How do Emerging Market MNEs and Advanced Market MNEs innovate?

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Abstract:

Global innovation is rising for advanced market MNEs (AMNEs) as well as emerging market MNEs (EMNEs). We study global innovation by examining whether and how AMNEs and EMNEs innovate differently. Our panel-data analysis of EMNEs (from China and India) and AMNEs (from France, Germany, Italy and USA) shows R&D intensity on average enhances innovation outcomes of the MNE, such effects are stronger for EMNEs. Interestingly, we find that AMNEs and EMNEs have different models of innovation. The innovation of AMNEs tends to be headquarter-led innovation and thus the effects of headquarter sourcing knowledge from the cluster are stronger for AMNEs. In contrast, the innovation of EMNEs is more likely to be subsidiary-led innovation, in which the geographic dispersion of subsidiaries plays more important role in enhancing EMNEs' innovation outcomes.

Keywords: Global innovation, Innovation outcomes, EMNEs, AMNEs, Headquarter-subsidiary roles

1. Introduction

Global innovation is becoming an important strategy for firms to gain competitive advantages (Agostino et al., 2013; Belderbos et al., 2013). Innovative activities especially research and development (R&D) are increasingly carried out across borders by multinational enterprises from advanced markets (AMNEs) as well as multinationals from emerging markets (EMNEs) (Chen et al., 2012; Nandkumar and Srikanth, 2015). A widely accepted argument is that AMNEs expand globally building upon superior technologies and strong innovative capabilities, while EMNEs originate from under-developed institutions with a lower level of knowledge stock and innovative capabilities (Cuervo-Cazurra, 2008; Luo and Tung, 2007). In this regard, global innovation has been viewed as a technologically catch-up strategy for EMNEs through seeking superior knowledge from their counterparts in advanced markets (e.g. Ramamurti and Singh, 2010; Ramamurti, 2016).

Although extant studies exploring global innovation have been done for AMNEs, little attention has been devoted to understanding how EMNEs internationalize and innovate to gain competitive advantages (Luo and Tung, 2007). Moreover, there is no research explicitly comparing the global innovation between AMNEs and EMNEs, as a result, we know very little about whether and how EMNEs may differ from AMNEs in their approaches towards innovation. Subsequently, it remains unknown how MNEs conduct global innovation differently depending on the contexts in terms of AMNEs and EMNEs.

To address these research gaps, we undertake a comparative approach to study the global innovation of these two groups of MNEs – AMNEs and EMNEs. In this study, we examine how AMNEs and EMNEs conduct in-house R&D differently to enhance their innovation outcomes, and how AMNEs and EMNEs assign different roles to their headquarters and subsidiaries to enhance their innovation. More specifically, by testing the different effects of headquarters' knowledge sourcing from local clusters on innovation outcomes of AMNEs and EMNEs, we explore the different roles of headquarters on global innovation of AMNEs and EMNEs. Additionally, we examine the different roles of subsidiaries on global innovation of AMNEs and EMNEs by testing the effects of geographic dispersion of overseas subsidiaries on innovation outcomes of AMNEs and EMNEs. This study shows that AMNEs and EMNEs benefit differently from R&D intensity and the knowledge sourcing activities of their headquarters and subsidiaries.

Prior research suggests that global innovation is a key mechanism that enables MNEs to utilize and enhance their competence internationally (Almeida, 1996). Existing research provides useful insights on how global innovation enhances firms' innovation outcomes and how this effect differs depending on firm age and national culture background (Rosenbusch et al., 2011). However, these studies have only considered the effect of context in terms of firm-specific and country-specific factors, while failing to recognize the context in terms of the cohort of MNEs. We, therefore, argue that the way of conducting innovation internationally differs with the cohort of MNEs because of the different nature and approaches of global innovation.

Previous studies explain the determinants and the process of MNE subsidiary mandate development (e.g. Achcaoucaou et al., 2014; Cantwell and Mudambi, 2015) and argue that the process of subsidiary mandate development may differ depending on the context of AMNEs and EMNEs (e.g. Awate et al., 2015). However, theory does not clearly explain how AMNEs and EMNEs enhance their innovation outcomes through assigning different mandates to their subsidiaries. Our study thus differs from the prior studies by testing the different roles of headquarters and subsidiaries in explaining the innovation outcomes of AMNEs and EMNEs.

We therefore extend prior understanding by proposing that the patents of AMNEs may mainly come from the competency generated by the headquarter, while patents of EMNEs are mainly explained by the creative role of their overseas subsidiaries in global innovation.

Our comparative approach also extends the literatures and theories on the innovation of EMNEs. Existing research mainly focused on exploring why theories using observations from advanced markets cannot be applied to the behaviours of EMNEs (e.g. Hoskisson et al., 2000; Ramamurti, 2016) and explaining how to understand the global innovation of EMNEs (e.g. Awate et al., 2015; Rugman and Verbeke, 2003). Hence, we know little about whether or how much classic paradigm requires modification when it is applied to the behaviours of EMNEs. By developing a conceptual framework and conducting a comparative analysis between AMNEs and EMNEs, we find that both AMENs and EMNEs internalize R&D to enhance their innovation but using distinctive approaches.

To test our predictions, this paper explores the global innovation of 358 MNEs including 116 EMNEs and 242 AMNEs (with established portfolios of foreign subsidiaries) for the time period 2006- 2014. Our findings demonstrate how R&D intensity contributes differently to innovation outcomes of AMNEs and EMNEs, how AMNEs innovate by their headquarters sourcing knowledge from the local cluster and how EMNEs innovate by the geographic dispersion of their overseas subsidiaries. Our analysis has implications for how AMNEs and EMNEs conduct their innovation globally and how they locate their headquarters and subsidiaries to enhance innovation performance.

2. Theoretical background

2.1. MNE’s global innovation and innovation performance

Our analysis starts with theories that explain why and how MNEs engage in international knowledge transfer and global innovation. Building upon the premises that unevenly distributed knowledge across countries stimulates international knowledge transfer (Breschi and Lissoni, 2009), the classic internalization theory argues that knowledge diffusion across national borders through external market is impeded by the external market imperfections (Buckley and Casson, 1976). Because knowledge that underpins firms’ competitive advantages is proprietary and cannot be traded in the external markets (Barney, 1991; Teece, 1986), there is a need for knowledge transfer through internal markets (Buckley, 2016). Consequently, international expansion enables firms to leverage and source knowledge globally and subsidiaries serves as agents for such internal knowledge transfer between home and host countries (Forsgren et al., 2005). Knowledge transfer within the internationalized firms’ networks generates the opportunities for MNEs to apply their valuable innovative knowledge and capabilities to the global markets (Awate et al., 2015). By internalizing local technological and market knowledge, subsidiaries create new knowledge and develop their innovative capabilities contributing to the whole MNEs (Michailova and Mustaffa, 2012).

Driven by intense competition and increased global interconnectedness, global innovation has become a key strategy for MNEs to generate knowledge-based assets in order to sustain competitive advantages (Qian et al., 2017). A large body of research has been developed to explain how MNEs source and leverage their knowledge globally through geographic dispersion of their R&D (Awate et al., 2015; Doz et al., 2001), for which the literature suggests two general models (Awate et al., 2015; Cantwell and Mudambi, 2005). The first is to utilize competence developed at home for adapting products to local markets (Dunning, 1988). The second is to create competence in host countries by enhancing innovative capabilities that can be used to tap into globally dispersed knowledge pools (Kafouros et al., 2012). The two models differ significantly and, as we shall explain in later section, MNEs use these models as an adaptive process to tune their innovation in order to remain competitive in different context.

