A General Explanation of Global Innovation Development of Multinational Enterprises from Advanced and Emerging Markets

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ABSTRACT

Global innovation is becoming a key for advanced (AMNEs) and emerging market multinational enterprises (EMNEs) to gain competitive advantages. The objective of this thesis is to find a general explanation of MNE global innovation development. We achieve this by applying a comparative approach to gain a better understanding of the nature of the differences between AMNEs and EMNEs. International business theories suggest that firms develop competitive advantages at home first before exploiting them in overseas markets, while recent studies suggest that EMNEs do not generally have competitive advantages before internationalization and they develop their competitiveness using global innovation. Incorporating such difference in our analyses of MNE global innovation provides valuable opportunities for exploring (1) a unifying explanation of MNE global innovation model - how AMNEs and EMNEs rely on headquarters vs. subsidiaries differently to innovate, (2) a general explanation of how MNEs operate in host countries - how overseas subsidiaries of AMNEs and EMNEs benefit from parent MNE competence and host environments differently, (3) a unifying explanation of MNE technological development - how innovative subsidiaries of AMNEs and those of EMNEs enable their parent MNEs to pursue different technological strategies.

In order to achieve the objective, our empirical analysis incorporates datasets at MNE-level (Paper 1), subsidiary-level (Paper 2) and the level of technologies owned by innovative subsidiaries of MNEs (Paper 3). Our sampled MNEs are from two emerging markets (China and India) and four advanced markets (France, Germany, Italy and US) during 2006-2014. Through the in-depth theoretical and empirical investigation, this thesis contributes to theorize a general explanation of MNE global innovation development.

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LIST OF ABBREVIATIONS

AMNEs	Advanced market multinationals
ASEAN	Association of Southeast Asian Nations
BvD	Bureau van Dijk
EMNEs	Emerging market multinationals
EPO	European Patent Office
GDP	Gross Domestic Product
GII	Global Innovation Index
GUO	Global ultimate owner
HIS	Hyperbolic sine transformation
HQs	Headquarters
IB	International business
IFDI	Inward foreign direct investment
IP	Intellectual property
IPC	International Patent Classification
IPR	Intellectual Property Regime
ioSubs	Innovative Subsidiaries
LOE	Liability of emergingness
LQ	Location-Quotients
M&A	Merger and acquisition
MNEs	Multinational enterprises
NB2	Negative Binomial model
NIS	National innovation system
OECD	The organisation for economic cooperation and development
OFDI	Outward foreign direct investment
Orbis IP	Orbis Intellectual Property database
PCT	Patent Co-operation Treaty
PLS	Panel Least Square
PIM	Perpetual Inventory Method
R&D	Research and development
ROE	Return on Equity
ROA	Return on Assets
SIC	Standard Industrial Classification
UNCTAD	United Nations Conference on Trade and Development
US	United States of America
USPTO	United States Patent and Trademark Office
VIF	Variance Inflation Factor
WGIs	Worldwide Governance Indicators
WIPO	World Intellectual Property Organization
WIR	World Investment Report

Chapter 1 Introduction

1.1 Introduction

Global innovation is the battle ground for multinational enterprises (MNEs) to gain competitive advantages (Awate et al., 2015; Cantwell and Mudambi, 2005). Indeed, firms have increasingly distributed their innovative activities (e.g., research and development, patenting activities, technological acquisition) across borders to become networked and embedded (Papanastassiou et al., 2020; McEvily et al., 2004). Subsequently, global innovation is becoming a key strategy for MNEs to leverage existing competence across geographic markets and create new competence through tapping into the global knowledge reservoirs (Cantwell and Piscitello, 2000; Cantwell and Mudambi, 2005).

MNEs are characterized as the global distributed innovation networks whose developments hinge on how headquarters and overseas subsidiaries contribute to the formation of the MNE as a whole (Bartlett and Ghoshal, 1989). A widely proposed view is that MNEs expand globally, building upon the resources and capabilities developed at home (typically at headquarters) (Buckley et al., 1976, 2009) and subsidiaries typically exploit the competencies of their parent MNEs (Wang and Wang, 2020). Recent research, however, suggests that subsidiaries may indeed create and develop new competencies for the use of the whole MNE (e.g., Cantwell and Mudambi, 2005; Colakoglu et al., 2014). For example, subsidiaries increasingly embed themselves into host environments (Castellani and Zanfei, 2006), which allows them to tap into host country knowledge bases (Colakoglu et al., 2014), develop new competence and transfer their new competence within the MNE internal network (Cantwell and Mudambi, 2005). In this perspective, the roles of subsidiaries as the nodes in knowledge sharing and knowledge creation within MNEs have been increasingly recognized (Santangelo et al., 2016), especially how the subsidiaries create and sustain competitiveness in the internationalization process (Almeida and Phene, 2004; Phene and Almeida, 2008) and how subsidiaries strategically contribute to the development of MNEs (Awate et al., 2015; Nair et al., 2016).

Innovative activities are increasingly carried out across borders by multinational enterprises from advanced markets (AMNEs) as well as those from emerging markets (EMNEs) (Chen et al., 2012; GII, 2016). The growing interest on global innovation of EMNEs is associated with the emergence of some of EMNEs as global innovators in their industries (e.g., Chinese telecommunication equipment manufacturer Huawei) (Cuervo-Cazurra, 2012) and the increasing number of cross-border acquisitions by EMNEs in advanced markets (Elia and

Santangelo, 2017; Kedia et al., 2012). For example, the Chinese technology company Lenovo undertook a series of acquisitions since 2000s in the advanced markets and have become the largest PC marker in the world with operations in sixty countries (Lenovo, 2011; Nylander, 2016). The classic theory building upon the observations of AMNEs postulates that MNEs develop their competitive advantages at home first and internationalize to exploit their superior technologies and strong innovative capabilities in overseas markets (Buckley and Casson, 1976; Dunning and Lundan, 2008). However, recent studies on EMNEs suggest that EMNEs do not generally have technological advantages (Cuervo-Cazurra, 2008) and they internationalize to develop their technologies and capabilities using global innovation (Elia et al., 2020; Nair et al., 2016). Extant literature thus raises the important question of how to reconcile observations of EMNEs with those of AMNEs (Cuervo-Cazurra, 2012; Hernandez and Guillén, 2018), especially at the MNE-level and the subsidiary-level.

The bulk of literature on global innovation has been developed using observations of AMNEs (e.g., Cantwell and Mudambi, 2005, 2011), while recent literature emphasises the importance of understanding global innovation by EMNEs (e.g., Awate et al., 2015; Rugman and Verbeke, 2003) and further argues that EMNEs offer a unique context in which to validate, refine and extend traditional theories (Kedia et al., 2012; Wright et al., 2005). Specifically, prior research mainly focuses on explaining why observations from advanced markets cannot be used to predict the behaviours of EMNEs (e.g., Hoskisson et al., 2000; Ramamurti, 2016) and furthers a debate of how to understand the innovative activities of EMNEs (Cuervo-Cazurra, 2012; Hernandez and Guillén, 2018). However, there is scarce theoretical and empirical evidence that integrates and explains the contrasting observations of cohorts of AMNEs and EMNEs arising from distinct home country developmental trajectories. Accordingly, the primary objective of this thesis is to address this gap and provide a general explanation of global innovation development of AMNEs and EMNEs by building on a comparative approach.

Limited research has explicitly compared the global innovation of large cohorts of AMNEs and EMNEs; as a result, this has limited our ability to understand whether and how EMNEs differ from AMNEs in their approaches towards innovation at MNE-level, whether and how EMNE subsidiaries differ from AMNE subsidiaries in their approaches to enhance performance at subsidiary-level, and whether and how EMNE innovative subsidiaries (ioSubs) and AMNE ioSubs enable their parent MNEs to purse technological development differently. Incorporating a comparative approach in the analysis of MNE global innovation provides valuable opportunities for exploring a unifying explanation of MNE global innovation and technology development, in particular, assisting our understanding of firms in both ends of the developmental spectrum and how contexts serve as indigenous and multi-dimensional factors (e.g., institutional conditions, organizational characteristics) (Jackson and Deeg, 2008; Geppert et al., 2003; Yildiz and Fey, 2012) influencing MNEs' models of global innovation, MNE subsidiaries' approaches towards profitability and MNEs' technology development using ioSubs.

1.2 Research Gaps and Research Questions

Existing literature provides valuable insights into the mechanisms (e.g., in-house R&D, external knowledge sourcing) through which global innovation enhances firms' innovation performance and facilitates the accumulations of intellectual property assets (e.g., patents) (e.g., Elia et al., 2020; Frank et al., 2016), and especially how firm-specific and country-specific factors may influence this relationship (e.g., Vrontis and Christofi, 2019; Belderbos et al., 2015). Significant differences have been observed between AMNEs and EMNEs in terms of their home country conditions, resources and capabilities and internationalization speed and scope (Cuervo-Cazurra and Genc, 2008). However, despite such findings, limited research has considered how AMNEs and EMNEs may differ in the ways of managing global innovation to enhance their innovation outputs.

Existing literature mainly argues the temporal sequence of subsidiary roles changes for a general population of MNEs, especially the roles of subsidiaries shift from the exploitation of competence developed at home (typically at the headquarters) towards the creation of new competence for the use of the whole MNE (e.g., Achcaoucaou et al., 2014; Cantwell and Mudambi, 2005). Recent case studies show that subsidiary roles differ between AMNEs and EMNEs that compete contemporarily in the same industry (e.g. Awate et al., 2015). However, research rarely examines how AMNEs and EMNEs employ different global innovation models (Cuervo-Cazurra, 2011, 2012), especially how AMNEs and EMNEs rely on headquarters and overseas subsidiaries differently for innovation: headquarter-led innovation vs. subsidiary-led innovation.

To address these gaps in the literature, this thesis aims to answer the following research questions in the third chapter (Paper 1):

(1) How do AMNEs and EMNEs rely on in-house R&D differently?
(2) How do AMNEs and EMNEs rely on headquarters and subsidiaries differently to enhance innovation performance?

The premise underpinning the stream of studies on subsidiary performance is that overseas subsidiaries are enabled by parent MNEs' firm specific advantages, typically superior knowledge and technologies, that can be replicated in foreign locations (Contractor et al., 2016; Gaur et al., 2019). Furthermore, as the subsidiaries are increasingly embedded in host environments (Castellani and Zanfei, 2006), they start to benefit from the host country environments (e.g., a technological rich environments) (e.g. Distel et al., 2019; Wu et al., 2016). However, the rise of EMNEs reveals that much of the current knowledge on subsidiaries has been based on the observations of AMNE subsidiaries and cannot explain the subsidiary performance of EMNEs. This understanding therefore explains EMNE subsidiary performance remains both an empirical and a theoretical question especially how EMNE subsidiaries differ from AMNE subsidiaries in their approaches to enhance performance, which provides opportunities for exploring a general explanation of how subsidiaries benefit from parent MNEs and host environments in enhancing their performance.

MNE competence and host country environment are suggested as the sources of competitive advantages for subsidiaries, enabling them to achieve better performance (Almeida and Phene, 2004; Contractor et al., 2016). Host country environment, on the one hand, can be the sources of resources and knowledge for the use of the subsidiaries, on the other hand, can be "rules of game" especially intellectual property regime (IPR) that constrain the behaviours of the subsidiaries (North, 1990; Meyer et al., 2020; Lu et al., 2014). However, existing literature mainly has focused on how MNE competencies influence subsidiary performance instead of how MNE competencies support their overseas subsidiaries to deal with the host environments (e.g., a technological rich environment and a weak IPR environment). The distinction among subsidiaries of AMNEs and EMNEs is therefore emerging from how AMNE subsidiaries and EMNE subsidiaries rely on MNE competence differently to deal with host country environments.

To address these gaps in the literature, this thesis aims to answer the following research questions in the fourth chapter (Paper 2):

(1) How do subsidiaries benefit from their MNEs and host country environments?
(2) How does this differ across subsidiaries of AMNEs and EMNEs?

Previous studies propose the typology of MNE strategies and specifically recognize the roles of subsidiaries in supporting parent MNEs' strategic balancing between global integration and local responsiveness (e.g., Bartlett and Ghoshal, 1989; Roth and Morrion, 1990; Harzing, 2000). While prior research has focused on the roles of innovative as well as non-innovative subsidiaries or used an input perspective such as subsidiary R&D activities and R&D intensity, the innovation outcome perspective of ioSubs - refers to the overseas units of an MNE with capability to independently or jointly own technologies (e.g., patents) that are valuable to the parent MNE - is relatively less well understood. Our study contributes to new theoretical explanations by focusing on the roles of ioSubs in MNE technology development and developing a taxonomy to describe MNE technological strategies through examining the technology portfolios owned by the ioSubs.

Firms have been theorized to internalize and exploit their technological resources and capabilities during the early stage of their internationalization (Buckley and Casson, 1976) building upon the observations of AMNEs. However, emerging markets are known to be less technologically developed and studies have suggested that EMNEs do not generally have technological advantages before internationalization (Mathews, 2006; Luo and Tung, 2007, 2018). The extant literature raises the question of how to reconcile observations of EMNEs with those of AMNEs (Cuervo-Cazurra, 2012; Hernandez and Guillén, 2018), particularly at the level of ioSubs. It is therefore puzzling as what exact principles underpin MNEs' technological development - how MNEs develop their technologies through ioSubs differently depending on the cohorts of AMNEs and EMNEs.

To address these gaps in the literature, this thesis aims to answer the following research questions in the fifth chapter (Paper 3):

(1) How do MNEs develop their technologies using ioSubs?
(2) How do AMNEs and EMNEs differ in their approaches to pursue certain technological strategy?

1.3 Structure of the Thesis

This thesis starts with an introduction chapter (Chapter 1) describing the background of the study and expanding on the research gaps and research questions we endeavour to address. The following chapter (Chapter 2) discusses the theoretical underpinning of the comparative approach in this thesis especially how a comparative approach helps us to develop a general explanation of MNE global innovation (Hernandez and Guillén, 2018). By summarizing the differences between AMNEs and EMNEs recognized in the existing literatures, this chapter explicitly explains how the duality of these literatures together provide limited evidence of differences between AMNEs and EMNEs, which provides opportunities for our further research on the differences between AMNEs and EMNEs in their global innovation models, subsidiaries' approach to enhance performance and their approach to purse certain technological strategy. We then describe our primary objective of the thesis is to provide a general explanation of global innovation development of AMNEs and EMNEs and explain how the following three empirical chapters (Chapter 3-5) together contribute to this objective. Finally, we explain how our three empirical chapters applying comparative approach theoretically contribute to extend the classic theory (e.g., internalization theory) (Buckley et al., 2007; Rugan and Verbeke, 2003) and empirically contribute to the micro-level comparative research on this topic.

Chapter 3 (Paper 1) aims to provide a general model of the mechanisms through which global innovation may boost a firm's innovation performance, more specifically, how MNE in-house R&D, headquarter-led and subsidiary-led innovation explain variations in MNE innovation performance. To achieve this, we investigated whether and how AMNEs and EMNEs differ in their approaches towards global innovation. We proposed three mechanisms through which global innovation can affect MNE innovation performance: MNE R&D intensity (García-Manjón and Romero-Merino, 2012; Roper et al., 2010), headquarter sourcing knowledge from home country clusters (Juhász and Lengyel, 2017), and geographic dispersion of overseas subsidiaries (Deng et al., 2020; Elia et al., 2020). We expected these effects to vary in the AMNEs and EMNEs cohorts that originated from different home country developmental trajectories. Using a comparative approach, this paper empirically examined these effects for the full-sample of MNEs and the sample of AMNEs and EMNEs, respectively. Our analysis built upon the global innovation of 358 MNEs including 116 EMNEs (from China and India) and 242 AMNEs (from France, Germany, Italy and US) for the time period 2006-2014. In this paper, we found that while R&D intensity on average has little effects on innovation outputs (patents), its benefits are significant for EMNEs but not AMNEs. We further found that AMNEs and EMNEs employ different innovation models: EMNEs rely more on the geographic dispersion of overseas subsidiaries to enhance innovation, while the effects of headquarter sourcing knowledge from home country clusters are not significantly different for AMNEs and EMNEs.

Chapter 4 (Paper 2) is a subsidiary-level analysis, which aims to provide a general explanation of subsidiary performance, especially how the performance of subsidiaries is influenced by MNEs' competence and host country environments. How competence created at home enables firms to internationalize is central to international business theory building, in particular, how firms internalize to serve the host markets and benefit from (generate returns) deploying their existing competence in different geographic markets. Therefore, the analysis of subsidiary performance variations offers valuable insight into how MNEs operate in host environments. To theorize a general model of subsidiary performance, we investigated how MNE subsidiaries benefit from their MNEs and home environments and whether and how AMNE subsidiaries and EMNE subsidiaries benefit from their MNEs and host environments differently. We distinguished between the host environment as a technological-rich environment measured by host patent stock and a host country IPR in this paper. We further tested the joint effects of MNEs R&D intensity and host environments on subsidiary profitability for the full sample (all subsidiaries), and sub-samples (AMNE subsidiaries and EMNE subsidiaries), respectively. Studying 4978 overseas subsidiaries of MNEs from France, Germany, Italy, US, China and India during 2006-2014, we found that AMNE subsidiaries rely more on internal competence (MNE R&D), while EMNE subsidiaries rely more on external competence (a technological-rich environment). Furthermore, compared with AMNE subsidiaries, EMNE subsidiarise with greater MNE R&D intensity are more positively influenced by host country technological richness. The joint effect of MNE R&D intensity and a host country IPR distance is not statistically different for AMNE subsidiaries and EMNE subsidiaries.

Chapter 5 (Paper 3) aims to provide a general explanation of MNE technology development and explore how ioSubs may contribute to the technology development of the MNE as a whole. In the Chapter 3 (Paper 1) and Chapter 4 (Paper 2), we have explored and explained the MNE global innovation at MNE-level and subsidiary-subsidiary. International business theory suggests that technological development gives firms competitive advantages, however, we still have limited understanding of MNE technological strategies and how specific technology portfolios are generated using overseas subsidiaries. Subsequently, in this chapter, we explore how MNE technological strategies differ at the level of technologies owned by their ioSubs. To achieve that, we developed a Taxonomy of Technological Integration and Diversification of MNEs based on two constructs: (1) Subsidiary Technological Integration (the degree of commonality shared by subsidiaries of the same MNE in their technology portfolios), (2) Subsidiary Technological Diversification (the extent to which the subsidiaries develop technologies across different technological fields). We therefore identify four clusters of ioSubs: Cluster 1 (Lone Wolf Exploration), Cluster 2 (Networked Exploitation), Cluster 3 (Mass Exploration) and Cluster 4 (Super Integration). We further explain the differences in the likelihood of AMNEs and EMNEs using acquisition to pursue certain technological strategy in the Taxonomy. Using a sample of 36,438 patents of 143 ioSubs belonging to 20 EMNEs (from China and India) and 31 AMNEs (from France, Germany, Italy and US) during the period of 2006-2014, we found that acquisition is most likely in Lone Wolf Exploration and Mass Exploration clusters and EMNEs are more likely than AMNEs to acquire ioSubs in Mass Exploration cluster.

The final chapter (Chapter 6), Discussion and Conclusion, summarises the key research findings, theoretical, empirical and practical contributions of the thesis and the final implications for future research.

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Chapter 2 Theoretical Overview

2.1 Need for A Comparative Approach

Comparative approach draws attention from different fields of social science, such as business studies (Chandler, 1990), economics (Greif, 2005), political science (Katzenstein, 1985), and sociology (Powell and DiMaggio, 1991). International Business (IB) is a field where multinationals (MNEs) are constantly in search of diverse environments, especially bring diverse home country contexts in their way of routines and capabilities and operate in different sets of environments where diverse opportunities and challenges may exist (Jackson and Deeg, 2008). Firms' internationalization has highlighted the important of context and comparative approach for understanding business behaviours and strategies of MNEs in IB field of research. Existing IB research has devoted to comparing the topography of home country institutional landscapes (e.g., Hu et al., 2019; Lin et al., 2009; Ma et al., 2011). The emphasis of this stream of literature is on how diverse institutions influence behaviours and strategies of embedded firms, often starting from a description of the elements comprising institutional environment (e.g., state capitalism, institutional development, latitude of objectives, culture context) and then comparing firms within specific national case (e.g., China vs. India, China vs. US, Taiwan vs. US) (Hu et al., 2019; Krause et al., 2019; Lin et al., 2009; Ma et al., 2011). For example, Hu et al. (2019) emphasises the importance of state capitalism and compares the effects of business group affiliation on firms' superior performance persistence between firms located in state-led systems of state capitalism (e.g., China) and firms in co-governed systems (e.g., India).

The comparative approach has been seen as the methodological tool that could assist the context-driven IB research and help researchers explicate how contextual idiosyncrasies influence the behaviours and strategies of firms. Despite a growing focus on comparative studies across institutional context in IB research, the meaning of context of firms remains contested. Relevant theoretical and empirical research has largely treated context as a "thin", measurable, exogenous and single-dimension variable, which hinders theorising (Poulis et al., 2013). In particularly, some studies capture context "as a set of interfering variables that need controlling" (Harvey and Myers, 1995, p.17), and others treat context as a single variable such as cultural environment or institutional context rather than in relation to distinct national constellation of factors that influence behaviours and strategies of firms (Hu et al., 2019; Jackson and Deeg, 2008). Hence, we argue for a deeper incorporation of context in IB research and suggest that context is complex, indigenous and multi-dimensional. As a result, context is defined as the surroundings (Cappelli and Sherer, 1991) or environmental forces (George and

Jones, 1997) associated with phenomena which help to illuminate that phenomena and a multi-dimensional combination of institutional, political, market, historical and organizational elements (Geppert et al., 2003; Yildiz and Fey, 2012).

Prior studies employing the comparative approach have predominantly focused on two different methodological approaches in the econometric analyses: one is the dummy variable approach based on a combined dataset, including data of both groups. This approach is consistent with the prior empirical studies (e.g., He et al., 2009; Lin et al., 2009) and these studies show that the dummy variable can effectively capture the difference between groups. More specifically, this approach is to include a group dummy variable that distinguishes two groups of the sample, with a value of 1 assigned to one group and 0 assigned to another group, and to examine the moderating effect of the group dummy variable on the main hypothesized effects. The other one is the split subsample analysis approach based on separate analysis in each group, which follows the approach of the prior empirical studies (e.g., Lin et al., 2009; Ma et al., 2011). Specifically, this approach is to conduct subsample analysis in each group and examine the general effects on different groups in order to compare the pattern of the effect of one group with that of the other group.

