Track 4: FDI in and from Emerging Market Economies
Competitive Session

RELATIONSHIP BETWEEN INTERNATIONALIZATION AND INNOVATION IN EMERGING ECONOMY FIRMS

ABSTRACT

Emerging economy multinationals (EMNEs) are increasingly internationalizing their operations as well as moving away from imitation towards innovation. We study the impact of internationalization on innovation in the context of EMNEs. Specifically, we propose a curvilinear relationship between outward foreign direct investment and patenting activity of these emerging economy firms. Data on Indian biopharmaceutical firms from 1997 to 2013 is used to empirically test our hypotheses. Our sample consists of all biopharmaceutical firms that have previously established at least one foreign subsidiary and patented with either the Indian Patent Office or the United States Patent and Trademark Office (USPTO). Controlling for firm specific characteristics such as firm age, size and R&D intensity, we find that innovation decreases in the initial stages of internationalization. However with increased internationalization, the impact of international expansion on innovation becomes positive. In the third and final stage of internationalization, the costs of international expansion outweigh the benefits and the impact on innovation becomes negative. We contribute to the literature on EMNEs which has primarily focused on the internationalization of these firms. As these firms begin to innovate, it is important to study the impact of internationalization on their ability to innovate.

INTRODUCTION

As emerging economies (EEs) adopted pro-market reforms in the 1980s and 1990s, a new breed of multinationals arose. Despite facing high levels of corruption, weak intellectual property rights regimes, underdeveloped capital markets and/or institutional voids at home (Khanna & Palepu, 2006; Cuervo-Cazurra, 2012; Luo & Tung, 2007), these emerging multinational enterprises (EMNEs) grew through increased international expansion and innovation. Outward foreign direct investments (OFDI) from emerging economies increased from less than 1 percent in 1970s to 27.6 percent in 2010 (Aharoni, 2014), underpinning the increasing internationalization of EMNEs. Nearly sixty percent of this OFDI went to other developing countries primarily in the form of greenfield investments (World Bank, 2011). EMNEs are also improving their organizational capabilities and gradually moving towards innovation rather than imitation to drive future growth (Amann & Cantwell, 2012; Luo, Sun & Wang, 2011; Govindarajan & Ramamurti, 2011).

Internationalization and innovation are two strategies for growth (Lecerf, 2012) that are especially important for new entrants from emerging economies hoping to compete with developed country firms. While there is an extensive body of literature on internationalization of EMNEs (Buckley & Hashai, 2013; Cuervo Cazurra & Genc, 2008; Luo & Tung, 2007; Ramamurti & Singh, 2009) and a nascent stream of research on innovation by these firms (Awate, et al., 2012; Govindarajan & Ramamurti, 2011), no prior research has looked at the impact of international expansion on innovation for EMNEs. The relationship between internationalization and innovation warrants further study as these two strategies are interdependent. We posit that internationalization and innovation can be complementary (Golovko & Valentini, 2001) or competing growth strategies (Kumar, 2009) depending on the level of internationalization.

In this paper, we investigate the impact of the degree of internationalization on innovation for EMNEs. We propose that the relationship between internationalization and innovation is not simply linear, i.e., a higher degree of internationalization does not always lead to more innovation. Instead, our findings

suggest that the internationalization-innovation relationship is horizontal S-shaped that is divided into three stages based on the degree of internationalization. The impact of internationalization on innovation differs in each of these three stages due to the differences in motives and the resulting differences in strategies adopted. Figure 1 shows the horizontal S-shaped internationalization-innovation curve.

INSERT FIGURE 1 HERE

We posit that at low levels of internationalization, EMNEs are exploiting their existing capabilities and resources by expanding to other emerging economies. The impact of internationalization on the level of innovation is negative as scarce resources are diverted away from research and development (R&D) towards the establishment of foreign subsidiaries. In the second stage when firms are at medium levels of internationalization, the motives for international expansion shift from exploitation to exploration as EMNEs begin to expand to developed countries in search of new markets, resources, and capabilities. As these firms tap into the innovation systems of developed countries, the impact of internationalization on innovation becomes positive. Interestingly, this relationship does not continue to be positive at high levels of internationalization. As EMNEs expand further and incur increasing transaction and coordination costs, internationalization has a negative impact on the level of innovation in the third stage.

We examine the proposed horizontal S-shaped curvilinear relationship in the context of the Indian EMNEs from the biopharmaceutical industry. India is a fast growing emerging country that adopted pro-market changes in 1990s. The timeframe for our data is from 1997 to 2013 which enables us to captures the starting point of post reform internationalization and innovation activity in this industry. We measure degree of internationalization as the total number of subsidiaries after taking in to consideration new additions and divestments in a given year. Innovation is measured by number of patent applications that are approved by United States Patent and Trademark Office (USPTO) in a year. Our longitudinal dataset comprises 64 EMNEs with 651 foreign subsidiaries and 786 patents filed with the USPTO.

The biopharmaceutical industry in India is an interesting and relevant context to study the internationalization-innovation relationship. Innovation is a core competence in the biopharmaceutical industry and the industry in India has a good mix of domestic and foreign multinationals. The Indian biopharmaceutical firms are gradually moving away from selling generic drugs, which are simply low-cost imitations to now developing new drugs. The firms in the industry are also at different stages of internationalization and this enables us to study the curvilinear relationship in its entirety.

