Foreign Expansion and Corporate Innovation: Cross-Country Evidence*

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Abstract

Using novel and comprehensive data on the timing of subsidiary establishment, we examine how firms' foreign expansions influence their ability to innovate. We find that after an expansion, especially into a highly innovative country, a firm significantly increases innovation output and its patents are more likely to cite those originating from the host country. We address endogeneity using breakthrough inventions and show that they mainly benefit firms with subsidiaries in host countries that experience an innovation shock. The observed improvement in innovation activity is associated with the role of multinationality in lowering cross-country information barriers, as international presence allows firms to acquire innovative foreign firms and attract foreign institutional investors. Overall, our results are consistent with an important explanation for why multinational firms tend to be highly innovative: they achieve significant agglomeration economies by efficiently exploiting the spatially concentrated knowledge capital around the world.

Keywords: Corporate innovation, foreign expansion, knowledge pillovers, institutional investors

1 Introduction

> "Location and geographic space have become key factors in explaining the determinants of innovation and technological change... After all, geographical proximity matters in transmitting knowledge because... intellectual breakthroughs must cross hallways and streets more easily than oceans and continents."

Audretsch and Feldman (2004)

In the era of globalization, the fast pace at which firms enter into new foreign markets has dramatically increased the geographical proximity between their operations. Starting from Grossman and Helpman (1991), a large literature has identified how this trend has created positive externalities on the developments of host-country economies by allowing local firms to learn from innovative multinational firms. In contrast, evidence on spillovers in the opposite direction remains sparse. By expanding operations into a foreign country, does a firm also improve its ability to innovate? The answer to this question is important because such innovation not only sustains a firm's comparative advantage, but is also a critical determinant of a country's long-term economic growth (Solow, 1957).

Thus far, a few studies that examine whether foreign expansions help firms absorb knowledge spillovers from their host countries have produced conflicting results. Using citations of previous patents as a spillover measure, Branstetter (2006) shows that, among Japanese firms, those with operations in the US are more likely to cite American patents. However, Macgarvie (2006) do not find the same difference between exporting and non-exporting French firms. These studies often focus on a single (often developed) economy, and the lack of cross-country variations, for both home and host countries, is a significant limitation. If a firm comes from a technologically advanced country, the benefits of expanding into another similarly advanced country may be small (and hard to detect). Without the ability to compare across different expansion destinations, it is also difficult to empirically isolate the effect of an expansion from other (unobservable) changes in firm characteristics that concurrently influence its ability to innovate.

In this paper, we address the above issues using a novel dataset of multinational firms' expansions into new foreign markets via the establishment of new subsidiaries. Our data are both comprehensive and granular, covering listed firms from 39 home countries and their expansions into 33 host countries over the period from 1997 to 2014. For each firm, we are able to observe the timing of the establishment of its first subsidiary in another country, and use this event to define the expansion of the firm's operations into that country.

These unique data on firms' cross-border expansions are combined with worldwide firm-matched patent data. Using patenting activities of multinational firms as an indicator of their ability to innovate, we find that improvements in innovation output occur precisely around firms' cross-border expansion events. The magnitudes of these changes are economically significant. For example, after controlling for firm fixed effects, our estimates indicate that the number of patents increases on average by about 10% and the number of citations by about 13% after a firm makes its first cross-border expansion.

Can such improvements be attributed to firms absorbing new knowledge when operating in another country? The large literature on agglomeration economies and innovation (see Carlino and Kerr, 2015, for a survey) provides rich evidence in support of this possibility. In particular, it is well established that innovative activities are highly (geographically) concentrated and specialized, arising from the need to share critical inputs (e.g., natural resources, technical knowledge, and skilled workers (Ellison and Glaeser, 1999; Ellison et al., 2010; Helsley and Strange, 2002).[1] It has also been shown that proximity is theoretically an important condition for knowledge spillovers (Feldman, 1994; Keller, 2002). We thus posit that after a firm expands into a foreign country, it can more efficiently tap into local resources and knowledge capital to improve its innovative activity.

There are many other alternative explanations. A correlation between cross-border expansions and innovation output may arise because of unobservable firm characteristics that drive both the decision to expand and the ability to innovate, e.g. superior management practices. A firm may also choose to expand internationally to capitalize on its newly developed technologies—a reverse causality concern. Importantly, a new market entry may in itself create additional incentives to invest in innovation, by increasing the size of the firm's potential markets (see Melitz and Trefler, 2012, for a review). None of these alternative explanations requires any knowledge spillovers from host countries to multinational firms.

We present three sets of evidence that such spillovers indeed occur on a systematic basis. Our analysis exploits the rich, multi-dimensional variations in the data. First, we explore the heterogeneity in technological developments of host countries, as measured by country-level innovation output. We find that expansions into "high-innovation" countries are on average associated with a much larger increase in innovation output than expansions into "low-innovation" countries.

[1] More broadly, Frésard et al. (2017) show that industry specialization (concentration) varies across countries and this pattern influences global M&A flows.

Second, we examine patent citations as a proxy for knowledge acquisitions, following a long line of studies that utilize the same measure (Gomes-Casseres et al., 2006; Jaffe et al., 1993; Keller, 2002). We expect that if a firm can learn more about local inventions after expanding into a host country, its new patents are more likely to cite patents from that country.

In this analysis, we utilize high-dimensional fixed effects to tackle endogeneity issues related to both time-invariant and time-varying omitted variables biases. Unlike prior work that relies on one geographic dimension (i.e., the presence of firms from one country in another country), our data pinpoint not only the location but also the timing of each expansion. Importantly, we exploit the fact that there are many host countries in our sample and the expansion events of each firm into different countries also tend to be staggered over our sample period. These features enables us to incorporate (i) firm-by-year fixed effects to control for all cross-sectional and time-varying characteristics that affect a firm's ability to innovate, (ii) firm-by-host-country fixed effects to control for all time-invariant factors that define the relation between a firm and a host country, and (iii) host-country-by-year fixed effects to control for all time-varying characteristics of each host country that.[2] Our estimates indicate that, after a firm expands into another country, its new patents cite more those whose owners or inventors are from that country, and that this difference is greater than the change in the firm's citations of other countries' patents over the same time period.

Third, we use breakthrough inventions as a quasi-natural experiment that generates a plausibly exogenous shock to technological knowledge and conduct a difference-in-differences (DiD) analysis. Following Kerr (2010), we define a patent in a given year as a breakthrough invention if it is very highly cited (within the top 1% of all cited patents from around the world in the same technology class and in the same application year). Applying this definition in our context, we identify a technology shock event for each country-technology pair as the first year (breakthrough year) that the country achieves a breakthrough invention in that technology class. We argue that these technology shocks are largely unpredictable, that is, on the global scale, it is difficult for multinational firms to base their expansion decisions on the potential that a country may experience a significant discovery.

We then compare innovation output of firms that are exposed to the technology shock (i.e., firms that already have a subsidiary presence in the breakthrough country prior to a breakthrough year) with that of firms that operate in the same technology class but do not have the same geographic exposure. Our results

[2]Similar estimation methods have been recently employed in other contexts, for example, to model the effect of monitoring by venture capitalists (Bernstein et al., 2016) and the productivity effect of capital account liberalization (Larrain and Stumpner, 2017).

suggest that firms exposed to a technology shock increase their patents in the post-shock period faster than those that operate in the same technology class but do not have the same geographic exposure. These results are again robust to the use of various types of high-dimensional fixed effects, suggesting that the positive effect of foreign expansion on innovation is causal. We also find that exposed firms are more likely to cite patents whose owners or inventors are from the breakthrough country than unexposed firms. These findings support the notion that establishing subsidiaries in a foreign country allows a parent firm to acquire technical knowledge in the host country that is used to improve its innovation output.

We next examine why having operations in other foreign countries help firms efficiently absorb knowledge and innovation. Drawing from the well-established themes of the internalization theory (Caves, 1971; Hymer, 1976), we argue that knowledge transfers are constrained by information frictions associated with national borders and physical distance that make it difficult for firms to learn new technologies from another country through contracting and arms-length transactions. Having diverse multinational operations allow these frictions to be internalize within firms and help them better understand and verify the value of host-country technologies. We present two results related to this argument. First, we show that, in a cross-sectional comparison, foreign firms with subsidiaries already established in a host country are more likely to acquire innovative local firms compared to other potential foreign acquirers that do not have the same local presence. Second, we consider the possibility that technology-related information frictions are also reduced because the investor composition of a firm changes following each of its cross-border expansions. This analysis builds on an important finding in the innovation literature that institutional investors can spur firm innovation through their monitoring activities (Aghion et al., 2013; Bena et al., 2017; Luong et al., 2017) . Our analysis indicates that a firm's foreign institutional ownership indeed increases following each of its cross-border expansions, and that innovation improvements observed after each expansion are also greater for firms with high institutional ownership. To the extent that institutional investors can enhance portfolio firm innovation, this evidence helps explain why foreign expansions generate more innovation.

We contribute to the literature in two ways. First, we add to the literature examining the geography of innovation. While it has been documented that innovation is spatially clustered around locations where input sharing and knowledge spillovers reduce the costs of scientific discovery and commercialization (Feldman and Kogler, 2010), most studies have so far focused on within-country geographic segmentation or variations across a few developed countries. Buzard and Carlino (2013) report that R&D activity for most industries in the U.S. tends to be concentrated in the Northeast Corridor, around the Great Lakes, in California's Bay

Area, and in Southern California. (Branstetter, 2006) documents that Japanese firms with US FDI experience the flow of knowledge spillovers to and from the US. Our cross-country analysis expands this literature and provides a more comprehensive evidence, thanks to our unique dataset on the timing of each firm's foreign expansion, which allows us to better address endogeneity concerns.