The dummy variable approach captures the difference between groups and understands how two groups of firms may behave differently from each other, while the split subsample analysis approach captures the differences within each subsample group and understands how firms within each subsample group may behave differently from each other. Therefore, the split subsample approach helps to gain deeper understanding of the general effects (e.g., social networks on opportunity identification, Ma et al., 2011) because it provides the opportunities to capture between-group and within-group differences on the general effects. In this thesis, we chose the split subsample analysis approach because it fits our object that is not only to understand the differences between groups, but also to gain deeper insights into how firms within each group may behave differently.

The remarkable rise in internationalization activities by MNEs originated from emerging markets (EMNEs) has highlighted the importance of contexts (e.g., advanced markets and emerging markets) for understanding MNEs' behaviours and strategies, especially their varied global innovation strategies (Awate et al., 2015; Hoskisson et al., 2013). Differences observed across MNEs from advanced (AMNEs) and emerging markets challenge the existing theories to explain the behaviours and strategies of EMNEs given their particularities (Cuervo-Cazurra, 2012). Existing research has illustrated how EMNEs differ from AMNEs in their home country conditions (e.g., institutional environment, resource endowments, Cuervo-Cazurra and Genc, 2008) and in their firm specific characteristics from a historical point of view (e.g., MNE size, MNE knowledge stock, Cuervo-Cazurra, 2012). Advancement in this stream of research has seen further theorisation and testing of how these particularities of EMNEs affect their internationalization and innovation strategies such as location choices of their subsidiaries (e.g., Elia et al., 2020), the entry mode choices of their subsidiaries (e.g., Alon et al., 2020; Kedia et al., 2012) and roles of their subsidiaries (Awate et al., 2015). Section 2.2 summarizes the previous arguments on the differences between AMNEs and EMNEs in detail and groups these differences into three dimensions - MNE home country conditions, firm-specific characteristics, and MNE internationalization and innovation strategies. However, the differences between AMNEs and EMNEs in their global innovation remains unidentified, especially how the above differences are inter-related and work together to affect the differences between AMNEs and EMNEs in their models of global innovation (headquarter-led vs. subsidiary-led innovation), the determinants of MNE subsidiary performance (internal MNE competence vs. external host environments), and their approaches towards technological development, which provides opportunities for our three comparative empirical chapters (papers). By applying the comparative approach and comparing global innovation of AMNEs and EMNEs, this thesis aims to develop a general explanation of MNE global innovation (see detailed discussion in Section 2.3). Our comparison between AMNEs and EMNEs theoretically contributes to the debate regarding the merits of using the observations of EMNEs to extend existing theories (e.g., internalization theory) and empirically contributes to the micro-level comparative research on MNE global innovation (see detailed discussion in Section 2.4).

2.2 Limited Evidence of Differences between AMNEs and EMNEs

Existing IB literature has emphasized the differences between AMNEs and EMNEs from different dimensions. Prior studies summarize the differences between the institutional environments of emerging markets and advanced markets adopting the rational that institutions shape organizational behaviours (Beckert, 1999; North, 1990). Compared with AMNEs, EMNEs are originated from a relatively weak and unpredictable institutional environment that is characterized by incomplete formal regulatory frameworks, poor law enforcement, weak intellectual property regime (IPR), weak national innovation system, and lower control of corruption (Cuervo-Cazurra and Genc, 2008). In contrast, AMNEs are originated from environments with sophisticated regulatory frameworks, strong law enforcement, mature IPR, strong national innovation system and stable political systems (Hoskisson et al., 2000).

Additionally, advanced markets are typically technologically superior with a relatively larger pool of advanced technologies, professionals and competent service providers (Govindarajan and Ramamurti, 2011), while emerging markets are technologically inferior with relatively limited pool of advanced technologies, professionals and service providers (Khanna and Palepu, 2000; Kumaraswamy et al., 2012).

Next, empirical studies have shown the firm-specific differences between AMNEs and EMNEs in terms of firm size, knowledge stock, innovative capabilities, internationalization experiences and expertise. AMNEs are often technological leaders with superior knowledge stock and greater innovative capabilities (Govindarajan and Ramamurti, 2011), whereas EMNEs significantly lag behind in these terms, e.g., with relatively lower R&D inputs and lower level of technology portfolios (Awate et al., 2012; Peng, 2012). Moreover, AMNEs are often considered "mature MNEs" because of their earlier start of cross-border ventures and their accumulated internationalization experiences (Luo and Tung, 2007). In contrast, EMNEs are "infant MNEs" because they have embarked their journey of internationalization and global innovation only during recent decades (Zhao and Hsu, 2007).

Following this, early studies on MNEs' internationalization and innovation strategies (Alon et al., 2020; Awate et al., 2015; Elia et al., 2020) show that EMNEs are distinct from AMNEs in terms of their speed, scope and means of internationalization, which is reflected in the location as well as the entry mode choice of their subsidiaries (Nayyar, 2008; UNCTAD, 2006). More specifically, prior studies emphasize EMNEs' tendency in overseas acquisitions in advanced markets with a greater host-home IPR distance in the early stage of their internationalization (Cuervo-Cazurra, 2012; Madhok and Keyhani, 2012). Additionally, research on MNE R&D internationalization shows that overseas subsidiaries serve different roles within AMNEs' and EMNEs' R&D internationalization. By examining the knowledge flows into subsidiaries of two leading MNEs in wind turbine industry -AMNE (Danish company Vestas) and EMNE (Indian company Suzlon) - Awate et al. (2015) suggests that overall subsidiaries of AMNEs primarily source knowledge from their home countries, while overall subsidiaries of EMNEs tend to source more knowledge from their host countries.

In order to examine the validity of above arguments on a larger group of AMNEs and EMNEs from different countries and industries during a longer period of time, we undertook similar patent analyses as those in Awate et al. (2015, Table 5 Share of home and host countries in knowledge inflows into Vestas subsidiaries, p.72; Table 9 Share of home and host countries in knowledge inflows into Suzlon subsidiaries, p. 77) based on the patent portfolios of overseas subsidiaries of AMNEs (from France, Germany, Italy and US) and those of EMNEs (from

China and India). This dataset is also used in Chapter 5 (Paper 3) to group innovative subsidiaries into different clusters. Since AMNEs and EMNEs have increasingly distributed their innovative activities across borders to become networked and embedded (Papanastassiou et al., 2020), this replication of previous work examining the internal and external knowledge flows into subsidiaries also helps us to better understand AMNEs and EMNEs from a networked point of view, especially knowledge networks, which leads to a more complete capture of the differences between AMNEs and EMNEs in this thesis. We followed the steps of patent analyses in Awate et al. (2015) and captured the knowledge inflows using backward citations made by subsidiary patent portfolios. We distinguished the knowledge flows from home countries, host countries and other countries except home and host countries using the country locations of the applicant firms of these backward citations made by subsidiary patent from 1953 to 2014. Figures 2.1 and 2.2 show the share of home, host and other countries in knowledge inflows into EMNE overseas subsidiaries and AMNE overseas subsidiaries, respectively. We can observe a similar pattern as the results in Awate et al. (2015), where EMNE subsidiaries draw a larger amount of knowledge from host countries than from their home countries, whereas AMNE subsidiaries draw a larger amount of knowledge from home countries as compared with host countries. We can further observe that AMNE subsidiaries are evolving to source more and more knowledge from their host countries since 2000s and EMNE subsidiaries are increasingly sourcing more knowledge from their home countries since 2000s.

Figure 2.1 Share of home, host and other countries in knowledge inflows into EMNE overseas subsidiaries during 1953-2014

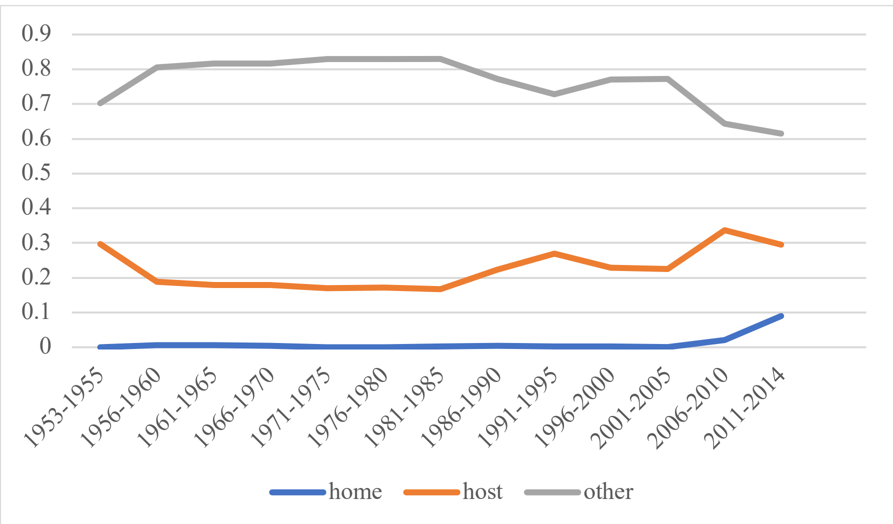
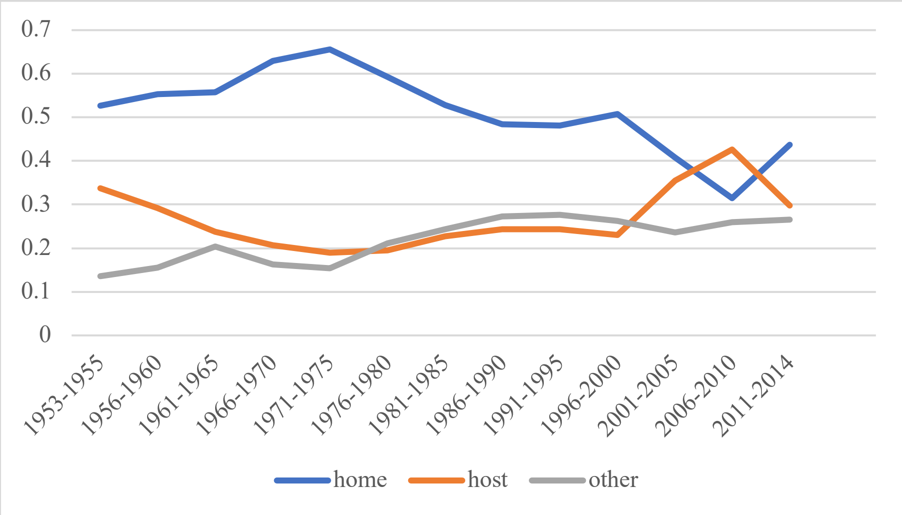


Figure 2.2 Share of home, host and other countries in knowledge inflows into AMNE overseas subsidiaries during 1953-2014



Existing literature sheds light on the differences between AMNEs and EMNEs from different dimensions, however, there is still limited evidence on how AMNEs and EMNEs differ in their global innovation, especially how these above differences may interact and work together to naturally influence firms' strategies in their global innovation processes, which open avenues for our research in search for a general explanation of MNE global innovation based on a more complete comparison between AMNEs and EMNEs at different level, especially at MNE-level, subsidiary-level and the level of technologies owned by individual innovative subsidiaries (ioSubs).

In summary, above section shows the institutional difference between advanced markets and emerging markets, the firm-specific differences between AMNEs and EMNEs, the differences between AMNEs and EMNEs in their internationalization and innovation strategies. However, these idiosyncratic characteristics and behaviours of EMNEs have generated questions about the existing theories especially whether and how the existing theories building upon the observations of AMNEs can fully explain the behaviours of EMNEs, which will be discussed in the next section.

2.3 IB: A General Theory

Recent literature on global innovation of EMNEs raises a debate regarding whether generalizability of classic paradigm or proposition of new theories for explaining phenomenon in emerging markets (Cuervo-Cazurra, 2012; Buckley et al., 2007; Hernandez and Guillén, 2018). Some scholars suggest that the distinct behaviours of EMNEs require new theories and models to explain (Mathews, 2006; Luo and Tung, 2007, 2018). For example, Luo and Tung

(2007) proposes a springboard perspective and argues that internationalization can be seen as a springboard for EMNEs to avoid home country institutional and market constraints, leapfrog the technological development process at home and gain access to strategic assets they needed to build their competitive advantages. However, we argue that these theories emphasize more on the distinct home country context of EMNEs and can only be used to explain the new arising phenomenon of EMNEs, therefore, a general theory about how MNEs develop global innovation remains unidentified. Following other scholars who suggest that the analysis of EMNEs can help to extend existing theories by bringing in home country context (e.g., Cuervo-Cazurra, 2012; Ramamurti, 2012), we argue that EMNEs can be used as a special application of traditional theories and the studies of EMNEs can contribute to the extension of traditional theories (e.g., internalization theory and transaction cost theory) by identifying the mechanisms and boundary conditions.

A comparative approach between AMNEs and EMNEs in their global innovation will help to achieve the goal of having a general model that integrates and explains contrasting observations. In order to reveal the mechanisms and boundary conditions of a general model and understand the true nature of the differences between AMNEs and EMNEs in their global innovation, comparisons between AMNEs and EMNEs are approached from different levels in this thesis: (1) MNE level - how AMNEs and EMNEs rely on headquarters vs. subsidiaries differently to enhance their innovation, in the first instance, which enables us to gain a better understanding of global innovation models of MNEs and opens avenue for our further research into detailed investigations of MNE overseas subsidiaries, (2) subsidiary level - how overseas subsidiaries of AMNEs and EMNEs benefit from parent MNE competence and host country environments differently, which enables us to gain a better understanding of how firms internalize and operate in host environments in order to gain and sustain their competitive advantages, (3) the level of technologies owned by ioSubs – how AMNEs differ from EMNEs in their approaches to develop technology using ioSubs, which enables us to gain a deeper understanding of MNE technology development using ioSubs. The differences between AMNEs and EMNEs we explored from different levels give us a full picture of MNEs global innovation. As differences between AMNEs and EMNEs are presuming at different levels, we assume that the differences between AMNEs and EMNEs can be detectable in different datasets. That is also the reason of the following three papers working on different datasets to compare AMNEs and EMNEs in terms of their global innovation.

Distinct home country conditions and firm-specific characteristics are observed between AMNEs and EMNEs (see detailed discussion in Section 2.2). Incorporating such differences in our MNE-level analysis in Chapter 3 (Paper 1) provides valuable opportunities for exploring how firms that at different ends of developmental spectrum may rely on their headquarters and subsidiaries differently to develop their global innovation, which subsequently contributes to exploring a unifying explanation of MNE global innovation model. Distinct home country conditions and subsidiary home-host IPR distance are observed between AMNE subsidiaries and EMNE subsidiaries. Incorporating such differences in our subsidiary-level analysis in Chapter 4 (Paper 2) provides valuable opportunities for exploring how subsidiaries of different cohorts of MNEs may rely on their internal MNE competence and external host environments differently, which subsequently contributes to exploring a unifying explanation of how MNE operate in host environments. Distinct home country conditions and MNE internationalization and innovation strategies are observed between AMNEs and EMNEs (see detailed discussion in Section 2.2). Incorporating such differences in our ioSubs analysis in Chapter 5 (Paper 3) provides valuable opportunities for exploring how MNEs from different home country conditions may develop their technologies using subsidiaries differently, which subsequently contributes to exploring a unifying explanation of MNE technology development. Table 2.1 summarizes the differences between AMNEs and EMNEs shown in prior studies from three dimensions and the opportunities for our research to explore a general theory.

2.4 Contributions of the Comparative Approach

The comparison between AMNEs and EMNEs from three levels together will theoretically contribute to identify the mechanisms and boundary conditions of traditional internalization theory in explaining firms' global innovation. While the classic internalization theory focuses on explaining the unidirectional version of competence creation and transfer (Buckley and Casson, 1976), the study of comparison between AMNEs and EMNEs extends the classic internalization theory to explain the competence creation in overseas subsidiaries and the multi-directional competence transfer within the MNEs (i.e. headquarter-to-subsidiary, subsidiary-to-headquarter, intra-subsidiaries) (Rugman and Verbeke, 2003). First, Chapter 3 (Paper 1) helps to extend classic internalization theory through emphasizing the role of overseas subsidiary in tapping into local knowledge reservoir and creating competence for the use of the whole MNE. Second, Chapter 4 (Paper 2) helps to extend classic internalization theory through explaining how overseas subsidiaries benefit from the host environments. Third, Chapter 5 (Paper 3) helps to extend internalization theory through explaining how MNEs develop their technologies with different technological strategies incorporating internal multi-directional competence transfer.

The comparison between AMNEs and EMNEs from three levels together will contribute to the micro-level empirical research on this topic. Limited research has explicitly compared the global innovation of large cohorts of AMNEs and EMNEs except a few papers which is mainly based on case studies (Awate et al., 2015), on particular industries (e.g., wind turbine industry, Awate et al., 2015; industrial machinery and equipment sector, Giuliani et al., 2014), on firms from a specific home country (e.g., firms from India and Sweden, Awate et al., 2015) and overseas subsidiaries in specific host countries (e.g., subsidiaries in India, Lahiri et al., 2014; subsidiaries in Italy and Germany, Guiliani et al., 2014). This study empirically utilizes both MNEs-level and subsidiary-level evidence capturing MNEs - originated from a number of large and innovative emerging and advanced markets and operating in a number of industries -, and overseas subsidiaries or ioSubs - located in a large number of host countries including advanced markets and emerging markets and generating profits or patents.

Table 2.1 Differences between AMNEs and EMNEs and opportunities for exploring a general explanation

		AMNEs	EMNEs	References	Opportunities for a general explanation	Descriptive from this thesis	Chapter for the investigation
Home country conditions	Institutional environments	Relatively more developed institutions that are characterized by sophisticated regulatory frameworks, strong law enforcement, mature intellectual property regime, strong national innovation system and stable political systems	Relatively weak and unpredictable institutional environments that are characterized by incomplete formal regulatory frameworks, poor law enforcement, weak intellectual property regime, weak national innovation system, and lower control of corruption	Cuervo-Cazurra and Genc, 2008; Elia and Santangelo, 2017; Hoskisson et al., 2000; Ramamurti and Singh, 2010	Distinct home country developmental trajectories exist and affect how MNEs effectively carry out global innovation, which provides opportunities for a general explanation of global innovation by MNEs from distinct home country environments.		
	resources endowments	A larger pool of advanced technologies, professionals and service provider	Limited pool of advanced technologies, professionals and service provider	Cuervo-Cazurra and Genc, 2008; Kumaraswamy et al., 2012	Distinct home country developmental trajectories exist and affect how MNEs effectively carry out global innovation, which provides opportunities for a general explanation of global innovation by MNEs from distinct home country environments.		
Firm-specific characteristics	MNE size	Relatively larger proportion of large MNEs	Relatively larger proportion of small MNEs	Contractor et al., 2007	Cohorts of MNEs that are at different ends of developmental spectrum may employ different strategies for global innovation, which provides opportunities for a general explanation of how different cohorts of MNEs may rely on their headquarters and subsidiaries differently to develop their global innovation.	**Figure 3.3** Distribution of MNE size	Chapter 3
	MNE knowledge stock and technological capabilities	Technological leaders with superior knowledge stock and innovative capabilities	Technological laggards with lower levels of knowledge stock and innovative capabilities	Awate et. al., 2012; Govindarajan and Ramamurti, 2011; Peng, 2012	Cohorts of MNEs that are at different ends of developmental spectrum may employ different strategies for global innovation, which provides opportunities for a general explanation of how different cohorts of MNEs may rely on their headquarters and subsidiaries differently to develop their global innovation.	**Figure 3.4** Distribution of MNE R&D Expenditure	Chapter 3
	MNE degree of internationalization	"Mature MNEs" because of their earlier start of cross-border ventures since centuries ago	"Infant MNEs" because they have embarked their journey of internationalization only during recent decades	Dunning, 1993; Wikipedia, 2018; Zhao and Hsu, 2007	Cohorts of MNEs that are at different ends of developmental spectrum may employ different strategies for global innovation, which provides opportunities for a general explanation of how different cohorts of MNEs may rely on their headquarters and subsidiaries differently to develop their global innovation.		
MNE internationalization and innovation strategies	Subsidiary host-home country IPR distance	Relatively weak IPR of host countries compared with that of home countries	Relatively stronger IPR of host countries compared with that of home countries	Luo and Tung, 2007; Piperopoulos et al., 2018; Ramamurti, 2012	Subsidiaries owned by different cohorts of MNEs may experience distinct host-home institutional distance, which provides opportunities for a general explanation of how MNE operate in host environments	**Figure 4.4** Distribution of IPR distance from host to home country	Chapter 4
	Subsidiary location choice	Technological competitive countries	Countries with most advanced technologies	Awate et al., 2015	MNEs from different home country conditions may develop their technologies using subsidiaries	**Figure 5.5** Distribution of the location rank of the host countries of ioSubs	Chapter 5

	Entry mode choice	A relatively lower likelihood of acquisition	A higher likelihood of acquisition	Kedia et al., 2012; Madhok and Keyhani, 2012	differently, which provides opportunities for a general explanation of MNE technology development.	**Table 5.4** Distributions of sampled ioSubs across four clusters by acquisition	Chapter 5
	Source of knowledge inflows into overseas subsidiaries	Subsidiaries draw more knowledge from home than host countries and these subsidiaries evolve	Subsidiaries draw more knowledge from host than home countries and these subsidiaries evolve	Awate et al., 2015		1. **Figure 2.1** Share of home, host and other countries in knowledge inflow into EMNE subsidiaries during 1953-2014 2. **Figure 2.2** Share of home, host and other countries in knowledge inflow into AMNE subsidiaries during 1953-2014	Chapter 2

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Chapter 3: How do Emerging Market MNEs and Advanced Market MNEs innovate?