Our paper contributes to the literature in several ways. First, by testing a horizontal S- shaped curvilinear relationship, this paper contributes to the scant prior work on internationalization and innovation which has only looked at a linear and positive relationship between the two constructs (Hitt, et al., 1997; Kafouros, et al., 2008). We find that the relationship is curvilinear and the impact of internationalization on innovation changes can be positive or negative depending on the level of internationalization. Second, by using OFDI as a measure of internationalization instead of the more commonly used measure of exporting, the paper provides a better measure for the impact of internationalization on innovation. Exporting does not necessarily lead to knowledge spillovers, which is the mechanism to stimulate innovation. By using OFDI we expect the effects on innovation to be stronger due to potential for learning from the host country.

Finally, our paper contributes to the literature on emerging economies and MNEs from these countries. Most of the current research on EMNEs focuses on their internationalization activities however only a handful of papers examine their innovation activities (Govindarajan & Ramamurti, 2011; Luo, et al., 2011). These papers on innovation by EMNEs are either conceptual or case study based (Awate et al., 2012; Brandl & Mudambi, 2014; Child & Rodrigues, 2005). After discovery and preliminary investigation of a new phenomenon, a quantitative study that looks at the whole industry over a longer period of time is the necessary and important step for the research stream to mature. In this paper we use a longitudinal panel of 16 years to study innovation activities of EMNEs in Indian biopharmaceutical industry.

This paper is organized as follows. In the next section, we discuss the background literature on the internationalization-innovation relationship. We develop testable hypotheses drawing from the literature on emerging economies and MNEs from these countries. The third section sets the background for our empirical analysis by briefly discussing the Indian economy and biopharmaceutical MNEs in this country. The fourth section describes our sample and our research methodology. The fifth section discusses our results from the econometric analysis, and the sixth section concludes the paper.

THE RELATIONSHIP BETWEEN INTERNATIONALIZATION AND INNOVATION

In the international business literature, the relationship between the degree of internationalization and performance has been well documented (Contractor, et al., 2003). However, relatively little research has been done on the relationship between internationalization and innovation (See exception: Penner-Hahn & Shaver, 2004). Prior research on the relationship between degree of internationalization and innovation has examined the correlation between these two constructs. According to Golovko and Valentini (2001), internationalization and innovation are complementary growth strategies that jointly have a positive impact on firm performance. Alternatively, Kumar (2009) and Roper and Kumar (2002) find a negative correlation between internationalization and innovation in their results suggesting that there is a trade-off between the two growth strategies. Despite the seemingly disparate results of past work, there is a general consensus among researchers that internationalization and innovation impact each other (Lecerf, 2012).

Researchers have also looked at the causality between these two constructs with arguments made in both directions. On one hand, researchers find that innovation leads to internationalization as firms need to seek new markets to sell their innovations and thus cover their R&D expenditures (Basile, 2001; Cassiman & Golovko, 2011; Filatotchev & Piesse, 2009; Roper and Love, 2002). On the other hand, there is plenty of evidence suggesting the opposite – internationalization impacts innovation as firms gain access to new resources and capabilities in foreign locations (Griffith et al., 2006; Hitt et al., 1997; Kafouros, et al., 2008; Solomon and Shaver, 2005). Damijian, Kostevc and Polonec (2010) tested the causal

relationship between degree of internationalization, measured by level of exporting activity, and innovation. They found significant support for the impact of internationalization on innovation however they had no significant results for the reverse direction of this relationship. In this research we adopt the later view by positing that internationalization impacts innovation especially for EMNEs. However the relationship can be complementary or supplementary depending on the level of internationalization.

Firms have two broad motivations to internationalize, exploitation and exploration driven expansion, and this influences the impact on innovation. Exploitation related activities use a firm's existing knowledge and resource base while exploration related activities refer to the acquisition of new knowledge to innovate (Gupta et al., 2006). Firms often switch between exploration and exploitation to manage their R&D portfolios (Mudambi & Swift, 2014). The scale, location and type of international expansion pursued by a firm depends on its decision to explore or exploit resources (Barkeman & Drogendijk, 2007). As discussed in the following subsection, EMNEs engage in exploitation initially, followed by exploration driven internationalization.

Internationalization and Innovation by EMNEs

According to the traditional internationalization theories (Dunning, 1988; Hymer, 1976; Zaheer, 1995), which were formulated in the context of developed country multinationals, firm specific (ownership) advantages (FSA) are necessary for firms to internationalize and overcome liabilities of foreignness (Rugman, 1981). These advantages are mostly intangible assets such as propriety technology or brand name. Today, international business scholars debate on whether EMNEs possess FSAs, also known as O-advantages (Dunning, 1988). On one hand, researchers argue that these firms lack FSAs (Madhok & Keyani, 2012; Rugman, 2009) and as a result their internationalization is primarily resource or asset seeking (Bruche, 2009). On the other hand, recent research has shown that EMNEs possess a few unique FSAs which are not like the traditional ones possessed by firms from developed countries (Lessard, 2014; Ramamurti, 2012). Examples of these non-traditional FSAs include low cost innovations (Williamson & Zeng, 2009), imitation and product adaptations to meet needs of other emerging markets

(Govindarajan & Trimble, 2012; Ramamurti & Singh, 2009), and the ability to deal with weak institutions (Morck, Yeung, & Zhao, 2008).