Second, we contribute to a fast-growing literature on the link between finance and innovation by identifying an important driver of innovation. Empirical evidence has identified factors that potentially affect firm innovation, such as laws (Acharya and Subramanian, 2009), financial market development (Hsu et al., 2014), market conditions (Nanda and Nicholas, 2014), labor unions (Bradley et al., 2017), and institutional investors (Aghion et al., 2013; Bena et al., 2017; Luong et al., 2017). We provide novel cross-country evidence that when a firm invests in a foreign location through a subsidiary establishment, it also generates economies of agglomeration. By operating in the proximity of the sources of new knowledge creation, the firm improves its ability to innovate.

The paper proceeds as follows. Section 2 discusses related literature. Section 3 describes sample selection and variable construction. Section 4 presents results and discussions. Section 5 concludes.

2 Related Literature

Our analysis is motivated by two strands of literature on: (1) the geographic concentration of innovation and (2) the role of foreign operations in knowledge creation.

According to the first strand of literature (see, for example, Audretsch and Feldman, 2004; Carlino and Kerr, 2015; Feldman and Kogler, 2010, for a survey), there is a substantial geographic concentration of innovative activities. For example, Buzard and Carlino (2013) show that R&D activity for most industries in the U.S. tends to be concentrated in the Northeast Corridor, around the Great Lakes, in California's Bay Area, and in Southern California. There are at least two reasons for such spatial concentration. First, input sharing makes innovative activities spatially concentrated.[3] Helsley and Strange (2002) develop a dynamic model in which a dense network of input suppliers facilitates innovation by lowering the costs needed to bring new ideas to realization.[4]

[3] Inputs are broadly defined as, including but not limited to, specialized labor and input supply network.

[4] We obtain some anecdotal evidence in support of this argument in an interview with James Fazzino, a former CEO of Incitec Pivot Limited, a multinational company in the fertilizer and explosive industry headquartered in Australia. Mr. Fazzino discussed that Incitec Pivot gained valuable new technologies related to the precision timing of mining explosives delivery from partner firms in South Africa after expanding into that country. After expanding into the United States, Incitec Pivot was also able to develop new types of explosives delivery trains through collaborations with U.S. firms located in Utah, an explosives industry hub.

Second, knowledge spillovers can be conducive to the geographic concentration of innovative activities. Feldman (1994) develop a theory that geographic proximity enhances the ability of firms to exchange ideas and be cognizant of important incipient knowledge, hence reducing uncertainty for their innovative activities. Thus, innovation agglomerates spatially where knowledge spillovers reduce the costs of scientific discovery and commercialization. Jaffe et al. (1993) shows that inventors are more likely to cite other inventors who are from the same states, suggesting knowledge spillovers occur in geographic proximity. Keller (2002) shows that to a large extent technology diffusion is local, not global, as the benefits from spillovers decline with geographical distance.

The second strand of the literature discusses the evolving role of foreign operations in knowledge creation in the global economy. In the traditional view of multinational corporations (e.g., Hymer, 1976), knowledge is created in headquarters and then diffused to subsidiaries worldwide in the form of new products and processes. Thus, subsidiaries are viewed as entities that apply and exploit knowledge. More recent views (e.g., Alcácer and Delgado, 2016; Bartlett and Ghoshal, 1989) take into account the possibility that knowledge is sourced from various locations and shared across the firm. In this networked corporation, subsidiaries play an important role in the innovative process. Importantly, subsidiaries can be located in host countries that are embedded with valuable resources such as social and human capital, technological knowledge, and natural resources (Porter, 1990). This implies that foreign subsidiaries allow the firm to have better access to inputs and knowledge externalities from the host country for innovative activities. As an example, Branstetter (2006) documents that Japanese firms expanding into the U.S. market experience an increase in the flow of knowledge spillovers both from and to the investing Japanese firms.

3 Sample Selection and Variable Construction

3.1 Data Sources

Our sample includes publicly listed firms from 39 home countries and their expansions into 33 host countries for the period from 1997 through 2014. We use patent and citation information from the Bureau van Dijk (BvD)'s Orbis patent database to construct proxies for innovation. The source of this database is the Worldwide Patent Statistical Database (PATSTAT) maintained by the European Patent Office (EPO). The database offers a comprehensive coverage of more than 110 million patent applications worldwide. These patents are filed by individuals, corporate sectors, and non-profit organizations through 94 regional, national, and international patent offices. Our dataset on the timing of subsidiary establishment in each host country is constructed from BvD's Orbis and Osiris databases. We obtain data on institutional ownership from Thompson Reuters Global Ownership database and mergers and acquisitions data from the Securities Data Company (SDC) Mergers and Acquisitions database. Finally, we collect firm accounting data from Worldscope and country-level data from World Bank.

3.2 Variable Construction

3.2.1 Firm-Level Measures of Innovation

We construct two proxies for innovation output at the firm level. The first measure is the number of patent applications filed by (and eventually granted to) a firm in a given year. As in the literature (e.g., Fang et al., 2014; Hall et al., 2001), we use a patent's application year instead of its grant year because the former better captures the actual time of innovation. If a patent is assigned to multiple assignees, we scale it by the number of assignees that own it, assuming equal ownership. Since a patent can belong to more than one technology group, we further scale this measure by the mean number of patent applications filed in a year for technology groups to which the patent belongs. We use the International Patent Classification (IPC) to classify patents into technology classes. As of 2015, there are 129 IPC classes. We use these patent classes to normalize our first innovation measure.[5]

The second measure is the total number of citations made to a patent in subsequent years, scaled by the average citation count received by each patent in the technology class of patents to which the patent of interest belongs. This measure is related to the quality of a patent because it captures the economic value of innovation by distinguishing a breakthrough innovation from an incremental discovery.

We address several common issues regarding the innovation output variables. The first one is the truncation problem caused by the fact that patents appear in the database only after they are granted. Since the lag between a patent's application year and its grant year is significant (about two years on average), many

[5] IPC is a hierarchical patent classification system used in over 100 countries. Each classification term consists of a symbol such as A01B 1/00. The first letter is the "section symbol" consisting of a letter: A ("Human Necessities"), B ("Performing Operations, Transporting"), C("Chemistry, Metallurgy"), D ("Textiles, Paper"), E ("Fixed Constructions"), F ("Mechanical Engineering, Lighting, Heating, Weapons"), G ("Physics"), and H ("Electricity"). The section is followed by a two-digit number representing a "class symbol". For example, A01 represents "Agriculture; forestry; animal husbandry; trapping; fishing". The final letter makes up the "subclass" (A01B represents "Soil working in agriculture or forestry; parts, details, or accessories of agricultural machines or implements, in general"). The subclass is then followed by a one-to-three-digit "group" number, an oblique stroke and a number of at least two digits representing a "main group" or "subgroup". For further details, see https://www.wipo.int/export/sites/www/classifications/ipc/en/guide/guide_ipc.pdf

patent applications were still under review and had not been granted by 2018 (when we retrieved the data). To adjust the truncation bias in patent counts, we follow the literature and end our sample period in 2014, which allows four more years for patents under review to be granted. Another truncation problem is related to patent citations. Patents keep receiving citations over a long period but we only observe citations received up to 2018. Following Hall et al. (2001), we address this issue by scaling the number of citation counts by the mean citation counts of the patent in the technology groups to which the patent belongs.

The second issue is related to the double counting of patents in the PATSTAT dataset, that is, the same patent based on the same invention might be submitted to and approved by more than one patenting authority. Using the priority number in the PATSTAT database, we can avoid this double-counting problem to retrieve patents that are based on the same invention and are granted by all patenting authorities. For the same invention's patents, we use the earliest application date to determine the number of unique patents.

The third issue is the right skewness of the distribution of patent grants and ex post citations in our sample with a median at zero. This issue is commonly reported in the innovation literature (e.g., He and Tian, 2013; Luong et al., 2017). To address this issue, we winsorize the two innovation variables at the 99th percentile and use the natural logarithms of (one plus) the number of patents and citations as our main innovation measures.

3.2.2 Foreign Expansion

To construct a variable that captures a firm's foreign expansion into a specific country, we construct a dataset that tracks the establishment of its new foreign subsidiaries using subsidiary information from the Orbis and Osiris databases. The timing of an expansion is defined as the year in which a firm establishes the first subsidiary in a given country. Our approach reflects a well-accepted view in the literature that subsidiary presence is a strong indicator of a country's strategic importance as arm's target market and/or production location (Antràs and Caballero, 2009). Conconi et al. (2016) show that the establishment by a firm of a subsidiary in a foreign country tends to occur around a large increase in its sales in that country.

Our procedure determines the establishment of a subsidiary depending on whether it is acquired or incorporated by the parent. To identify acquired subsidiaries, we match subsidiary data to M&A deals in the Thomson Reuters SDC Platinum database. This matching process helps detect both directly acquired subsidiaries (where they are perfectly matched to actual M&A targets) and indirectly acquired subsidiaries (where their parents are M&A targets). For each of these subsidiaries, the establishment year is the year in which the acquisition is announced. For the remaining subsidiaries, we use a name-parsing algorithm to identify those that are likely to be set up (incorporated) by their parents. This step exploits a convention that multinational firms tend to maintain and promote their corporate identities in foreign markets: naming a foreign subsidiary eponymously after the parent firm or the main brand of the firm. For these subsidiaries, we use the year of incorporation as the establishment year. The remaining gap in the data is filled through our own manual data collection effort to obtain information on the year that a firm establishes the first subsidiary in a foreign country. Finally, if our manual searches fail, we use the first year that a subsidiary is linked to its parent firm by BvD (referred to as BvD entry year) as the estimate of its establishment year.