ABSTRSCT
Global innovation is a battle ground for advanced (AMNEs) and emerging market multinational enterprises (EMNEs). We examine whether and how AMNEs and EMNEs innovate differently. Our analysis of EMNEs (from China and India) and AMNEs (from France, Germany, Italy and US) shows that, while R&D intensity on average has little effect on innovation outputs (patents), its benefits are significant for EMNEs but not AMNEs. We also find that AMNEs and EMNEs employ different innovation models: EMNEs' innovation tends to more influenced by the subsidiary-led innovation. Specifically, the effect of geographic dispersion of overseas subsidiaries is stronger for EMNEs than for AMNEs. Our results also suggest that the effect of headquarters sourcing knowledge from home country clusters does not statistically differ between AMNEs and EMNEs. Unifying these differences, we theorise a general model of MNE global innovation.

Keywords: global innovation, patents, EMNEs, AMNEs, headquarter-subsidiary roles

3.1 Introduction

Global innovation is a key 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 those from emerging markets (EMNEs) (Chen et al., 2012; He et al., 2017). A widely accepted argument is that AMNEs expand globally building upon superior technologies and strong innovative capabilities, while EMNEs generally originated from relatively under-developed world have lower levels of technological stock and innovative capabilities before internationalization (Cuervo-Cazurra, 2008; Luo and Tung, 2007). In this context, global innovation by EMNEs has been viewed as a catch-up strategy for seeking superior knowledge from advanced markets (e.g., Awate et al., 2015; Ramamurti and Singh, 2010; Ramamurti, 2016).

While extant studies exploring global innovation are often based on observations of AMNEs, the role of EMNEs in the global innovation has attracted relatively lower but albeit-growing attention in recent research, especially how EMNEs internationalize to gain competitive advantages (Nieto and Rodríguez, 2011; Hernandez and Guillén, 2018; Wang et al., 2018). Moreover, limited research has explicitly compared the global innovation of large cohorts of AMNEs and EMNEs; as a result, we know very little about whether and how EMNEs differ from AMNEs in their approaches towards innovation. Subsequently, a general explanation of how MNEs develop global innovation remains unidentified and our study aims to fill in this gap by making the very first step towards it - a comparison of innovation models of a large number of AMNEs and EMNEs, assisting the understanding of firms in both ends of the developmental spectrum.

There are several reasons why these gaps are important. Firstly, prior research suggests that global innovation is a key mechanism that enables MNEs to exploit and augment their competence (Almeida, 1996). Existing research provides useful insights into why global innovation enhances firms' innovation and facilitates the accumulation of intellectual property assets (i.e., patents) (Elia et al., 2020; Frank et al., 2016), and particularly how firm size (Vrontis and Christofi, 2019) and the relative level of global technology frontier of the home country (Belderbos et al., 2015) may play a role. However, these studies have only considered the contingent effects of firm-specific and country-specific factors, essentially assuming the random distribution of these occurrences across the population of firms examined. Failing to acknowledge that such assumption does not reflect reality and that significant between-cohort differences arising from distinct home country developmental trajectories hinders theoretical development. We, therefore, argue that a test of whether models of global innovation differs between the cohorts of AMNEs and EMNEs is warranted.

Secondly, previous studies suggest the temporal sequence of subsidiary mandate changes for a general population of MNEs (e.g., Achcaoucaou et al., 2014; Cantwell and Mudambi, 2005), while recent case studies show that subsidiary mandates differ between AMNEs and EMNEs that compete contemporarily in the same industry (e.g., Awate et al., 2015). However, we have a very limited understanding of whether and how global innovation paths of using headquarters and subsidiaries differ across AMNEs and EMNEs and how that may affect their innovation performance. It is therefore puzzling as what exact principles underpin MNEs' development overtime - how do AMNEs and EMNEs rely on their headquarters and subsidiaries to source external resources and capabilities differently to innovate? Examining a large number of AMNEs and EMNEs that compete contemporarily and globally, our study contributes to this body of research by testing the variations in the influences of headquarters and subsidiaries between AMNEs and EMNEs cohorts and the relative influences of headquarters vs. subsidiaries within each cohort.

Thirdly, existing research mainly focuses on explaining why observations from advanced markets cannot be used to predict the behaviours of EMNEs (e.g., Hoskisson et al., 2000; Ramamurti, 2016) and the importance of understanding global innovation by EMNEs (e.g., Awate et al., 2015; Rugman and Verbeke, 2003). But we do not yet have a general model that integrates and explains contrasting observations. By developing a conceptual framework and testing it on comparative cohorts of firms, our study contributes with valuable insights to this domain.

To address these gaps, we use a comparative approach. We examine how AMNEs and EMNEs rely on in-house R&D differently to innovate, and how they rely on headquarters' presence in clusters vs. subsidiaries' geographic dispersion differently to enhance innovation outputs. Specifically, by testing the effects of headquarters' knowledge sourcing from local clusters, we examine the roles of headquarters on global innovation by AMNEs and EMNEs. We also examine the roles of subsidiaries by testing the effects of geographic dispersion of overseas subsidiaries on innovation outputs of AMNEs and EMNEs. Thus, comparisons between cohorts of firms and, for the same cohort, among key determinants of global innovation (R&D intensity, headquarter and subsidiaries) enable us to map AMNEs and EMNEs on a developmental spectrum that reveal general principles of change in MNEs. Using the most comparable and comprehensive secondary data of MNEs available (BvD database), our data captures global innovation of 358 MNEs including 116 EMNEs (from China and India) and 242 AMNEs (from France, Germany, Italy and US) for the time period 2006-2014.

3.2 Theoretical Background

3.2.1 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 serve as agents for such internal knowledge transfer between home and host countries (Forsgren et al., 2005). Knowledge transfer within the firms' networks generates opportunities for MNEs to apply their valuable resources and capabilities to the global markets (Awate et al., 2015). By internalizing local resources and capabilities, subsidiaries create new knowledge-based assets 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 gain and 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 innovative activities (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 transfer and leverage existing knowledge developed at home in order to extend the knowledge across locations (Chen et al., 2012). The second is to augment firms' knowledge base by tapping into diverse global knowledge reservoirs (Kafouros et al., 2012). The two models differ significantly and, as we shall explain in later section, both AMNEs and EMNEs use them as an adaptive process to tune their innovation to contexts in order to remain competitive.

MNEs need to manage their global innovation carefully, in both inputs and outputs. Studies show that MNE innovation performance is affected by internal generation of knowledge (e.g., in-house R&D investment) as well as external knowledge sourcing (e.g., Becker and Dietz, 2004; Frenz and letto-Gillies, 2009). The studies on MNE global innovation suggest that investment in R&D enables firms to create an internal stock of knowledge, advance existing technologies and adapt products to local markets (Cantwell and Mudambi, 2005). Since external knowledge serves as the seed for future innovations (Griliches, 1992), a more diverse range of literatures attributes determinants of MNE innovation outputs to external knowledge sourcing from home country and host countries of the overseas subsidiaries (e.g., Li and Bathelt, 2020; Song and Shin, 2008). Building upon studies on innovation, we propose that headquarter can affect MNEs' innovation outputs by locating in the clusters as it constitutes a unique external knowledge sourcing process (Porter, 1998). Being in the industrial clusters provides the headquarters with valuable opportunities to gain access to new technological knowledge, skilled labours, resources and government support (Li, 2014). Building upon theoretical knowledge from the fields of internationalization and innovation, we also propose that an international portfolio of subsidiaries can influence MNEs' innovation outputs. When firms engage in international expansion and operate in multiple locations, they can source diversified and differentiated knowledge from different locations (Elia et al., 2020; Kafouros et al., 2012).

Studies also show that MNE innovation performance is affected by the process of internal knowledge management (Mudambi and Navarra, 2004). Resources and capabilities of headquarters and subsidiaries can be mobilised within the MNE, leading to enhancement of knowledge and capabilities of the MNE as a whole (Ambos et al., 2006; Bartlett and Ghoshal, 1989). However, research rarely examines how contexts serve as latent factors influencing these mechanisms. Variations in operational conditions such as institutional environment determine the availability of resources and knowledge combinations existing in the market of innovation (Aulakh et al., 2016; Hoskisson et al., 2000). However, "Contexts" go beyond the single dimension variable such as institutional variations. A nation's developmental trajectory results in distinct methods of international expansion (Hernandez and Guillén, 2018; Santangelo and Meyer, 2017) and subsequently models of global innovation. Contrasting headquarter-subsidiary relationships in MNEs of different country origins (Awate et al., 2015) is evidence of powerful contexts.

The bulk of literature on global innovation has been developed using observations of AMNEs (e.g., Cantwell and Mudambi, 2005, 2011; Dunning and Narula, 1995), while recent literature on EMNEs (Luo and Tung, 2007, 2018) implicitly treat EMNEs as a special case of AMNEs. But are they? Few studies explicitly compare global innovation by AMNEs and

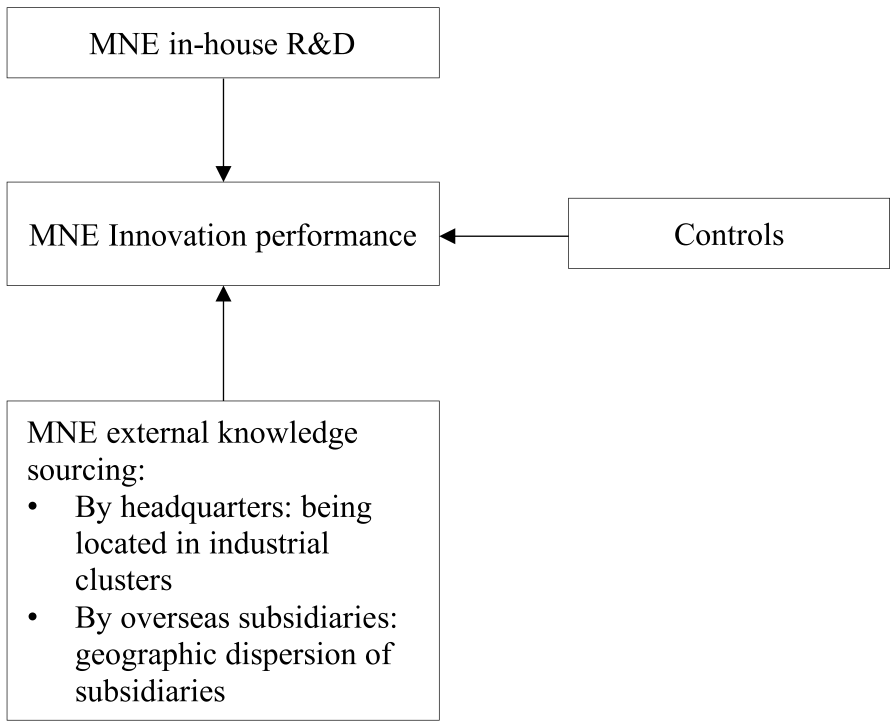
EMNEs. MNEs from emerging markets are regards latecomers with deficit technological know-how and innovative capabilities compared with advanced market rivals (Cantwell, 1989; Ramamuti and Hillemann, 2018). While AMNEs expand geographically to utilize competence developed at home (Dunning, 1988), EMNEs are said to employ a technological catch-up strategy (Ramamurti and Singh, 2010; Ramamurti, 2016). Unlike AMNEs, international expansion becomes an important strategy for EMNEs to leapfrog the multi-generation technological development conducted by AMNEs through sourcing requisite knowledge from their counterparts in advanced markets (Awate et al., 2012). These perspectives highlight the role of EMNEs' overseas subsidiaries as sourcing superior technological knowledge but present a contradiction – that while AMNEs are seen superior, for EMNEs, they are neither the aspirational model nor the effective means for achieving such a goal.

Innovation performance represents the effectiveness of transforming resources and knowledge inputs into innovation outputs (Love and Roper, 1999). Successful innovation assists firms in reducing manufacturing cost, introducing new products and gaining monopoly power of their new knowledge (Levin et al., 1987). Prior literature suggests that both patents and new products effectively capture innovation outputs of firms (García and Salomon, 2013; Jin et al., 2019). Unlike the introduction of new products as the physical embodiment of new knowledge, patents capture the creation of underlying "new to the market" knowledge (Griliches et al., 1986), and are believed to be an objective and observable measure (Adegbesan and Higgins, 2010). Patents reflect a firm's performance in terms of creating technology that is granted monopoly power over other similar ideas (Somaya, 2012), is tradable on a market through, e.g., licensing (Steensma et al., 2015), and increases a firm's bargaining power in patent disputes with rivals (Noel and Schankerman, 2013). MNEs around the world have actively engaged in patenting to manage their innovation outputs (Steensma et al., 2015). Thus, our conceptual framework (Figure 3.1) incorporates the mechanisms for MNEs' global innovation in this study.

3.2.2 The Roles of Headquarters and Subsidiaries in Innovation

Headquarters and subsidiaries play important roles in internally transferring knowledge as a strategic resource of MNEs (Rabbiosi and Santangelo, 2013). MNEs engage in different types of knowledge transfer, ranging from headquarter-to-subsidiary to subsidiary-to-headquarter reverse transfer (Bartlett and Ghoshal, 1989; Mudambi and Navarra, 2004; Vernon, 1966). The asymmetrical relationships between headquarters and subsidiaries have

Figure 3.1 Conceptual framework



been conceptualized from an evolutionary perspective. In the early stage of development, an MNE employs a headquarter-to-subsidiary transfer model while, in the advanced stage of development, subsidiaries of an MNE start to engage in competence creating rather than exploiting (Cantwell, 2017), and hence reversely transfer knowledge to headquarters. This stream of research implicitly assumes that there is a temporal sequence of the change in the asymmetrical relationships between headquarters and subsidiaries. This conceptualisation fits AMNEs well because early studies (e.g., Bartlett and Ghoshal, 1989; Hedlund, 1994) draw on observations of innovation activities of AMNEs, but what does it do for EMNEs (Ambos et al., 2006; Govindarajan and Ramamurti, 2011)?

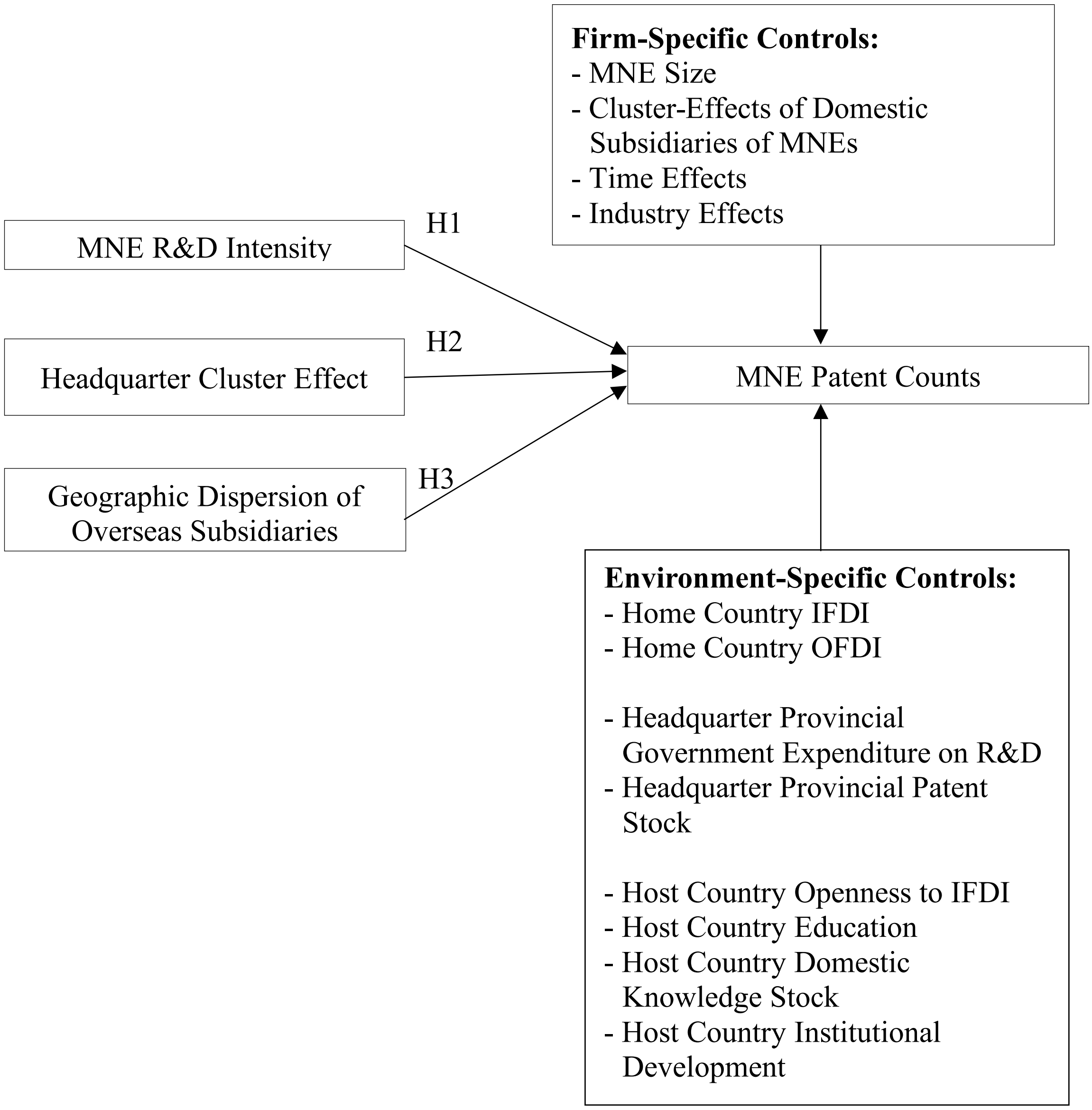
MNEs initially build competence at home (typically at the headquarters) by conducting experimental R&D – a primary competence-creating process, and then transfer such competence to subsidiaries worldwide through internal networks (Buckley and Casson, 1976, 2009). Subsidiaries apply knowledge from headquarters to conduct innovative activities in order to adapt products to the local markets (Birkinshaw, 1996; Birkinshaw and Hood, 1998) - a competence-exploiting process (Cantwell and Mudambi, 2005). This theory suggests that headquarters play the role of accessing home country knowledge that is deemed superior internationally, creating and supplying such strategic resource to overseas subsidiaries to support their innovation, while the subsidiaries serve the role of knowledge recipients (Awate et al., 2015). During the past decades, based on again observations of AMNEs, some subsidiaries are found to source knowledge locally and generate new competence for the use of the whole MNE (Frost et al., 2002). With "competence-creating subsidiary mandate" (Cantwell and Mudambi, 2005), these subsidiaries are considered to have evolved to play a more proactive and creative role in generating new knowledge and serve the role of competence supplier in MNEs' global innovation (Awate et al., 2015).

Applying this conceptualisation to EMNEs, we immediately see contradictions. First, EMNE headquarters may access home country knowledge which however is not likely to be superior internationally (Peng, 2012). The value of such competence is reduced if its global application is limited. Indeed, foreign ventures are established to seek superior knowledge from host markets in order to leapfrog the stage of knowledge development at home (Luo and Tung, 2007). By sourcing requisite knowledge from host markets, overseas subsidiaries create new competences unavailable at home (Luo and Tung, 2007), but this takes place not in the later stage of development of an EMNE but in the early stage. "Chinese companies had the 7th largest foreign footprint of all countries with 178 R&D centres set up or acquired outside China by the end of 2015" (Von Zedtwitz and Gassmann, 2016, p.125). In other words, using early conceptualisation, EMNEs appear to evolve backwards. The fact that some EMNEs are gaining success in technological battle grounds globally is an evidence of effectiveness of their global innovation model, shedding lights on the importance of bridging conceptualisation of AMNE innovation with observations of EMNE innovation.

3.3 Hypotheses Development

Our analysis draws upon theories that explain why and how MNEs engage in international knowledge transfer and global innovation and the roles of headquarters and subsidiaries in such processes. Using a comparative approach with the aim to bridge different conceptualisations, our analytical framework (Figure 3.2) incorporates some key constructs suggested in the extant literature for global innovation by AMNEs and EMNEs. Hence, we include constructs from the general innovation literature - firm's internal R&D intensity and constructs of international knowledge transfer using different headquarter-subsidiary models. Furthermore, because of the importance of contexts in terms of emerging market vs. advanced market developmental trajectories, we include constructs that capture such differences in home and host markets of an MNE. In the following section, we develop hypotheses to predict how AMNEs and EMNEs differ in the effects of key conducts.

Figure 3.2 Analytical framework



3.3.1 R&D Intensity

Extant research emphasizes the important role of internal R&D investment (e.g., García-Manjón and Romero-Merino, 2012; Roper et al., 2010), the prerequisites of which are financial and human capital (Guan et al., 2009) owned by the firm or available to it from the external markets. Firms typically innovate while "running to standstill" in technological race (Greenhalgh and Longland, 2005); maintaining R&D intensity (ratio of annual R&D expenditure over sales revenue) becomes a key indicator of commitment to enhancing innovation performance.

For AMNEs, the importance of R&D intensity for maintaining their technologically superior status has been studied for decades. However, evidence suggests that, being on the top of the technology spectrum, complexity of ideas and intensity of competition mean that the effect of R&D intensity on innovation outputs is uncertain. Firstly, in-house R&D effort alone becomes less effective because valuable ideas reside largely outside of firm boundaries (Chesbrough et al., 2006). Therefore, investment in buying or sourcing creative ideas outside the firm becomes crucial for AMNEs' innovation performance. Specifically, acquisition of most innovative start-ups has become an important channel for AMNEs to gain access to valuable ideas towards innovation (Cassiman and Veugelers, 2006). For example, Cisco system, an American technology conglomerate specialised in high-technology services and products, has acquired Hungry-based Banzai Cloud for their knowledge in end-to-end cloud-native application development (Centoni, 2020; Jose, 2021). Secondly, R&D by AMNEs aims to defend their technological frontiers in face of global competition but pushing the frontiers of science is a highly risky endeavour, with uncertain outputs. Indeed, there is higher risk in R&D investment for AMNEs compared to that for EMNEs (McKinsey & Company, 2018)

For EMNEs, being on the lower end of the technology spectrum, technological race is of a different nature. Unlike AMNEs, R&D intensity of EMNEs aims to comprehend existing technology frontiers and identify opportunities to respond to markets using such knowledge. Hence, for EMNEs, R&D intensity is more about maintaining the firm's absorptive capacity (Cohen and Levinthal, 1990; Gupta and Govindarajan, 2000). EMNEs are considered to come from relatively resource-poor home environments, where there is typically a lack of financial and human capital necessary for the kind of in-house R&D AMNEs conduct (Cuervo-Cazurra, 2012). The absorptive capacity approach to innovation competition is most likely to be effective and generate outputs (e.g., Chudnovsky et al., 2006). This corroborates the remarkable growth in the share of world's R&D investment by emerging markets (UNCTAD, 2005).