In this research we adopt a middle approach by positing that initially EMNEs do possess a few unique non-traditional FSAs which they use to internationalize first to other EEs but they also seek to further build their FSAs by venturing into developed countries.

EMNEs are latecomers in international expansion, and they are also slow to innovate. Due to hurdles faced at home, such as weak intellectual property protection regime, inadequate capital markets and lack of sophisticated consumer base, EMNEs begin by imitating products produced by developed country firms before graduating to incremental innovations (Govindarajan, & Trimble, 2009). According to Luo, Sun & Wang (2011), EMNEs tend to first engage in duplicative imitation by reverse engineering existing technologies or designs created by developed country multinationals. Next, duplicative imitation gives way to creative imitation which is often a mix of imitation and process innovation to create low cost versions of existing products. Creative imitation is a type of incremental innovation often achieved by: disrupting business models to reduce costs; modifying organizational capabilities to make the best of available resources; or creating or sourcing new capabilities by leveraging external capabilities to reduce operational costs (Prahalad & Mashelkar, 2010). As EMNEs gain more experience in innovation related activities they gradually move to more novel innovations.

To summarize, studying the impact of internationalization on innovation in the context of EMNEs is interesting as these firms have only recently began to use the two growth strategies. Problems with reverse causality are reduced as we study the early stages of internationalization and innovation. Next, we discuss the three stages of internationalization for EMNEs.

Three Stages of Internationalization

Stage I of Internationalization

In the early stages of international expansion, EMNEs only have a few non-traditional FSAs (Cuervo Cazurra, 2012), mostly in the form of low cost imitation products (Lou et al., 2011) and the ability

to navigate institutional voids in other EEs with similar institutional environments (Cuervo Cazurra & Genc, 2008; Khanna & Palepu, 2006). These firms tend to internationalize to other similar emerging markets (Khanna & Palepu, 2006; Luo & Tung, 2007) which are closer to them in psychic distance and have less sophisticated customers (Hobday, 2010). At this stage, location choices are driven by the ability of EMNEs to exploit their current FSAs. Since the motivation behind early internalization is exploitation, foreign subsidiaries are primarily focused on either manufacturing or sales.

Due to their focus on exploitation of current FSAs in other emerging markets, we posit that the EMNEs will not see an increase in innovation at this stage of internationalization. EMNEs are not engaged in exploration related activities and other EEs do not possess location specific advantages (CSAs) that are conducive to innovation (Dunning, 1988; Makino, Isobe & Chan, 2004). Many of the advantages of internationalization arise from the ability to access new resources and capabilities in the host country, which can positively impact innovation. However, by entering similar markets, EMNEs are sacrificing long term profitability through innovation for short term profits through sales of current products.

Not only does internationalization to other EEs fail to stimulate new innovation, it could lead to a decline in current innovation related activities. The relationship between internationalization and innovation is supplementary at this stage due to limited resources that need to be diverted towards FDI instead of R&D projects. As has been observed by prior research (Cuervo-Cazurra, 2012), resource constraints is one of the key obstacles faced by EMNEs. When resources are scarce, internationalization and innovation are two alternate growth strategies and focusing on one will divert resources away from the other (Kumar, 2009; Roper and Love, 2002). When internationalizing, the firm may cut down on its research activities which leads to an overall decrease in innovation.

Thus, based on our above arguments, we hypothesize:

Hypothesis 1. Other things equal, the relationship between internationalization and innovation is negative at low levels of internationalization.

Stage II of Internationalization

As EMNEs gain experience in other emerging countries, they begin to change their internationalization strategy in terms of their location choices as well as the types of activities internationalized. The change in internationalization strategy is driven by a shift in their motive from exploitation to exploration. According to Mudambi and Swift (2014), firms transition between exploration and exploitation activities to improve their performance. At medium levels of internationalization, EMNEs exhaust their non-traditional FSAs in other emerging economies. These firms now seek to generate new FSAs through exploration by entering technologically advanced developed countries (Chittoor et al., 2009).

With greater international experience, the role of subsidiaries in EMNEs also evolves from engaging in just manufacturing or marketing to include more complex R&D activities. The drivers for EMNEs at this stage of internationalization are broadly summarized as being asset seeking and opportunity seeking (Luo & Tung, 2007). One of their primary drivers behind internationalization is to build their capabilities instead of using their existing advantages (Mathews, 2002; Luo & Tung, 2007).

In the first stage EMNEs used imitation to build their FSAs but in the second stage they engage in incremental innovation using host country advantages. Thus in the second stage of internationalization the relationship between internationalization and innovation becomes complementary. Innovation is a knowledge and information intensive activity (Nonaka & Takeuchi, 1995) and R&D internationalization to developed countries enables EMNEs to access information from different sources. One mechanism by which EMNEs gain access to technology assets available abroad is by learning from spillovers that occur when these firms operate in clusters with other innovating firms in international locations (Kummerle, 1999; Wessson, 2004). Competition with global giants in similar technological and geographical space can also encourage innovation by EMNEs (Frost, 2001; Wesson, 2004).