3.2.3 Control Variables

Following the literature on innovation, we control for a full set of firm and country characteristics that can affect a firm's innovation output. For firm-level variables, we use firm size, measured as the natural logarithm of total assets (SIZE), firm age (AGE), investments in intangible assets (RD), capital expenditures (CAPEX), asset tangibility (PPE), leverage (LEV), profitability (ROA), financial constraints (the Kaplan and Zingales (1997)'s index, KZ), and growth opportunities (TOBINQ). We also include industry concentration (the Herfindahl index, HHI) and the squared Herfindahl index (HHISQ) to mitigate the nonlinear effects of product market competition on innovation output Aghion et al. (2005). We winsorize all firm-level variables at the top and bottom 1% to eliminate the effects of outliers.

For country-level variables, we adopt several controls drawn from the literature that may be related to firm innovation. We control for regulatory environment by using one dimension of the worldwide governance indicators, namely, the rule of law (RULE) constructed by Kaufmann et al. (2011). Hsu et al. (2014) find that financial development is related to innovation, we control for equity market development, using the ratio of a country's stock market capitalization to its GDP (EQUITY), and credit market development, which is the ratio of a country's domestic credit to its GDP (CREDIT). Finally, we follow Acharya and Subramanian (2009) to control for a country's levels of exports (EXPORT) and imports (IMPORT), defined as the percentages of exports and imports to its GDP, respectively, and GDP growth (GDPG).

3.3 Summary Statistics

Table 1 presents sample statistics. In Panel A, PAT refers to the total number of patent applications that are filed by, and are eventually granted to, a firm in a year. CITE is the total number of citations received by each patent. Of all countries in the sample, the U.S. has the largest number of firms (3,214), followed by Japan (1,979), Korea (842), China (808), and United Kingdom (663). On average, firms in the Netherlands have the largest number of patents per year (28), followed by firms in Finland (25), Japan (23), Germany (18), and U.S. (16). This pattern is broadly similar for citations. Firms in the Netherlands and Switzerland have the largest number of foreign subsidiaries (13), followed by Denmark (10.6), France (10.5), Finland (10.4), Austria (10.2), and Belgium (10.1).

Insert Table 1 about here

Panel B shows the summary statistics for firm and country variables. On average, a firm has a book value of assets of $295.3 million, an R&D to asset ratio of 2%, a capital expenditure to asset ratio of 5.7%, a PPE to asset ratio of 28%, a leverage ratio of 21.8%, an ROA of 0.9%, and a Tobin's Q of 1.67. The average firm age, measured as the length of time since a firm has been listed on a stock exchange is 7 years.

4 Results and Discussion

4.1 Cross-border Expansions and Corporate Innovation

To examine the relation between cross-border expansions and corporate innovation, we estimate a firm's innovation output in response to it establishing a subsidiary in a foreign country, using variants of the following model specification:

$$\text{INNOVATION}_{ijkt} = \alpha + \beta \, \text{EXPAND}_{ijkt-1} + \gamma' \mathbf{X}_{ijkt-1} + \text{Fixed Effects} + \varepsilon_{ijkt}, \tag{1}$$

where i, k, j, and t refer to firm, industry, home country, and year, respectively. The dependent variable is a proxy for innovation, measured by either the natural logarithm of one plus the number of patents (LPAT) or the natural logarithm of one plus the number of citations per patent (LCITE). EXPAND is the foreign expansion variable, measured by either an indicator for whether a firm has established a foreign subsidiary by year t (SUB) or the natural logarithm of one plus the number of foreign subsidiaries (LNSUB) that a firm has had by year t. $\mathbf{X}$ denotes a vector of firm and country characteristics as discussed in Subsection 3.2.3, all lagged by one year relative to the dependent variable.

Insert Table 2 about here

Table 2 reports the baseline results. In column (1) where we control for year, industry, and home country fixed effects, the coefficient estimate of SUB is a positive and strongly significant at the 1% level (0.043, *t*-stat 2.88), suggesting that a firm with a foreign subsidiary is associated with greater innovation output as measured by the number of patents. This effect still holds qualitatively, but becomes larger in magnitude (ranging from 0.091 to 0.098), when controlling for firm and year fixed effects[6] (column (2)) or when absorbing both time-invariant firm unobservables and time-varying country characteristics (column (3)). Qualitatively similar results obtain when we use the log number of subsidiaries (LNSUB) in place of the subsidiary dummy (columns (7)–(12)). A coefficient of 0.091 in column (3), for example, implies that firms with at least one foreign subsidiary have about 9.10% more patents than those without subsidiaries. This difference appears to be economically significant. When using the log number of citations as the dependent variable (columns 4–6 and 10–12), we obtain qualitatively similar results. Specifically, firms with at least one foreign subsidiary or have more foreign subsidiaries are associated with a higher number of citations. The coefficient estimate of 0.067, shown in column (11), suggests that, on average, for each 1% increase in the number of subsidiaries established, the number of citations made to patents increase by about 6.70%. Overall, all the baseline results suggest that establishing subsidiaries in foreign countries is positively associated with greater innovation output.

A large literature (e.g., Carlino and Kerr, 2015; Keller, 2002) contends that innovation is spatially concentrated to exploit the advantages of input sharing and knowledge diffusion. In the context of MCNs, literature documents that knowledge is sourced from various locations and shared within the multinational firm (e.g., Bartlett and Ghoshal, 1989; Hedlund, 1994). Thus, if a firm's expansion into a foreign country is associated with greater innovation output as the baseline results show, then this effect likely differs in magnitude between a high-innovation host location and a low-innovation one. To explore this issue, we classify a firm's subsidiary establishments as whether it is an expansion into a high-innovation or a low-innovation country.

We follow Luong et al. (2017) and construct four country-level measures of innovation using the World Bank patent database. The first measure is the total number of patents granted to all residents of a country in a year scaled by its total number of listed firms. The second measure is the total number of patents granted to all residents of a country in a year scaled by its GDP. The third measure is the total number of patents granted to all residents of a country in a year scaled by its total population. The last measure is

[6]Thus industry and country fixed effects are dropped since they do not vary within a firm.

the residuals from a regression of the total number of patents granted to all residents of a country in a year against its total number of listed firms, GDP, and total population. Then, we average these measures over the period of 1997–2014. We define a country as a high- (low-) innovation country if its innovation measure is above (below) the median of all measures. We define a firm's subsidiary establishment in a given year as an expansion into a high-innovation (low-innovation) country if it has established at least one subsidiary in a high-innovation (low-innovation) country by that year. For each country-level innovation measures, we construct an indicator for whether a firm expands into a high-innovation country (SUB_HIGH_FIRM, SUB_HIGH_GDP, SUB_HIGH_POP, and SUB_HIGH_RESID) and another dummy indicating whether a firm expands into a low-innovation country by a given year (SUB_LOW_FIRM, SUB_LOW_GDP, SUB_LOW_POP, and SUB_LOW_RESID).

Insert Table 3 about here

Table 3 reports the results of re-estimating Equation (1) with these dummy variables used in place of EXPAND. In Panel A, where year and firm fixed effects are included, the coefficient estimates of the two dummies are positive and strongly significant at the 1% level in all model specifications, suggesting that expanding into a foreign country, be it a high-innovation country or a low-innovation country, is associated with greater innovation output as measured by patent and citation counts. However, the coefficients on the dummies for expansion into high-innovation host countries are larger in magnitude as shown by the F-tests for differences in coefficient estimates. These results suggest that firms benefit more from high-innovation host countries than from low-innovation host countries when establishing foreign subsidiaries. In Panel B, where we include year, industry, and home country fixed effects, the coefficient estimates of the dummy variables for expansion into a high-innovation country remain positive and strongly significant at the 1% level, whereas the dummy variables for expansion into a low-innovation country are all statistically insignificant. Taken together, all these results imply that the positive effect of establishing foreign subsidiaries on a firm's innovation output appears to be driven by high-innovation host countries.

4.2 Foreign Expansion and Knowledge Acquisitions

To study whether a multinational firm can acquire more technical knowledge from a foreign country where it establishes a subsidiary, we follow prior studies (e.g., Jaffe and Trajtenberg, 1996; Jaffe et al., 1993) and use patent citations as a measure of knowledge acquisition. We estimate a firm's knowledge acquisitions in response to its establishing a subsidiary into a foreign country, incorporating pair-wise fixed effects to control for variations in firm and foreign country characteristics based on the following high-dimensional fixed effects regression:

$$\text{LCITATION\_LOC}_{ijt} = \alpha + \beta \ \text{SUB}_{ijt-1} + \mu_{it} + \eta_{jt} + \delta_{ij} + \varepsilon_{ijt} \tag{2}$$

where i, j, and t refer to firm, host country, and year, respectively. The dependent variable, $\text{LCITATION\_LOC}_{ijt}$, is the natural logarithm of one plus the number of citations made by firm i to all patents of host country j. SUB_{ijt-1} is a dummy variable that equals one if firm i has established a subsidiary in host country j by year $t-1$ and zero otherwise. μ_{it} is firm-and-year (Firm×Year) fixed effects, which absorb all cross-sectional time-varying firm characteristics that can affect firm innovation. η_{jt} is host-country-and-year (Host×Year) fixed effects, which control for all time-varying characteristics of host countries. δ_{ij} is firm-and-host-country (Firm×Host) fixed effects, which absorb time-invariant characteristics defining the relation between a firm and a host country.