Although general innovation theory emphasizes the importance of R&D intensity, it plays different roles for AMNEs and EMNEs because of firms' positions in the technology spectrum and their home country conditions that foster or restrict internal R&D efforts. Hence, we propose the following hypothesis:

> ***Hypothesis 1:*** *The positive effects of R&D intensity on innovation outputs are stronger for EMNEs than for AMNEs.*

3.3.2 Headquarter-led Innovation

In the case where home-base innovation (Schubert et al., 2018) is warranted, headquarters lead innovation by renewing technology-bases constantly to resist erosion by emerging designs (Figueira-de-Lemos and Hadjikhani, 2014). To achieve this, headquarters source knowledge and upgrade innovative capabilities by locating in industrial clusters - which has long been regarded as engine of knowledge spillovers and innovation (Porter, 1998; Bresnahan and Gambardella, 2004). Industrial cluster is "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities" (Porter, 1998, p.79). Building upon the theoretical knowledge from the fields of innovation and clustering, we propose that headquarters can enhance MNEs' innovation outputs through following mechanisms.

First, spatial proximity provides opportunities for frequent and face-to-face interactions, boosting spillovers of tacit or spatially sticky knowledge (Storper and Venables, 2004). Co-locating with similar and related businesses enhances collective learning during frequent formal and informal interactions (Juhász and Lengyel, 2017). Hence locating in clusters enables headquarters to anticipate development and avoid longer-term technological lock-out. Second, co-location with similar and related businesses enhances collaborations between organizations (Li, 2014; Steinle and Schiele, 2002). Locating in clusters enables headquarters to identify new collaborative opportunities with other organizations (e.g., rivals, suppliers), which therefore assists the acquisition of complementary assets and inputs for innovation of the firms (Juhász and Lengyel, 2017). Third, headquarters may also benefit from accessing regional pools of skilled engineers and professionals (Saxenian, 1994), government institutional support (e.g., policies on bank loans and skilled labours, infrastructure, administration) and government financial support (e.g., R&D subsidies, government funds) (Broekel et al., 2015). Subsequently, locating their headquarters in clusters enables MNEs to broaden their search scope, avoid technological lock-out, access to resources and knowledge (Turkina et al., 2016), and finally enhance innovation performance (Cassiolato et al., 2003; Rabellotti, 1999).

Early studies (Bartlett and Ghoshal, 1989; Cantwell and Mudambi, 2005; Hedlund, 1994) explain the headquarter-led innovation in AMNEs very well. AMNE headquarters are network orchestrators and integrators of intra-organizational knowledge flows among subsidiaries (Mudambi and Navarra, 2004). Using behaviour approach, Schubert et al. (2018) postulates that firms with higher technological capabilities prefer home-base innovation when faced with technological uncertainties, emulating a risk-averse decision in a gain-domain; in contrast, firms with lower capabilities prefer internationalised innovation, i.e., a risk-taking decision in a loss-domain. It is expected that within AMNEs cohort, there is a larger proportion of AMNEs with relatively higher-than-average capabilities. In other words, because the AMNE cohort possesses higher technological capabilities, headquarters' innovative activities regarding sourcing resources and knowledge by locating in industrial clusters play more important role in the innovative development of the whole MNE.

Comparing with the cohort of AMNEs, EMNE cohort possesses lower technological capabilities. When competing with AMNEs, a higher proportion of EMNEs may face high uncertainty of direction of technological change and high speed of change, which reflects an urgent need of technology development in a short period of time (Cuervo-Cazurra, 2012). Thus, home-based innovation may not be advantageous for EMNEs and they may prefer internationalised innovation.

EMNEs are seen as technological laggards (Cuervo-Cazurra, 2008) and complex technologies and knowledge are not available in EMNEs' home countries. AMNEs located their units in emerging countries are not willing to share their proprietary knowledge and enhance their capabilities to protect their knowledge through different mechanisms (Rugman and Verbeke, 2003; Nandkumar and Srikanth, 2015). Additionally, the weak home country institutional environment especially home country national innovation system (NIS) determines that home-based innovation may not be advantageous for EMNEs. More specifically, weak home-country NIS (e.g., weak education system, Freeman, 1987; poor regulatory framework, Furman et al., 2002) constrains the capabilities of EMNEs' headquarters to source, acquire and integrate resources and capabilities from the external environments (Elia and Santangelo, 2017; Narula, 2015). Consequently, recent studies show that EMNEs are increasingly relying on overseas subsidiaries to develop their innovativeness (e.g., Awate et al., 2015; Elia et al., 2020). Particularly, Awate et al. (2015, p.65) documented that EMNEs rely on overseas subsidiaries rather than headquarters to develop ability "to access established knowledge – and thereby leapfrog AMNEs' initial stages of knowledge development and dispersion".

Hence, we expect that headquarters in industrial clusters benefit MNE innovation performance overall, but this effect is particularly stronger for AMNEs than for EMNEs because of the relatively higher likelihood of headquarter-led innovation observed in AMNEs than in EMNEs. We propose the following hypothesis:

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

3.3.3 Subsidiary-led Innovation

Learning from host country locations is important for MNEs' knowledge creation (Almeida and Phene, 2004; Lo and Chung, 2010). First, through locating subsidiaries in multiple countries, MNEs gain access to diverse knowledge reservoirs (Ahuja and Lampert, 2001; Kafouros et al., 2012), accumulate and exploit knowledge embodied within such locations (Wood and Reynolds, 2011) and augment their knowledge bases (Kafouros and Wang, 2015). Second, since countries differ in their technological specialization, geographic dispersion of overseas subsidiaries exposes an MNE to more expansive learning opportunities (Goerzen and Beamish, 2003) and a higher probability of accessing valuable knowledge (Leiponen and Helfat, 2010). Thus, it enables MNEs to benefit idiosyncrasies in each host countries (Kafouros et al., 2012) and arbitrage international resources and capabilities for innovation (Qian et al., 2010). This perspective is consistent with the research suggesting that geographically dispersed MNEs are more likely to experience higher returns on innovation (Caves and Caves, 1996; Elia et al., 2020).

Third, MNEs can benefit from capturing and combining ideas from different locations for innovation through global dispersed subsidiaries, as the recombination process is key for innovation (Narula, 2015). A widely dispersed portfolio of subsidiaries enhances MNEs' overall innovation by providing opportunities for MNEs to combine and integrate diverse knowledge in different technological fields to create complex technologies, and to gain access to broader innovation teams with complementary skills and high efficiency (Kafouros and Wang, 2015). Fourth, subsidiary dispersion furthermore helps MNEs to mitigate innovation risks and uncertainty by balancing knowledge and resource deficiencies of a specific location (Tang and Tikoo, 1999).

Extant literature suggests the competence exploiting and creating roles of AMNE subsidiaries (Awate et al., 2015) and argues that these roles enable AMNEs to employ dual-strategy to enhance innovation performance. This body of research is anchored on the observations that AMNEs' innovation was initially centralised at headquarters and only later subsidiaries started to be given a higher-order mandate. In contrast, empirical evidence of EMNEs shows that, from the early stage of development, their subsidiaries were assigned similar role - accessing knowledge from local markets to create new knowledge for the use of the whole EMNE (Awate et al., 2015; Nair et al., 2016). Schubert et al. (2018) provides explanations for such observations – that EMNEs face technological uncertainty that is not proportionate to their ability and hence exhibit a risk-taking preference by internationalising R&D, i.e., to allow their subsidiaries to take up a more important role in enhancing innovation performance. In cases of both AMNEs and EMNEs, geographic dispersion of subsidiaries is expected to benefit innovation outputs. However, because the EMNE cohort is more likely to rely on subsidiary-led innovation to increase innovation outputs than the AMNE cohort, we expect the benefits of subsidiary dispersion is stronger for EMNEs than for AMNEs. Hence,

> ***Hypothesis 3:*** *The geographic dispersion of subsidiaries enhances innovation outputs; this effect is stronger in EMNEs than in AMNEs.*

3.4 Methods

3.4.1 Sample and Data

Using comparative approach, we identify MNEs from two emerging markets (China and India) and four advanced markets (France, Germany, Italy and US) during 2006 and 2014. We chose Chinese and Indian MNEs for a number of reasons (1) largest emerging economies witness remarkable economic and technological growths 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 global innovation by Chinese and Indian MNEs (Nair et al., 2016; Meyer and Peng, 2005). The focus on MNEs from Western European countries and US is based on several reasons: top-ranked countries in (1) global innovation (GII, 2020) and (2) patent applications (WIPO, 2016), (3) availability of standardized regional data, and (4) important actors of global innovation (Cantwell and Mudambi, 2005; Awate et al., 2015).

Cross-country MNE-level comparison can be very challenging because of the lack of comparable data. The most comparable and comprehensive secondary data of MNEs available is the Orbis - Bureau van Dijk database. The standard Orbis subscription provides up to ten years of data of each firm; hence we have chosen the maximum period available. Sampled MNEs have been first selected from Orbis following these steps: (1) identify subsidiaries with a global ultimate owner (GUO) - an entity at the top of the corporate ownership structure - located in the above six countries, (2) identify individual GUOs of these subsidiaries from the previous step, and we have identified 3,005 EMNEs (2,740 MNEs in China and 265 MNEs in India) and 14,904 AMNEs (1,958 MNEs in France, 5,473 MNEs in Germany, 2,643 MNEs in Italy and 4,830 MNEs in US), (3) exclude those GUOs with less than 50 employees, those

GUOs with unconsolidated data and those GUOs without any R&D expenditure during the entire examined time period. Subsequently, we have selected 613 EMNEs (447 MNEs in China and 166 MNEs in India) and 683 AMNEs (162 MNEs in France, 203 MNEs in Germany, 49 MNEs in Italy and 269 MNEs in US). For each MNE, Orbis provides MNE-level data we required in the analysis, such as financials and R&D, and locations of its subsidiaries. We obtained individual MNE's patent data from OECD REGPAT database (OECD). To ensure patent measures are comparable across MNEs of different countries, we used data of patent application filed under the Patent Co-operation Treaty (PCT). We matched the MNE-level data from Orbis with patent application data from OECD REGPAT using harmonized firm names. Afterwards, we have matched 181 EMNEs (127 MNEs in China and 54 MNEs in India) and 289 AMNEs (45 MNEs in France, 73 MNEs in Germany, 16 MNEs in Italy and 155 MNEs in US). Excluding incomplete observations, our full sample is a balanced panel data of 358 MNEs including 116 EMNEs (66 Chinese MNEs and 50 Indian MNEs) and 242 AMNEs (43 French MNEs, 53 German MNEs, 11 Italian MNEs and 135 US MNEs) competing in 36 two-digits industries over 9 years. Our models also use home and host country specific data, the sources of which are reported in Tables 3.1 and 3.2.

3.4.2 Measures

3.4.2.1 Dependent variable

We measure MNEs' innovation outputs using MNE Patent Counts, the number of patent applications under the PCT by the MNE in each year. Patent captures "a creation of an underlying knowledge stock" (Griliches et al., 1986). Additionally, patent data enables the comparison across countries, which suits our comparative approach (Rothaermel and Hess, 2007). Unlike patent data from USPTO or EPO that raises concerns about capturing mainly patenting activities of US- or European-based applicants thus leading to biased results, our chosen PCT data captures better the international patenting innovation of MNEs across countries (WIPO, 2017).

3.4.2.2 Independent variables

MNE R&D Intensity is the ratio of annual MNE R&D expenditure over its total sales (Cohen, 1996). The literature has widely used this measure for explaining innovation inputs (e.g., Chen et al., 2012; Heeley et al., 2007; Wang and Kafouros, 2009).

Table 3.1 Sources of data

Variables	Data sources
MNE Patent Counts	OECD REGPAT database
MNE R&D Expenditures and Sales	Orbis BvD database
Headquarter Cluster Effect	Orbis BvD database, see Table 3.2 for cluster data
Geographic Dispersion of Overseas Subsidiaries	Orbis BvD database
MNE Size	Orbis BvD database
Cluster-Effects of the Domestic Subsidiaries of MNEs	Orbis BvD database, see Table 3.2 for cluster data
Home Country OFDI	See Table 3.2
Home Country IFDI	See Table 3.2
Headquarter Provincial Government Expenditure on R&D	See Table 3.2
Headquarter Provincial Patent Stock	See Table 3.2
Host Country Domestic Knowledge Stock	WIPO
Host Country Openness to IFDI	World bank
Host Country Education	UNESCO
Host Country Institutional Development	Worldwide Governance Indicators

Table 3.2 Data sources of home country control variables

Indicators	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 secondary education enrolment	China educational development yearbook	NITI Aayog regional data	United States Census Bureau	Eurostat	Eurostat	Eurostat

Headquarter Cluster Effect is a dummy variable that takes the value of 1 if the headquarter of an MNE is located in an industrial cluster in a given year. Firstly, to identify clusters in the six home countries during the time period 2006-2014, we followed Bathelt and Li (2013) to calculate the location-quotients (LQ) that capture the concentration of a particular industry in a sub-national region using data of the number of employees. Specifically, for a given country, the LQ for industry *f* in region *r* in year *t* is:

$$LQ_{frt} = \frac{E_{frt}/E_{rt}}{E_{ft}/E_t} \tag{1}$$

where E_{frt} is the number of employees in industry *f* in region *r* in year *t*, E_{rt} is the total number of employees in region *r* in year *t*, E_{ft} is the number of employees in industry *f* in year *t*, and E_t is the national total of the number of employees in year *t*. An LQ value larger than 1 is commonly an indication of agglomeration (Bathelt and Li, 2013). Secondly, for each of the six home countries, we calculated LQ for each industry in a given sub-national region. Through this stepwise process, we have finally identified the industrial clusters in the six countries with an LQ larger than 1 during the examined time period. Since the industrial cluster changes with time, we chose to present the identified industrial clusters in the six countries in 2014 (Appendix, Tables A3.1-A3.6). Consequently, the variable to enter our final model is a dummy variable with a value of 1 if, in a given year, an MNE's headquarter is located in a sub-national region where the headquarter's corresponding 2-digit industry has a LQ value larger than 1, and the dummy has a value of 0 otherwise.

Geographic Dispersion of Overseas Subsidiaries captures the extent to which the overseas subsidiaries of an MNE is spread across different geographical areas. We use the Hirschman-Herfindahl index to calculate the concentration ratio of each host countries where the subsidiaries of the MNE operate (Zhang et al., 2010). We operationalize the geographic dispersion of overseas subsidiaries in MNE *i* as:

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

where K is the total number of countries in which MNE i locate its subsidiaries during the examined period[1] and j is a given host country. Q_{ji} is the number of subsidiaries of MNE i in host country j, while Q_i is the total number of subsidiaries of MNE i. Thus, a value close to 1 means the subsidiaries of the MNE are widely dispersed, while a value close to 0 more concentratedly.

3.4.2.3 Control variables

MNE size controls for effects arising from the size of a firm as larger firms typically possess and have access to more resources 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.

Cluster-Effects of Domestic Subsidiaries of MNEs. Our hypotheses are concerned with innovation led by headquarters and overseas subsidiaries; thus we control for effects arising from domestic subsidiaries. Because spatial proximity facilitates knowledge spillovers and increases organizational learning (Turkina et al., 2016), domestic subsidiaries in industrial clusters may influence MNE innovation outputs. Following the above, for each MNE, we identified if a domestic subsidiary is located within an industrial cluster in a given year. Hence, this variable is the ratio of the number of domestic subsidiaries located in industrial clusters over the number of total domestic subsidiaries for an MNE in a year.

Home country environment has various impacts on MNEs' global innovation [2] (e.g., Jin et al., 2019; Li et al., 2012). Home Country IFDI, an MNE's home country inward foreign direct investment (IFDI) flow over its GDP in a given year, is a key mechanism of international knowledge diffusion that stimulates overall learning and technological upgrade among host economy firms but also negatively influences MNE global innovation performance if the foreign MNEs pose competition threats to the incumbent MNEs (Jin et al., 2019). Accordingly, Home Country OFDI, an MNE's home country OFDI flow over its GDP in a given year, captures, on the one hand, the reversely-transferred technological competence back home (e.g., Awate et al., 2015; Li et al., 2012), and on the other hand, the greater opportunities of arbitraging R&D resources abroad; hence may have both negative and positive effects on MNE innovation performance.

Given our focus on understanding how headquarters play a role in MNE innovation, we control for differences in innovation system and innovative capabilities of sub-national

[1] The number of subsidiaries in an MNE does vary over time, but Orbis only shows a subsidiary's year of corporation, rather than when it entered (or exited) the MNE.

[2] Because of data limitation, sub-national regions are not all at the same disaggregated level across the examined countries.

regions of home countries (Huang et al., 2012; Li, 2009). These particularly influence how MNE headquarters leverage home conditions for innovation. Headquarter Provincial Government Expenditure on R&D, the ratio of governmental R&D expenditure over the GDP in the sub-national region where the MNE headquarter is located, is used to account for variations of MNE innovation outputs caused by headquarters' associated regional R&D commitments. Regional governments play an important role in providing policy and support such as R&D expenditure to complement the innovation activities of firms within own regions (Aulakh et al., 2016). Accordingly, Headquarter Provincial Patent Stock, the ratio of patent stock over the total number of labours in the sub-national region where the MNE headquarter is located, is used to account for variations of MNE innovation outputs attributed to a technological rich regional environment (Li, 2009). Patent stock is operationalized using the perpetual inventory method (PIM) (Kafouros et al., 2012) based on the annual regional patent application data. Provincial R&D expenditure and patent stock may be also expected to influence the domestic subsidiaries of MNEs. Because of the spatial auto-correlation of these regional variables widely reported in the literature of regional innovation (e.g., Li, 2009), causing potential multicollinearity among variables of our models, we have decided not to introduce domestic-subsidiary-specific regional R&D and patent stock variables.

We further control for the influence of host country environment on MNEs' innovation outputs (Kafouros and Wang, 2015; Wu et al., 2016). Host Country Openness to IFDI, the average of IFDI stock-to-GDP ratio of all host countries of an MNE in a given year, may positively influence innovation outputs because of a highly opened host environment providing better opportunities for learning (Buckley et al., 2007; Kafouros and Wang, 2015) but may also reduce innovation outputs when competition rises with openness (Mariotti et al., 2010). Host Country Domestic Knowledge Stock, the average of the number of patents granted to residence in all host countries of an MNE in a given year, captures the effect of host country knowledge stock that may influence the innovation outputs (Kumar, 2001). Host Country Education, the average of the ratio of secondary education over the population of a given age group[3] in all host countries of an MNE in a year, captures the available pool of skilled human resources for innovation (Kafouros et. al., 2015). Host Country Institutional Development, the average of the mean of six Worldwide Governance Indicators (WGIs) of all host countries of an MNE in a given year, controls for host institutional qualities that may enhance innovation outputs by

[3] This refers to the number of students successfully completing education at the secondary level. The measure is calculated as the ratio of total enrolment to the population of the age group that officially corresponds to the level of education. Secondary education is the only comparable data available across all countries we examine.

effectively providing resources and innovation intermediaries with low cost (Jackson and Deeg, 2008). The six WGIs are voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption. Because these are highly correlated with a Cronbach alpha above 0.95, we have decided to take the average. A higher value of the measure indicates a higher level of host country institutional development.

Time and industry effects. We use a set of year and 2-digit industry dummies to control for the time and industry effects on innovation outputs.

3.4.3 Statistical Modelling

As our dependent variable relies on count data, a linear regression model is likely to be biased. A common solution to this problem is Poisson model, but our data violates the assumption of Poisson model that the variance of the dependent variable equals to the mean. We hence use a Negative Binomial (NB2) model that allows the variation between conditional variance of the dependent variable and the conditional mean. This approach is widely used in recent studies estimating innovation outputs measured by patent counts (Marin, 2014; Wu et al., 2016). All variables except dummies have been transformed using logarithm[4] before entering the model.

3.5 Analysis

Table 3.3 reports descriptive statistics. It is worth noting that R&D Intensity, Headquarter Cluster Effect and Geographic Dispersion of Overseas Subsidiaries significantly varies for AMNEs and EMNEs lending support to our comparative research approach. To visualise the differences, we provide Figures 3.3-3.7 to show, respectively, the kernel distribution of MNE Size, MNE R&D Expenditure, MNE Patent Counts, MNE’s Headquarter Cluster Effect and Geographic Dispersion of Overseas Subsidiaries of the MNE for the sampled AMNEs and EMNEs.

[4] In the case of zero or negative values, we used the inverse hyperbolic sine transformation (IHS) which is interpreted in the same way as a standard logarithmic transformation (Di Cintio et al., 2017). We also used alternative methods such as adding a constant to the values so that the logarithmic transformation can be carried out. The results remain qualitatively the same.