As firms move away from competence exploitation towards competence creation they are better able to leverage the resources available in the developed countries (Cantwell & Mudambi, 2011; Kobrin,

1991). Better access to developed country resources such as highly skilled labor, foreign universities, and alliances with foreign firms, more stringent IP regimes, and catering to sophisticated consumers further enables EMNEs to upgrade their capabilities (Kotabe, 1990; Kafouros et al., 2008; Santos et al., 2004). According to Hitt et al. (1997), greater international diversification gives firms incentives and resources for innovation in addition to also gaining greater returns from innovation. R&D internationalization leads to a positive impact on the EMNEs' innovative capabilities.

Thus, the positive gains for innovation cannot be observed till the EMNEs internationalize to developed countries for exploration and the role of foreign subsidiaries evolve from marketing and manufacturing to more core activities such as R&D. These two conditions begin to occur at medium levels of internationalization. The arguments presented above suggest the following hypothesis.

Hypothesis 2. Other things equal, the relationship between internationalization and innovation is positive at medium levels of internationalization.

Stage III of Internationalization

At the highest level of internationalization, EMNEs have created a portfolio of foreign subsidiaries that are located in both emerging and developed countries. As EMNEs begin to move towards the networked MNE model, the headquarters becomes the integrator of knowledge flows from different and diverse subsidiaries (Mudambi & Navarra, 2004). Subsidiaries are engaged in exploration and exploitation activities. FSAs are created primarily in developed country subsidiaries which are then exploited in other developed and emerging countries. Because EMNEs have only recently forayed in to international expansion, we expect only a few firms to be at this stage of high levels of internationalization.

At this stage EMNEs continue to engage in incremental innovation but also begin to engage in radical innovation related activities. While the relationship between internationalization and innovation continues to be complementary at this stage, the added coordination costs may have a negative impact on innovation performance due to two factors. First, as is the case with highly networked firms, the subsidiaries could be simultaneously working on the same R&D project (Zhao, 2006). Greater

interdependence leads to an increase in inter-firm transactions which is accompanied by greater transaction and coordination costs (Lu & Beamish, 2004). Information asymmetry and cultural differences between the R&D teams can lead to a slowing down of the innovation process. Second, as the subsidiaries depend on other subsidiaries within the MNE network, their connections with the host country firms decreases. This can decrease the EMNE's ability to benefit from host country advantages.

Thus, there is a threshold beyond which the firm overextends its foreign operations and the drawbacks from internationalization outweigh the benefits (Contractor et al., 2003). In this case, over-internationalization has a negative impact on innovation performance. Accordingly, we hypothesize:

Hypothesis 3. Other things equal, the relationship between internationalization and innovation is negative at high levels of internationalization.

RESEARCH SETTING

The Indian biopharmaceutical industry has undergone many changes in the past few decades. The introduction of the Indian Patent Act in 1970, which allowed firms to patent manufacturing processes rather than end products, had a twofold effect on the domestic pharmaceutical industry. On one hand, it drove foreign MNEs from developed countries, who were concerned about the weak intellectual property protection, out of the country thus decreasing domestic competition. On the other hand, the policy change legalized reverse engineering of R&D which allowed Indian firms to imitate and develop generics drugs (Kale, 2012; Nair, 2008). As a result of minimal patent protection and other incentives to domestic firms, the Indian pharmaceutical industry grew in the 1970s and 1980s.

However pro market reforms of early 1990s and the adoption of the Trade Related Aspects of Intellectual Property Rights (TRIPs) in 1995, changed the playing field for firms in the Indian pharmaceutical industry. The new patent laws came into effect in 2005, ten years after the signing of TRIPs agreement. Improvement in patent protection is supposed to encourage innovation by firms (Levin, 1987; Prasad, 1999). In addition to patent reforms, 100% inward FDI in the pharmaceutical industry has been recently approved and licensing restrictions have been relaxed by the Indian government. As a result,

foreign MNEs that had exited the country in 1970 returned after the reforms, creating greater competition for the Indian firms (Chaudhari, 2011). Changes in patent laws and increased domestic competition forced many of the Indian pharmaceutical firms to internationalize their activities in search of newer markets as well as to ramp up their R&D activities to reduce dependence on imitation based products.

Thus, the Indian biopharmaceutical firms are now evolving from imitating products from developed countries and producing cheap generics to actively engaging in innovation of new drugs. In addition to having a strong presence in the generic segment, firms in this industry are gradually moving into mainstream drug discovery and development, Today, the biopharmaceutical industry is one of the key contributors to India's growth (Chittoor & Ray, 2007). The industry is made up of many EMNEs with firms that have a presence in both developing and developed countries. According to Chittoor et al. (2009), in 2005 nearly half the Indian EMNEs in the pharmaceutical industry had fifty percent or more of their total sales coming from foreign countries.