Insert Table 4 about here

Panel A of Table 4 contains the results of estimating Equation (3). In column (1), where we incorporate firm-and-year fixed effects and use standard errors clustered by firm-and-year pair, the coefficient estimate of SUB is positive and strongly significant at the 1% level, suggesting that after establishing a subsidiary in a foreign host country, a firm owning patents cite more patents of the host country. A coefficient of 0.244 implies that on average, a firm cites about 2.4% more patents of the host country after it has established a subsidiary in that country. In columns (2)–(3), we allow for high-dimensional fixed effects and use more conservative inference (i.e., allowing residuals to be correlated across larger groups). Specifically, in column (2), where both firm-and-year and host-country-and-year fixed effects are included and standard errors are clustered by both firm-and-year and host-country-and-year levels, the coefficient estimate of SUB remains positive and significant, even though it becomes smaller in magnitude. Similarly, in column (3) where we incorporate firm-and-year fixed effects, host-country-and-year fixed effects, and firm-and-host-country fixed effects and cluster standard errors by firm-and-year, host-country-and-year, as well as firm-and-host-country levels, the coefficient estimate of SUB remains positive and highly significant at the 1% level. Collectively, these results indicate that the positive effect of foreign expansion on knowledge acquisitions is robust to the inclusion of all time-varying and time-invariant characteristics that may affect knowledge acquisition at both firm- and country-levels.

In Panel B of Table 4, we replace SUB with two variables: SUB_GREENFIELD and SUB_M&A. SUB_GREENFIELD (SUB_M&A) is a dummy variable that equals one if a subsidiary is established as a greenfield investment (through an acquisition) in a host country by a given year and zero otherwise. The coefficients on both SUB_GREENFIELD and SUB_M&A are positive and statistically significant across all model specifications, suggesting that all types of foreign expansions facilitate the acquisition of technical knowledge from host countries.

Overall, these results support the notion that multinational firms can acquire more technical knowledge from host countries where they establish subsidiaries.

4.3 Endogeneity Attempts using Breakthrough Patents

4.3.1 Breakthrough Patents and Innovation Output

In this section, we utilize breakthrough patents and conduct two sets of analyses. The first one addresses potential endogeneity concerning the effect of foreign expansion on firm innovation. Our evidence so far shows a positive effect of foreign expansion on firm innovation output. This effect is robust to a variety of estimation methods including firm and country-and-year fixed effects that absorb all time-invariant firm-level unobservable characteristics and time-varying country characteristics that may affect firm innovation. Endogeneity concerns remain, however, because reverse causality could bias the inference. For example, the decision to expand into a foreign country can be influenced by how innovative a firm is. To tackle these issues, we employ two identification strategies in this analysis.

First, we use breakthrough inventions as a quasi-natural experiment that generates a plausibly exogenous shock to technological knowledge and conduct a DiD analysis. Using a sample of public U.S. firms, Kerr (2010) documents that breakthrough inventions, defined as the top 1% of U.S. inventions for a technology in terms of subsequent citations, in a technology class within a given location attract subsequent research efforts to that pair of location and technology class, and that patenting growth is significantly higher in cities and technologies where breakthrough inventions occur as compared with peer locations without such inventions. Thus, we argue that if two firms expanding into two different locations at the same time but breakthrough inventions occur subsequently in only one of these locations, then the firm with a subsidiary in the breakthrough-invention location should experience greater innovation output as compared with the one without it.

We identify a technology shock occurring in a given country (breakthrough country) in a given year (breakthrough year) if there are at least one breakthrough patent in a given technology class in that country. We use the inventor country of the breakthrough patent as the breakthrough country. A breakthrough patent in a given year is defined as that which lies within the top 1% of all inventions for a technology class across all sample countries in terms of subsequent citations.[7] For each of 129 IPC technology classes, we use as the breakthrough year the earliest year during the period of 1992–2014 in which there is a breakthrough patent for that technology class. Using a DiD regression approach, we compare the innovation output of firms that are exposed to the technology shock (i.e., firms with its subsidiary in a breakthrough country prior to the breakthrough year) with that of firms without such exposure before and after the breakthrough year.

In the second strategy, we employ high-dimensional fixed effects regressions that allow us to better address endogeneity associated with both time-invariant and time-varying omitted-variables biases. A unique feature of our dataset is that we can observe not only the geographic dimension but also the timing dimension of each firm's expansion. We therefore estimate the following DiD regression:

$$\text{LPAT\_TECH\_CLASS}_{ict} = \alpha + \beta \ \text{TECH\_SHOCK}_{ict} + \mu_{it} + \delta_{ic} + \gamma_{ct} + \varepsilon_{ict}, \tag{3}$$

where i, c, and t refer to firm, technology class (Tech_Class), and year, respectively. The dependent variable, LPAT_TECH_CLASS, is the natural logarithm of one plus the number of patents per technology class. The key independent variable, TECH_SHOCK, is an indicator for whether a firm has established a subsidiary in a breakthrough (host) country before a breakthrough year. μ_{it} is firm-and-year fixed effects, which control for time-varying firm-level characteristics that can affect firm innovation. δ_{ic} is firm-and-tech_class (Firm$\times$Tech_Class) fixed effects, which control for time-invariant firm and technology class characteristics that can affect firm innovation. γ_{ct} is Tech_Class-and-year (Tech_Class$\times$Year) fixed effects, which control for time-varying technology class characteristics that can affect firm innovation.

We note that a technology shock (TECH_SHOCK) is defined as an indicator for whether a firm has established a subsidiary in a breakthrough country before a breakthrough year. Thus, there should be no reason to believe that a technology shock so defined is affected by the decision to establish a foreign subsidiary

[7] In robustness checks, we consider different thresholds for identifying breakthrough patents, such as the top 0.5% or the top 0.1%, and find that our results still hold.

since we require that a firm has established its foreign subsidiary in a breakthrough host country before a breakthrough year. A technology shock is apparently a source of exogenous variation in the host country innovativeness, which allows us to compare innovation output of firms that are exposed to the technology shock (i.e., firms that already have a subsidiary presence in a host country subsequently experiencing a technology shock) with that of firms that operate in the same technology class but do not have such exposure. The coefficient estimate of TECH_SHOCK is the DiD estimator that captures the causal effect of a firm's expansion into a host country subsequently experiencing a technology shock on its innovation output.

Insert Table 5 about here

Table 5 contains the results of estimating Equation (2). In column (1), where we include both firm-and-year fixed effects and firm-and-tech_class fixed effects and use standard errors clustered at the firm-and-year and firm-and-tech_class levels, the coefficient estimate of TECH_SHOCK is positive and highly significant at the 1% level, suggesting that firms that expose to a technology shock have greater innovation output than those that do not. A coefficient of 0.013 implies that, on average, firms establishing a subsidiary in a foreign host country that subsequently experiences a technology shock in a technology class has about 1.3% more patents in that technology than firms with a subsidiary in a foreign country without such a technology shock. When including more fixed effects (Firm×Year and Tech_Class×Year in column (2) or Firm×Year and Firm×Tech_Class as well as Tech_Class×Year in column (3)), we find that the coefficients on TECH_SHOCK remain positive and strongly significant, even though smaller in magnitude. These results collectively suggest that the positive effect of foreign expansion on firm innovation is causal. Put differently, firms that have established a subsidiary in a foreign country subsequently having breakthrough patents have higher innovation output than those that have not.

4.3.2 Breakthrough Patents and Knowledge Acquisitions

In the second set of analyses, we use breakthrough patents and address potential endogeneity concerning the effect of foreign expansion on knowledge acquisitions. Our evidence so far shows that a positive effect of foreign expansion on knowledge acquisitions, that is, multinational firms with subsidiary establishments overseas tend to cite more patents of host countries. This effect is robust to the inclusion of high-dimensional fixed effects, which absorb all relevant time-varying and time-invariant characteristics that may affect a firm's ability to acquire technical knowledge from a host country. However, there is a possibility that firms with the better ability to acquire technical knowledge from a certain country will expand to that country, that is, reverse causality concerns remain.

To address such concerns, we use breakthrough inventions as before and argue that if two firms expanding to two different locations at the same time but breakthrough inventions occur subsequently in only one of those locations, then the firm experiencing a technology shock (i.e., the firm with a subsidiary in the host country where breakthrough inventions occur) should exhibit greater knowledge acquisition than the one without such exposure, as demonstrated by the number of citations it make to the patents of the host country where the shock occurs. To test this conjecture, we estimate the following regression model:

$$\text{LCITATION\_LOC\_TECH\_CLASS}_{icjt} = \alpha + \beta\ \text{TECH\_SHOCK}_{icjt} + \mu_{it} + \eta_{jt} + \delta_{ij} + \gamma_{cj} + \varepsilon_{icjt}, \quad (4)$$

where i, c, and t refer to firm, technology class (Tech_Class), and year, respectively. The dependent variable, $\text{LCITATION\_LOC\_TECH\_CLASS}_{icjt}$, is the natural logarithm of one plus the number of citations made by firm i to all patents in technology class c of country j in year t. TECH_SHOCK_{icjt} equals one if a firm has established a subsidiary in a breakthrough country before the breakthrough year and zero otherwise. μ_{it} is firm-and-year fixed effects, which control for time-varying firm-level characteristics that can affect firm innovation. η_{jt} is the host country-and-year fixed effects that control for time-varying host country characteristics that may affect firm citations. δ_{ij} is firm-and-host country fixed effects, which control for time-invariant firm and host country characteristics that define the relation between a firm and a host country. γ_{cj} is technology-class-and-host country fixed effects, which control for time-invariant technology class and host country characteristics that can affect firm citations. In this framework, the coefficient estimate of TECH_SHOCK is the DiD estimator that captures the causal effect of a firm's expansion into a host country subsequently experiencing a technology shock on its knowledge acquisitions from such a country.

Insert Table 6 about here

Table 6 reports the results. The coefficient estimates of TECH_SHOCK range from 0.039 to 0.084 and are all positive and highly significant at the 1% level, suggesting that firms exposed to a technology shock, that is, firms that expand to a host country which subsequently experiencing a technology shock, cites more patents of that country, compared to those that do not. These results suggest that the positive effect of foreign expansion on knowledge acquisitions is causal.