Figure 3.3 Distribution of MNE Size

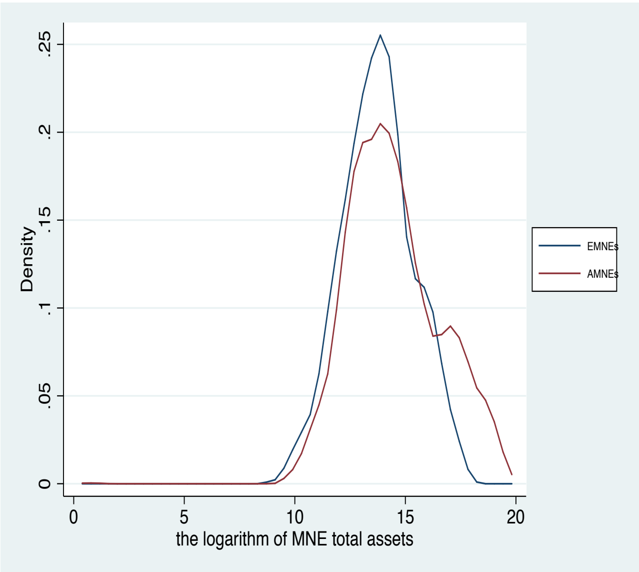


Figure 3.4 Distribution of MNE R&D Expenditure

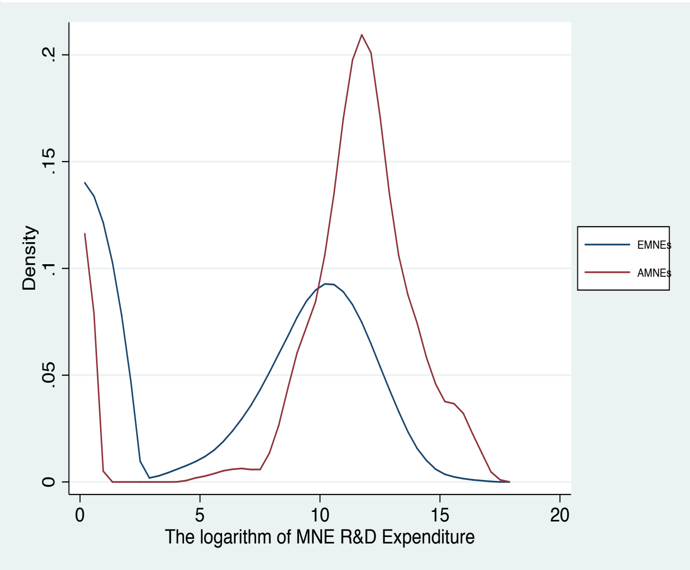


Figure 3.5 Distribution of MNE Patent Counts

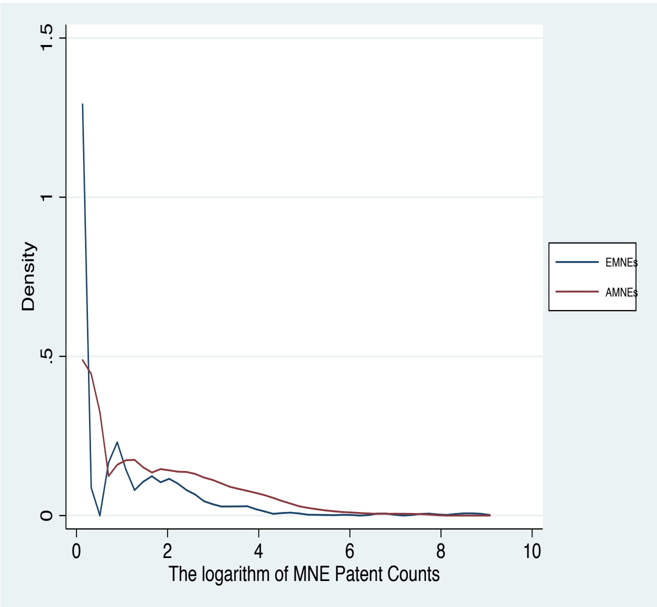


Figure 3.6 Distribution of MNE's Headquarter Cluster Effect

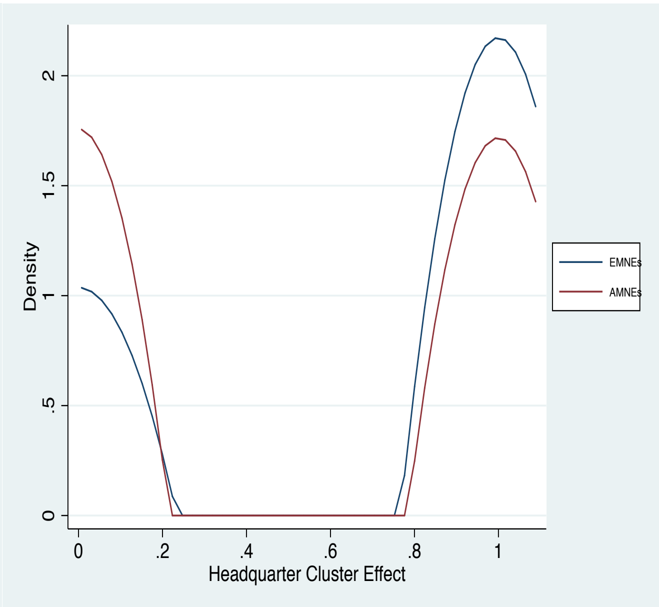
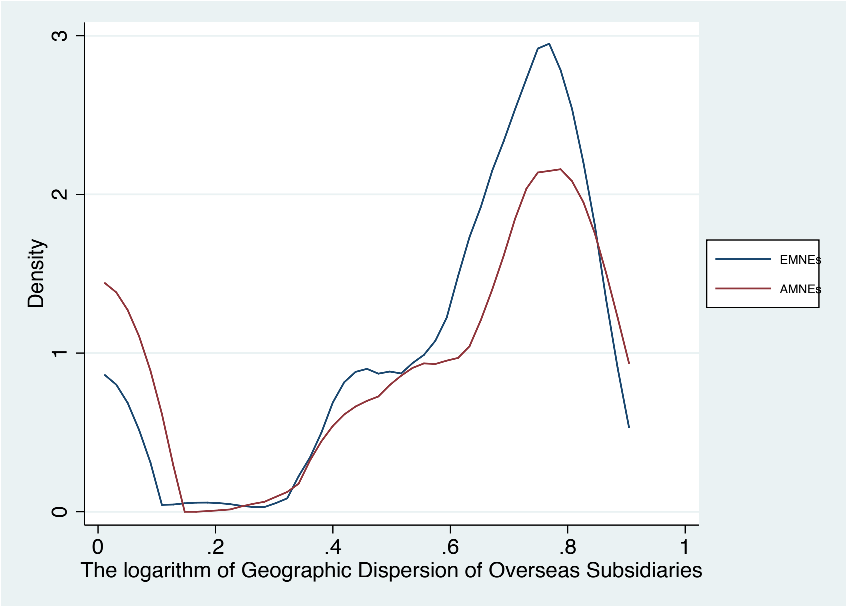


Figure 3.7 Distribution of Geographic Dispersion of Overseas Subsidiaries of the MNE



To detect potential multicollinearity, we calculated the variance inflation factor (VIF) for each variable across the models of full and sub-samples. The average and maximum VIF across the models are below the acceptable level of 5 (Neter et al., 1985), representing no serious problems of multicollinearity. Because we theorize the determinants of innovation and our analysis includes a time-invariant variable (Geographic Dispersion of Overseas Subsidiaries), we utilize NB2 model with random effects. Table 3.4 reports correlation matrix of all variables concerned in our analysis.

Table 3.3 Descriptive statistics

	All MNEs		EMNEs		AMNEs		Mean Differences between EMNEs and AMNEs samples
	Mean (SD)	Min (Max)	Mean (SD)	Min (Max)	Mean (SD)	Min (Max)	
MNE Patent Counts	15.44 (132.65)	0 (3416)	20.88 (211.50)	0 (3416)	12.76 (65.29)	0 (921)	8.12
MNE R&D Intensity	0.05 (0.08)	0 (1.07)	0.01 (0.03)	0 (0.35)	0.07 (0.09)	0 (1.07)	0.05**
Geographic Dispersion of Overseas Subsidiary	0.62 (0.33)	0 (0.97)	0.68 (0.25)	0 (0.96)	0.59 (0.35)	0 (0.97)	0.09**
Headquarter Cluster Effect	0.55 (0.50)	0 (1)	0.67 (0.47)	0 (1)	0.49 (0.50)	0 (1)	0.19**
MNE Size	11,200,000 (30,900,000)	2.07 (287,000,000)	3,141,228 (5780556)	8807.73 (43,000,000)	15,100,000 (36,900,000)	2.07 (287,000,000)	11,958,772**
Cluster Effects of Domestic Subsidiaries of MNEs	0.38 (0.37)	0 (1)	0.50 (0.28)	0 (1)	0.32 (0.40)	0 (1)	0.18**
Home Country IFDI	0.02 (0.01)	0 (0.05)	0.03 (0.01)	0.01 (0.05)	0.01 (0.005)	0 (0.02)	0.02**
Home Country OFDI	0.02 (0.01)	0.001 (0.05)	0.01 (0.004)	0.001 (0.018)	0.02 (0.009)	0.004 (0.049)	0.01**
Headquarter Provincial Government Expenditure on R&D	0.004 (0.006)	0 (0.05)	0.007 (0.010)	0.00 (0.05)	0.002 (0.003)	0 (0.0096)	0.01**
Headquarter Provincial Patent Stock	0.006 (0.01)	0.0001 (0.13)	0.01 (0.02)	0.0001 (0.13)	0.003 (0.002)	0.0001 (0.01)	0.01**
Host Country Domestic Knowledge Stock	36477.08 (53176.07)	133 (704936)	53839.38 (53248.81)	133 (287831)	27945.89 (51035.87)	133 (704936)	25893.49**
Host Country Openness to IFDI	0.86 (0.94)	0.03 (9.76)	1.25 (1.10)	0.07 (9.76)	0.67 (0.79)	0.03 (5.42)	0.57**
Host Country Education	0.58 (0.11)	0.12 (0.95)	0.54 (0.12)	0.12 (0.89)	0.60 (0.10)	0.20 (0.95)	0.05**
Host Country Institutional Development	1.02 (0.45)	-0.76 1.89	1.01 (0.43)	-0.17 1.84	1.02 (0.46)	-0.76 1.89	0.01
Number of observations	2331	2331	768	768	1563	1563	

Note: For ease of reading, mean and standard deviations are statistics of variables in original form. **p<0.01, *p<0.05, +p<0.1.

Table 3.4 Correlation matrix

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	MNE Patent Counts	1												
2	MNE R&D Intensity	0.02	1											
3	Headquarter Cluster Effect	0.01	-0.14**	1										
4	Geographic Dispersion of Overseas Subsidiaries	0.09**	-0.18**	0.06*	1									
5	MNE Size	0.13**	-0.04	-0.10**	0.53**	1								
6	Cluster-Effects of the Domestic Subsidiaries of MNEs	0.04+	-0.26**	0.28**	0.22**	0.14**	1							
7	Home Country OFDI	-0.02	0.24**	-0.03	-0.11**	0.11**	-0.10**	1						
8	Home Country IFDI	0.03	-0.11**	0.13**	0.02	-0.19**	0.12**	-0.15**	1					
9	Headquarter Provincial Government Expenditure on R&D	0.04	-0.35**	-0.01	0.23**	0.07*	0.35**	-0.42**	0.11**	1				
10	Headquarter Provincial Patent Stock	0.06*	0.01	0.16**	0	-0.13**	0.02	-0.45**	0.27**	0.14**	1			
11	Host Country Domestic Knowledge Stock	0.00	-0.13**	0.06*	0.46**	0.12**	0.08**	-0.18**	0.02	0.21**	0.09*	1		
12	Host Country Openness to IFDI	-0.00	-0.06*	0.06*	0.03	-0.01	0.10**	-0.23**	0.31**	0.07*	0.14*	-0.34*	1	
13	Host Country Education	-0.04	0.16**	-0.14**	0.04	0.11**	-0.02	0.06*	-0.19**	-0.06*	-0.05*	0.08**	0.07**	1
14	Host Country Institutional Development	-0.10**	0.22**	-0.04	-0.10**	-0.10**	-0.06*	0.01	0.09**	-0.19**	0.02	-0.07**	0.35**	0.51**

Note: Pairwise correlation coefficients. ** p<0.01, * p<0.05, + p<0.1.

Table 3.5 reports our results. Column 1 is a full-sample estimation. Following Lin et al. (2009), we examine this effect for the sample of EMNEs and AMNEs, respectively and Columns 2 and 3 reports the results, respectively. The coefficient of MNE R&D Intensity is significant and positive for EMNEs in Column 2 (5.484; $p<0.05$) but is insignificant for AMNEs and only marginally significant in full sample ($p<0.1$). In Column 3, the coefficient of MNE R&D intensity is insignificant for AMNEs. A Chow test comparing the coefficients between the sub-samples confirms that these coefficients in Columns 2 and 3 are significantly different from each other. To better compare cohorts of AMNEs and EMNEs, we plotted the confidence intervals of the mean differences in terms of MNE R&D intensity. As shown in Figure 3.8, the confidence intervals for means on MNE R&D intensity between subsamples are not overlapping, which confirms that significant differences in this effect between AMNEs and EMNEs. Thus, H1 is supported.

The coefficient of Headquarter Cluster Effect in Column 3 is positive and significant (0.440; $p<0.01$), indicating that headquarters of AMNEs enhance innovation by locating in the cluster. However, the coefficient of this variable in Column 2 is insignificant. Chow test confirms that these coefficients in Column 2 and 3 are significantly different from each other. However, the confidences intervals on this effect between subsamples are overlapping (see Figure 3.8), which indicates that the differences between AMNEs and EMNEs are not statistically significant. Thus, the headquarter cluster effect on MNE innovation outputs is not significantly different for AMNEs and EMNEs.

The coefficient of Geographic Dispersion of Overseas Subsidiaries is positive and significant in Column 2 (2.291; $p<0.01$), while insignificant in Column 3. Similarly, a Chow test confirms that significant differences in this effect in Column 2 and 3. We further plot the confidence intervals of the mean differences, as shown in Figure 3.8, the non-overlapping confidence intervals confirm that significant differences on this effect in Column 2 and 3, supporting H3.

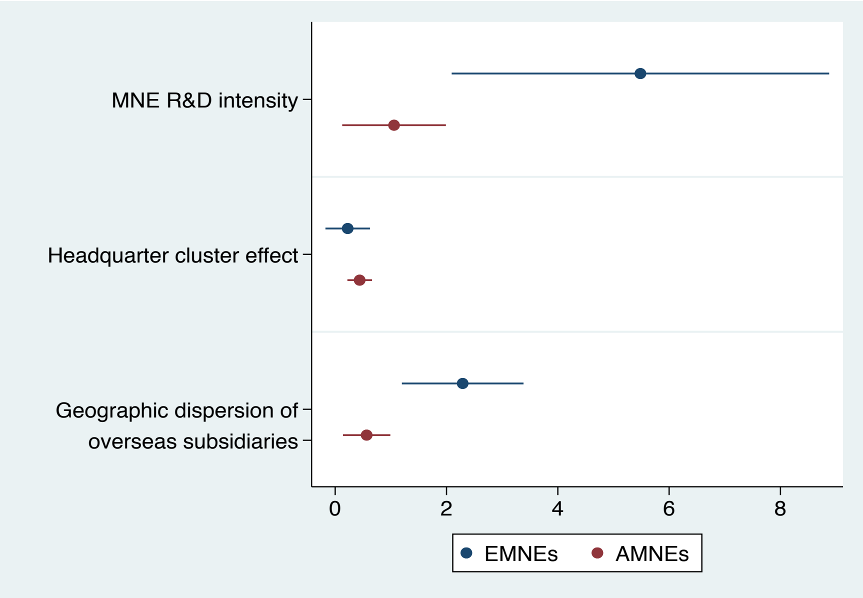
We also consider the potential endogeneity problems and the endogeneity problems occurs due to the unobserved heterogeneity and reverse causality where certain exploratory variables are potentially influenced by other variables. For instance, in our study, firms' innovative activities may influence the geographical dispersion of their overseas subsidiaries. Firms with higher level of innovations may intentionally internationalize and disperse their business activities globally in order to better leverage own innovation during their geographic dispersion (Chen et al., 2012). Accordingly, MNEs innovation outputs may affect the geographic dispersion of overseas subsidiaries. Although identifying strong instrumental variables in this context would be difficult, establishing causality accurately would require further tests of endogeneity. Therefore, we acknowledge that the implied causality in the results are subject to the assumption of exogeneity. Nevertheless, it is worth noting that the core of the findings in this chapter is the differences identified in the effects for AMNEs and EMNEs which is not the causality, even if the causality is weaker than the results show. Our assumption of the causality itself is consistent with the prior literature (e.g., Zhang et al., 2019).

Table 3.5 Results (Dependent variable: MNE Patent Counts)

	(1) **Full sample**	**(2)** **EMNEs**	**(3)** **AMNEs**	**(4)** **AMNEs Robustness**
H1: MNE R&D Intensity	1.131+ (0.673)	5.484* (2.414)	1.057 (0.663)	0.838 (0.756)
H2: Headquarter Cluster Effect	0.265* (0.113)	0.224 (0.285)	0.440** (0.157)	0.309+ (0.169)
H3: Geographic Dispersion of Overseas Subsidiaries	0.574* (0.268)	2.291** (0.778)	0.565+ (0.303)	0.684* (0.32)
MNE Size	0.145*** (0.039)	0.529*** (0.09)	-0.006 (0.03)	0.009 (0.035)
Cluster Effects of Domestic Subsidiaries of MNEs	-0.22 (0.175)	-0.2 (0.426)	0.201 (0.212)	0.174 (0.221)
Home Country OFDI	0.130+ (0.075)	-0.128 (0.172)	-0.174 (0.119)	-0.032 (0.145)
Home Country IFDI	-0.136** (0.047)	0.501 (0.346)	0.008 (0.058)	-0.012 (0.063)
Home Country Institutional Development				-2.279* (0.911)
Headquarter Provincial Government Expenditure on R&D	-0.140*** (0.023)	-0.474** (0.167)	-0.051 (0.031)	-0.078* (0.038)
Headquarter Provincial Patent Stock	0.168** (0.061)	0.514** (0.178)	0.320** (0.102)	0.293* (0.125)
Headquarter Provincial Education				0.260* (0.105)
Host Country Domestic Knowledge Stock	-0.064 (0.044)	-0.153+ (0.09)	0.004 (0.064)	-0.017 (0.068)
Host Country Openness to IFDI	-0.355*** (0.094)	-0.505* (0.211)	-0.027 (0.139)	0.023 (0.147)
Host Country Education	0.544+ (0.299)	0.487 (0.622)	-0.259 (0.399)	-0.592 (0.418)
Host Country Institution Development	0.268 (0.22)	0.949+ (0.51)	0.465 (0.284)	0.620* (0.296)
Time Effects	Included	Included	Included	Included
Industry Effects	Included	Included	Included	Included
Constant	-2.028* (0.99)	-7.841** (2.386)	0.451 (1.166)	0.926 (1.240)
Number of observations	2,331	768	1,563	1,458
Number of MNEs	358	116	242	236
Log-Likelihood	-4352	-1005	-3283	-3071
Wald's χ^2	285.4	131.2	156.8	138.7
VIF average	1.56	1.93	1.73	1.9
VIF max	3.41	4.1	3.18	3.51

Note: Standard errors in parentheses. ***p<0.001, **p<0.01, *p<0.05.

Figure 3.8 Confidence intervals of the mean differences



3.5.1 Robustness Checks

In addition to host institutions, home institutions may be expected to influence MNEs' innovation outputs, even though the actual effects can be complex for AMNEs and EMNEs (Cuervo-Cazurra, 2008; Luo et al., 2010). Moreover, human resource in the regions where headquarters are located may influence MNE innovation outputs (Li, 2009). We thus introduced two additional variables into the models. Home Country Institutional Development is the mean of six WGIs of the home country of an MNE in a given year; Headquarter Provincial Education is the ratio of secondary education over the population of a given age group in the home country of an MNE in a year. VIF becomes higher than accepted level when we include these into the full sample and EMNEs estimations, potentially because that these are often important determinants of Home Country IFDI and OFDI. Nonetheless, VIFs do not exceed 5 when they are in the model of AMNEs; we report the results in Column 4 in Table 3.5. The coefficient of Geographic Dispersion of Overseas Subsidiaries becomes significant and positive (0.684; $p<0.05$) while the coefficient of Headquarter Cluster Effect remains positive but becomes marginally significant ($p<0.1$). But the Column 4 results show that Headquarter Cluster Effect is weaker as Headquarter Provincial Education shows a significantly positive effect while the Home Country Institutional Development shows a significantly negative effect.

We identified there is a proportion of firms in both AMNEs and EMNEs cohorts that have low R&D investment in the distribution of MNE R&D expenditure (see Figure 3.4), and

MNEs may employ different innovative strategies depending on the level of their R&D expenditure (Kirner et al., 2009). We introduced the sample excluding the low-R&D-expenditure MNEs using the distribution of MNE R&D expenditure. The results of this analysis, displayed in Table 3.6, provide some interesting insights. Indeed, the geographic dispersion of overseas subsidiaries effect becomes stronger for AMNEs than for EMNEs when only examining R&D intensive MNEs. The switch in pattern suggests that EMNEs with low R&D seem to use geographic dispersion as a way of increasing innovation outputs.

Table 3.6 Results of robustness check (Dependent variable: MNE Patent Counts)

	(1) Full sample	(2) EMNEs	(3) AMNEs
H1: MNE R&D Intensity	0.841	6.379*	1.157+
	(0.731)	(2.603)	(0.643)
H2: Headquarter Cluster Effects	0.243+	0.342	0.471**
	(0.127)	(0.366)	(0.166)
H3: Geographic Dispersion of Overseas Subsidiaries	0.790**	1.837+	0.662*
	(0.305)	(1.020)	(0.320)
MNE Size	0.058	0.584***	-0.015
	(0.042)	(0.127)	(0.029)
Cluster Effects of Domestic Subsidiaries of MNEs	-0.031	-0.002	0.219
	(0.196)	(0.572)	(0.219)
Home Country OFDI	0.007	-0.111	-0.122
	(0.083)	(0.190)	(0.117)
Home Country IFDI	-0.074	-0.222	0.027
	(0.050)	(0.432)	(0.063)
Headquarter Provincial Government Expenditure on R&D	-0.117***	-0.414+	-0.057+
	(0.026)	(0.220)	(0.032)
Headquarter Provincial Patent Stock	0.028	0.113	0.108
	(0.053)	(0.220)	(0.066)
Host Country Domestic Knowledge Stock	-0.068	-0.154	-0.015
	(0.056)	(0.117)	(0.068)
Host Country Openness to IFDI	-0.189+	-0.491+	-0.021
	(0.114)	(0.287)	(0.146)
Host Country Education	0.371	1.101	-0.279
	(0.358)	(0.822)	(0.420)
Host Country Institution Development	0.381	0.689	0.697*
	(0.265)	(0.786)	(0.314)
Time Effects	Included	Included	Included
Industry Effects	Included	Included	Included
Constant	-1.871+	-11.768***	-0.913
	(1.054)	(3.127)	(1.041)
Number of observations	1,742	386	1,356
Number of MNEs	320	97	223
Log-Likelihood	-3733	-610.2	-3079
Wald's χ^2	149.3	70.74	141.5

Note: Standard errors in parentheses. ***p<0.001, **p<0.01, *p<0.05.