MNEs need to manage their global innovation carefully, in terms of both inputs and outputs. Studies show that innovation performance of MNEs involves the role of in-house R&D investment as well as internal knowledge sharing (e.g. Becker and Dietz, 2004; Mudambi and Navarra, 2004). Investment in R&D enables firms to create an internal stock of scientific knowledge (Wang and Kafouros, 2009), advance existing technologies and adapt products to the local markets (IBRD, 2010). Meanwhile, the resources and capabilities of the headquarters and subsidiaries can be transferred within the MNE, which may lead to the enhancements of knowledge and capabilities of the MNE as a whole (Ambos et al., 2006; Bartlett and Ghoshal, 1989). However, research rarely examines the determinants of firm's innovation within different context. The difference in operational context in terms of institutional environment where the firm operates determines different resources and knowledge existing in the market for innovation (Aulakh et al., 2016; Hoskisson et al., 2000). Distinct driver of international expansion determines different models of global innovation by MNEs (Cantwell and Mudambi, 2005). Additionally, asymmetrical headquarter-subsidiary relationship determines the different roles of the headquarter and subsidiaries of the MNE in the process of global innovation (Awate et al., 2015). The context in terms of cohort of MNEs, AMNEs and EMNEs, differ significantly in above dimensions, which may lead to the differences in the process of global innovation.

A bulk of literature on global innovation has been done under the context of AMNEs (e.g. Cantwell and Mudambi, 2005, 2011; Dunning and Narula, 1995), while recent stream of literature building upon the evidence of EMNEs draws relatively less attention (Cuervo-Cazurra and Dau, 2009; Luo and Tung, 2007, 2018). Furthermore, very few studies explicitly compare the global innovation in AMNEs and EMNEs. When we compare EMNEs with AMNEs, substantial differences have been recognized in terms of the operational contexts we discussed earlier. MNEs from emerging markets are regards as latecomers with deficit technological know-how and innovative capabilities that many of their rivals in advanced markets have (Cantwell, 1989; Ramamuti and Hillemann, 2018). While AMNEs mainly expand their geographic dispersion to utilize their competency developed at home globally (Dunning, 1995), EMNEs' global innovation is rooted in a technological catch-up strategy (Ramamurti and Singh, 2010; Ramamurti, 2016). Unlike AMNEs, international expansion becomes the "springboard" for EMNEs to leapfrog the multi-generation technological development which has been conducted by AMNEs (Luo and Tung, 2007, 2018) through sourcing requisite knowledge from their counterparts in advanced markets (Awate et al., 2012). These perspectives stress on the role of EMNEs' overseas subsidiaries as sourcing superior technological knowledge and upgrade the knowledge stock and innovative capabilities of EMNEs as a whole which enables them to participate in the global competition (Awate et al., 2012; Cantwell, 1989). Hence, AMNEs and EMNEs internalize the R&D to enhance their innovation performance with different approaches because of the differences in their operational context.

Innovation represents the process of transforming resources and knowledge inputs into innovation outputs (Love and Roper, 1999) and MNEs need to manage their innovation outputs carefully. Success innovation assists firms in reducing manufacturing cost, introducing new products to the markets and generating monopoly power of the new knowledge (e.g. unique products and patent) (Levin et al., 1987). Prior literature suggests that both patent and new products accurately capture the innovation outcomes of the firms (Garcia et al., 2013; Jin et al., 2019). Unlike the introduction of new product which represents the physical embodiment of the new knowledge, patent captures the creation of underlying "new to the market" knowledge stock within the firm (Griliches et al., 1986), which is an objective and observable indicator of firm's technological capabilities (Adegbesan and Higgins, 2010). The patent-generating innovation, represents the firm's underlying knowledge stock, assists the firm in generating monopoly power to trade with other firms (e.g. licensing) (Steensma, 2015), to defensively block rivals from commercializing (Somaya, 2012), to offensively fence off the technological space to impede other firms, and to increase the bargaining power in the patent disputes with rivals (Noel and Schankerman, 2013). Hence, MNEs are actively engaged in global patenting activities to manage their innovation outcomes.

2.2. The roles of headquarters and subsidiaries in innovation

Knowledge as a strategic resource is an important input of innovation (Rabbiosi and Santangelo, 2013), and MNEs engage in different types of knowledge transfer to enhance their innovation outcomes, particularly the internal knowledge transfer between headquarters and subsidiaries (Bartlett and Ghoshal, 1989; Mudambi and Navarra, 2004; Vernon, 1966). However, the asymmetrical relationship between headquarters and subsidiaries may determine their different roles in innovation. The process by which an MNE create competence was conceptualized building upon an evolutionary perspective (Bartlett and Ghoshal, 1989; Hedlund, 1994), which is mainly building upon the observations of innovation activities of AMNEs (Ambos et al., 2006; Govindarajan and Ramamurti, 2011).

Firms initiated to build the competence at home (typically at the headquarters) by conducting experimental R&D, which represents the primary competence-creating strategy and then diffused their competence to subsidiaries worldwide through the internal network (Buckley and Casson, 1976, 2009). Subsidiaries applied and utilized the knowledge sourced from their headquarters and conducted R&D to adapt products to the local markets (Birkinshaw, 1996; Birkinshaw and Hood, 1998), which represents the competence- exploiting subsidiary mandate (Cantwell and Mudambi, 2005). Hence, the headquarters play important role in accessing, creating knowledge and finally serve the role of knowledge supplier in MNEs' knowledge network in the innovation process, while the subsidiaries serve the role of knowledge receiver (Awate et al., 2015). During the last decade, some subsidiaries started to source knowledge locally and generate new competence for the use of the whole MNE (Frost et al., 2002), which represents the competence- creating subsidiary mandate (Cantwell and Mudambi, 2005). These subsidiaries evolved to play a more creative role by generating new knowledge and finally serve the role of knowledge supplier in MNEs' global innovation (Awate et al., 2015).

However, EMNEs are likely to experience a different story because of the different operational context and traditional model formulated from the observations of AMNEs (Ambos et al., 2006; Govindarajan and Ramamurti, 2011) cannot fully explain the roles of headquarters and subsidiaries in innovation of EMNEs. As technological laggards, the headquarters of EMNEs have a relatively lower level of knowledge (Peng, 2012) and foreign ventures were established to seek superior knowledge from the host countries to leapfrog the stage of knowledge development at home (Luo and Tung, 2007). By sourcing requisite knowledge resided in host countries, the overseas subsidiaries originated to create new competences that are not available in their home countries (Luo and Tung, 2007). In other words, EMNEs are primarily motived to engage in global innovation to seek proprietary knowledge from foreign markets and assign competence-creating mandate to their subsidiaries to enhance their innovation as a whole (Awate et al., 2015). For instance, Chinese multinational Galanz, the world's largest microwave manufacturer, set up a R&D centre in Washington (US) to tap into the local knowledge pool in order to enhance their innovative capabilities (Deng, 2007).