4.4 Foreign Expansion and Acquisitions of Innovative Firms

Prior studies show that mergers and acquisitions play a significant role in promoting corporate innovation (e.g., Bena and Li, 2014; Sevilir and Tian, 2012; Stiebale, 2016). We thus expect that when expanding into a foreign country with close geographical proximity, a firm should have a better knowledge of the market of innovative firms in the host country. This advantage allows them to acquire those innovative firms in order to improve their technical know-how and patent portfolios. Our conjecture is supported by some important pieces of anecdotal evidence. As an example, Google established a subsidiary in Australia in 2002 and acquired Where 2 Technologies, a a Sydney-based company whose technology was a core component in Google Maps. Similarly, Apple expanded its operation to India in 1996 and later acquired Tuplejump, a machine learning company, to support its Siri application.

To empirically test our conjecture, we collect information on firms' acquisitions from the Securities Data Company (SDC) Mergers and Acquisitions database. We first study the effect of a firm's foreign expansion on its subsequent acquisition activity in the host country. To measure a firm's acquisition activity, we construct two variables to capture the probability of acquiring a firm in another country (ACQUI) and the number of acquired firms in a country (NACQUI). Specifically, $\text{ACQUI}_{(t+1)}$, $\text{ACQUI}_{(t+1)-(t+3)}$, and $\text{ACQUI}_{(t+1)-(t+5)}$ are dummy variables equal to one if a firm acquires at least one other firm from a certain country during the next periods of one, three, and five years, respectively, after the expansion year (t), and zero otherwise. $\text{NACQUI}_{(t+1)}$, $\text{NACQUI}_{(t+1)-(t+3)}$, and $\text{NACQUI}_{(t+1)-(t+5)}$ are the natural logarithms of one plus the number of acquired firms from a certain country during the next periods of one, three, and five years, respectively, after the expansion year (t). We then use the Fama-Macbeth cross-section regressions to predict firms' acquisition activity in a country for the periods of one, three, and five years subsequent to the year of expanding to that country.[8]

Insert Table 7 about here

We present the results in Panel A of Table 7. In columns (1)–(3), the dependent variable is ACQUI while it is NACQUI in columns (4)–(6). The key independent variable, SUB, is an indicator for whether a firm has established a subsidiary in a host country by a given year. The results show that the coefficient estimates of SUB are all positive and statistically significant, suggesting that, compared with other firms, a firm expanding

[8]Using cross-sectional regressions allows us to compare the acquisition activity of firms with foreign expansion with the acquisition activity of firms without such expansion at a certain point in time while accounting for the correlation between observations of these firms at that time.

to a host country will undertake more acquisitions in that country in the next periods of one, three, and five years after its expansion. These findings support our conjecture that a firm's geographical proximity to a certain country facilitates its acquisition activities in that country.

Given that a firm's geographical proximity to a country facilitates its acquisition activity in that country, we next examine the innovativeness of acquired firms to see whether the acquirer is more likely to acquire more innovative targets in the country. We construct two variables as proxies for the innovativeness of the acquired firms: the accumulated number of patents (TARG_LPAT) and the accumulated number of citations (TARG_LCITE) of all target firms from a certain country for each year up to the year in which they are acquired. Specifically, $\text{TARG\_LPAT}_{(t+1)}$, $\text{TARG\_LPAT}_{(t+1)-(t+3)}$, and $\text{TARG\_LPAT}_{(t+1)-(t+5)}$ are the natural logarithms of one plus the number of accumulated patents of all target firms from a certain country acquired during the next periods of one, three, five years, respectively, subsequent to the year of expansion into that country (year t). Similarly, $\text{TARG\_LCITE}_{(t+1)}$, $\text{TARG\_LCITE}_{(t+1)-(t+3)}$, and $\text{TARG\_LCITE}_{(t+1)-(t+5)}$ are the natural logarithms of one plus the number of accumulated citations of all target firms from a certain country acquired during the next periods of one, three, five years, respectively, subsequent to the year of expansion into that country (year t).

Panel B of Table 7 presents the results. In columns (1)–(3), the dependent variable is TARG_LPAT while in columns (4)–(6) it is TARG_LCITE. The results show that the coefficients on SUB are all positive and significant, suggesting that foreign expansion is associated with acquiring more innovative firms. Collectively, our results show that a firm's expansion to a host country allows it not only to increase M&A activity but also to acquire innovative firms in the host country.

4.5 Institutional Investor Monitoring and Host-Country Knowledge Spillovers

Several studies (Aghion et al., 2013; Bena et al., 2017; Luong et al., 2017) document that institutional investors, including foreign institutions, can spur innovation by actively monitoring managers, insuring managers against career concerns, and facilitating the knowledge spillover. Meanwhile, Moshirian et al. (2018) find that foreign expansion is followed by an increase in equity ownership by institutional investors of the host countries. Thus, we explore whether our evidence of firms learning new technologies from host countries is consistent with the incentives of their investors. We argue that to the extent institutional investors can promote innovation, a multinational firm's foreign expansion can increase its innovation output through attracting institutional investors, including those from the host countries.

To test this hypothesis, we first examine whether foreign expansion leads to greater institutional ownership by re-estimating the baseline model specification but using three measures of institutional ownership (total institutional ownership, domestic institutional ownership, and foreign institutional ownership) as the dependent variables.

Insert Table 8 about here

Panel A of Table 8 reports the results, where we control for firm- and year-fixed effects in all regressions. In column (1), where the dependent variable is total institutional ownership (TIO), the coefficient estimate of NSUB is positive and strongly significant at the 1% level, suggesting that foreign expansion predicts greater institutional equity investment. A coefficient estimate of 0.016 indicates that establishing one more foreign subsidiary is associated with an increase of about 1.6% in total institutional ownership in the following year. In columns (2) and (3), where total institutional ownership is decomposed into domestic and foreign institutional ownership, respectively, the coefficients on NSUB remain positive and significant. In sum, Panel A shows that institutional ownership of a firm increases following its foreign expansion.

We next explore the possible role of institutional investors in promoting innovation in firms with foreign subsidiaries. As equity ownership of institutional investors can increase following foreign expansion, we condition on a firm's level of institutional ownership prior to its foreign expansion and expect that firms with high institutional ownership should have higher innovation output than those with low institutional ownership. To test this conjecturer, we classify firms based on the level of institutional ownership in the year prior to its first subsidiary establishment. Specifically, we define a firm as one with high (low) institutional ownership if its institutional ownership is above (below) the median of institutional holdings of all firms in the sample in that year. We construct an indicator, SUB_HIGH_TIO (SUB_LOW_TIO), for all the periods following the year of its first subsidiary establishment if a firm is classified as the one with high (low) institutional ownership. This variable is zero if a firm never expands abroad over the sample period. We then re-estimate equation (1) but replace EXPAND with SUB_HIGH_TIO and SUB_LOW_TIO. The coefficients on SUB_HIGH_TIO (SUB_LOW_TIO) captures the effect of foreign expansion on innovation for firms with a high (low) level of institutional ownership.

Panel B of Table 8 reports the results. The coefficient estimates of both SUB_HIGH_TIO and SUB_LOW_TIO are positive and highly significant, suggesting that firms expanding abroad are associated with higher future innovation output regardless of institutional ownership levels. The F-tests at the bottom of the panel suggests that firms with greater institutional ownership experiences higher innovation output than those with lower institutional ownership. Overall, these results imply that institutional investors can be a driver of innovation among multinational firms.

5 Conclusion

We examine the effect of multinational firms' cross-border expansions on corporate innovation. Using a unique dataset on the timing of subsidiary establishment for a large sample of firms from 39 countries for the period of 1997–2014, we find that after expanding into a host foreign country, especially one with a high degree of innovativeness, a firm experiences a significant increase in its innovation output. We also find that after establishing foreign subsidiaries, firms cite more patents of the host countries, supporting the notion that such expansions allow multinational firms to acquire more technical knowledge from the host countries. To tackle endogeneity, we exploit a source of plausibly exogenous breakthrough inventions as a quasi-natural experiment and find that such technology shocks mainly benefit multinational firms with a subsidiary presence in the relevant host countries. Digging further into why multinational firms have greater innovation output after subsidiary establishment, we find that institutional investors can be a driver of firms absorbing knowledge spillovers from the foreign countries where they operate. In addition, acquiring more innovative firms from the host countries after expanding to such countries is another important facilitator of firm innovation. Overall, we provide novel evidence contributing to the debate on why multinational corporations tend to be highly innovative firms: they achieve significant agglomeration economies by efficiently exploiting the spatially concentrated knowledge capital around the world.