3.6 Discussion and Conclusion

We examined how MNE R&D Intensity, headquarter-led and subsidiary-led innovation explain the variations in MNE innovation performance and expected these effects to vary in the AMNEs and EMNEs cohorts. We found such differences. While R&D intensity on average has little effect on innovation outputs (patent counts), its benefits are significant for EMNEs but not AMNEs. We also found that compared with AMNEs, EMNEs' innovation tends to be subsidiary-led, specifically the effect of geographic dispersion of overseas subsidiaries is stronger for EMNEs than for AMNEs. However, our empirical analysis shows that headquarter cluster effects on MNE innovation do not differ across the cohort of AMNEs and EMNEs. This finding differs from our theoretical prediction but in line with some empirical evidence on EMNEs showing that locating their headquarters in industrial clusters is beneficial for EMNEs' innovation (see, for instance, Tan, 2006). The results indicate that what matters is not only how EMNEs start to develop their global innovation, but also how they innovate over time with accumulated knowledge, resources and capabilities and the development of home country NIS (Elia and Santangelo, 2017). Therefore, it would be interesting to explore and examine how EMNE innovate using different technological strategies over time.

We contribute to the literature exploring contingent effects of firm-specific and country-specific factors on global innovation by demonstrating that such contingent approach is not appropriate without careful scrutiny of firm distribution. Our comparative analysis reveals significant differences between two cohorts of MNEs that are at different ends of developmental spectrum. Our findings point to the need to address the fact that distinct home country developmental trajectories exist and affect how MNEs effectively carry out global innovation. Thus, a general framework explaining MNE global innovation conceptualise contexts more rigorously.

We contribute to the literature on MNE development by demonstrating that the roles of headquarters and subsidiaries vary between AMNEs and EMNEs cohorts, suggesting that the temporal sequence of headquarter and subsidiary mandate development differs between cohorts of firms, depending on how their home environments have shaped global innovation decisions in the first place. We thus add to the large body of studies on the development of MNE global innovation strategies by demonstrating that a global dispersed portfolio of subsidiaries is becoming a strategic tool for firms to gain competitive advantages, especially in the early stage of development of an EMNE but in the later stage of development of an AMNE.

Our research contributes to the valuable efforts of developing a general theory of MNE global innovation by demonstrating that observations of AMNEs cannot be used to predict behaviours of EMNEs and thus interpretation of observations of EMNEs should not simply rely on a mindset that emerging markets and their firms will follow a similar developmental path as that of their counterparts.

Our research has several limitations, some of which open avenues for future research. First, because of constraints of sub-national data availability, our sampled EMNEs come from two particularly large and diversified emerging countries (China and India), and therefore future research may expand into other emerging market firms to provide more complete capture of EMNEs globally. Second, in addition to patents, with better data availability, innovation performance may be captured using other measurement such as new products. Third, constrained by Orbis offering, we were not able to capture the variations of subsidiary distribution in an MNE over time; future research may employ a time-variant construct. Fourth, our empirical analysis is not able to capture the distinct effects on different types of innovation (e.g., product and process innovation, Haneda and Ito, 2018; radical innovation and incremental innovation, Ettlie et al., 1984). Future studies may attempt to explore the effects of MNE R&D intensity, headquarter-led and subsidiary-led innovation on different types of MNE innovation and the data on different types of innovation is more easily to be gained through national innovation survey (e.g., Frenz and letto-Gillies, 2009; Kim and Lui, 2015). There is still much more to be explored regarding home country factors that result in different trajectories of firm development. This research is only the first step towards it and future research pursuing this perspective will produce important contributions.

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Appendix

Table A3.1 Identified Chinese clusters by city-region and industry, 2014

Identified cluster by city-region and industry	Year	LQ of employment
Anhui Mining	2014	1.812
Anhui Producing and Supply of Electricity, Gas and Water	2014	1.032
Anhui Construction	2014	1.189
Anhui Financial Intermediation	2014	1.116
Anhui Management of Water Conservancy, Environment and Public Facilities	2014	1.043
Anhui Education	2014	1.315
Anhui Health, Social Securities and Social Welfare	2014	1.229
Anhui Public Management and Social Organization	2014	1.070
Beijing Transport, Storage and Post	2014	1.708
Beijing Information Transmission, Computer Service and Software	2014	4.341
Beijing Wholesale and Retail Trade	2014	1.885
Beijing Hotels and Catering Services	2014	2.484
Beijing Financial Intermediation	2014	1.775
Beijing Real Estimate	2014	2.649
Beijing Leasing and Business Service	2014	3.827
Beijing Scientific Research, Technical Services, and Geological Prospecting	2014	3.753
Beijing Services to Households and Other Services	2014	3.067
Beijing Culture, Sports and Entertainment	2014	3.004
Chongqing Construction	2014	1.598
Chongqing Transport, Storage and Post	2014	1.388
Chongqing Wholesale and Retail Trade	2014	1.117
Chongqing Hotels and Catering Services	2014	1.048
Chongqing Financial Intermediation	2014	1.098
Chongqing Real Estimate	2014	1.219
Chongqing Leasing and Business Service	2014	1.159
Chongqing Education	2014	1.043
Fujian Manufacturing	2014	1.351
Fujian Construction	2014	1.407
Gansu Agriculture, Forestry, Animal Husbandry and Fishing	2014	1.251
Gansu Mining	2014	1.173
Gansu Producing and Supply of Electricity, Gas and Water	2014	1.751
Gansu Construction	2014	1.112
Gansu Transport, Storage and Post	2014	1.056
Gansu Scientific Research, Technical Services, and Geological Prospecting	2014	1.250
Gansu Management of Water Conservancy, Environment and Public Facilities	2014	1.477
Gansu Education	2014	1.527
Gansu Health, Social Securities and Social Welfare	2014	1.171
Gansu Culture, Sports and Entertainment	2014	1.205
Gansu Public Management and Social Organization	2014	1.818
Guangdong Manufacturing	2014	1.786
Guangdong Hotels and Catering Services	2014	1.190
Guangdong Real Estimate	2014	1.293
Guangdong Leasing and Business Service	2014	1.217
Guangxi Agriculture, Forestry, Animal Husbandry and Fishing	2014	1.393
Guangxi Producing and Supply of Electricity, Gas and Water	2014	1.637
Guangxi Transport, Storage and Post	2014	1.128
Guangxi Leasing and Business Service	2014	1.049
Guangxi Scientific Research, Technical Services, and Geological Prospecting	2014	1.087
Guangxi Management of Water Conservancy, Environment and Public Facilities	2014	1.665
Guangxi Education	2014	1.647
Guangxi Health, Social Securities and Social Welfare	2014	1.635
Guangxi Culture, Sports and Entertainment	2014	1.015
Guangxi Public Management and Social Organization	2014	1.296
Guizhou Mining	2014	1.766
Guizhou Producing and Supply of Electricity, Gas and Water	2014	2.036
Guizhou Real Estimate	2014	1.122
Guizhou Scientific Research, Technical Services, and Geological Prospecting	2014	1.027
Guizhou Management of Water Conservancy, Environment and Public Facilities	2014	1.089
Guizhou Services to Households and Other Services	2014	1.096
Guizhou Education	2014	1.720
Guizhou Health, Social Securities and Social Welfare	2014	1.327
Guizhou Public Management and Social Organization	2014	1.808
Hainan Agriculture, Forestry, Animal Husbandry and Fishing	2014	2.966
Hainan Producing and Supply of Electricity, Gas and Water	2014	1.004
Hainan Transport, Storage and Post	2014	1.179
Hainan Wholesale and Retail Trade	2014	2.637

Hainan Hotels and Catering Services	2014	4.076
Hainan Real Estimate	2014	2.865
Hainan Management of Water Conservancy, Environment and Public Facilities	2014	2.163
Hainan Education	2014	1.354
Hainan Health, Social Securities and Social Welfare	2014	1.264
Hainan Culture, Sports and Entertainment	2014	1.575
Hainan Public Management and Social Organization	2014	1.317
Hebei Mining	2014	1.231
Hebei Producing and Supply of Electricity, Gas and Water	2014	1.344
Hebei Financial Intermediation	2014	1.321
Hebei Management of Water Conservancy, Environment and Public Facilities	2014	1.228
Hebei Education	2014	1.474
Hebei Health, Social Securities and Social Welfare	2014	1.213
Hebei Public Management and Social Organization	2014	1.510
Heilongjiang Agriculture, Forestry, Animal Husbandry and Fishing	2014	10.490
Heilongjiang Mining	2014	2.336
Heilongjiang Producing and Supply of Electricity, Gas and Water	2014	1.750
Heilongjiang Transport, Storage and Post	2014	1.284
Heilongjiang Financial Intermediation	2014	1.146
Heilongjiang Scientific Research, Technical Services, and Geological Prospecting	2014	1.113
Heilongjiang Management of Water Conservancy, Environment and Public Facilities	2014	1.518
Heilongjiang Services to Households and Other Services	2014	2.499
Heilongjiang Education	2014	1.038
Heilongjiang Health, Social Securities and Social Welfare	2014	1.121
Heilongjiang Culture, Sports and Entertainment	2014	1.205
Heilongjiang Public Management and Social Organization	2014	1.069
Henan Mining	2014	1.655
Henan Manufacturing	2014	1.001
Henan Producing and Supply of Electricity, Gas and Water	2014	1.022
Henan Construction	2014	1.091
Henan Education	2014	1.166
Henan Health, Social Securities and Social Welfare	2014	1.059
Henan Public Management and Social Organization	2014	1.165
Hubei Producing and Supply of Electricity, Gas and Water	2014	1.165
Hubei Construction	2014	1.249
Hubei Transport, Storage and Post	2014	1.020
Hubei Wholesale and Retail Trade	2014	1.218
Hubei Hotels and Catering Services	2014	1.041
Hubei Scientific Research, Technical Services, and Geological Prospecting	2014	1.014
Hubei Education	2014	1.050
Hubei Health, Social Securities and Social Welfare	2014	1.257
Hunan Producing and Supply of Electricity, Gas and Water	2014	1.240
Hunan Construction	2014	1.107
Hunan Financial Intermediation	2014	1.187
Hunan Management of Water Conservancy, Environment and Public Facilities	2014	1.111
Hunan Education	2014	1.289
Hunan Health, Social Securities and Social Welfare	2014	1.424
Hunan Culture, Sports and Entertainment	2014	1.036
Hunan Public Management and Social Organization	2014	1.567
Inner Mongolia Agriculture, Forestry, Animal Husbandry and Fishing	2014	4.867
Inner Mongolia Mining	2014	2.017
Inner Mongolia Producing and Supply of Electricity, Gas and Water	2014	1.968
Inner Mongolia Transport, Storage and Post	2014	1.527
Inner Mongolia Information Transmission, Computer Service and Software	2014	1.066
Inner Mongolia Financial Intermediation	2014	1.227
Inner Mongolia Management of Water Conservancy, Environment and Public Facilities	2014	1.879
Inner Mongolia Education	2014	1.241
Inner Mongolia Health, Social Securities and Social Welfare	2014	1.078
Inner Mongolia Culture, Sports and Entertainment	2014	1.412
Inner Mongolia Public Management and Social Organization	2014	1.531
Jiangsu Manufacturing	2014	1.273
Jiangsu Construction	2014	1.734
Jiangsu Information Transmission, Computer Service and Software	2014	1.121
Jiangxi Producing and Supply of Electricity, Gas and Water	2014	1.327
Jiangxi Construction	2014	1.272
Jiangxi Transport, Storage and Post	2014	1.022
Jiangxi Management of Water Conservancy, Environment and Public Facilities	2014	1.159
Jiangxi Education	2014	1.104
Jiangxi Health, Social Securities and Social Welfare	2014	1.039
Jiangxi Public Management and Social Organization	2014	1.253
Jilin Agriculture, Forestry, Animal Husbandry and Fishing	2014	2.480

Jilin Mining	2014	1.294
Jilin Producing and Supply of Electricity, Gas and Water	2014	1.856
Jilin Transport, Storage and Post	2014	1.085
Jilin Information Transmission, Computer Service and Software	2014	1.101
Jilin Financial Intermediation	2014	1.096
Jilin Scientific Research, Technical Services, and Geological Prospecting	2014	1.108
Jilin Management of Water Conservancy, Environment and Public Facilities	2014	1.714
Jilin Education	2014	1.176
Jilin Health, Social Securities and Social Welfare	2014	1.209
Jilin Culture, Sports and Entertainment	2014	1.309
Jilin Public Management and Social Organization	2014	1.198
Liaoning Agriculture, Forestry, Animal Husbandry and Fishing	2014	2.079
Liaoning Mining	2014	1.405
Liaoning Producing and Supply of Electricity, Gas and Water	2014	1.069
Liaoning Construction	2014	1.008
Liaoning Transport, Storage and Post	2014	1.169
Liaoning Information Transmission, Computer Service and Software	2014	1.021
Liaoning Financial Intermediation	2014	1.134
Liaoning Scientific Research, Technical Services, and Geological Prospecting	2014	1.145
Liaoning Management of Water Conservancy, Environment and Public Facilities	2014	1.611
Liaoning Services to Households and Other Services	2014	1.016
Liaoning Health, Social Securities and Social Welfare	2014	1.139
Ningxia Agriculture, Forestry, Animal Husbandry and Fishing	2014	1.708
Ningxia Mining	2014	2.602
Ningxia Producing and Supply of Electricity, Gas and Water	2014	2.134
Ningxia Transport, Storage and Post	2014	1.198
Ningxia Financial Intermediation	2014	1.428
Ningxia Leasing and Business Service	2014	1.175
Ningxia Management of Water Conservancy, Environment and Public Facilities	2014	2.042
Ningxia Education	2014	1.309
Ningxia Health, Social Securities and Social Welfare	2014	1.330
Ningxia Culture, Sports and Entertainment	2014	1.377
Ningxia Public Management and Social Organization	2014	1.486
Qinghai Agriculture, Forestry, Animal Husbandry and Fishing	2014	1.359
Qinghai Mining	2014	1.957
Qinghai Producing and Supply of Electricity, Gas and Water	2014	1.293
Qinghai Transport, Storage and Post	2014	1.586
Qinghai Financial Intermediation	2014	1.133
Qinghai Scientific Research, Technical Services, and Geological Prospecting	2014	1.704
Qinghai Management of Water Conservancy, Environment and Public Facilities	2014	1.128
Qinghai Education	2014	1.278
Qinghai Health, Social Securities and Social Welfare	2014	1.348
Qinghai Culture, Sports and Entertainment	2014	1.564
Qinghai Public Management and Social Organization	2014	1.684
Shaanxi Mining	2014	2.045
Shaanxi Producing and Supply of Electricity, Gas and Water	2014	1.081
Shaanxi Transport, Storage and Post	2014	1.060
Shaanxi Information Transmission, Computer Service and Software	2014	1.037
Shaanxi Wholesale and Retail Trade	2014	1.044
Shaanxi Hotels and Catering Services	2014	1.479
Shaanxi Financial Intermediation	2014	1.002
Shaanxi Scientific Research, Technical Services, and Geological Prospecting	2014	1.547
Shaanxi Management of Water Conservancy, Environment and Public Facilities	2014	1.235
Shaanxi Education	2014	1.243
Shaanxi Health, Social Securities and Social Welfare	2014	1.090
Shaanxi Culture, Sports and Entertainment	2014	1.115
Shaanxi Public Management and Social Organization	2014	1.274
Shandong Mining	2014	1.645
Shandong Manufacturing	2014	1.167
Shandong Wholesale and Retail Trade	2014	1.059
Shandong Health, Social Securities and Social Welfare	2014	1.023
Shandong Public Management and Social Organization	2014	1.004
Shanghai Manufacturing	2014	1.179
Shanghai Transport, Storage and Post	2014	1.700
Shanghai Information Transmission, Computer Service and Software	2014	1.936
Shanghai Wholesale and Retail Trade	2014	2.197
Shanghai Hotels and Catering Services	2014	2.024
Shanghai Financial Intermediation	2014	1.634
Shanghai Real Estimate	2014	1.881
Shanghai Leasing and Business Service	2014	2.919
Shanghai Scientific Research, Technical Services, and Geological Prospecting	2014	1.539

Shanghai Services to Households and Other Services	2014	2.065
Shanghai Culture, Sports and Entertainment	2014	1.172
Shanxi Mining	2014	6.316
Shanxi Producing and Supply of Electricity, Gas and Water	2014	1.107
Shanxi Transport, Storage and Post	2014	1.090
Shanxi Financial Intermediation	2014	1.132
Shanxi Management of Water Conservancy, Environment and Public Facilities	2014	1.329
Shanxi Education	2014	1.211
Shanxi Culture, Sports and Entertainment	2014	1.240
Shanxi Public Management and Social Organization	2014	1.497
Sichuan Producing and Supply of Electricity, Gas and Water	2014	1.437
Sichuan Construction	2014	1.302
Sichuan	2014	1.021
Sichuan Scientific Research, Technical Services, and Geological Prospecting	2014	1.096
Sichuan Management of Water Conservancy, Environment and Public Facilities	2014	1.000
Sichuan Education	2014	1.152
Sichuan Health, Social Securities and Social Welfare	2014	1.185
Sichuan Public Management and Social Organization	2014	1.145
Tianjin Manufacturing	2014	1.393
Tianjin Transport, Storage and Post	2014	1.015
Tianjin Wholesale and Retail Trade	2014	1.154
Tianjin Hotels and Catering Services	2014	1.292
Tianjin Real Estimate	2014	1.465
Tianjin Scientific Research, Technical Services, and Geological Prospecting	2014	1.660
Tianjin Services to Households and Other Services	2014	8.965
Tibet Agriculture, Forestry, Animal Husbandry and Fishing	2014	1.679
Tibet Producing and Supply of Electricity, Gas and Water	2014	1.482
Tibet Hotels and Catering Services	2014	1.194
Tibet Financial Intermediation	2014	1.047
Tibet Scientific Research, Technical Services, and Geological Prospecting	2014	1.625
Tibet Services to Households and Other Services	2014	1.202
Tibet Education	2014	1.528
Tibet Health, Social Securities and Social Welfare	2014	1.268
Tibet Culture, Sports and Entertainment	2014	2.624
Tibet Public Management and Social Organization	2014	4.920
Xinjiang Agriculture, Forestry, Animal Husbandry and Fishing	2014	10.896
Xinjiang Mining	2014	1.812
Xinjiang Producing and Supply of Electricity, Gas and Water	2014	1.203
Xinjiang Transport, Storage and Post	2014	1.209
Xinjiang Management of Water Conservancy, Environment and Public Facilities	2014	1.232
Xinjiang Education	2014	1.284
Xinjiang Health, Social Securities and Social Welfare	2014	1.271
Xinjiang Culture, Sports and Entertainment	2014	1.179
Xinjiang Public Management and Social Organization	2014	1.762
Yunnan Agriculture, Forestry, Animal Husbandry and Fishing	2014	1.020
Yunnan Mining	2014	1.523
Yunnan Producing and Supply of Electricity, Gas and Water	2014	1.077
Yunnan Construction	2014	1.067
Yunnan Wholesale and Retail Trade	2014	1.211
Yunnan Hotels and Catering Services	2014	1.327
Yunnan Real Estimate	2014	1.140
Yunnan Scientific Research, Technical Services, and Geological Prospecting	2014	1.003
Yunnan Management of Water Conservancy, Environment and Public Facilities	2014	1.279
Yunnan Education	2014	1.454
Yunnan Health, Social Securities and Social Welfare	2014	1.219
Yunnan Culture, Sports and Entertainment	2014	1.000
Yunnan Public Management and Social Organization	2014	1.356
Zhejiang Manufacturing	2014	1.150
Zhejiang Construction	2014	1.754
Zhejiang Financial Intermediation	2014	1.141
Zhejiang Leasing and Business Service	2014	1.154

Table A3.2 Identified Indian clusters by region and industry, 2014

Identified cluster by region and industry	Year	LQ of employment
Andaman & Nicobar Construction	2014	2.046
Andaman & Nicobar Transport, Storage and Communication	2014	1.189
Andaman & Nicobar Public Administration and Community Service	2014	1.770
Andhra Pradesh Agriculture	2014	1.413
Andhra Pradesh Mining & Quarrying	2014	2.346
Andhra Pradesh Transport, Storage and Communication	2014	1.497
Andhra Pradesh Public Administration and Community Service	2014	1.025
Arunachal Pradesh Agriculture	2014	1.811
Arunachal Pradesh Financial and Insurance Service	2014	2.012
Arunachal Pradesh Public Administration and Community Service	2014	1.678
Assam Agriculture	2014	1.102
Assam Mining & Quarrying	2014	5.289
Assam Wholesale, Retail and Trade	2014	1.509
Assam Public Administration and Community Service	2014	1.143
Bihar Agriculture	2014	1.351
Bihar Wholesale, Retail and Trade	2014	1.317
Bihar Financial and Insurance Service	2014	1.664
Chandigarh Manufacturing	2014	1.153
Chandigarh Wholesale, Retail and Trade	2014	3.739
Chandigarh Transport, Storage and Communication	2014	5.057
Chandigarh Financial and Insurance Service	2014	2.491
Chhattisgarh Agriculture	2014	2.105
Chhattisgarh Mining & Quarrying	2014	1.166
Chhattisgarh Electricity	2014	1.832
Chhattisgarh Construction	2014	1.597
Dadra & Nagar Haveli Mining & Quarrying	2014	4.493
Dadra & Nagar Haveli Manufacturing	2014	3.828
Dadra & Nagar Haveli Transport, Storage and Communication	2014	1.144
Dadra & Nagar Haveli Public Administration and Community Service	2014	1.118
Daman & Diu Manufacturing	2014	5.446
Daman & Diu Electricity	2014	1.651
Daman & Diu Transport, Storage and Communication	2014	1.256
Daman & Diu Public Administration and Community Service	2014	2.272
Delhi Electricity	2014	9.289
Delhi Transport, Storage and Communication	2014	4.620
Delhi Financial and Insurance Service	2014	7.058
Delhi Public Administration and Community Service	2014	1.436
Goa Mining & Quarrying	2014	1.157
Goa Electricity	2014	2.294
Goa Wholesale, Retail and Trade	2014	2.779
Goa Financial and Insurance Service	2014	6.074
Goa Public Administration and Community Service	2014	1.305
Gujarat Agriculture	2014	1.384
Gujarat Mining & Quarrying	2014	1.362
Gujarat Manufacturing	2014	2.160
Gujarat Electricity	2014	3.758
Haryana Agriculture	2014	1.186
Haryana Construction	2014	1.292
Haryana Transport, Storage and Communication	2014	1.411
Himachal Pradesh Agriculture	2014	1.362
Himachal Pradesh Manufacturing	2014	2.393
Himachal Pradesh Financial and Insurance Service	2014	2.112
Jammu & Kashmir Construction	2014	2.486
Jammu & Kashmir Public Administration and Community Service	2014	1.086
Jharkhand Agriculture	2014	1.306
Jharkhand Mining & Quarrying	2014	8.967
Jharkhand Wholesale, Retail and Trade	2014	1.151
Jharkhand Financial and Insurance Service	2014	1.094
Karnataka Agriculture	2014	1.316
Karnataka Transport, Storage and Communication	2014	1.626
Kerala Construction	2014	1.649
Kerala Wholesale, Retail and Trade	2014	1.198
Kerala Transport, Storage and Communication	2014	1.423
Kerala Public Administration and Community Service	2014	1.027
Lakshadweep Electricity	2014	4.110
Lakshadweep Construction	2014	2.984
Lakshadweep Transport, Storage and Communication	2014	1.678
Lakshadweep Financial and Insurance Service	2014	2.293
Lakshadweep Public Administration and Community Service	2014	1.494

