0.20	-0.44	-0.09	-0.30	-0.67	-1.15*	-1.05	-0.83*	-0.99*	-0.60	-0.77	-1.02*	-1.43**	-1.35**
Current ratio	-7.58**	-10.38***	-5.03	-3.27	6.47	2.05	-6.96	-6.83*	-9.77**	-4.66	-2.90	6.79	2.64	-5.83
Solvency ratio	-0.16	0.01	-0.50	-0.79*	-1.08**	-0.39	0.61	-0.12	0.03	-0.44	-0.72*	-1.01**	-0.37	0.63
Home R&D advantage	2.30***	1.74***	1.60***	1.45***	0.98***	0.64***	1.31***	2.22***	1.61***	1.55***	1.42***	0.96***	0.64***	1.32***
Home market size	0.56***	0.61***	0.55***	0.51***	0.43**	0.27	0.37*	0.23**	0.32***	0.39***	0.41***	0.36***	0.15	0.22
Host market size	0.34*	0.25	0.15	0.02	-0.21	-0.41*	-0.22	0.35*	0.24	0.16	0.04	-0.14	-0.32	-0.14
Weighted geographic distance	-1.10***	-0.99***	-0.55	-0.37	-0.31	-0.36	-0.46	-1.26***	-1.11***	-0.74**	-0.58*	-0.47	-0.42	-0.51
Home tax burden	-3.18**	-2.42*	-0.86	-0.37	0.52	-0.89	-0.33	-4.09***	-3.24**	-1.29	-0.71	0.04	-1.60	-0.97
Common official language	0.31	0.58	-0.30	-0.46	-0.70	-0.60	-0.76	0.51	0.70	-0.42	-0.60	-0.84	-0.69	-0.88
Constant	-14.36**	-12.07	-11.65	-7.53	-1.62	3.95	-3.59	-3.23	-2.27	-5.60	-3.30	0.78	7.20	0.33
Sigma u	2.03***	2.13***	2.08***	2.13***	2.23***	2.34***	2.51***	1.98***	2.07***	1.96***	2.01***	2.17***	2.31***	2.47***
Sigma e	2.00***	1.78***	1.52***	1.32***	1.04***	0.80***	0.69***	2.00***	1.79***	1.52***	1.32***	1.04***	0.80***	0.69***
Year Dummy	included							included						
Home Dummy	included							included						
Host Dummy	included							included						
Statistics														
Number of Firms	231	231	192	191	188	188	185	231	231	192	191	188	188	185
Number of Left-Censored Observations	155	108	69	47	28	25	20	155	108	69	47	28	25	20
Number of Observations	1559	1393	1188	1021	686	520	351	1559	1393	1188	1021	686	520	351
Chi-Square	436.20	275.96	185.53	131.65	78.24	111.66	101.74	450.35	287.67	214.23	161.17	98.98	119.44	108.91
P-Value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* p<0.1, ** p<0.05, *** p<0.01
Host measures include independent variable and host market size.