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Appendix A: Variable Definitions

Variables	Definition	Data Source
1. Innovation		
LPAT	Natural logarithm of one plus the total number of patents granted to each firm in each year, scaled by the mean number of patent applications filed in a year for technology classes to which the patent belongs.	Orbis Patent
LPAT_TECH_CLASS	Natural logarithm of one plus the number of patents in a technology class in a given year.	Orbis Patent
LCITE	Natural logarithm of one plus the total number of citations received by each firm's patents in each year, scaled by the mean citation count received by each patent in a year for technology classes to which the patent belongs.	Orbis Patent
2. Knowledge Acquisition		
LCITATIONS_PER_LOC	The natural logarithm of one plus the number of citations made by a firm to all patents of a country in a given year.	Orbis Patent
LCITATIONS_LOC_TECH_CLASS	The natural logarithm of one plus the number of citations made by a firm to all patents of each technology class of each country in a given year.	Orbis Patent
3. Foreign Expansion		
SUB	An indicator for whether a firm has established a foreign subsidiary by year t	Orbis and Osiris
LNSUB	The natural logarithm of one plus the number of foreign subsidiaries.	Orbis and Osiris
4. Firm-level Variables		
AGE	Natural logarithm of the number of years since the firm has its listed price.	Worldscope
HHI	Herfindahl index of 4-digit standard industrial classification (SIC) industry to which the firm belongs, measured at the end of the fiscal year.	Worldscope
HHISQ	Squared HHI.	Worldscope
RD	Research and development expenditures scaled by total assets, measured at the end of the fiscal year, set to zero if missing.	Worldscope
CAEX	Capital expenditures divided by total assets, measured at the end of the fiscal year.	Worldscope
PPE	Net properties, plants and equipment scaled by total assets, measured at the end of the fiscal year.	Worldscope
LEV	Ratio of total debt to total assets, measured at the end of the fiscal year.	Worldscope
ROA	Return on assets, defined as operating income before depreciation divided by total assets, measured at the end of the fiscal year.	Worldscope
SIZE	Natural logarithm of total assets.	Worldscope
TOBINQ	Growth opportunities, defined as market value of equity plus book value of assets minus book value of equity minus balance sheet deferred taxes, scaled by total assets, measured at the end of the fiscal year.	Worldscope
KZ	The KZ index measured at the end of fiscal year, calculated as –1.002 × Cash flow [(Income before extraordinary items + Depreciation and Amortization)/Lagged net property, plant and equipment] + 0.283 × Q [Market value of equity + book value of total assets – book value of equity – balance sheet deferred tax] + 3.139 × Leverage[Total debt/Total assets] – 39.368 × Dividends [(Preferred dividends + Common dividends)/Lagged net property, plant and equipment] – 3.315 × Cash holdings [(Cash and short-term investment)/(Lagged net property, plant and equipment)].	Worldscope

Appendix A: Variable Definitions (continued)

5. Country-level Variables		
RULE	The rule of law indicator of Kaufmann et al. (2011), which captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular, the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	Kaufmann, Kraay, and Mastruzzi (2011)
EXPORT	The ratio of a country's export to its GDP.	World Bank
IMPORT	The ratio of a country's import to its GDP.	World Bank
EQUITY	The ratio of a country's stock market capitalization to its GDP.	World Bank
CREDIT	The ratio of a country's bank credit to its GDP.	World Bank
GDPG	GDP growth rate	World Bank
6. Institutional Ownership		
DIO	Domestic institutional ownership, defined as the sum of shares owned by all institutions domiciled in the same country as where the stock is listed, as a percentage of the firm's total number of shares outstanding, set to zero if the stock is not held by any institution.	Thompson Reuters Global Ownership
FIO	Foreign institutional ownership, defined as the sum of shares owned by all institutions domiciled in a country different from where the stock is listed, as a percentage of the firm's total number of shares outstanding, set to zero if the stock is not held by any institution.	
TIO	Total institutional ownership, defined as the sum of shares owned by all institutions, as a percentage of the firm's total number of shares outstanding, set to zero if the stock is not held by any institution.	

Table 1: Summary Statistics

This table reports the sample statistics for the 1997–2014 period. Panel A reports firm innovation and foreign expansion variables by a home country. "Firms" is the number of firms. "Firm-years" is the number of firm-year observations. PAT is the total number of patent applications filed by each firm in each year. CITE is the total number of citations received by each firm's patents in each year. SUB is an indicator for whether a firm has a foreign subsidiary by a given year. NSUB is the number of foreign locations (foreign country in our sample where a firm has a subsidiary presence). Panel B contains the summary statistics of firm- and country-level variables. Details of variable definitions are in Appendix A.

Panel A: Firm Innovation and Foreign Expansion by Country

Country	Firms	Firm-years	PAT	CITE	SUB	NSUB
Argentina	20	221	0.000	0.000	0.769	1.715
Austria	51	464	0.892	0.702	0.989	10.228
Australia	544	5,157	0.328	0.511	0.801	2.796
Belgium	83	712	2.069	5.730	1.000	10.128
Brazil	34	285	0.000	0.000	0.926	3.509
Canada	429	2,837	0.780	1.028	0.866	2.352
Switzerland	165	1,801	0.560	1.008	0.967	13.218
Chile	34	378	0.000	0.000	0.836	2.146
China	808	5,685	10.616	11.837	0.276	0.467
Germany	418	3,834	18.477	29.137	0.980	9.103
Denmark	47	162	10.852	18.297	0.994	10.698
Egypt	12	78	0.000	0.000	0.923	3.987
Spain	90	799	0.140	0.114	0.930	7.758
Finland	55	203	25.680	48.251	1.000	10.478
France	450	4,125	5.442	9.261	0.973	10.544
United Kingdom	663	5,303	0.493	0.983	0.911	5.982
Greece	76	689	0.094	0.041	0.885	2.990
Hong Kong	84	1,044	0.011	0.012	0.915	3.059
Ireland	40	338	0.000	0.000	0.997	9.166
Israel	132	1,157	1.118	1.194	0.909	4.713
India	496	3,523	0.542	0.510	0.842	2.875
Italy	161	1,445	1.500	1.993	0.963	8.383
Japan	1,979	26,638	23.331	37.477	0.711	3.913
Korea	842	8,455	19.558	26.397	0.382	1.181
Sri Lanka	33	251	0.000	0.000	0.797	1.378
Mexico	48	643	0.078	0.040	0.798	2.370
Malaysia	338	3,620	0.002	0.000	0.806	1.706
Netherlands	106	944	28.917	40.245	0.987	13.207
Norway	145	1,240	0.675	0.611	0.952	6.903
New Zealand	64	526	0.842	1.335	0.875	2.762
Philippines	16	187	0.000	0.000	0.668	1.684
Poland	84	699	0.080	0.070	0.654	1.861
Russian Federation	41	139	0.072	0.000	0.928	5.101
Sweden	99	258	10.589	18.206	0.977	8.969
Singapore	306	3,083	0.923	1.099	0.857	2.491
Thailand	34	372	0.013	0.008	0.672	1.513
Turkey	94	1,083	1.222	1.342	0.631	1.765
United States	3,214	32,780	16.269	23.211	0.812	6.006
South Africa	111	1,299	0.044	0.046	0.828	3.219

Panel B: Summary Statistics								
Variable	N	Mean	STD	P5	P25	P50	P75	P95
LPAT	122,726	0.431	0.995	0.000	0.000	0.000	0.000	2.996
LCITE	122,726	0.363	1.048	0.000	0.000	0.000	0.000	3.215
SUB	122,726	0.764	0.425	0.000	1.000	1.000	1.000	1.000
LNSUB	122,726	1.215	0.994	0.000	0.693	1.099	1.946	3.091
AGE	122,726	1.985	0.809	0.000	1.609	2.079	2.565	2.996
HHI	122,726	0.439	0.319	0.066	0.172	0.337	0.660	1.000
HHISQ	122,726	0.294	0.356	0.004	0.030	0.114	0.435	1.000
RD	122,726	0.020	0.036	0.000	0.000	0.000	0.022	0.121
CAPEX	122,726	0.057	0.061	0.003	0.016	0.036	0.072	0.209
PPE	122,726	0.280	0.204	0.022	0.111	0.245	0.404	0.677
LEV	122,726	0.218	0.186	0.000	0.045	0.192	0.344	0.591
ROA	122,726	0.009	0.147	-0.356	0.004	0.040	0.081	0.177
SIZE	122,726	19.503	2.107	16.129	18.213	19.457	20.815	23.074
TOBINQ	122,726	1.674	1.219	0.659	0.937	1.225	1.877	4.792
KZ	122,726	-5.438	11.241	-38.444	-5.319	-1.235	0.410	2.247
RULE	122,726	1.170	0.594	-0.224	0.859	1.281	1.608	1.820
EXPORT	122,726	30.968	36.873	9.625	11.498	18.934	34.153	106.169
IMPORT	122,726	29.955	31.759	9.667	14.319	20.149	30.691	87.252
EQUITY	122,726	1.015	0.774	0.310	0.618	0.959	1.298	1.712
CREDIT	122,726	1.884	0.777	0.698	1.311	1.863	2.344	3.230
GDPG	122,726	10.155	0.950	7.808	10.093	10.504	10.699	10.848