Unlike AMNEs, headquarters of EMNEs catch up through sourcing superior knowledge and learn from their subsidiaries as overseas subsidiaries tend to have a higher level of knowledge stock and innovative capabilities (Gupta and Govindarajan, 2000; Nair et. Al., 2016). Awate et al (2015) empirically examines the benefits of the headquarters of EMNEs from organizational learning by observing the backward citations of the headquarters' patents. Therefore, overseas subsidiaries of EMNEs play an important role in accessing, creating new knowledge and finally serve the role of knowledge suppliers in the internal knowledge network in the innovation process of EMNEs, while the headquarters are knowledge seeking (Awate et al., 2015).

3. Hypothesis development

The previous section focuses on international knowledge transfer and different models of global innovation in explaining the drivers and process of MNEs' global innovation. Furthermore, the importance of context in terms of emerging market and advanced market in understanding global innovation has been demonstrated by explaining the different drivers and processes of their global innovation and specifically exploring the contextual effects on how MNEs manage their innovation inputs in terms of R&D investment and different roles of headquarters and subsidiaries in innovation. In the following, we employ a comparative perspective to explain how AMNEs and EMNEs conduct global innovation differently. Given our focus on determinants of innovation, R&D investment is regarded as an important driver of scientific knowledge creation (Griliches, 1979; Hall and Mairesse, 1995), thus, may result in growth of firm's internal knowledge stock. Moreover, knowledge flow within the MNE' internal network also enhances the innovation outcomes of the MNE (Ambos et al., 2006). In this study, we aim to extend the current understanding of global innovation by comparing the impact of R&D investment and roles of headquarters and subsidiaries in innovation under different contexts- AMNEs and EMNEs. The next section discusses how AMNEs and EMNEs manage their in-house R&D investment differently and different models of innovation by AMNEs and EMNEs in detail. Figure 1 summarizes the theoretical framework and hypotheses.

************Figure 1 about here************

3.1. R&D intensity

Extant research has largely explained the important role of R&D investment in innovation of AMNEs (e.g. Garcia-Manjon and Romero-Merino, 2012; Roper et al., 2010), which requires necessary financial and human capital (Guan et al., 2009). However, over time, the important role of in-house R&D on AMNEs' innovation may change because of great changes in global competition. In contrast, EMNEs are historically weak in their R&D resources (Cuervo-Cazurra, 2012), and over time emerging markets witness a remarkable growing share of world's total R&D investment (UNCTAD, 2005). The recent literature based on EMNEs also reports a strong and positive relationship between R&D investment and innovation performance of EMNEs (e.g. Chudnovsky et al., 2006; Wang and Kafouros, 2009). However, there is rare research explicitly comparing the effect of R&D investment on innovation outcomes of AMNEs and EMNEs, and there is still a major deficit in our understanding of how AMNEs and EMNEs manage their R&D investment to innovate.

In the context of AMNEs, the important role of R&D investment on innovation has been recognized for decades. However, over time, along with the changes in global competition in innovation, only sourcing knowledge via its own in-house R&D becomes less creative for AMNEs as valuable ideas may largely stay outside their boundaries (Chesbrough et al., 2006). Therefore, investment in buying or sourcing creative ideas outside the firm is becoming crucial for AMNEs in their innovation. For instance, Google, the American leading Information Technology Company, acquired Meebo, an instant messaging and social networking service provider, and merged the staff of the company with Google plus developer team to enhance their innovative strength in 2012 (Meebo, 2012). Moreover, R&D is conducted by AMNEs to advance their technologies and make them stay in the frontier. Because of the higher uncertainty existing to go forward, there is higher risk in R&D investment for AMNEs comparing to EMNEs (McKinsey & Company, 2018), which leads to a higher uncertainty on return of R&D investment for AMNEs. Hence, the impact of in-house R&D on innovation outcomes is diminishing over time for AMNEs.

Building upon firm's capabilities arguments, R&D investment facilitates the increase of organizational learning (Wang and Kafouros, 2009). The concept of absorptive capacity and its important role in MNE-capabilities building has been largely explored in innovation literatures (Cohen and Levinthal, 1990; Gupta and Govindarajan, 2000). Absorptive capacity represents the recipient firm's ability to understand, appreciate and apply the external knowledge (Cohen and Levinthal, 1990). In-house R&D enhances the firm's capability to understand and learn from the external knowledge, which is especially vital for EMNEs. Specifically, EMNEs' awareness of their knowledge gaps between AMNEs drives their international expansion and their global innovation is rooted in the technological catch-up strategy through accessing to knowledge established by AMNEs (Luo and Tung, 2007). Because of the large knowledge gaps between AMNEs and EMNEs, R&D becomes fundamentally important for EMNEs, as the knowledge recipients, to enhance their absorptive capacity in order to better assimilate, transform and exploit external knowledge acquiring from AMNEs in their knowledge creation process (Nair et al., 2016). Hence:

Hypothesis 1. The positive effects of R&D intensity on innovation outcomes are stronger for EMNEs than for AMNEs.

3.2. Different models of innovation by AMNEs and EMNEs

MNEs engage in different types of knowledge transfer especially the internal knowledge transfer across borders to enhance their innovation (Birkinshaw and Hood, 1998; Kogut and Zander, 1993). In the innovative process, different roles are assigned to headquarters and subsidiaries by MNEs imply heterogeneity in models of innovation by MNEs, which is headquarter-led innovation and subsidiary-led innovation. Headquarter-led innovation represents the vital role of headquarters in enhancing MNEs' overall innovation outcomes. The headquarter plays important role in accessing knowledge, creating competence and sharing knowledge in internal network (Cantwell and Mudambi, 2005), which greatly contributes to innovation performance of the MNE as a whole. Hence, the headquarter has relatively higher level of knowledge stock and greater innovative capabilities (Awate et al., 2015) and thus the headquarter is more likely to transfer knowledge to the subsidiaries (Almeida, 1996). In contrast, the subsidiaries upgrade their competence by accessing knowledge from the headquarter (Awate el al., 2015).

Subsidiary-led innovation represents the vital role of subsidiaries in enhancing MNEs' overall innovation outcomes. The subsidiaries play more creative role to access knowledge and create new competence in order to contribute to the innovation efforts of the whole MNE (Cantwell and Mudambi, 2005, 2011). Hence, the subsidiaries are more likely to have a higher level of knowledge stock and greater innovative capabilities comparing to the headquarters and thus subsidiaries play the role as the knowledge supplier (Awate et al., 2015). In contrast, the role of the headquarter as knowledge receiver is crucial.

3.2.1. Headquarters-led innovation

Headquarters may source requisite knowledge and upgrade their innovative competence by locating in cluster as industrial cluster has long been regarded as engine of knowledge spillovers and innovation (Porter, 1998; Bresnahan and Gambardella, 2004). Industrial cluster is defined as "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities" (Porter, 1998). Spatial proximity provides opportunities for frequent and face-to-face interactions between firms in the cluster which boost the spillover of tacit or spatial- sticky knowledge (Storper and Venables, 2004). By co-locating with similar and related firms, firms enhance their collective learning by assessing to tacit or spatial-sticky knowledge in the process of frequent formal and informal interactions (Juhász and Lengyel, 2018). Headquarters may benefit from accessing to regional pool of skilled labour, learning from rivals (Turkina et al., 2016) and collaborating within the supply chain (Li, 2014). This is consistent with extant empirical studies by showing that knowledge spillover within industrial clusters is an important determinant of firms' innovation (Juhász and Lengyel, 2018; Tan, 2006). Hence, by locating in cluster, headquarter can create new knowledge and upgrade their innovative competence through effectively learning from the counterparts in the cluster, which may enhance MNEs' innovation as a whole through the internal knowledge transfer.