Madhya Pradesh Agriculture	2014	1.373
Madhya Pradesh Construction	2014	1.463
Maharashtra Agriculture	2014	1.484
Maharashtra Transport, Storage and Communication	2014	1.136
Manipur Agriculture	2014	1.051
Manipur Manufacturing	2014	1.104
Manipur Construction	2014	2.226
Manipur Transport, Storage and Communication	2014	1.074
Meghalaya Agriculture	2014	1.221
Meghalaya Mining & Quarrying	2014	3.157
Meghalaya Wholesale, Retail and Trade	2014	1.709
Meghalaya Public Administration and Community Service	2014	1.501
Mizoram Agriculture	2014	1.627
Mizoram Wholesale, Retail and Trade	2014	1.126
Mizoram Public Administration and Community Service	2014	1.581
Nagaland Agriculture	2014	1.746
Nagaland Electricity	2014	4.579
Nagaland Public Administration and Community Service	2014	1.821
Orissa Agriculture	2014	1.407
Orissa Wholesale, Retail and Trade	2014	1.150
Orissa Transport, Storage and Communication	2014	1.054
Pondicherry Manufacturing	2014	1.158
Pondicherry Construction	2014	1.536
Pondicherry Wholesale, Retail and Trade	2014	1.385
Pondicherry Transport, Storage and Communication	2014	1.584
Pondicherry Financial and Insurance Service	2014	1.309
Punjab Manufacturing	2014	1.638
Punjab Electricity	2014	2.619
Punjab Public Administration and Community Service	2014	1.179
Rajasthan Agriculture	2014	1.215
Rajasthan Mining & Quarrying	2014	2.024
Rajasthan Manufacturing	2014	1.420
Rajasthan Electricity	2014	2.222
Rajasthan Construction	2014	1.520
Sikkim Agriculture	2014	1.851
Sikkim Electricity	2014	6.272
Tamil Nadu Mining & Quarrying	2014	1.336
Tamil Nadu Manufacturing	2014	1.583
Tamil Nadu Electricity	2014	1.095
Tamil Nadu Construction	2014	1.301
Tripura Mining & Quarrying	2014	1.118
Tripura Construction	2014	2.914
Tripura Public Administration and Community Service	2014	1.384
Uttar Pradesh Agriculture	2014	1.299
Uttar Pradesh Mining & Quarrying	2014	1.676
Uttar Pradesh Manufacturing	2014	1.426
Uttar Pradesh Electricity	2014	1.428
Uttar Pradesh Construction	2014	1.087
Uttarakhand Agriculture	2014	1.059
Uttarakhand Construction	2014	1.020
Uttarakhand Wholesale, Retail and Trade	2014	1.497
Uttarakhand Transport, Storage and Communication	2014	1.560
West Bengal Mining & Quarrying	2014	1.032
West Bengal Manufacturing	2014	1.984
West Bengal Financial and Insurance Service	2014	1.052

Table A3.3 Identified French clusters by region and industry, 2014

Identified cluster by region and industry	Year	LQ of employment
Île de France Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.044
Île de France Information and Communication	2014	2.173
Île de France Financial and Insurance Activities	2014	1.666
Île de France Real Estate Activities	2014	1.472
Île de France Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.417
Île de France Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.208
Centre-Val de Loire Agriculture, Forestry and Fishing	2014	1.198
Centre-Val de Loire Industry (except construction)	2014	1.219
Centre-Val de Loire Construction	2014	1.094
Bourgogne Agriculture, Forestry and Fishing	2014	2.713
Bourgogne Industry (except construction)	2014	1.271
Bourgogne Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.041
Franche-Comté Agriculture, Forestry and Fishing	2014	1.299
Franche-Comté Industry (except construction)	2014	1.904
Basse-Normandie Agriculture, Forestry and Fishing	2014	1.924
Basse-Normandie Industry (except construction)	2014	1.227
Basse-Normandie Construction	2014	1.124
Basse-Normandie Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.030
Basse-Normandie Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.028
Haute-Normandie Industry (except construction)	2014	1.477
Haute-Normandie Construction	2014	1.217
Haute-Normandie Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.021
Nord-Pas de Calais Industry (except construction)	2014	1.143
Nord-Pas de Calais Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.141
Picardie Agriculture, Forestry and Fishing	2014	1.068
Picardie Industry (except construction)	2014	1.146
Picardie Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.121
Picardie Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.026
Alsace Industry (except construction)	2014	1.370
Alsace Construction	2014	1.108
Alsace Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.084
Champagne-Ardenne Agriculture, Forestry and Fishing	2014	1.785
Champagne-Ardenne Industry (except construction)	2014	1.323
Champagne-Ardenne Construction	2014	1.036
Champagne-Ardenne Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.005
Lorraine Industry (except construction)	2014	1.329
Lorraine Construction	2014	1.121
Lorraine Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.002
Lorraine Financial and Insurance Activities	2014	1.092
Pays de la Loire Agriculture, Forestry and Fishing	2014	1.393
Pays de la Loire Industry (except construction)	2014	1.193
Pays de la Loire Construction	2014	1.137
Pays de la Loire Financial and Insurance Activities	2014	1.108
Bretagne Agriculture, Forestry and Fishing	2014	1.848
Bretagne Industry (except construction)	2014	1.032
Bretagne Construction	2014	1.078
Bretagne Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.096
Aquitaine Agriculture, Forestry and Fishing	2014	1.370
Aquitaine Construction	2014	1.131
Aquitaine Real Estate Activities	2014	1.284
Aquitaine Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.050
Aquitaine Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.048
Limousin Agriculture, Forestry and Fishing	2014	2.041
Limousin Industry (except construction)	2014	1.055
Limousin Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.255
Limousin Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.182
Poitou-Charentes Agriculture, Forestry and Fishing	2014	1.485
Poitou-Charentes Industry (except construction)	2014	1.144
Poitou-Charentes Construction	2014	1.092
Poitou-Charentes Financial and Insurance Activities	2014	1.190

Poitou-Charentes Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.090
Languedoc-Roussillon Agriculture, Forestry and Fishing	2014	1.750
Languedoc-Roussillon Construction	2014	1.058
Languedoc-Roussillon Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.199
Languedoc-Roussillon Real Estate Activities	2014	1.379
Languedoc-Roussillon Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.030
Languedoc-Roussillon Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.052
Midi-Pyrénées Agriculture, Forestry and Fishing	2014	1.380
Midi-Pyrénées Industry (except construction)	2014	1.047
Midi-Pyrénées Construction	2014	1.085
Midi-Pyrénées Information and Communication	2014	1.309
Midi-Pyrénées Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.178
Auvergne Agriculture, Forestry and Fishing	2014	2.101
Auvergne Industry (except construction)	2014	1.261
Auvergne Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.045
Rhône-Alpes Industry (except construction)	2014	1.281
Rhône-Alpes Construction	2014	1.015
Rhône-Alpes Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.037
Provence-Alpes-Côte d'Azur Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.094
Provence-Alpes-Côte d'Azur Real Estate Activities	2014	1.439
Provence-Alpes-Côte d'Azur Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.047
Provence-Alpes-Côte d'Azur Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.083
Provence-Alpes-Côte d'Azur Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.114
Corse Construction	2014	2.320
Corse Wholesale and Retail Trade, Transport, Accomodation and Food Service Activities	2014	1.095
Corse Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.133
Corse Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.129
Guadeloupe Agriculture, Forestry and Fishing	2014	1.095
Guadeloupe Construction	2014	1.180
Guadeloupe Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.015
Guadeloupe Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.164
Guadeloupe Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.681
Martinique Agriculture, Forestry and Fishing	2014	1.705
Martinique Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.315
Martinique Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.340
Guyane Agriculture, Forestry and Fishing	2014	2.663
Guyane Construction	2014	1.353
Guyane Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.394
Guyane Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.065
La Réunion Agriculture, Forestry and Fishing	2014	1.274
La Réunion Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.344
La Réunion Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.375
Mayotte Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.091
Mayotte Public Administration, Defence, Education, Human Health and Social Work Activities	2014	2.400

Table A3.4 Identified German clusters by region and industry, 2014

Identified cluster by region and industry	Year	LQ of employment
Stuttgart Industry (except construction)	2014	1.439
Stuttgart Information and Communication	2014	1.133
Stuttgart Financial and Insurance Activities	2014	1.155
Stuttgart Real Estate Activities	2014	1.366
Karlsruhe Industry (except construction)	2014	1.247
Karlsruhe Information and Communication	2014	1.429
Karlsruhe Real Estate Activities	2014	1.485
Freiburg Industry (except construction)	2014	1.325
Tübingen Agriculture, Forestry and Fishing	2014	1.409
Tübingen Industry (except construction)	2014	1.412
Tübingen Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.023
Oberbayern Agriculture, Forestry and Fishing	2014	1.261
Oberbayern Information and Communication	2014	1.739
Oberbayern Financial and Insurance Activities	2014	1.411
Oberbayern Real Estate Activities	2014	2.011
Oberbayern Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.248
Niederbayern Agriculture, Forestry and Fishing	2014	2.231
Niederbayern Industry (except construction)	2014	1.297
Niederbayern Construction	2014	1.370
Niederbayern Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.002
Niederbayern Financial and Insurance Activities	2014	1.019
Oberpfalz Agriculture, Forestry and Fishing	2014	1.677
Oberpfalz Industry (except construction)	2014	1.332
Oberpfalz Construction	2014	1.063
Oberfranken Industry (except construction)	2014	1.437
Oberfranken Financial and Insurance Activities	2014	1.056
Mittelfranken Agriculture, Forestry and Fishing	2014	1.024
Mittelfranken Industry (except construction)	2014	1.207
Mittelfranken Information and Communication	2014	1.258
Mittelfranken Financial and Insurance Activities	2014	1.071
Unterfranken Agriculture, Forestry and Fishing	2014	1.016
Unterfranken Industry (except construction)	2014	1.356
Schwaben Agriculture, Forestry and Fishing	2014	1.821
Schwaben Industry (except construction)	2014	1.309
Schwaben Construction	2014	1.109
Berlin Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.005
Berlin Information and Communication	2014	2.076
Berlin Real Estate Activities	2014	4.175
Berlin Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.567
Berlin Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.114
Berlin Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.598
Brandenburg Agriculture, Forestry and Fishing	2014	1.375
Brandenburg Construction	2014	1.372
Brandenburg Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.028
Brandenburg Real Estate Activities	2014	2.179
Brandenburg Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.116
Brandenburg Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.108
Bremen Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.235
Bremen Information and Communication	2014	1.110
Bremen Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.295
Bremen Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.029
Bremen Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.234
Hamburg Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.217
Hamburg Information and Communication	2014	1.602
Hamburg Financial and Insurance Activities	2014	1.150
Hamburg Real Estate Activities	2014	2.538
Hamburg Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.648
Hamburg Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.186
Darmstadt Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.077
Darmstadt Information and Communication	2014	1.401
Darmstadt Financial and Insurance Activities	2014	2.096
Darmstadt Real Estate Activities	2014	1.792
Darmstadt Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.289

Darmstadt Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.055
Gießen Agriculture, Forestry and Fishing	2014	1.024
Gießen Industry (except construction)	2014	1.068
Gießen Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.162
Gießen Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.017
Kassel Agriculture, Forestry and Fishing	2014	1.153
Kassel Industry (except construction)	2014	1.092
Kassel Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.068
Kassel Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.076
Mecklenburg-Vorpommern Agriculture, Forestry and Fishing	2014	2.063
Mecklenburg-Vorpommern Construction	2014	1.460
Mecklenburg-Vorpommern Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.068
Mecklenburg-Vorpommern Real Estate Activities	2014	2.368
Mecklenburg-Vorpommern Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.133
Mecklenburg-Vorpommern Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.092
Braunschweig Agriculture, Forestry and Fishing	2014	1.012
Braunschweig Industry (except construction)	2014	1.233
Braunschweig Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.091
Hannover Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.067
Hannover Financial and Insurance Activities	2014	1.357
Hannover Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.028
Hannover Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.067
Hannover Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.111
Lüneburg Agriculture, Forestry and Fishing	2014	2.761
Lüneburg Construction	2014	1.072
Lüneburg Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.143
Lüneburg Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.040
Lüneburg Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.023
Weser-Ems Agriculture, Forestry and Fishing	2014	2.335
Weser-Ems Construction	2014	1.231
Weser-Ems Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.070
Weser-Ems Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.023
Weser-Ems Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.006
Düsseldorf Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.086
Düsseldorf Financial and Insurance Activities	2014	1.117
Düsseldorf Real Estate Activities	2014	2.121
Düsseldorf Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.137
Düsseldorf Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.026
Köln Information and Communication	2014	1.379
Köln Financial and Insurance Activities	2014	1.165
Köln Real Estate Activities	2014	1.697
Köln Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.153
Köln Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.070
Köln Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.185
Münster Agriculture, Forestry and Fishing	2014	1.334
Münster Industry (except construction)	2014	1.010
Münster Construction	2014	1.040
Münster Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.022
Münster Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.052
Detmold Industry (except construction)	2014	1.253
Detmold Construction	2014	1.033
Detmold Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.007
Arnsberg Industry (except construction)	2014	1.159
Arnsberg Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.024
Arnsberg Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.025
Koblenz Construction	2014	1.065
Koblenz Financial and Insurance Activities	2014	1.100
Koblenz Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.146
Trier Agriculture, Forestry and Fishing	2014	2.553
Trier Construction	2014	1.153

Trier Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.065
Trier Financial and Insurance Activities	2014	1.387
Trier Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.012
Trier Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.110
Rheinhessen-Pfalz Agriculture, Forestry and Fishing	2014	1.160
Rheinhessen-Pfalz Industry (except construction)	2014	1.047
Rheinhessen-Pfalz Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.013
Rheinhessen-Pfalz Information and Communication	2014	1.014
Rheinhessen-Pfalz Financial and Insurance Activities	2014	1.078
Rheinhessen-Pfalz Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.026
Saarland Industry (except construction)	2014	1.029
Saarland Construction	2014	1.018
Saarland Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.102
Saarland Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.051
Dresden Construction	2014	1.312
Dresden Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.100
Dresden Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.026
Dresden Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.086
Chemnitz Industry (except construction)	2014	1.177
Chemnitz Construction	2014	1.465
Leipzig Agriculture, Forestry and Fishing	2014	1.132
Leipzig Construction	2014	1.248
Leipzig Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.035
Leipzig Information and Communication	2014	1.067
Leipzig Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.278
Leipzig Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.008
Leipzig Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.050
Sachsen-Anhalt Agriculture, Forestry and Fishing	2014	1.148
Sachsen-Anhalt Construction	2014	1.536
Sachsen-Anhalt Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.071
Sachsen-Anhalt Real Estate Activities	2014	1.679
Sachsen-Anhalt Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.022
Schleswig-Holstein Agriculture, Forestry and Fishing	2014	1.536
Schleswig-Holstein Construction	2014	1.054
Schleswig-Holstein Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.115
Schleswig-Holstein Financial and Insurance Activities	2014	1.023
Schleswig-Holstein Real Estate Activities	2014	2.129
Schleswig-Holstein Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.045
Schleswig-Holstein Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.094
Schleswig-Holstein Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.063
Thüringen Agriculture, Forestry and Fishing	2014	1.341
Thüringen Industry (except construction)	2014	1.081
Thüringen Construction	2014	1.432
Thüringen Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.010

Table A3.5 Identified Italian clusters by region and industry, 2014

Identified cluster by region and industry	Year	LQ of employment
Piemonte Industry (except construction)	2014	1.246
Piemonte Information and Communication	2014	1.157
Piemonte Financial and Insurance Activities	2014	1.126
Valle d'Aosta Construction	2014	1.563
Valle d'Aosta Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.067
Valle d'Aosta Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.385
Valle d'Aosta Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.041
Liguria Construction	2014	1.084
Liguria Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.198
Liguria Financial and Insurance Activities	2014	1.177
Liguria Real Estate Activities	2014	1.787
Liguria Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.024
Liguria Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.043
Liguria Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.229
Lombardia Industry (except construction)	2014	1.300
Lombardia Information and Communication	2014	1.463
Lombardia Financial and Insurance Activities	2014	1.381
Lombardia Real Estate Activities	2014	1.412
Lombardia Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.104
Abruzzo Agriculture, Forestry and Fishing	2014	1.447
Abruzzo Industry (except construction)	2014	1.040
Abruzzo Construction	2014	1.255
Abruzzo Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.020
Abruzzo Real Estate Activities	2014	1.280
Molise Agriculture, Forestry and Fishing	2014	2.214
Molise Construction	2014	1.211
Molise Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.197
Campania Agriculture, Forestry and Fishing	2014	1.183
Campania Construction	2014	1.092
Campania Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.152
Campania Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.146
Campania Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.010
Puglia Agriculture, Forestry and Fishing	2014	2.077
Puglia Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.062
Puglia Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.196
Basilicata Agriculture, Forestry and Fishing	2014	2.274
Basilicata Construction	2014	1.276
Basilicata Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.204
Calabria Agriculture, Forestry and Fishing	2014	2.914
Calabria Construction	2014	1.036
Calabria Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.086
Calabria Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.046
Calabria Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.288
Sicilia Agriculture, Forestry and Fishing	2014	1.930
Sicilia Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.067
Sicilia Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.440
Sardegna Agriculture, Forestry and Fishing	2014	1.716
Sardegna Construction	2014	1.249
Sardegna Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.160
Sardegna Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.244
Sardegna Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.083
Provincia Autonoma di Bolzano Agriculture, Forestry and Fishing	2014	1.740
Provincia Autonoma di Bolzano Construction	2014	1.106
Provincia Autonoma di Bolzano Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.180
Provincia Autonoma di Bolzano Financial and Insurance Activities	2014	1.190
Provincia Autonoma di Bolzano Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.217
Provincia Autonoma di Trento Agriculture, Forestry and Fishing	2014	1.056
Provincia Autonoma di Trento Construction	2014	1.162
Provincia Autonoma di Trento Financial and Insurance Activities	2014	1.060
Provincia Autonoma di Trento Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.059

Provincia Autonoma di Trento Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.286
Veneto Industry (except construction)	2014	1.389
Veneto Construction	2014	1.006
Veneto Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.018
Friuli-Venezia Giulia Industry (except construction)	2014	1.229
Friuli-Venezia Giulia Financial and Insurance Activities	2014	1.020
Friuli-Venezia Giulia Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.085
Emilia-Romagna Industry (except construction)	2014	1.301
Emilia-Romagna Financial and Insurance Activities	2014	1.006
Toscana Industry (except construction)	2014	1.017
Toscana Construction	2014	1.121
Toscana Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.068
Toscana Financial and Insurance Activities	2014	1.005
Toscana Real Estate Activities	2014	1.191
Toscana Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.185
Umbria Agriculture, Forestry and Fishing	2014	1.086
Umbria Industry (except construction)	2014	1.013
Umbria Construction	2014	1.007
Umbria Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.006
Umbria Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.236
Marche Industry (except construction)	2014	1.479
Lazio Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities	2014	1.007
Lazio Information and Communication	2014	2.222
Lazio Financial and Insurance Activities	2014	1.109
Lazio Real Estate Activities	2014	1.636
Lazio Professional, Scientific and Technical Activities; Administrative and Support Service Activities	2014	1.237
Lazio Public Administration, Defence, Education, Human Health and Social Work Activities	2014	1.170
Lazio Arts, Entertainment and Recreation, other Service Activities and Activities of Household and Extra-territorial organizations and bodies	2014	1.427