The Indian biopharmaceutical industry is ranked third largest in volume and 10th largest in value worldwide (IBEF, 2014). During 2013-14, pharma exports from India were US$ 14.55 billion out of which, the share of new formulations was 71 per cent (PEPC, 2014). The Indian pharmaceutical firms show increasing trends in R&D spending both in absolute terms (approximately Rs. 7 billion) and as a percentage of revenues – R&D intensity (8-11 percent) (ICRA, 2014). While the R&D intensity of Indian firms was about 2 percent in 2000 it had shown a steady increase to about 9 percent by 2011 (Joseph, 2011). In comparison, the R&D intensity of biopharmaceutical firms from developed countries is about 18 percent (Gassmann, et al., 2004). Indian firms are also moving from traditional drug segments to more complex therapy segments like injectables, inhalers, dermatology, controlled-release substances and even biosimilars (ICRA, 2014). Despite this, firms are still struggling to reach the forefront of innovating new drugs due to the high R&D investments and lack of innovative capabilities in this technology intensive sector (Joseph, 2011).

We believe that the Indian biopharmaceutical industry is an ideal research setting to study the relationship between internationalization and innovation. As a result of a natural experiment stemming from the institutional changes in the home countries, Indian biopharmaceutical firms have been forced out of their protective environment to internationalize and innovate in order to survive and compete in the global economy.

METHODOLOGY

Data

Our empirical analysis is based on data from the Prowess Database published by Center for Monitoring Indian Economy (CMIE). The Prowess database, categorized according to the National Industrial Classification, contains data on over 600 foreign and domestic firms in the Indian biopharmaceutical industry. To be included in our sample, a firm had to: 1) be an biopharmaceutical firm, with headquarters in India, engaged in drug discovery and development, and 2) have at least one foreign subsidiary during our sample time period. Most of the firms in our sample have at least one patent with either the Indian Patent Office (IPO) or the United States Patent and Trademark Office (USPTO). Our resulting sample contains detailed firm level data on sixty-four biopharmaceutical firms for the time period 1997-2013. There are 6 biotech firms and 58 pharmaceutical firms in our sample. We do not include those firms which only have exporting activities or minority joint ventures. We also exclude state-owned enterprises. Firms in our study are either niche entrepreneurs focusing on select geographic locations or world-stage aspirants which have a more diversified geographic presence (Luo & Tung, 2007). Our final sample of EMNEs have a total of 651 foreign subsidiaries and 786 patents filed with the USPTO. Data on patenting activities of these firms was collected from USPTO. We also collected additional information on subsidiaries and R&D locations from annual reports of the firms.

Measures

We provide the measurement for dependent, independent and control variables in the following subsections.

Dependent Variable. The focus of our analysis is on innovation activity by a firm. The dependent variable (INNOV), used to measure innovation is patent count. Patents are considered the output of R&D process and patent application is a well-established measure of new innovations (Griliches, 1990; Acs, et al., 2002). Although one of the potential concerns with the use of patents as a measures of innovative activity by firms is that patents do not capture all new innovations, we believe that patents are good indicators of innovation especially in biopharmaceutical industry. Firms in this industry generally adopt an aggressive patenting strategy (Henderson & Cockburn, 1994; Penner-Hahn & Shaver, 2005) and the average propensity to patent new innovations is nearly 80 percent in many firms (Arundel & Kabla, 1998).

We include both product and process patents in our count. Data from USPTO is used instead of the Indian Patent Office to measure innovation in Indian firms. The Indian Patent Office (IPO) did not receive many patent applications prior to the TRIPS agreement in 2005 and we wanted to avoid an artificial inflation in our data in the more recent years. Also, India did not recognize process patents prior to 2005 (Chadha, 2009) therefore patents from USPTO is a better measure for Indian EMNEs.

Independent Variable. Our independent variable is the degree of internationalization (INT). This construct is measured by the ratio of foreign subsidiaries to total subsidiaries. FDI has been used as a measure of internationalization by a number of previous studies (Lu & Beamish, 2001; Ramaswamy, 1995). Many of the classic works on internationalization (Vernon, 1971) have also used the number of subsidiaries as a measure. We use subsidiaries which is a measure of OFDI activity in our research because it involves higher risks as well as higher potential for knowledge spillovers when compared to exporting.

Data for this variable was collected from the Prowess database. Since the Prowess data was unbalanced for this variable we also did a thorough search of annual reports for all firms in our sample. This variable was lagged by one, three and five years. Since the signs and strength of the coefficients did not change with the lags we only report the regression results with three years lag variables. As we test a curvilinear relationship we also created second (INTSQ) and third order (INTCUBE) terms for internationalization.

Controls. Several firm level variables, from Prowess database, were included in the model to control for firm specific characteristics. First, we control for firm age (AGE) which is measured by the total years from incorporation to the year in the data. It has been argued that firms can be early or late to internationalize and the age at which they internationalize influences the level of capabilities and resources they possess (Sapienza, et al., 2006). Thus, we expect firm age to influence the ability to innovate. On one hand, younger firms may lack the firm specific advantages to innovate but on the other hand, older firms may have problems with organizational inertia that can influence their ability to innovate. Second, we control for firms size as prior studies have found it to be positively related to innovation (Audretsch & Acs, 1991; Damanpour, 1992). Firm size (SIZE) was measured by the total number of employees. We took natural log for firm size. Third, we include R&D intensity (RD), measured by total R&D expenditure over total sales, in our model. Firms that spend a greater portion of their sales revenue on R&D are more likely to have a higher propensity to patent their innovations (Arundel & Kabla, 1998). Fourth, we distinguish between biotechnology and pharmaceutical firms with a dummy variable (BIO), taking the value 1 if a biotech firm. Prior research has found significant differences in the innovation related activities of these two types of firms in terms of the breadth and depth of their R&D pipelines as well as their propensity to patent their innovations (Diestre & Rajagopalan, 2012). Prior firm performance, measured by Tobin's Q, was also initially included in the model but later dropped due to multicollinearity. All firm level control variables was lagged by a year. Finally we also include firm and year dummy variables in our model (Zhao, 2006).