AMNEs and EMNEs may manage their headquarters' innovative activities differently because of the different roles played by the headquarters. AMNEs initially develop their competence at home and hence the primary knowledge flow is the "teaching" flow from headquarters to subsidiaries (Cantwell and Mudambi, 2005). Although some subsidiaries evolve to create competence and transfer knowledge to the headquarters over time, we still expect the headquarters of AMNEs play the role of knowledge supplier in general building upon relatively greater innovative capabilities and a higher level of breadth and depth of knowledge portfolios (Awate et al., 2015). Hence, AMNEs tend to experience headquarter-led innovation, where the headquarters of AMNEs play important role in accessing knowledge, creating new knowledge and sharing knowledge in order to enhance MNEs' innovation as a whole. AMNEs focus on their headquarters to learn and develop their innovations and their headquarters can learn from the knowledge spillover within the industrial cluster. In contrast to AMNEs, headquarters of EMNEs are knowledge seeking from their overseas subsidiaries (Ramamurti, 2012) often because of the lack of knowledge stock and innovative capabilities (Luo and Tung, 2007). Hence,

Hypothesis 2. Headquarters enhance MNEs' innovation outcomes by locating in cluster; this effect is stronger in AMNEs than in EMNEs.

3.2.2. Subsidiary-led innovation

Learning from the host country locations is becoming an important source of knowledge creation for MNEs (Almeida and Phene, 2004; Lo and Chung, 2010). Through the location of subsidiaries in multiple countries, MNEs can gain access to a wider range of global knowledge reservoirs (Ahuja and Lampert, 2001; Kafouros et al., 2012), accumulate and assimilate knowledge embodied within multiple locations (Wood and Reynolds, 2011) and further add new value to their knowledge base (Kafouros and Wang, 2015). Thus, geographic dispersion of overseas subsidiaries exposes the MNE to more expansive learning opportunities (Goerzen and Beamish, 2003) and enable the MNE to flexibly source international innovation resources and capabilities to enhance its innovation (Qian et al., 2010). This perspective is consistent with the theory suggests that geographically dispersed MNE is more likely to experience higher return on innovation (Caves and Caves, 1996). By sourcing knowledge from various locations through dispersed subsidiaries, MNEs can generate diverse innovation team with complementary skills ((Kafouros and Wang, 2015), have a higher probability of accessing valuable knowledge (Leiponen and Helfat, 2010), and further mitigate the risks and uncertainty related to the innovation by balancing the deficiency of the knowledge and resources from a specific location. Hence, geographic dispersion of subsidiaries may further facilitate the expansive knowledge sourcing and development of new knowledge and capabilities for MNEs.

AMNEs and EMNEs may manage the innovative activities of their subsidiaries differently because of the different roles played by their subsidiaries. The subsidiaries of the EMNE are assigned a more creative role to access knowledge from local markets, create new knowledge for the use of the whole EMNE (Awate et al., 2015; Nair et al., 2016). Hence, EMNEs tend to experience subsidiary-led innovation and they focus on the overseas subsidiaries to geographically learn and contribute to their overall innovations. In contrast to EMNEs, AMNEs' subsidiaries are documented to employ a dual-strategy of competence-exploiting and competence-creating mandates (Awate et al., 2015), but the subsidiaries of AMNEs in general play the role of knowledge recipients based on the evidence that the headquarters of AMNEs are at a higher level of the breadth and depth of knowledge. Hence,

Hypothesis 3. The geographic dispersion of subsidiaries enhances innovation outcomes; this effect is stronger in EMNEs than in AMNEs.

4. Methods

4.1. Sample and data

For the comparative research setting, we identified a set of MNEs from two emerging markets (China and India) and four advanced markets (France, Germany, Italy and US) in a period of 2006-2014. We chose Chinese and Indian MNEs for a number of reasons (1) largest emerging economies witness a remarkable economic and technological growth in recent decades (Kafouros and Wang, 2015) (2) significant boom in R&D investments, Outward Foreign Direct Investment (OFDI) and global patenting activities (UNCTAD, 2005; WIPO, 2016; WIR, 2014) (3) evidence of learning by Chinese and Indian MNEs from their overseas subsidiaries (Nair et al., 2016; Meyer and Peng, 2005). The focus on MNEs from European countries and US is based on several reasons (1) top-ranked countries in global innovation (GII, 2014) (2) top-ranked countries in patent applications (WIPO, 2016) (3) access of standardized regional data (4) evidence of important actors of global innovation (Cantwell and Mudambi, 2005; Awate et al., 2015).

The list of MNEs has been selected from Orbis database following these steps (1) searching for subsidiaries which has a global ultimate owner located in above 6 countries (2) searching for the global ultimate owner of these subsidiaries from the first step (3) exclude the global ultimate owner of these subsidiaries with unconsolidated data. The Orbis database provides detailed financial, structure of ownership and R&D data of MNEs across the global during a long period of time. We obtained patent data from OECD REGPAT database- patent application filed under the Patent Co-operation Treaty (PCT). We matched the firm-level financial data from Orbis database with patent application data from OECD REGPAT database using firm name. We finalized the sample of this study to 358 MNEs across 36 two-digits industries, including 116 MNEs from emerging markets and 242 MNEs from advanced markets. Moreover, this research also includes a set of home country and host country environmental-level control variables, Table 1 summarises the data sources of these variables.

************Table 1 about here************

4.2 Measures

4.2.1. Dependent variable

We measure the dependent variable, MNEs' innovation outcomes, using the annual number of patent application under the PCT by the MNE during the time period 2006-2014. Patent captures "a creation of an underlying knowledge stock" (Griliches et al., 1986) and further indicates a firm's technological capabilities (Adegbesan and Higgins, 2010). These patents may come from the innovative activities at home and innovative activities by MNEs' overseas subsidiaries, which is appropriate for the research design that captures MNEs' innovation.

Additionally, it is possible to compare the patent data across countries which suits the comparative research design (Rothaermel and Hess, 2007). Especially patent application data under PCT can be used to accurately compare the innovation outcomes of MNEs from multiple countries. The patent data drawn from the United States Patent and Trademark Office (USPTO) or European Patent Office (EPO) may raise concerns that it mainly captures the patenting activities of United States or European based applicants thus leading to biased results. The OECD REGPAT database captures the international patenting activities of MNEs from multiple countries because the patent under the PCT is protected in a large number of countries (WIPO, 2017).

4.2.2. Independent variables

4.2.2.1 R&D intensity. This key independent variable captures MNE's innovation input, which is measured by the ratio of annual R&D expenditure to total sales of the MNE (Cohen, 1996). This is consistent with the innovation literatures using R&D intensity as a measurement of innovation input (e.g. Chen et al., 2012; Heeley et al., 2007; Wang and Kafouros, 2009).