Table 2: Foreign Expansion and Corporate Innovation

This table reports the regressions of firm innovation out on foreign expansion. The dependent variable is either the natural logarithm of one plus the number of patents (LPAT) or the natural logarithm of one plus the number of citations per patent (LCITE). The key variable of interest is foreign expansion, measured by either an indicator variable for whether the firm has established a foreign subsidiary by a given year (SUB) or the natural logarithm of one plus the number of its foreign locations (foreign country in our sample where a firm has a subsidiary presence) (LNSUB). All explanatory variables are lagged by one year relative to the dependent variable. Variable definitions are in Appendix A. The *t*-statistics based on standard errors clustered by firm are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	LPAT	LPAT	LPAT	LCITE	LCITE	LCITE	LPAT	LPAT	LPAT	LCITE	LCITE	LCITE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
SUB	0.043***	0.098***	0.091***	0.066***	0.129***	0.113***						
	(2.88)	(9.49)	(8.58)	(4.55)	(10.59)	(9.08)						
LNSUB							0.133***	0.049***	0.048***	0.149***	0.067***	0.056***
							(10.78)	(3.99)	(3.88)	(11.92)	(4.54)	(3.67)
AGE	0.01	0.036*	0.002	0.006	0.034	0.011	-0.001	0.042**	0.007	-0.007	0.041*	0.018
	(1.11)	(1.87)	(0.09)	(0.59)	(1.47)	(0.46)	(-0.14)	(2.14)	(0.36)	(-0.78)	(1.77)	(0.76)
HHI	0.028	-0.203**	-0.059	-0.002	-0.292**	-0.168	-0.008	-0.210**	-0.063	-0.04	-0.300***	-0.174
	(0.24)	(-2.19)	(-0.62)	(-0.02)	(-2.53)	(-1.44)	(-0.07)	(-2.25)	(-0.67)	(-0.35)	(-2.59)	(-1.49)
HHISQ	0.006	0.140*	0.028	0.033	0.212**	0.121	0.024	0.142**	0.03	0.051	0.216**	0.124
	(0.07)	(1.93)	(0.38)	(0.36)	(2.36)	(1.34)	(0.26)	(1.97)	(0.41)	(0.56)	(2.39)	(1.37)
RD	4.838***	0.135	0.174	4.810***	0.036	0.125	4.597***	0.128	0.167	4.549***	0.025	0.117
	(17.19)	(0.65)	(0.83)	(16.65)	(0.14)	(0.48)	(16.47)	(0.61)	(0.80)	(15.92)	(0.10)	(0.45)
CAPEX	0.571***	0.038	0.055	0.576***	0.044	0.058	0.599***	0.04	0.056	0.606***	0.047	0.06
	(7.53)	(0.97)	(1.41)	(7.32)	(0.90)	(1.19)	(7.94)	(1.02)	(1.45)	(7.76)	(0.96)	(1.23)
PPE	-0.05	0.052**	0.077***	-0.044	0.064**	0.092***	0.022	0.054**	0.079***	0.034	0.068**	0.096***
	(-1.42)	(2.36)	(3.48)	(-1.25)	(2.43)	(3.42)	(0.63)	(2.47)	(3.60)	(0.97)	(2.54)	(3.54)
LEV	-0.159***	-0.067***	-0.074***	-0.131***	-0.072***	-0.067**	-0.176***	-0.066***	-0.072***	-0.148***	-0.071***	-0.065**
	(-4.46)	(-3.02)	(-3.32)	(-3.72)	(-2.64)	(-2.42)	(-4.94)	(-2.96)	(-3.24)	(-4.23)	(-2.58)	(-2.33)
ROA	-0.269***	-0.015	0.02	-0.217***	-0.052**	-0.017	-0.264***	-0.015	0.02	-0.212***	-0.053**	-0.017
	(-6.13)	(-0.75)	(1.02)	(-4.81)	(-2.09)	(-0.69)	(-6.01)	(-0.77)	(1.02)	(-4.68)	(-2.09)	(-0.69)
SIZE	0.150***	0.024***	0.026***	0.141***	0.014**	0.016***	0.113***	0.023***	0.025***	0.101***	0.013**	0.015**
	(24.85)	(5.11)	(5.30)	(23.08)	(2.45)	(2.71)	(19.84)	(4.86)	(5.05)	(17.72)	(2.16)	(2.52)
TOBINQ	0.073***	0.009***	0.008**	0.070***	0.014***	0.014***	0.064***	0.010***	0.008**	0.060***	0.015***	0.014***

Table 2 (continued)

	(12.31)	(3.17)	(2.49)	(11.40)	(3.84)	(3.55)	(11.04)	(3.20)	(2.52)	(10.02)	(3.88)	(3.57)
KZ	0.000	0.000	0.000	0.000	0.000	-0.001*	-0.001**	0.000	0.000	-0.001**	0.000	-0.001*
	(-0.68)	(0.46)	(-0.73)	(-0.78)	(-0.90)	(-1.85)	(-2.25)	(0.42)	(-0.82)	(-2.48)	(-0.96)	(-1.93)
RULE	-0.008	0.083***		-0.001	0.080***		0.004	0.087***		0.011	0.086***	
	(-0.34)	(4.57)		(-0.04)	(3.45)		(0.17)	(4.79)		(0.42)	(3.70)	
EXPORT	0.007***	0.006***		0.009***	0.008***		0.007***	0.006***		0.009***	0.008***	
	(5.60)	(5.04)		(6.72)	(5.97)		(5.60)	(4.99)		(6.73)	(5.92)	
IMPORT	-0.004***	-0.003**		-0.007***	-0.006***		-0.003***	-0.003**		-0.007***	-0.006***	
	(-2.97)	(-2.22)		(-5.09)	(-4.11)		(-2.69)	(-2.20)		(-4.84)	(-4.08)	
EQUITY	-0.005	0.007*		0.020***	0.030***		-0.004	0.008**		0.020***	0.030***	
	(-1.02)	(1.86)		(4.07)	(6.68)		(-1.00)	(1.97)		(4.18)	(6.78)	
CREDIT	-0.053***	-0.054***		-0.033*	-0.030*		-0.054***	-0.056***		-0.034*	-0.033*	
	(-3.21)	(-3.84)		(-1.78)	(-1.76)		(-3.27)	(-4.00)		(-1.85)	(-1.93)	
GDPG	0.379***	0.396***		0.420***	0.454***		0.406***	0.404***		0.451***	0.465***	
	(16.39)	(18.71)		(16.45)	(18.71)		(17.25)	(18.97)		(17.32)	(18.97)	
Year fixed effects	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Firm fixed effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Industry fixed effects	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No
Home country fixed effects	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No
Home country×Year fixed effects	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
Adjusted R^2	0.249	0.758	0.766	0.201	0.640	0.646	0.256	0.757	0.766	0.209	0.640	0.646
Number of observations	122,726	122,726	122,721	122,726	122,726	122,721	122,726	122,726	122,721	122,726	122,726	122,721

Table 3: Foreign Expansion, Host Country Innovativeness, and Multinational Firm Innovation

This table reports the regressions of firm innovation on foreign expansion conditional on the innovativeness of the host country. A country-level measure of innovativeness is constructed based on four ratios: the total number of patents applied by all residents of a country in a year scaled by (1) total number of listed firms, (2) GDP, (3) total population, and (4) the residuals from a regression of total number of patents on total number of listed firms, GDP, and total population. A country is a high- or low-innovation country if its measure of innovativeness is above or below the median of all home countries of sample firms. The dependent variable is innovation, measured by the natural logarithm of either one plus the number of patents (LPAT) or one plus the number of citations per patent (LCITE). The key variables of interest are the alternative pairs of indicators for whether a firm has established a foreign subsidiary in a high-innovation country or a low-innovation country by a given year. All explanatory variables are lagged by one year relative to the dependent variable. Variable definitions are in Appendix A. The F-test tests the null that the subsidiary dummies for high- and low-innovation host countries are equal. The t-statistics based on standard errors clustered by firm are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Firm Fixed Effects

	LPAT	LPAT	LPAT	LPAT	LCITE	LCITE	LCITE	LCITE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SUB_HIGH_FIRM	0.126***				0.173***			
	(9.52)				(11.17)			
SUB_LOW_FIRM	0.079***				0.099***			
	(6.96)				(7.29)			
SUB_HIGH_GDP		0.156***				0.209***		
		(10.72)				(12.19)		
SUB_LOW_GDP		0.083***				0.108***		
		(7.62)				(8.45)		
SUB_HIGH_POP			0.134***				0.172***	
			(9.00)				(9.87)	
SUB_LOW_POP			0.082***				0.110***	
			(7.39)				(8.29)	
SUB_HIGH_RESID				0.112***				0.149***
				(8.89)				(10.23)
SUB_LOW_RESID				0.086***				0.112***
				(7.52)				(8.09)
F-test	18.27	45.71	16.17	6.65	30.53	65.61	16.53	9.64
p-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.758	0.758	0.758	0.758	0.640	0.641	0.640	0.640
Number of observations	122,726	122,726	122,726	122,726	122,726	122,726	122,726	122,726

Table 3 (continued)

Panel B: Industry and Country Fixed Effects								
	LPAT	LPAT	LPAT	LPAT	LCITE	LCITE	LCITE	LCITE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SUB_HIGH_FIRM	0.080***				0.112***			
	(4.79)				(6.79)			
SUB_LOW_FIRM	-0.012				0.000			
	(-0.76)				(0.00)			
SUB_HIGH_GDP		0.169***				0.208***		
		(8.55)				(10.53)		
SUB_LOW_GDP		-0.023				-0.007		
		(-1.54)				(-0.50)		
SUB_HIGH_POP			0.084***				0.113***	
			(4.90)				(6.65)	
SUB_LOW_POP			-0.007				0.01	
			(-0.48)				(0.68)	
SUB_HIGH_RESID				0.076***				0.101***
				(4.38)				(5.92)
SUB_LOW_RESID				-0.006				0.015
				(-0.41)				(1.00)
F-test	42.45	137.13	39.48	28.76	63.66	168.93	52.13	33.86
p-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Home country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.250	0.254	0.250	0.250	0.203	0.207	0.203	0.202
Number of observations	122,726	122,726	122,726	122,726	122,726	122,726	122,726	122,726

Table 4: Foreign Expansion and Knowledge Acquisitions—Firm Citations of Host-Country Patents

This table reports the results of a test for the relation between foreign expansion and knowledge spillovers. The dependent variable, LCITATION_PER_LOC, is the natural logarithm of one plus the number of citations made by a firm to all patents of a country in a given year. In Panel A, SUB is an indicator for whether a firm has established a subsidiary in a host country by a given year. In Panel B, SUB_GREENFIELD (SUB_M&A) is an indicator for whether the subsidiary is established as a greenfield investment (through M&A). The *t*-statistics based on clustered standard errors are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: All Types of Subsidiaries			
	LCITATIONS_PER_LOC		
	(1)	(2)	(3)
SUB	0.244***	0.139***	0.017***
	(78.18)	(16.53)	(3.31)
Types of fixed effects			
Year			
Firm × Year	Yes		
Firm × Year + Host × Year		Yes	
Firm × Year + Host × Year + Firm × Host			Yes
Adjusted R^2	0.486	0.549	0.758
Number of observations	1,873,709	1,873,709	1,873,709

Panel B: Greenfield versus M&A Subsidiaries			
	LCITATIONS_PER_LOC		
	(1)	(2)	(3)
SUB_GREENFIELD	0.066***	0.018***	0.013**
	(16.27)	(3.63)	(2.18)
SUB_M&A	0.107***	0.037***	0.024***
	(21.03)	(5.90)	(2.88)
Types of fixed effects			
Year			
Firm × Year	Yes		
Firm × Year + Host × Year		Yes	
Firm × Year + Host × Year + Firm × Host			Yes
Adjusted R^2	0.456	0.528	0.748
Number of observations	1,873,709	1,873,709	1,873,709