Model

The basic regression model used in this analysis is as follows:

$$E(\gamma_{it}) = exp(\beta_0 + \beta_1 INT_{i(t-3)} + \beta_2 INT^2_{i(t-3)} + \beta_3 INT^3_{i(t-3)} + \beta_{4-7} Controls_{i(t-1)} + \mu + \tau_i + \epsilon_{it})$$

Where,

Y_{it} = Innovation for firm i in time period t (INNOVATE)

$\beta_1 INT_{i(t-3)}$ = Internationalization for firm i in time period t with three year lag (INT)

$\beta_2 INT^2_{i(t-3)}$ = Square term for internationalization for firm i in time period t with three year lag (INTSQ)

$\beta_3 INT^3_{i(t-3)}$ = Cube term for internationalization for firm i in time period t with three year lag (INTCUBE)

$\beta_{4\text{-}7} Controls_{i(t-1)}$ = Time variant firm level controls for firm i in time period t with one year lag

μ = Time invariant firm fixed effects (dummies)

τ_i = Year dummies

ε_{it} = Error term for firm i in time period t

Since our dependent variable is the non-negative count of patents, our choices for empirical estimation of our model were restricted to Poisson or Negative Binomial models. These methods are often used for studies that use patents as the dependent variable (Penner-Han & Shaver, 2005; Rothaermel & Thursby, 2007). Preliminary analysis showed that not only was our patent data over dispersed (variance much larger than mean) but also had excess of zeros, thus eliminating poisson models. The excess zeros were a result of two processes, first there were zeros for when the firms were not engaged in any R&D and the resulting patenting activities. Second, there were zeros for firms that were engaged in R&D activities but not applied for any patents. The presence of over dispersion and excess zeros lead us to use zero inflated negative binomial (ZINB). The Vuong test (Vuong, 1989) showed that negative binomial was rejected in favor of zero inflated negative binomial. We also performed the zero inflated poisson (ZIP) likelihood-ratio test which confirmed that ZINB is a better fit for our model compared to ZIP. To deal with these excess zeros we used R&D expenditures (RDEXP) to predict (inflate) the certain zeros.

RESULTS

In this section, we begin by highlighting summary statistics of key measures. Next, we report regression results and discuss our interpretation of the coefficient estimates.

Descriptive Analysis

Table 1 reports the means and standard deviations for our dependent, independent and control variables. Table 2 shows the correlation matrix for the key variables. We present the values without the natural logs to make it easier to interpret. The mean for INNOV is 0.71 while the standard deviation is

2.02 showing that our patent data is over dispersed. We have a total of 449 firm-year observations for our patent data and of these 264 are zeros which suggests that our data is also zero inflated. Thus as mentioned in the previous section, we have used zero inflated negative binomial to estimate our model. The independent variable INT has a mean of 0.72 with standard deviation of 0.32. Many firms in our sample have more foreign subsidiaries than domestic subsidiaries. The average firm is 31.5 years old and has close to 3000 employees. As can also be seen, the Indian biopharmaceutical firms spend an average of $8.85 million per year and has R&D intensity of 3.6 percent. Table 2 gives the correlation matrix for the regression variables. As can be seen, there appears to be no serious multicollinearity problems. No correlations are greater than 0.5.

INSERT TABLE 1 HERE

INSERT TABLE 2 HERE

Regression Results

Table 3 presents the results of our ZINB regression analysis. We do not report the time and firm dummy variables in this table. The first column in Table 3 shows the baseline model with only the control variables. Our control variable AGE is negative but not significant. The coefficient estimation of SIZE, which is measured by the number of employees, is positive and highly significant confirming prior research that suggest that larger firms have more innovations. We find evidence for positive and significant correlation between R&D intensity of the firm and its patenting activity. As expected, firms that spend greater portion of their sales revenue on R&D are more likely to have a better patenting performance. The variable BIO is negative and significant suggesting that biotech firms have a lower propensity to patent compared to pharmaceutical firms in our sample. Lastly, the R&D expenditure is

used to predict certain zeros and this variable is negative and significant. This provides evidence that lower the R&D expenditure, the more likely the firm will have certain zeros for patent count. The z-value for the Vuong test were significant showing that ZNIB is a better fit than standard negative binomial.

INSERT TABLE 1 HERE

The second column of Table 3 shows Model 2, the internationalization-innovation relationship without any controls. The coefficient for INT is negative and marginally significant while the one for INTSQ is positive and significant. The third degree term, INTCUBE is negative and significant. All three internationalization terms taken together suggest a horizontal S-shaped relationship with innovation. The results for Model 2 are not different from the complete model in terms of coefficient signs and strengths thus we will discuss coefficients for these three variables in greater detail for Model 3.