4.2.2.2. Cluster-specific effect of MNEs' headquarter. This construct captures whether the headquarter of the MNE is located in the cluster. It relies on a dummy that take 1 when the headquarter is located in the cluster. To identify the clusters in the six home countries during the time period 2006-2014, we calculate the location-quotients (LQs) to capture the concentration of a particular industry in a state-level region using the number of employee data following the previous studies (Bathelt and Li, 2013). We operationalize the location quotient for industry *f* in region *r* in year *t* as:

$$LQ_{frt} = \frac{E_{frt}/E_{rt}}{E_{ft}/E_t}$$

Where E_{frt} refers to the number of employees in industry *f* in region *r* in year *t*, and E_{rt} is the total number of employees in region *r* in year *t*. E_{ft} refers to the number of employees in industry *f* in year *t*, and E_t refers to the national total number of employees in year *t*. Although there is not a commonly accepted LQ criterion for identifying clusters in a country (O'Donoghue and Gleave, 2004), LQ value of larger than 1 is commonly used in practice to define agglomeration (Bathelt and Li, 2013). Hence, we use an LQ of larger than 1 as one criterion for identifying clusters in the six countries. We merged MNE's headquarter state-level location with its industry information (Standard Industrial Classification code) to test if the headquarter of the MNE is located in the cluster during the period of 2006-2014.

4.2.2.3. Geographic dispersion of overseas subsidiaries. This key independent variable captures the extent to which the overseas subsidiaries of MNEs is spread across different geographical areas. To capture how widely MNE spread their subsidiaries globally, we use the Hirschman-Herfindahl index to calculate the concentration ratio of the countries where the subsidiaries of the MNE operate (Zhang et al., 2010). We operationalize the geographic dispersion of overseas subsidiaries in MNE *i* as:

$$A_i = 1 - \sum_{j=1}^{K} \left[\frac{Q_j}{Q_i}\right]^2$$

Where K is the total number of countries in which the subsidiaries of MNE *i* operate and *j* is the host country of MNE *i*. Q_j refers to the number of subsidiaries in host country *j,* while Q_i refers to the total number of subsidiaries of MNE *i.* Thus, the value is close to 1 if the subsidiaries of the firm are widely dispersed, while the value is close to 0 if the subsidiaries of the MNE are located concentratedly.

4.2.3. Control variables

4.2.3.1. Size of the MNE. This variable controls for the size of the MNE, because a large number of literatures suggest that large firm size may result in abundant resources to conduct innovation leading to better innovation performance (e.g. Wang and Kafouros., 2009; Wu et al., 2016). We measure size of the MNE by its total assets.

4.2.3.2. Cluster-effects of domestic subsidiaries of MNEs. Spatial proximity drives the knowledge spillover and increases organizational learning of the firm, which may further enhance the innovation outcomes of the firm (Turkina et al., 2016). Hence, the innovation outcomes may be impacted by the knowledge sourcing from the clusters by the domestic subsidiaries of the MNE. This variable is measured by the ratio of number of domestic subsidiaries located in the cluster to number of total domestic subsidiaries. We merge the domestic subsidiaries' state-level location with their industry information to test if the domestic subsidiary is located in the cluster.

4.2.3.3. Home country environment. Prior studies suggest that home country environment may affect MNE's innovation (e.g. Jin et al., 2019; Li et al., 2012). Inward FDI (IFDI) brings knowledge to the country which enables the local firms to learn and upgrade their own innovation (Jin et al., 2019). Outward FDI (OFDI) provides firms the opportunity to seek knowledge from different locations (Li et al., 2012). Extant research also suggests that IFDI and OFDI are the key mechanisms for firms from emerging markets to learn and develop their technological capabilities (e.g. Cantwell, 1989; Jin et al., 2019; Zhang et al., 2010). To control for these home-country effects, we take IFDI and OFDI flow and normalize it by calculating a ratio of IFDI flow to MNEs' home country to home country GDP and a ratio of OFDI flow from the MNEs' home country to home country GDP.

Extant studies on regional innovation suggest that there are great differences in innovation system and innovative capabilities across regions (Huang et al., 2012; Li, 2009). We control for the regional-specific impact on MNEs' innovation by including a set of regional-level variables. As different regions may have different innovation system, we then measure the R&D expenditure by the regional government and regional absorptive capacity on state (provincial) level. Regional governments play an important role in providing policy and financial support for the innovation of local firms, which is especially important for the innovation of EMNEs (Aulakh et al., 2016). This variable is measured by the ratio of R&D expenditure by regional government to regional GDP. The absorptive capacity of the regions where the firm is located is proved to impact the innovation outcomes of the firm (Li, 2009). We control for the regional absorptive capabilities using the ratio of regional patent stock to the total number of labours in the region. The patent stock is operationalized using the perpetual inventory method (Kafouros et al., 2012) based on the regional patent application data.

4.2.3.4. Host country environment. Various studies demonstrate the impact of host country environment on MNEs' innovation (e.g. Wu et al., 2016; Kafouros and Wang, 2015). We control for the host country environment impact on MNEs' innovation by including a set of home country environmental variables. We control for the host country openness to FDI, because highly opened host country environment provides better opportunities for MNEs to obtain and learn from the local markets (Kafouros and Wang, 2015). This variable is calculated by the ratio of IFDI stock to host country GDP (Buckley et al., 2007). Another variable which influences MNEs' innovation is host country domestic knowledge stock (Kafouros and Wang, 2015). It is measured as the number of patents granted by domestic enterprises in the host countries. Highly skilled labour who carries knowledge has been proved to play an important role in the process of innovation and tapping into the pool of skilled labour in the host countries enable the MNE to effectively learn from the local markets (Kafouros et. al., 2015). Thus, we control for this effect using high education enrolment, which is calculated by the ratio of total high education enrolment to the population of the age group. Host country institutional environment has been taken into consideration because well-functioning institutions may enhance firms' innovation by effectively providing resources and innovation intermediaries with low cost (Jackson and Deeg, 2008). The measurement of host country institutional development is composed of six indicators from the Worldwide Governance Indicators: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption. However, these six indicators are highly correlated with the Cronbach alpha above 0.95. We operationalized this variable by taking the average of these six indicators. A higher value of the measure indicates a higher level of host country institutional development.

4.2.3.5. Time and industry effect. This model uses a set of year and industry dummies to control for the time and industry effects because idiosyncrasies of time and industries may influence the innovation outcomes of the MNE.

4.3. Statistical modelling

As our dependent variable measured by the number of firms' patent application is count data, a linear regression model is likely to be biased. The baseline model to deal with the problem of using the count data for dependent variable is Poisson model, but our data violated the assumption of Poisson model that the variance of the dependent variable equals to the mean. We utilized a Negative Binomial (NB2) model which allows the varies between conditional variance of dependent variable and conditional mean. This approach is consistent with statistical models employed by other studies to test the impact on innovation outcomes measured by patent count (Marin, 2014; Wu et al., 2016).

5. Results

Table 2 provides some descriptive statistics for the key variables of the study. It is worth noting that the R&D intensity and patent counts significantly varies for AMNEs and EMNEs, which also demonstrates the validity of the research design to compare AMNEs and EMNEs in terms of their innovation. Figures 2-4 show, respectively, the kernel distribution of log of total assets, log of R&D investment and log of patent count for the two samples, AMNEs and EMNEs. Figure 1 shows that AMNEs are slightly bigger than EMNEs. Moreover, we observe a clear evidence that AMNEs generally invest more in R&D than EMNEs, with a fatter right tail. Figure 3 shows that AMNEs seem to generate more patent-innovation than EMNEs. However, the patent count of EMNEs has a wider range from 0 to 3416, which is not surprising because we expect that some "fast-follower" EMNEs have caught up with AMNEs in terms of innovation outcomes (Awate et al., 2012).