Table 5
Robustness Check: More Panel Tobit Regression Results using Measure 2

Measure 2	Host Measures Take Means							Host Measures Take Summations						
	21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
	(No lag)	**(Lag 1)**	**(Lag 2)**	**(Lag 3)**	**(Lag 5)**	**(Lag 6)**	**(Lag 7)**	**(No lag)**	**(Lag 1)**	**(Lag 2)**	**(Lag 3)**	**(Lag 5)**	**(Lag 6)**	**(Lag 7)**
Independent Variable														
Host DM's industry-level # of R&D workers	0.17**	0.19***	0.21***	0.13**	0.10	0.28***	0.20**	0.17**	0.20***	0.22***	0.15**	0.10	0.28***	0.21**
Control Variables														
Firm size	0.29***	0.28***	0.27***	0.22***	0.45***	0.79***	0.81***	0.28***	0.27***	0.25***	0.20***	0.40***	0.68***	0.68***
Firm age	-0.60	-0.64	-0.62	-0.74	-1.21**	-1.53***	-1.55**	-1.24**	-1.22**	-1.14**	-1.21**	-1.60***	-1.92***	-1.96***
Current ratio	-6.80*	-10.57**	-9.86**	-11.68**	-5.34	-2.13	-6.57	-6.36*	-10.10**	-9.32**	-11.09**	-4.81	-1.49	-6.21
Solvency ratio	-0.39	-0.15	-0.34	-0.50	-0.61	-0.35	0.07	-0.36	-0.11	-0.30	-0.47	-0.59	-0.33	0.12
Home R&D advantage	1.70***	1.40***	1.25***	1.01***	0.53***	0.30*	0.69***	1.56***	1.28***	1.14***	0.92***	0.47***	0.27*	0.67***
Home market size	0.84***	0.70***	0.59***	0.56***	0.55***	0.44**	0.56**	0.48***	0.44***	0.40***	0.45***	0.41***	0.18	0.28*
Host market size	0.31	0.16	0.04	-0.01	-0.19	-0.33	-0.12	0.31	0.15	0.04	0.00	-0.16	-0.29	-0.07
Weighted geographic distance	-0.82***	-0.69**	-0.57**	-0.49	-0.79**	-1.05***	-1.11***	-0.95***	-0.84***	-0.73***	-0.66**	-0.90***	-1.02***	-1.09***
Home tax burden	-5.35***	-4.11***	-2.22*	-1.28	1.26	1.57	-0.52	-6.29***	-4.93***	-2.89**	-1.81	0.63	0.44	-1.38
Common official language	0.54	0.52	0.32	0.30	0.36	0.56	0.76	0.75	0.66	0.41	0.35	0.41	0.66	0.86
Constant	-21.14***	-14.41**	-9.47	-6.64	-1.48	1.64	-6.44	-9.12	-5.06	-2.27	-1.68	3.34	9.34	2.07
Sigma u	2.25***	2.16***	2.12***	2.22***	2.29***	2.41***	2.68***	2.21***	2.10***	2.06***	2.15***	2.27***	2.41***	2.68***
Sigma e	2.18***	1.99***	1.77***	1.54***	1.21***	0.94***	0.74***	2.18***	1.99***	1.77***	1.54***	1.20***	0.94***	0.74***
Year Dummy	included							included						
Home Dummy	included							included						
Host Dummy	included							included						
Statistics														
Number of Firms	238	238	238	237	231	231	227	238	238	238	237	231	231	227
Number of Left-Censored Observations	219	157	108	74	41	35	29	219	157	108	74	41	35	29
Number of Observations	1878	1673	1468	1262	846	641	432	1878	1673	1468	1262	846	641	432
Chi-Square	434.93	305.56	213.38	125.82	90.43	116.90	108.56	441.94	324.20	236.95	149.45	105.55	118.85	109.51
P-Value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* p<0.1, ** p<0.05, *** p<0.01
Host measures include independent variable and host market size.

Table 6
Robustness Check: More Panel Tobit Regression Results using Measure 3

Measure 3	Using Host-Measure Means							Using Host-Measure Summations						
	35	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**
	(No lag)	**(Lag 1)**	**(Lag 2)**	**(Lag 3)**	**(Lag 5)**	**(Lag 6)**	**(Lag 7)**	**(No lag)**	**(Lag 1)**	**(Lag 2)**	**(Lag 3)**	**(Lag 5)**	**(Lag 6)**	**(Lag 7)**
Independent Variable														
Host DM's industry-level number of patents	-0.12	-0.11	-0.11	-0.14	-0.03	0.03	0.14	-0.05	-0.07	-0.08	-0.10	-0.04	-0.01	0.10
Control Variables														
Firm size	0.26***	0.26***	0.26***	0.20***	0.44***	0.74***	0.75***	0.26***	0.25***	0.25***	0.19***	0.39***	0.65***	0.65***
Firm age	-0.51	-0.74	-0.69	-0.79	-1.13**	-1.57***	-1.46**	-1.25**	-1.36**	-1.14**	-1.21**	-1.44***	-1.85***	-1.75***
Current ratio	-6.93*	-10.86***	-9.31**	-11.18**	-4.68	-1.81	-7.39	-6.45*	-10.30**	-8.75**	-10.63**	-4.19	-1.30	-6.99
Solvency ratio	0.16	0.21	-0.39	-0.48	-0.61	-0.37	0.10	0.19	0.24	-0.36	-0.45	-0.59	-0.37	0.11
Home R&D advantage	2.15***	1.29***	1.14***	0.96***	0.49***	0.22	0.65***	1.92***	1.16***	1.04***	0.89***	0.44***	0.21	0.64***
Home market size	1.26***	0.97***	0.71***	0.63***	0.51***	0.49***	0.51***	0.74***	0.70***	0.57***	0.56***	0.45***	0.37***	0.38***
Host market size	0.44*	0.18	0.04	-0.04	-0.20	-0.29	-0.04	0.41*	0.18	0.05	-0.02	-0.17	-0.26	0.00
Weighted geographic distance	-1.02***	-0.76**	-0.59**	-0.49	-0.69**	-0.96***	-1.02***	-1.17***	-0.95***	-0.75***	-0.68**	-0.81***	-0.97***	-1.03***
Home tax burden	-9.76***	-5.30***	-2.50*	-1.60	0.65	1.28	-1.10	-10.69***	-6.11***	-3.04**	-2.00	0.22	0.60	-1.71
Common official language	0.97*	0.71	0.47	0.43	0.40	0.58	0.78	1.24**	0.87*	0.53	0.47	0.39	0.60	0.79
Constant	-31.69***	-19.70**	-10.58	-6.18	0.21	1.75	-5.29	-14.53*	-9.80	-5.20	-2.72	2.70	5.84	-0.84
Sigma u	2.62***	2.29***	2.20***	2.28***	2.34***	2.48***	2.73***	2.59***	2.22***	2.14***	2.21***	2.31***	2.47***	2.72***
Sigma e	2.04***	1.93***	1.75***	1.51***	1.18***	0.93***	0.72***	2.04***	1.93***	1.75***	1.51***	1.18***	0.93***	0.72***
Year Dummy	included							included						
Home Dummy	included							included						
Host Dummy	included							included						
Statistics														
Number of Left-Censored Observations	196	144	109	74	41	35	29	196	144	109	74	41	35	29
Number of Observations	1486	1491	1509	1297	871	659	445	1486	1491	1509	1297	871	659	445
Chi-Square	375.62	281.24	211.85	125.45	87.33	97.16	99.04	371.85	298.52	230.83	146.31	101.32	99.90	101.12
P-Value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* p<0.1, ** p<0.05, *** p<0.01
Host measures include independent variable and host market size.