The last column shows the complete model (Model 3) containing the key independent variables plus controls. Hypothesis 1 predicts a negative relationship between low level of internationalization and innovation. The first order term for internationalization (INT) is negative and significant thus providing support to Hypothesis 1. We find a positive and highly significant coefficient for our squared term (INTSQ) thereby providing support for Hypothesis 2 which proposes that there is a positive impact of medium level of internationalization on innovation. Finally, the cubic or third order level of internationalization (INTCUBE) is negative and significant. Hypothesis 3 predicts that as firms reach higher levels of internationalization, there are negative returns and the level of innovation decreases. This hypothesis is also strongly supported in our model.

With the exception of SIZE, coefficients of the other three time variant firm level controls have the opposite sign. AGE was negative and not significant in Model 1 but in Model 3 the sign becomes positive and highly significant. The controls in our complete model show that firm type (BIO) and firm size to an extent are important for predicting the propensity for a firm to innovate. A positive and

significant Vuong test shows that for our sample, a zero inflated model performs better that the binomial model.

CONCLUSION

As EMNEs begin to internationalize to other developing and developed countries, initially to exploit their limited FSAs but later to gradually explore and gain new resources and competences, an important question arises regarding the impact of internationalization on innovation. Do these firms from emerging economies benefit from internationalization and become better innovators? Are there costs associated with internationalization that may negatively impact innovation? Is there an optimal level of internationalization beyond which innovation decreases? This paper attempts to answer the above questions and argues that there is a curvilinear relationship between internationalization and innovation. Using data from 1997-2013 on 64 Indian biopharmaceutical firms, this paper finds that there is indeed an S-shaped relationship between internationalization and innovation (See Figure 1).

We find that at lower levels of internationalization, when the EMNEs are still new to international expansion, the level of innovation decreases. Prior research has shown that EMNEs prefer to internationalize first to other EEs which have similar macroeconomic conditions (Cuervo Cazurra, 2012). MNEs in general tend to expand to markets close to their home markets in terms of psychic distance and so it is no surprise that EMNEs prefer other EEs for early expansion. However, while this choice is good for exploiting their limited resources and competences, it is not the best for gaining new capabilities. Other EEs also lack the infrastructure necessary to stimulate innovation and as a result the EMNEs do not increase their innovative capabilities. In fact, their patenting activities decrease as they shift their limited resources from R&D towards setting up a foreign subsidiary or acquiring an existing foreign firm.

As firms gain more international experience and expand to newer countries, their choice shifts from developing to more developed countries. We observe in our data that starting around 2005, firms set up more subsidiaries in developed countries. The role of subsidiaries also evolves with international experience. We expect to see foreign subsidiaries undertake more exploration activities rather than

exploitation especially in developed countries. Tapping into the innovation systems of developed counties and benefiting from knowledge spillovers, the overall patenting activity of the firms increase in this second stage of internationalization. Thus we observe an increase in innovation at higher levels of internationalization.

Finally, we also observe a decline in innovation activity at highest levels of internationalization. We currently do not have project level data to test it but we believe the decline could occur because firms are now highly networked and multiple subsidiaries are working on a single R&D project - a drug in the case of our firms. Having multiple subsidiaries working on a project may be helpful in protecting intellectual property and accessing greater pool of resources but it can also increase transaction and coordination costs. Interactions between multiple subsidiaries can delay the R&D projects causing an overall delay in patent submissions. At first glance the negative relationship between internationalization and innovation appears counter intuitive. Why do firms over extend their activities to such a level that it begins to get counterproductive? However, as a related stream of research on the international diversification and performance literature has shown, firms are not aware of the threshold beyond which the returns start to diminish (Contractor et al., 2003).

This paper makes significant contributions to research on emerging market firms. While the nascent stream of research on this topic has focused on internationalization by EMNEs (Child & Rodrigues, 2005; Cuervo Cazurra & Genc, 2008; Luo & Tung, 2007) relatively little has been done on innovation by these firms (Govindarajan & Ramamurti, 2011). There is a general consensus that EMNEs are innovating and moving beyond simply imitating products from developed countries. However this is mostly anecdotal evidence based on case study research. Our study uses quantitative data on internationalization and innovation to provide some unique insights on these two related phenomena. The research also has important implications for practitioners. There appears to be a threshold beyond which international expansion is not beneficial for innovation. Managers need to be aware of this threshold. In

addition, location choice is an important factor to consider for firms that are just starting their expansion outside of their home country.

While our study uses data on EMNEs, it will be interesting to examine this relationship for firms from developed countries. As mentioned in the conceptual framework section, there are only a few handful of papers that have explored this relationship (Hitt et al., 1997; Kafouros, et al., 2008) and there is no general consensus on the shape or direction.

As is the case with most research, this study has limitations. This is a single industry and single country study and the findings from this research may not be applicable to firms in other industries or other countries. However, there has been very little quantitative research done on firms from emerging countries and we hope to get a deeper understanding of internationalization by EMNEs. In spite of the limitations of a single industry study, the findings of this research could be applied to other highly research intensive industries such as the semiconductor industry and to EMNEs from other emerging economies such as China and Brazil.