************Table 2 about here************

***********Figure 2-4 about here***********

The integrated framework is empirically estimated for three samples (1) full sample including AMNEs and EMNEs (2) sub-sample including EMNEs (3) sub-sample including AMNEs. While analysis for the full sample explains the determinants of innovation in general, looking at EMNEs and AMNEs sample separately enables us to test the importance of context on innovation. To detect potential multicollinearity, we calculate the variance inflation factor (VIF) for each variable across the models for different samples. The average VIF across the models is below the acceptable level of 5 (Neter et al., 1985), which represents no serious problems of multicollinearity. Because we theorize the determinants for innovation in AMNEs and EMNEs and our analysis includes a time-invariant variable (geographic dispersion of overseas subsidiaries), we utilize NB2 model with random effects to estimate across models with different samples.

Table 3 provides the estimation results of the main regressions that test the 3 hypotheses and the results of the additional robust regressions. Model 1 estimates the determinants of innovation for the full sample of MNEs. Model 2 and Model 3 respectively examines this effect for the sample of EMNEs and AMNEs. We include all the key determinants of innovation outcomes together with a set of control variables in the Model 1-3. In Model 2, the coefficient of R&D intensity is positive and statistically significant. This indicates that R&D intensity enhances EMNEs' innovation outcomes. In Model 3, the effect of R&D intensity is not statistically significant for AMNEs. The results confirm our predictions of the theoretical framework, demonstrating that the positive effect of R&D intensity on innovation outcomes is stronger for EMNEs than AMNEs. Thus, H1 is supported. Moreover, the coefficient of the variable, cluster-specific effects of the headquarter in Model 3 is positive and significant, indicating that headquarter of AMNEs enhances the innovation by locating in the cluster. However, the coefficient of this variable in Model 2 is insignificant. Thus, H2 is corroborated. H3 is also supported as the coefficient of the variable, geographic dispersion of overseas subsidiaries, is positive and significant in Model 2, while it is statistically insignificant in Model 3.

***********Table 3 about here***********

We further estimate additional model to examine the robustness of our results. Prior studies suggest the role of well-functioned institutions in enhancing firms' innovation performance (Jackson and Deeg, 2008). Unlike AMNEs that are more likely to experience well-functioned intuitions at home, EMNEs' global innovation is accelerated by the motive to avoid under-developed home institutions that constrain the development of innovation (Cuervo-Cazurra, 2008; Luo et al., 2010). Therefore, the home country institutional development may impact MNEs' innovation. Moreover, extant research suggests that education-level of the region where the firm is operated may influence the innovation of the firm (Li, 2009). We thus measure this variable by the ratio of high education enrolment in the region where headquarter of the MNE operates to the number of labours in the region. We do not include these two variables in the model to test their effects on innovation of EMNEs because of the problems of multicollinearity. Model 4 includes these two variables for the sub-sample of AMNEs to test whether they impact the overall results. Although the changes in the value of Log-likelihood in Model 4 indicates slightly increase of the explanatory power of the variables compared with Model 3, the results for the hypotheses do not change.

6. Discussion and conclusion

This study proposes a framework that examined the determinants of innovation outcomes of EMNEs and AMNEs and explores how AMNEs and EMNEs conduct global innovation differently. Although the determinants of innovation such as R&D and knowledge diffusion is well integrated in the literature (Wang and Kafouros, 2009), prior study has not focused on the role of context in determining how firms conduct innovation. Our findings extend current understanding on global innovation by revealing the different ways of conducting innovation by AMNEs and EMNEs. Specifically, our analysis shows that R&D intensity is likely to be a more important driver of innovation outcomes in EMNEs than in AMNEs. Furthermore, our findings reveal that the innovation of AMNEs tends to be headquarter-led innovation and the role of the headquarters' innovative activities of souring knowledge from the cluster in promoting innovation is greater for AMNEs than for EMNEs. We further find that the innovation of EMNEs tends to be subsidiary-led innovation and the role of sourcing knowledge from the geographic dispersion of overseas subsidiaries is more important for EMNEs than for AMNEs.

Our analysis extends current understanding of global innovation by demonstrating that the determinants of innovation differ within the cohort of MNEs. Adding to the traditional models on the factors that determine innovation outcomes and current literatures focusing on exploring the rise of EMNEs as innovators (e.g. Wang and Kafouros, 2009; Xie and Li, 2018), we posit that AMNEs and EMNEs conduct global innovation differently. From the evolutionary perspective, our results deepen understanding of how AMNEs evolve to rely less on in-house R&D to conduct their innovation. The findings indicate the importance of exploring global innovation from a contextual-specific perspective and an evolutionary perspective. Hence, our results open up tracks for future research on innovation to explore how firms innovate differently depending on firm-specific factors and country-specific factors, or how firms evolve to innovate in a different way.

Our research enriches understanding of the MNE subsidiary mandate by demonstrating that the role of subsidiaries differs for AMNEs and EMNEs and explains consequently how such differences lead to variances in innovation outcomes. Combined with the finding that a unit within MNE can benefit from the innovative competence generated within the network of the MNE through the internal knowledge transfer, our results highlight the different roles of headquarter and subsidiaries in the internal knowledge transfer of AMNEs and EMNEs and further empirically demonstrate how AMNEs and EMNEs enhance their innovation through different ways of assigning mandates to their Headquarters and subsidiaries. This view provides new explanations for the strategies employed by EMNEs to innovate and compete with their rivals in advanced markets on a global basis (Awate et. al., 2015).

Our research deepens understanding of developing a general theory the innovation of MNEs' innovation by applying internalization theory to global innovation of MNEs and demonstrating that both AMNEs and EMNEs enhance innovation through internal knowledge transfer but using distinctive approaches because of their operational contexts. Our findings extend the existing theories by demonstrating how classic paradigm can be applied to the behaviours of EMNEs in a distinctive way. This adds value to the on-going debate about the generalizability of internalization theory for explaining phenomenon in emerging markets (Buckley et al., 2007; Rugman and Verbeke, 2003). By comparing the global innovation of AMNEs and EMNEs, our findings support the view that classic theories of the MNE can be applied to the phenomenon of EMNEs through a certain extent of modifying deeper assumptions of classic theories (Hernandez and Guillén, 2018; Rugman and Verbeke, 2003).

This research has several limitations. First, our empirical findings of EMNEs rely on data of MNEs from two particularly large and diversified emerging countries (e.g. China and India), and therefore our finding may not be equally applied to firms from other emerging markets because of potentially different peculiarity of EMNEs from China and India. Future research may extend this research by testing the theoretical framework on a large sample of EMNEs and AMNEs originated from a large group of countries. Second, the use of patent data as the measurement of innovation outcomes is characterised by some limitations. Patent only captures a narrower part of innovation outcomes, most are often technological knowledge which cannot always be transformed into new products. Many innovations are not patentable. Moreover, the propensity to use patent to protect innovation varies across industries. Future analyses can develop current research by using different measures of innovation and comparing the effects of innovation inputs on different forms of innovation outputs. Third, a limitation of this study lies on the restrictions of data from Orbis database. Our data only captures the subsidiaries of the MNE in the Orbis database rather than capturing all the subsidiaries owned by the MNE. The theoretical framework discusses the role of environmental factors on innovation outcomes of MNEs and this effect may be different for AMNEs and EMNEs. To extend theory on global innovation, future research can examine the different role of home country environmental factors and host country environmental factors on innovation outcomes of AMNEs and EMNEs.