Table 7
Robustness Check: Panel Tobit Regression Results using Different Weights
(Estimates for independent variables only)

	Host Measures Weighted by Host GDP								**Host Measures Weighted by Distance**							
	(No lag)	**(Lag 1)**	**(Lag 2)**	**(Lag 3)**	**(Lag 4)**	**(Lag 5)**	**(Lag 6)**	**(Lag 7)**	**(No lag)**	**(Lag 1)**	**(Lag 2)**	**(Lag 3)**	**(Lag 4)**	**(Lag 5)**	**(Lag 6)**	**(Lag 7)**
Host DM's industry-level $ value of R&D investments	0.51***	0.32***	0.30***	0.25***	0.22***	0.23***	0.38***	0.34***	0.23***	0.23***	0.24***	0.15**	0.12*	0.11*	0.32***	0.25**
Host DM's industry-level # of R&D workers	0.74***	0.48***	0.43***	0.35***	0.31***	0.31***	0.52***	0.47***	0.32***	0.33***	0.34***	0.22**	0.16*	0.16*	0.45***	0.35**
Host DM's industry-level number of patents	-0.13	-0.12	-0.12	-0.15	-0.07	-0.03	0.04	0.16	-0.12	-0.15	-0.16	-0.21	-0.1	-0.05	0.05	0.22

* p<0.1, ** p<0.05, *** p<0.01
Host measures include independent variables and host market size.

APPENDIX

Table A1

Variable	**Measurement**	**Data Source**
Dependent Variable		
Proprietary R&D activeness	Annual R&D spending by the EM parent	BvD Orbis
Independent Variables		
Measure 1	industry-level (3-digit SIC) dollar value of R&D investments in a DM	SourceOECD
Measure 2	industry-level (3-digit SIC) number of R&D researchers and technicians in a DM	SourceOECD
Measure 3	industry-level (3-digit SIC) number of patents applied by both residents and non-residents in a DM	SourceOECD
Control Variables		
Firm size	total assets of EM parent	BvD Orbis
Firm age	number of years since incorporations	BvD Orbis
Firm current ratio	total current assets to total current liability ratio of EM parent	BvD Orbis
Firm solvency ratio	total assets to total liability ratio of EM parent	BvD Orbis
Home R&D advantage	Logarithm of the amount of home industry-level (3-digit SIC) R&D investment over mean among all EM homes (adjusted to positive before taking the logarithm by adding a fixed positive amount)	BvD Orbis SourceOECD
Home market size	real GDP of home market	World Bank WDI
Host market size	real GDP of host market	World Bank WDI
Weighted geographic distance	a composite of geographic distance between home and host markets' major metropolis cities weighted by each city's population	CEPII of France
Home tax burden	effective corporate tax rate in home market	KPMG GTS
Common official language	1 if home and host markets share a common official language, and 0 otherwise	CEPII of France
Year dummy	Dummy variable for each year	Self-constructed
Home dummy	Dummy variable for each home market	Self-constructed
Host dummy	Dummy variable for each host market (average if having multiple host markets)	Self-constructed