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SELECTED KEY REFERENCES ONLY DUE TO SPACE CONSTRAINTS

TABLE 1 - Descriptive Analysis

	Variable	Mean	S.D.
1	INNOV	0.71	2.02
2	INT (Foreign/Total Subsidiaries)	0.72	0.32
3	BIO	0.97	0.29
4	AGE	31.52	13.93
5	SIZE	2962.71	3303.47
6	RD EXP	8.85	20.16
7	RD	3.6	5.7

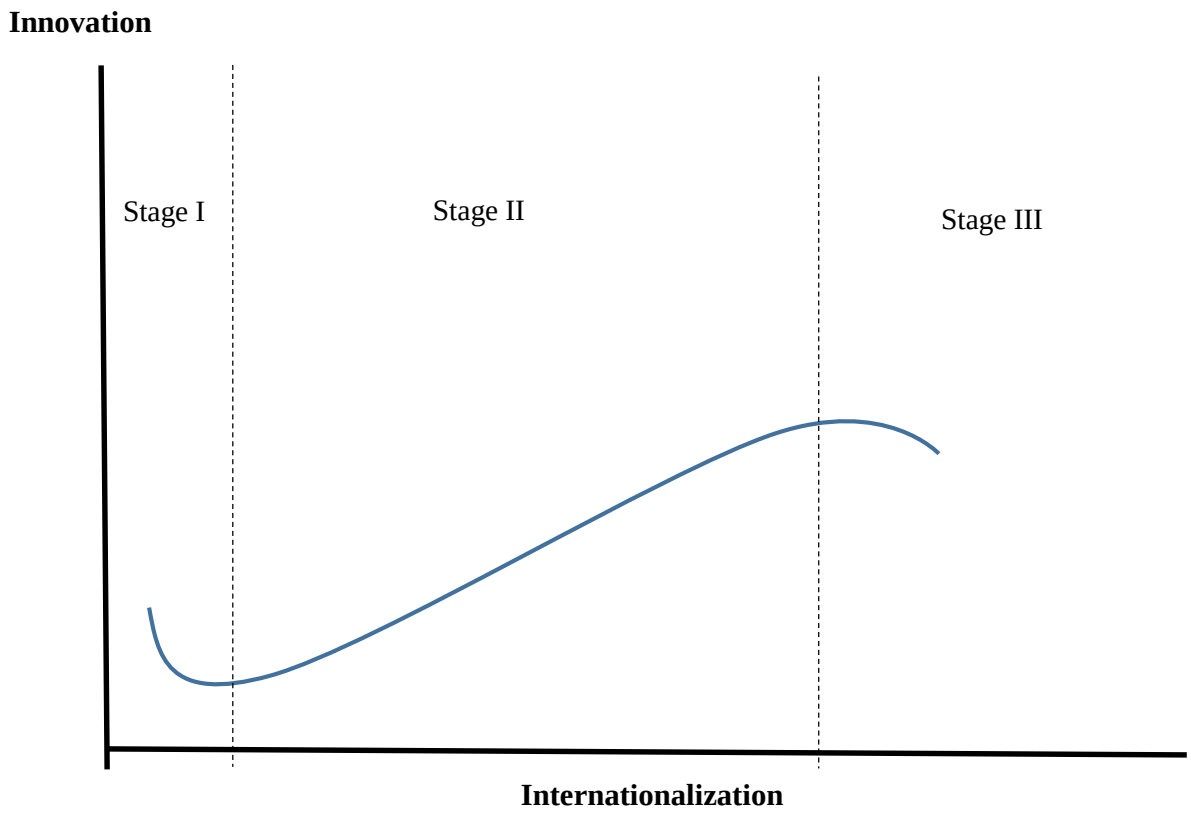
TABLE 2 -Correlation Matrix

	Variable	1	2	3	4	5	6	7
1	INNOV	1.00						
2	INT	-0.06	1.00					
3	BIO	-0.12	0.50	1.00				
4	AGE	0.09	0.03	0.03	1.00			
5	SIZE	0.25	0.23	0.20	0.41	1.00		
6	RD EXP	0.27	0.21	0.15	0.19	0.46	1.00	
7	RD	0.21	0.16	-0.11	0.21	0.41	0.49	1.00

TABLE 3
Zero Inflated Negative Binomial Regression Results

DV: INNOV	Variables	Controls Only Model 1	IVs Only Model 2	Full Sample Model 3
	INT		-6.08* (2.29)	-6.85** (2.29)
	INTSQ		18.18** (5.62)	20.73*** (5.52)
	INTCUBE		-12.52** (3.59)	-13.84*** (3.49)
Controls				
	AGE	-0.02 (0.07)		0.02*** (0.05)
	SIZE	0.01*** (0.03)		0.01* (0.03)
	R&D	2.33 (3.19)		-0.67 (2.03)
	BIO	-0.86** (0.28)		-1.05** (0.21)
Constant		1.69*** (0.47)	1.56*** (0.32)	1.56*** (0.32)
Inflate				
	R&D EXP	-0.84* (0.31)	-0.51*** (0.14)	-0.49*** (0.14)
Obs		430	430	430
Log likelihood		-293.21	-585.05	-575.04

Year and Firm dummy variables are included in the models, but regression coefficients are not shown. Standard errors are in parentheses.
*p < 0.05, **p < 0.01, ***p < 0.001

FIGURE 1

Curvilinear Relationship between Internationalization and Innovation