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Table 1 Sources of home country environment data

Variables	China	India	US	Germany	Italy	France
National IFDI	OECD statistics	OECD statistics	OECD statistics	OECD statistics	OECD statistics	OECD statistics
National OFDI	OECD statistics	OECD statistics	OECD statistics	OECD statistics	OECD statistics	OECD statistics
National institutional development	World bank	World bank	World bank	World bank	World bank	World bank
Regional government expenditure on R&D	China science and technology statistical yearbook	Reserve Bank of India	US national science foundation	Eurostat	Eurostat	Eurostat
Regional GDP	China statistical yearbook	Reserve Bank of India	Bureau of Economic Analysis	Eurostat	Eurostat	Eurostat
Regional patent application	SIPO statistical yearbook	Annual report of the intellectual property of India	USPTO	Eurostat	Eurostat	Eurostat
Regional number of labours	Statistical yearbook of Chinese provinces	Reserve Bank of India	Bureau of Economic Analysis	Eurostat	Eurostat	Eurostat
Regional number of employees across industries	China statistical yearbook	NITI Aayog regional data	US Census government	Eurostat	Eurostat	Eurostat
Regional high-education enrolment	China educational development yearbook	NITI Aayog regional data	United States Census Bureau	Eurostat	Eurostat	Eurostat

Table 2 Descriptive statistics

	Variables	Full sample		EMNEs		AMNEs	
		Mean (SD)	Min (Max)	Mean (SD)	Min (Max)	Mean (SD)	Min (Max)
Firm-specific	Patent count	15.4414(132.6585)	0 - 3416	20.8854(211.5027)	0 - 3416	12.7665(65.2954)	0 - 921
	R&D intensity	0.0511(0.0798)	0 - 1.0738	0.0144(0.0287)	0 - 0.3544	0.0692(0.09)	0 - 1.0738
	Total assets	11200000(30900000)	2.07 - 287000000	3141228(5780556)	8807.737 - 43000000	15100000(36900000)	2.07 - 287000000
	Overseas subsidiary dispersion	0.6161(0.3253)	0 - 0.9671	0.6794(0.2514)	0 - 0.959	0.585(0.3519)	0 - 0.9671
	Cluster dummy of headquarter	0.5491(0.4977)	0 - 1	0.6745(0.4689)	0 - 1	0.4875(0.5)	0 - 1
	Cluster effects of domestic subsidiaries	0.3823(0.3757)	0 - 1	0.4998(0.2812)	0 - 1	0.3246(0.402)	0 - 1
Home country environment	IFDI/GDP	0.0186(0.0106)	0 - 0.0451	0.0301(0.01)	0.0131 - 0.0451	0.0129(0.0048)	0 - 0.0233
	OFDI/GDP	0.018(0.01)	0.001 - 0.0492	0.0084(0.0037)	0.001 - 0.0175	0.0227(0.0087)	0.0039 - 0.0492
	Regional government R&D expenditure/regional GDP	0.0035(0.0063)	0 - 0.0483	0.007(0.0095)	0.0007 - 0.0483	0.0017(0.0025)	0 - 0.0096
	Regional patent stock/regional number of labours	0.0061(0.0104)	0.0001 - 0.1299	0.0133(0.0155)	0.0001 - 0.1299	0.0025(0.0021)	0.0001 - 0.0132
Host country environment	Knowledge stock	36477.08(53176.07)	133 - 704936	53839.38(53248.81)	133 - 287831	27945.89(51035.87)	133 - 704936
	Openness to IFDI	0.8622(0.9444)	0.0294 - 9.7632	1.2469(1.1012)	0.0657 - 9.7632	0.6731(0.7915)	0.0294 - 5.4249
	High education enrolment	0.5778(0.1113)	0.1154 - 0.9492	0.5417(0.1203)	0.1154 - 0.8873	0.5956(0.1021)	0.1951 - 0.9492
	Institutional development	1.0201(0.4501)	-0.7558 - 1.889	1.0129(0.4274)	-0.1699 - 1.8317	1.0237(0.4609)	-0.7558 - 1.889

Table 3 Regression results

Dep: patent count		Model 1 Full sample	Model 2 EMNEs	Model 3 AMNEs	Model 4 AMNEs
Firm-specifc	log(R&D/sales)	1.131+	**5.484***	1.057	0.838
		(0.673)	(2.414)	(0.663)	(0.756)
	log(foreign_subsidiary_geographic_dispersion)	**0.574***	**2.291****	**0.565+**	**0.684***
		(0.268)	(0.778)	(0.303)	(0.320)
	cluster_dummy	**0.265***	0.224	**0.440****	**0.309+**
		(0.113)	(0.285)	(0.157)	(0.169)
	log(total assets)	0.145***	0.529***	-0.006	0.009
		(0.039)	(0.090)	(0.030)	(0.035)
	log(number of domestic subsidiaries in cluster/number of domestic subsidiaries)	-0.220	-0.200	0.201	0.174
		(0.175)	(0.426)	(0.212)	(0.221)
Home country (national)	log(OFDI_national/GDP_national)	0.130+	-0.128	-0.174	-0.032
		(0.075)	(0.172)	(0.119)	(0.145)
	log(IFDI_national/GDP_national)	-0.136**	0.501	0.008	-0.012
		(0.047)	(0.346)	(0.058)	(0.063)
	log(home_country_institution)	-	-	-	-2.279*
		-	-	-	(0.911)
Home country (regional)	log(gov_fun_province/GDP_province)	-0.140***	-0.474**	-0.051	-0.078*
		(0.023)	(0.167)	(0.031)	(0.038)
	log(patent_stock_province/labor_province)	0.168**	0.514**	0.320**	0.293*
		(0.061)	(0.178)	(0.102)	(0.125)
	log(high_education_population/labor_province)	-	-	-	0.260*
		-	-	-	(0.105)
Host country	log(patent_number_average)	-0.064	-0.153+	0.004	-0.017
		(0.044)	(0.090)	(0.064)	(0.068)
	log(IFDI/GDP_average)	-0.355***	-0.505*	-0.027	0.023
		(0.094)	(0.211)	(0.139)	(0.147)
	log(high_education/population_average)	0.544+	0.487	-0.259	-0.592
		(0.299)	(0.622)	(0.399)	(0.418)
	log(institution_average)	0.268	0.949+	0.465	0.620*
		(0.220)	(0.510)	(0.284)	(0.296)
	Year dummies	Included	Included	Included	Included
	Industrial dummies	Included	Included	Included	Included

N	2,331	768	1,563	1,458
Number of MNEs	358	116	242	236
Log-Likelihood	-4352	-1005	-3283	-3071
Chi Sq	285.4	131.2	156.8	138.7
VIF average	1.56	1.93	1.73	1.90
VIF max	3.41	4.1	3.18	3.51

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Figure 1 Conceptual framework