Table 5: Foreign Expansion, Technology Shock, and Firm Innovation

This table reports the regressions of innovation on technology shocks, used to identify the effect of subsidiary establishment on firm innovation, controlling for a variety of multi-dimensional fixed effects. A shock in a host country (breakthrough country) in a given year (breakthrough year) is a technology shock if inventors of that country have breakthrough patents in that year. A breakthrough patent is defined as the top 1% of patents in terms of subsequent patent citations for a technology class during the sample period. The dependent variable, LPAT_TECH_CLASS, is the natural logarithm of one plus the number of patents in a technology class in a given year. The independent variable, TECH_SHOCK, is an indicator for whether a firm is exposed to the technology shock. A firm is exposed to a technology shock if it has at least one subsidiary in the breakthrough country before the breakthrough year. The t-statistics based on clustered standard errors are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	LPAT_TECH_CLASS		
	(1)	(2)	(3)
TECH_SHOCK	0.013***	0.008***	0.006***
	(7.62)	(3.41)	(2.74)
Types of fixed effects			
Firm × Year + Firm × Tech_Class	Yes		
Firm × Year + Tech_Class × Year		Yes	
Firm × Year + Firm × Tech_Class + Tech_Class × Year			Yes
Adjusted R^2	0.589	0.217	0.599
Number of observations	1,852,902	1,852,830	1,852,830

Table 6: Foreign Expansion, Technology Shock, and Knowledge Acquisitions

This table presents an empirical test for whether firms acquire knowledge from host countries after establishing foreign subsidiaries, using a plausibly exogenous source of variation in host countries' innovativeness to identify the effect of foreign expansion on firm innovation. A shock in a host country (breakthrough country) in a given year (breakthrough year) is a technology shock if inventors of that country have breakthrough patents in that year. A breakthrough patent is defined as the top 1% of patents in terms of subsequent patent citations for a technology class during the sample period. The dependent variable, LCITATIONS_LOC_TECH_CLASS, is the natural logarithm of one plus the number of citations made by a firm to all patents of each technology class of each country in a given year. The independent variable, TECH_SHOCK, is an indicator for whether a firm is exposed to a technology shock. A firm is exposed to a technology shock if it has at least one subsidiary established in the breakthrough country before the breakthrough year. The t-statistics based on clustered standard errors are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	LCITATIONS_ LOC_TECH_CLASS		
	(1)	(2)	(3)
TECH_SHOCK	0.084***	0.082***	0.039***
	(9.05)	(8.02)	(4.15)
Types of fixed effects			
Firm × Year + Firm × Host	Yes		
Firm × Year + Firm × Host + Host × Year		Yes	
Firm × Year + Firm × Host + Host × Year + Host × Tech_Class			Yes
Adjusted R^2	0.259	0.285	0.351
Number of observations	8,849,032	8,848,816	8,848,816

Table 7: Foreign Expansion and Acquisitions

This table reports the cross-section regressions of foreign expansion on acquisition activities during the next periods of one (t+1), three ((t+1)–(t+3)), and five years ((t+1)–(t+5)) following the expansion year (year t). In Panel A, the dependent variable, in columns (1)–(3), is a dummy variable (ACQUI) equal to one if the firm acquires at least one other firm from another country and zero otherwise. In columns (4)–(6), the dependent variable (NACQUI) corresponds to the natural logarithm of one plus the number of acquired firms from a country. SUB is an indicator for whether a firm has established a subsidiary in a host country by a year t. In Panel B, the dependent variable (TARG_LPAT), in columns (1)–(3), is the natural logarithm of one plus the accumulated number of patents of all target firms from a country acquired up to the year in which they are acquired. In columns (4)-(6), the dependent variable (TARG_LCITE) corresponds to the natural logarithm of one plus the accumulated number of citations of all target firms from a country acquired up to the year in which they are acquired. The robust t-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively

Panel A: Foreign Expansion and Acquisitions

	ACQUI			NACQUI		
	(1)	(2)	(3)	(4)	(5)	(6)
	(t+1)	(t+1)–(t+3)	(t+1)–(t+5)	(t+1)	(t+1)–(t+3)	(t+1)–(t+5)
SUB	0.033***	0.080***	0.115***	0.025***	0.067***	0.100***
	(11.88)	(14.65)	(19.08)	(11.49)	(13.87)	(17.93)
Average R^2	0.028	0.069	0.097	0.026	0.061	0.084
Number of observations	9,555,175	8,003,335	6,517,462	9,555,175	8,003,335	6,517,462

Panel B: Foreign Expansion and Acquisition Innovativeness

	TARG_LPAT			TARG_LCITE		
	(1)	(2)	(3)	(4)	(5)	(6)
	(1)	(2)	(3)	(4)	(5)	(6)
	(t+1)	(t+1)–(t+3)	(t+1)–(t+5)	(t+1)	(t+1)–(t+3)	(t+1)–(t+5)
SUB	0.0007***	0.0021***	0.0035***	0.0006***	0.0017***	0.0028***
	(9.28)	(11.80)	(16.32)	(7.21)	(8.24)	(9.85)
Average R^2	0.001	0.001	0.001	0.001	0.001	0.001
Number of observations	9,555,175	8,003,335	6,517,462	9,555,175	8,003,335	6,517,462

Table 8: Foreign Expansion, Institutional Ownership, and Firm Innovation

Panel A reports the regressions of institutional ownership on foreign expansion. TIO, DIO, and FIO are total, domestic, and foreign institutional ownership, respectively. NSUB is the natural logarithm of one plus the number of foreign subsidiaries. Panel B reports the regressions of firm innovation on foreign expansion conditional on levels of institutional ownership. All explanatory variables are lagged by one year relative to the dependent variable. The *t*-statistics based on standard errors clustered by firm are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Foreign Expansion and Institutional Ownership

	(1)	(2)	(3)
	TIO	DIO	FIO
NSUB	0.016***	0.014***	0.002*
	(5.43)	(4.99)	(1.91)
AGE	0.032***	0.038***	-0.006***
	(6.79)	(8.34)	(-3.49)
HHI	0.039*	0.032	0.007
	(1.91)	(1.64)	(0.96)
HHISQ	-0.014	-0.013	-0.001
	(-0.88)	(-0.87)	(-0.18)
RD	-0.131***	-0.136***	0.005
	(-3.14)	(-3.35)	-0.43
CAPEX	-0.009	-0.016**	0.006*
	(-1.07)	(-1.98)	(1.72)
PPE	-0.013**	-0.010*	-0.003
	(-2.06)	(-1.70)	(-1.37)
LEV	-0.037***	-0.026***	-0.011***
	(-6.63)	(-4.97)	(-5.96)
ROA	0.038***	0.041***	-0.003*
	(7.04)	(7.83)	(-1.77)
SIZE	0.033***	0.024***	0.009***
	(21.67)	(16.64)	(17.98)
TOBINQ	0.011***	0.010***	0.002***
	(15.02)	(13.38)	(6.59)
KZ	-0.000**	0.000	-0.000***
	(-2.18)	(-1.20)	(-3.13)
RULE	-0.000**	-0.000**	0.000
	(-2.44)	(-2.57)	(-0.77)
EXPORTS	-0.001***	-0.001***	0.000***
	(-3.88)	(-6.57)	(3.76)
IMPORTS	0.001***	0.001***	-0.000**
	(6.30)	(7.99)	(-2.04)
EQUITY	-0.018***	-0.015***	-0.003***
	(-15.81)	(-16.36)	(-5.92)
CREDIT	0.002	-0.010***	0.012***
	(0.81)	(-3.88)	(6.65)
GDPG	-0.003***	-0.003***	0.000
	(-14.74)	(-20.71)	(0.28)
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Adjusted R^2	0.899	0.907	0.707
Number of observations	122,726	122,726	122,726

Table 8 (continued)

Panel B: Foreign Expansion, Institutional Ownership, and Firm Innovation		
	(1)	(2)
	LPAT	LCITE
SUB_HIGH_TIO	0.131***	0.168***
	(8.40)	(9.96)
SUB_LOW_TIO	0.097***	0.126***
	(7.79)	(7.87)
AGE	0.072***	0.078***
	(3.60)	(3.27)
HHI	-0.336***	-0.439***
	(-3.59)	(-3.77)
HHISQ	0.197***	0.276***
	(2.70)	(3.04)
RD	0.234	0.140
	(1.10)	(0.52)
CAPEX	-0.015	-0.019
	(-0.37)	(-0.38)
PPE	0.035	0.043
	(1.57)	(1.58)
LEV	-0.075***	-0.078***
	(-3.31)	(-2.78)
ROA	-0.044**	-0.089***
	(-2.25)	(-3.48)
ASSETS	0.046***	0.039***
	(9.56)	(6.78)
TOBINQ	0.019***	0.026***
	(6.38)	(6.70)
KZ	0.000	0.000
	(0.81)	(-0.58)
RULE	0.003***	0.004***
	(3.35)	(3.75)
EXPORTS	0.003**	0.004***
	(2.26)	(3.32)
IMPORTS	-0.003**	-0.006***
	(-2.37)	(-4.41)
EQUITY	0.041***	0.064***
	(9.47)	(12.79)
CREDIT	-0.077***	-0.047**
	(-5.25)	(-2.56)
GDPG	-0.012***	-0.009***
	(-13.07)	(-7.84)
F-test (SUB_HIGH_TIO = SUB_HIGH_TIO)	3.48 (p=0.06)	3.83 (p=0.05)
Adjusted R^2	0.755	0.637
Number of observations	122,726	122,726