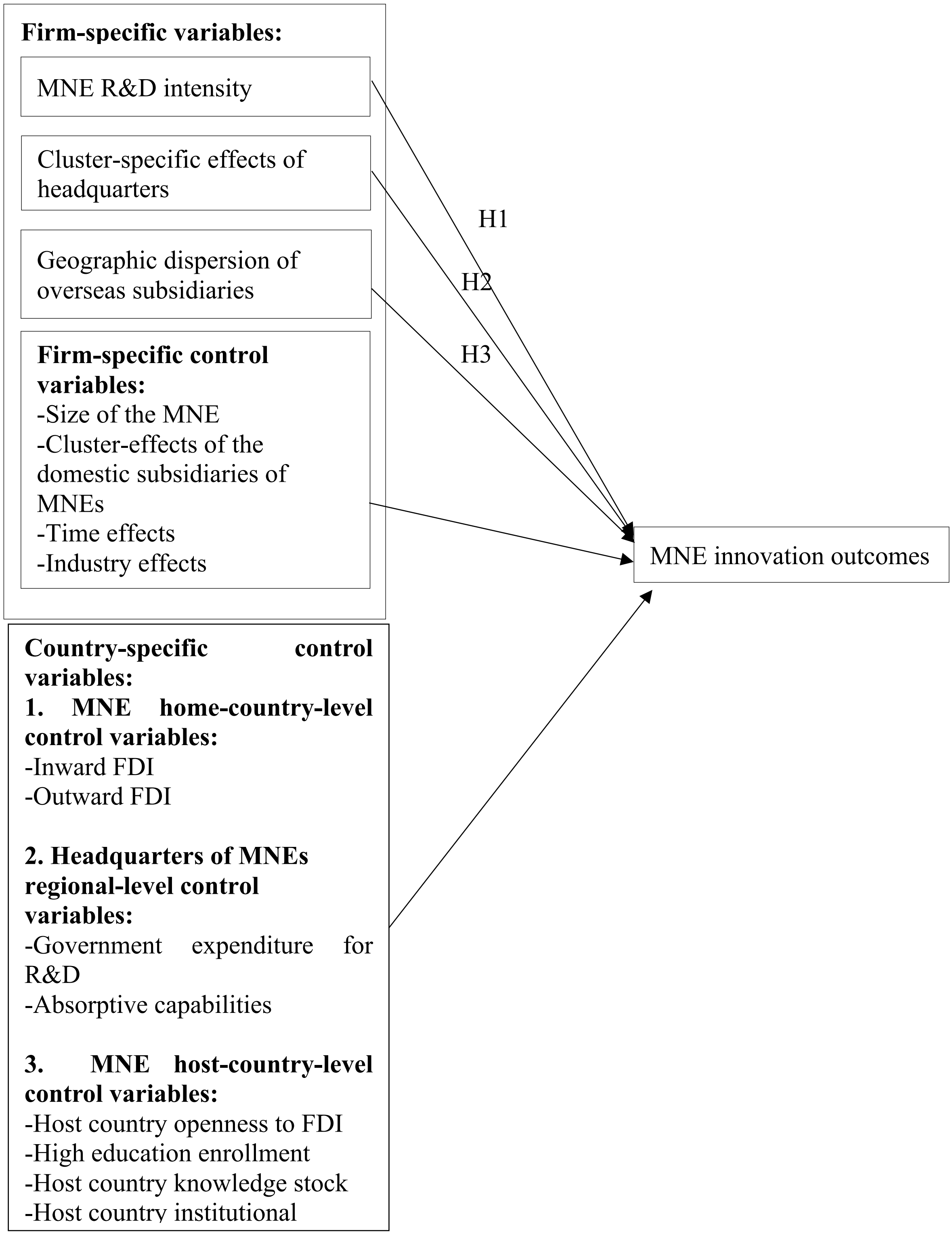

Figure 2 Distribution of total assets

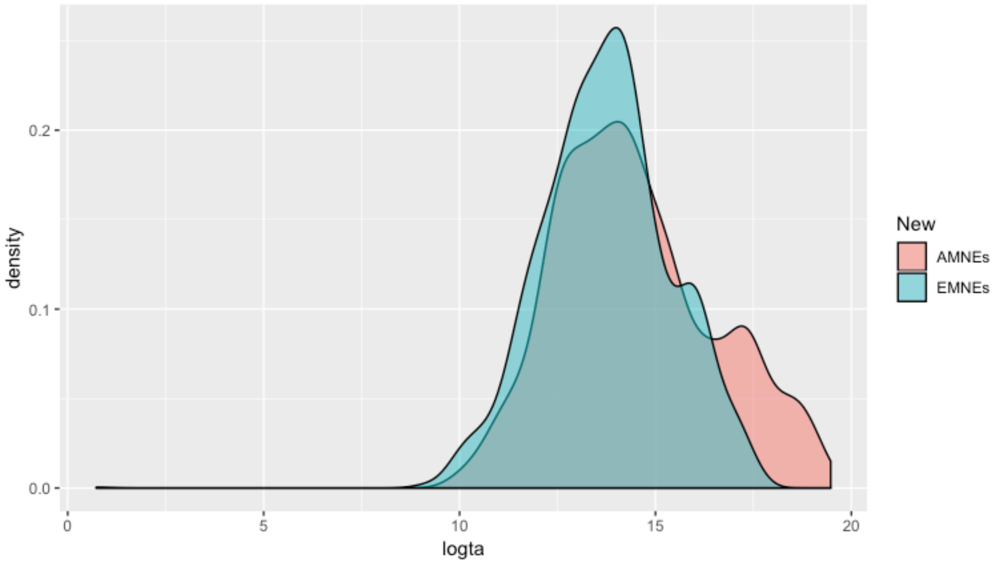

Figure 3 Distribution of R&D

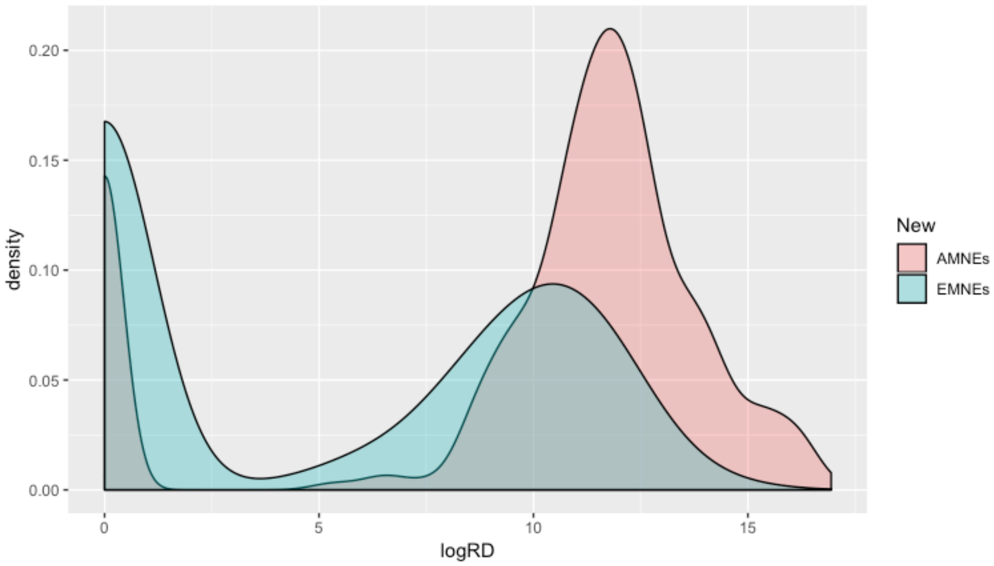

Figure 4 Distribution of patent count