Table A3.6 Identified US clusters by region and industry, 2014

Identified cluster by region and industry	Year	LQ of employment
Alabama Construction	2014	1.038
Alabama Manufacturing	2014	1.626
Alabama Retail Trade	2014	1.130
Alabama Transportation and Warehousing	2014	1.023
Alabama Other Services (except Public Administration)	2014	1.152
Alaska Forestry, Fishing, Hunting, and Agriculture Support	2014	2.908
Alaska Mining	2014	7.613
Alaska Utilities	2014	1.956
Alaska Construction	2014	1.606
Alaska Transportation and Warehousing	2014	1.920
Alaska Management of Companies and Enterprises	2014	1.034
Alaska Health Care and Social Assistance	2014	1.133
Alaska Arts, Entertainment, and Recreation	2014	1.033
Arizona Utilities	2014	1.371
Arizona Construction	2014	1.240
Arizona Retail Trade	2014	1.076
Arizona Transportation and Warehousing	2014	1.034
Arizona Finance and Insurance	2014	1.214
Arizona Real Estate and Rental and Leasing	2014	1.162
Arizona Administrative and Support and Waste Management and Remediation Services	2014	1.312
Arizona Arts, Entertainment, and Recreation	2014	1.057
Arizona Accommodation and Food Services	2014	1.150
Arkansas Forestry, Fishing, Hunting, and Agriculture Support	2014	3.539
Arkansas Mining	2014	1.301
Arkansas Utilities	2014	1.888
Arkansas Manufacturing	2014	1.640
Arkansas Retail Trade	2014	1.120
Arkansas Transportation and Warehousing	2014	1.387
Arkansas Management of Companies and Enterprises	2014	1.381
Arkansas Health Care and Social Assistance	2014	1.101
California Forestry, Fishing, Hunting, and Agriculture Support	2014	1.479
California Wholesale Trade	2014	1.236
California Information	2014	1.683
California Real Estate and Rental and Leasing	2014	1.221
California Professional, Scientific, and Technical Services	2014	1.249
California Administrative and Support and Waste Management and Remediation Services	2014	1.079
California Arts, Entertainment, and Recreation	2014	1.301
California Accommodation and Food Services	2014	1.055
Colorado Mining	2014	2.255
Colorado Construction	2014	1.326
Colorado Information	2014	1.382
Colorado Real Estate and Rental and Leasing	2014	1.131
Colorado Professional, Scientific, and Technical Services	2014	1.252
Colorado Administrative and Support and Waste Management and Remediation Services	2014	1.246
Colorado Arts, Entertainment, and Recreation	2014	1.344
Colorado Accommodation and Food Services	2014	1.135
Colorado Other Services (except Public Administration)	2014	1.060
Connecticut Manufacturing	2014	1.084
Connecticut Finance and Insurance	2014	1.528
Connecticut Educational Services	2014	1.717
Connecticut Health Care and Social Assistance	2014	1.199
Connecticut Arts, Entertainment, and Recreation	2014	1.041
Delaware Utilities	2014	1.519
Delaware Construction	2014	1.000
Delaware Retail Trade	2014	1.094
Delaware Finance and Insurance	2014	1.988
Delaware Professional, Scientific, and Technical Services	2014	1.186
Delaware Management of Companies and Enterprises	2014	1.480
Delaware Health Care and Social Assistance	2014	1.051
Delaware Arts, Entertainment, and Recreation	2014	1.246
District of Columbia Information	2014	1.618
District of Columbia Real Estate and Rental and Leasing	2014	1.315
District of Columbia Professional, Scientific, and Technical Services	2014	2.842
District of Columbia Educational Services	2014	3.390
District of Columbia Accommodation and Food Services	2014	1.243
District of Columbia Other Services (except Public Administration)	2014	3.403
Florida Retail Trade	2014	1.085
Florida Real Estate and Rental and Leasing	2014	1.264

Florida Administrative and Support and Waste Management and Remediation Services	2014	2.158
Florida Arts, Entertainment, and Recreation	2014	1.378
Florida Accommodation and Food Services	2014	1.098
Georgia Forestry, Fishing, Hunting, and Agriculture Support	2014	1.661
Georgia Utilities	2014	1.625
Georgia Manufacturing	2014	1.050
Georgia Wholesale Trade	2014	1.137
Georgia Retail Trade	2014	1.004
Georgia Transportation and Warehousing	2014	1.297
Georgia Information	2014	1.190
Georgia Management of Companies and Enterprises	2014	1.264
Georgia Administrative and Support and Waste Management and Remediation Services	2014	1.100
Georgia Accommodation and Food Services	2014	1.039
Hawaii Utilities	2014	1.760
Hawaii Construction	2014	1.135
Hawaii Retail Trade	2014	1.073
Hawaii Transportation and Warehousing	2014	1.545
Hawaii Real Estate and Rental and Leasing	2014	1.404
Hawaii Administrative and Support and Waste Management and Remediation Services	2014	1.272
Hawaii Educational Services	2014	1.222
Hawaii Arts, Entertainment, and Recreation	2014	1.217
Hawaii Accommodation and Food Services	2014	1.909
Hawaii Other Services (except Public Administration)	2014	1.113
Idaho Forestry, Fishing, Hunting, and Agriculture Support	2014	4.436
Idaho Construction	2014	1.304
Idaho Manufacturing	2014	1.111
Idaho Wholesale Trade	2014	1.134
Idaho Retail Trade	2014	1.188
Idaho Health Care and Social Assistance	2014	1.069
Idaho Accommodation and Food Services	2014	1.033
Illinois Utilities	2014	1.339
Illinois Manufacturing	2014	1.085
Illinois Wholesale Trade	2014	1.199
Illinois Transportation and Warehousing	2014	1.195
Illinois Finance and Insurance	2014	1.229
Illinois Professional, Scientific, and Technical Services	2014	1.106
Illinois Management of Companies and Enterprises	2014	1.408
Illinois Administrative and Support and Waste Management and Remediation Services	2014	1.015
Illinois Educational Services	2014	1.050
Illinois Other Services (except Public Administration)	2014	1.043
Indiana Utilities	2014	1.429
Indiana Manufacturing	2014	1.935
Indiana Transportation and Warehousing	2014	1.259
Indiana Other Services (except Public Administration)	2014	1.093
Iowa Forestry, Fishing, Hunting, and Agriculture Support	2014	1.517
Iowa Utilities	2014	1.515
Iowa Manufacturing	2014	1.682
Iowa Wholesale Trade	2014	1.024
Iowa Retail Trade	2014	1.078
Iowa Transportation and Warehousing	2014	1.161
Iowa Finance and Insurance	2014	1.373
Iowa Educational Services	2014	1.162
Iowa Health Care and Social Assistance	2014	1.053
Kansas Mining	2014	1.486
Kansas Utilities	2014	1.513
Kansas Construction	2014	1.117
Kansas Manufacturing	2014	1.480
Kansas Wholesale Trade	2014	1.115
Kansas Retail Trade	2014	1.003
Kansas Transportation and Warehousing	2014	1.174
Kansas Information	2014	1.054
Kansas Finance and Insurance	2014	1.058
Kansas Health Care and Social Assistance	2014	1.062
Kentucky Mining	2014	1.656
Kentucky Utilities	2014	1.354
Kentucky Manufacturing	2014	1.564
Kentucky Retail Trade	2014	1.043
Kentucky Transportation and Warehousing	2014	1.560
Kentucky Health Care and Social Assistance	2014	1.032
Kentucky Accommodation and Food Services	2014	1.019
Louisiana Forestry, Fishing, Hunting, and Agriculture Support	2014	1.776

Louisiana Mining	2014	5.398
Louisiana Construction	2014	1.791
Louisiana Retail Trade	2014	1.057
Louisiana Transportation and Warehousing	2014	1.169
Louisiana Real Estate and Rental and Leasing	2014	1.189
Louisiana Health Care and Social Assistance	2014	1.082
Louisiana Accommodation and Food Services	2014	1.139
Louisiana Other Services (except Public Administration)	2014	1.032
Maine Forestry, Fishing, Hunting, and Agriculture Support	2014	5.197
Maine Utilities	2014	1.078
Maine Manufacturing	2014	1.048
Maine Retail Trade	2014	1.302
Maine Finance and Insurance	2014	1.062
Maine Educational Services	2014	1.252
Maine Health Care and Social Assistance	2014	1.399
Maryland Utilities	2014	1.094
Maryland Construction	2014	1.379
Maryland Retail Trade	2014	1.036
Maryland Real Estate and Rental and Leasing	2014	1.178
Maryland Professional, Scientific, and Technical Services	2014	1.772
Maryland Educational Services	2014	1.247
Maryland Health Care and Social Assistance	2014	1.044
Maryland Arts, Entertainment, and Recreation	2014	1.025
Maryland Other Services (except Public Administration)	2014	1.155
Massachusetts Utilities	2014	1.003
Massachusetts Information	2014	1.310
Massachusetts Finance and Insurance	2014	1.151
Massachusetts Professional, Scientific, and Technical Services	2014	1.189
Massachusetts Management of Companies and Enterprises	2014	1.062
Massachusetts Educational Services	2014	2.357
Massachusetts Health Care and Social Assistance	2014	1.263
Michigan Utilities	2014	1.514
Michigan Manufacturing	2014	1.580
Michigan Management of Companies and Enterprises	2014	1.166
Michigan Administrative and Support and Waste Management and Remediation Services	2014	1.015
Michigan Health Care and Social Assistance	2014	1.054
Minnesota Manufacturing	2014	1.236
Minnesota Wholesale Trade	2014	1.054
Minnesota Finance and Insurance	2014	1.177
Minnesota Management of Companies and Enterprises	2014	2.100
Minnesota Health Care and Social Assistance	2014	1.118
Minnesota Other Services (except Public Administration)	2014	1.029
Mississippi Forestry, Fishing, Hunting, and Agriculture Support	2014	3.803
Mississippi Mining	2014	1.083
Mississippi Utilities	2014	2.720
Mississippi Manufacturing	2014	1.627
Mississippi Retail Trade	2014	1.214
Mississippi Transportation and Warehousing	2014	1.064
Mississippi Health Care and Social Assistance	2014	1.147
Mississippi Accommodation and Food Services	2014	1.236
Missouri Utilities	2014	1.638
Missouri Manufacturing	2014	1.093
Missouri Wholesale Trade	2014	1.062
Missouri Retail Trade	2014	1.016
Missouri Finance and Insurance	2014	1.082
Missouri Management of Companies and Enterprises	2014	1.306
Missouri Educational Services	2014	1.038
Missouri Health Care and Social Assistance	2014	1.080
Missouri Other Services (except Public Administration)	2014	1.026
Montana Forestry, Fishing, Hunting, and Agriculture Support	2014	2.162
Montana Mining	2014	3.351
Montana Utilities	2014	2.071
Montana Construction	2014	1.351
Montana Retail Trade	2014	1.273
Montana Health Care and Social Assistance	2014	1.209
Montana Arts, Entertainment, and Recreation	2014	1.633
Montana Accommodation and Food Services	2014	1.246
Nebraska Forestry, Fishing, Hunting, and Agriculture Support	2014	1.034
Nebraska Construction	2014	1.027
Nebraska Manufacturing	2014	1.159
Nebraska Wholesale Trade	2014	1.015

Nebraska Retail Trade	2014	1.018
Nebraska Finance and Insurance	2014	1.417
Nebraska Professional, Scientific, and Technical Services	2014	1.616
Nevada Mining	2014	2.037
Nevada Construction	2014	1.142
Nevada Retail Trade	2014	1.021
Nevada Transportation and Warehousing	2014	1.186
Nevada Real Estate and Rental and Leasing	2014	1.544
Nevada Administrative and Support and Waste Management and Remediation Services	2014	1.118
Nevada Arts, Entertainment, and Recreation	2014	1.384
Nevada Accommodation and Food Services	2014	2.706
New Hampshire Utilities	2014	1.382
New Hampshire Manufacturing	2014	1.243
New Hampshire Retail Trade	2014	1.360
New Hampshire Finance and Insurance	2014	1.027
New Hampshire Educational Services	2014	1.411
New Hampshire Health Care and Social Assistance	2014	1.002
New Hampshire Arts, Entertainment, and Recreation	2014	1.176
New Jersey Utilities	2014	1.466
New Jersey Wholesale Trade	2014	1.473
New Jersey Retail Trade	2014	1.018
New Jersey Transportation and Warehousing	2014	1.229
New Jersey Finance and Insurance	2014	1.086
New Jersey Professional, Scientific, and Technical Services	2014	1.261
New Jersey Management of Companies and Enterprises	2014	1.462
New Jersey Health Care and Social Assistance	2014	1.022
New Mexico Mining	2014	5.741
New Mexico Utilities	2014	1.921
New Mexico Construction	2014	1.344
New Mexico Retail Trade	2014	1.249
New Mexico Real Estate and Rental and Leasing	2014	1.036
New Mexico Professional, Scientific, and Technical Services	2014	1.083
New Mexico Health Care and Social Assistance	2014	1.232
New Mexico Arts, Entertainment, and Recreation	2014	1.157
New Mexico Accommodation and Food Services	2014	1.315
New York Utilities	2014	1.263
New York Information	2014	1.283
New York Finance and Insurance	2014	1.357
New York Real Estate and Rental and Leasing	2014	1.299
New York Professional, Scientific, and Technical Services	2014	1.119
New York Educational Services	2014	1.821
New York Health Care and Social Assistance	2014	1.191
New York Arts, Entertainment, and Recreation	2014	1.205
New York Other Services (except Public Administration)	2014	1.078
North Carolina Forestry, Fishing, Hunting, and Agriculture Support	2014	1.015
North Carolina Utilities	2014	1.371
North Carolina Manufacturing	2014	1.213
North Carolina Retail Trade	2014	1.037
North Carolina Administrative and Support and Waste Management and Remediation Services	2014	1.141
North Carolina Health Care and Social Assistance	2014	1.009
North Carolina Accommodation and Food Services	2014	1.008
North Dakota Forestry, Fishing, Hunting, and Agriculture Support	2014	1.085
North Dakota Mining	2014	11.450
North Dakota Construction	2014	1.441
North Dakota Wholesale Trade	2014	1.346
North Dakota Retail Trade	2014	1.125
North Dakota Transportation and Warehousing	2014	1.518
North Dakota Health Care and Social Assistance	2014	1.071
North Dakota Accommodation and Food Services	2014	1.005
Ohio Utilities	2014	1.314
Ohio Manufacturing	2014	1.467
Ohio Wholesale Trade	2014	1.011
Ohio Finance and Insurance	2014	1.065
Ohio Management of Companies and Enterprises	2014	1.191
Ohio Health Care and Social Assistance	2014	1.136
Oklahoma Mining	2014	6.903
Oklahoma Utilities	2014	1.517
Oklahoma Construction	2014	1.089
Oklahoma Manufacturing	2014	1.061
Oklahoma Retail Trade	2014	1.044

Oklahoma Real Estate and Rental and Leasing	2014	1.005
Oklahoma Management of Companies and Enterprises	2014	1.027
Oklahoma Health Care and Social Assistance	2014	1.020
Oklahoma Arts, Entertainment, and Recreation	2014	1.141
Oklahoma Accommodation and Food Services	2014	1.009
Oklahoma Other Services (except Public Administration)	2014	1.038
Oregon Forestry, Fishing, Hunting, and Agriculture Support	2014	6.417
Oregon Utilities	2014	1.358
Oregon Construction	2014	1.128
Oregon Manufacturing	2014	1.184
Oregon Wholesale Trade	2014	1.040
Oregon Retail Trade	2014	1.071
Oregon Real Estate and Rental and Leasing	2014	1.138
Oregon Management of Companies and Enterprises	2014	1.098
Oregon Health Care and Social Assistance	2014	1.010
Oregon Arts, Entertainment, and Recreation	2014	1.002
Oregon Accommodation and Food Services	2014	1.056
Oregon Other Services (except Public Administration)	2014	1.012
Pennsylvania Utilities	2014	1.403
Pennsylvania Manufacturing	2014	1.105
Pennsylvania Transportation and Warehousing	2014	1.109
Pennsylvania Finance and Insurance	2014	1.007
Pennsylvania Management of Companies and Enterprises	2014	1.318
Pennsylvania Educational Services	2014	1.690
Pennsylvania Health Care and Social Assistance	2014	1.188
Pennsylvania Arts, Entertainment, and Recreation	2014	1.101
Pennsylvania Other Services (except Public Administration)	2014	1.035
Rhode Island Manufacturing	2014	1.013
Rhode Island Wholesale Trade	2014	1.011
Rhode Island Finance and Insurance	2014	1.297
Rhode Island Educational Services	2014	2.497
Rhode Island Health Care and Social Assistance	2014	1.348
Rhode Island Arts, Entertainment, and Recreation	2014	1.427
Rhode Island Accommodation and Food Services	2014	1.063
South Carolina Forestry, Fishing, Hunting, and Agriculture Support	2014	1.811
South Carolina Utilities	2014	1.877
South Carolina Manufacturing	2014	1.439
South Carolina Retail Trade	2014	1.116
South Carolina Administrative and Support and Waste Management and Remediation Services	2014	1.153
South Carolina Accommodation and Food Services	2014	1.166
South Carolina Other Services (except Public Administration)	2014	1.117
South Dakota Utilities	2014	1.617
South Dakota Construction	2014	1.113
South Dakota Manufacturing	2014	1.341
South Dakota Wholesale Trade	2014	1.076
South Dakota Retail Trade	2014	1.177
South Dakota Finance and Insurance	2014	1.508
South Dakota Health Care and Social Assistance	2014	1.205
South Dakota Accommodation and Food Services	2014	1.089
Tennessee Manufacturing	2014	1.331
Tennessee Retail Trade	2014	1.014
Tennessee Transportation and Warehousing	2014	1.448
Tennessee Management of Companies and Enterprises	2014	1.256
Tennessee Administrative and Support and Waste Management and Remediation Services	2014	1.107
Tennessee Health Care and Social Assistance	2014	1.023
Texas Mining	2014	4.028
Texas Utilities	2014	1.334
Texas Construction	2014	1.303
Texas Wholesale Trade	2014	1.044
Texas Transportation and Warehousing	2014	1.126
Texas Real Estate and Rental and Leasing	2014	1.130
Texas Management of Companies and Enterprises	2014	1.190
Texas Administrative and Support and Waste Management and Remediation Services	2014	1.055
Texas Accommodation and Food Services	2014	1.018
Utah Mining	2014	1.584
Utah Construction	2014	1.262
Utah Manufacturing	2014	1.060
Utah Transportation and Warehousing	2014	1.165
Utah Information	2014	1.315
Utah Finance and Insurance	2014	1.044

Utah Professional, Scientific, and Technical Services	2014	1.128
Utah Administrative and Support and Waste Management and Remediation Services	2014	1.219
Utah Educational Services	2014	1.298
Vermont Forestry, Fishing, Hunting, and Agriculture Support	2014	1.347
Vermont Construction	2014	1.103
Vermont Manufacturing	2014	1.219
Vermont Retail Trade	2014	1.170
Vermont Educational Services	2014	2.053
Vermont Health Care and Social Assistance	2014	1.156
Vermont Arts, Entertainment, and Recreation	2014	1.758
Vermont Accommodation and Food Services	2014	1.136
Virginia Utilities	2014	1.141
Virginia Construction	2014	1.137
Virginia Retail Trade	2014	1.046
Virginia Information	2014	1.066
Virginia Real Estate and Rental and Leasing	2014	1.013
Virginia Professional, Scientific, and Technical Services	2014	1.930
Virginia Other Services (except Public Administration)	2014	1.169
Washington Forestry, Fishing, Hunting, and Agriculture Support	2014	4.022
Washington Construction	2014	1.255
Washington Manufacturing	2014	1.083
Washington Wholesale Trade	2014	1.021
Washington Retail Trade	2014	1.005
Washington Information	2014	1.797
Washington Real Estate and Rental and Leasing	2014	1.108
Washington Professional, Scientific, and Technical Services	2014	1.091
Washington Management of Companies and Enterprises	2014	1.205
Washington Arts, Entertainment, and Recreation	2014	1.337
West Virginia Forestry, Fishing, Hunting, and Agriculture Support	2014	1.134
West Virginia Mining	2014	8.086
West Virginia Utilities	2014	2.730
West Virginia Retail Trade	2014	1.172
West Virginia Health Care and Social Assistance	2014	1.481
West Virginia Accommodation and Food Services	2014	1.087
Wisconsin Utilities	2014	1.469
Wisconsin Manufacturing	2014	1.914
Wisconsin Transportation and Warehousing	2014	1.101
Wisconsin Finance and Insurance	2014	1.105
Wisconsin Management of Companies and Enterprises	2014	1.214
Wisconsin Health Care and Social Assistance	2014	1.016
Wyoming Mining	2014	19.268
Wyoming Construction	2014	1.947
Wyoming Retail Trade	2014	1.149
Wyoming Transportation and Warehousing	2014	1.386
Wyoming Real Estate and Rental and Leasing	2014	1.393
Wyoming Arts, Entertainment, and Recreation	2014	1.043
Wyoming Accommodation and Food Services	2014	1.258

Chapter 4: The MNE vs. Host Environment: Which Drives Subsidiary Performance?

- A Comparison between Advanced and Emerging Market MNE Subsidiaries

ABSTRACT

The performance of subsidiaries is influenced by MNEs' competence and host country environment. We distinguish the host environment as a technological-rich environment measured by host patent stock and a host country intellectual property regime (IPR). However, do subsidiaries of advanced market multinationals (AMNEs) and emerging market multinationals (EMNEs) benefit from their MNEs and host environments in the same way? By examining these differences, this study contributes to the literature that seeks a general explanation of multinational enterprises originating from contrasting home environments. We develop a general model on subsidiary performance examining the direct and joint effects of MNEs and host environments on subsidiary performance and different patterns of effects are expected emerging from the sub-samples (AMNE subsidiaries and EMNE subsidiaries). We find support in our analysis of data on 4978 overseas subsidiaries of MNEs including 4676 overseas subsidiaries belong to AMNEs (from France, Germany, Italy and US) and 302 overseas subsidiaries belong to EMNEs (from China and India) in a time period, 2006-2014. Our results suggest that AMNE subsidiaries rely more on internal competence (MNE R&D), while EMNE subsidiaries rely more on external competence (technological-rich environment). Moreover, compared with AMNE subsidiaries, EMNE subsidiaries with greater MNE R&D intensity are more positively influenced by the host technological-rich environment.

Keywords: subsidiary performance, host country environment, MNE competence, AMNEs and EMNEs

4.1 Introduction

While economies around the world host income-generating activities of MNEs, subsidiaries are often placed at the centre of geopolitical debates, which have profound implications on how open the host countries are towards certain groups of MNEs. However, such effects and debates are often built upon little conclusive knowledge of subsidiary performance variations, especially among diverse MNEs. Indeed, performance variations of overseas subsidiaries offer valuable insights into how MNEs operate in host environments, but to date, we have incomplete understanding of such variations.

The premise underpinning the stream of studies on subsidiary performance is that overseas subsidiaries are enabled by parent MNEs' firm specific advantages, typically superior knowledge and intangible assets that can be replicated in foreign locations, before some of which gain higher order mandates to develop competence (Cantwell and Mudambi, 2005). However, our knowledge of subsidiary performance variations does not extend, whereas new cohorts of MNEs, especially those without superior knowledge or intangible assets, have emerged and continued to flourish.

New cohorts of MNEs have originated from economies of different developmental trajectories resulted from differences in institutional, social and economic predispositions. The rise of emerging market multinationals (EMNEs) in recent decades reveals that much of the current knowledge on subsidiaries has been based on the observations of advanced market multinationals (AMNEs) (e.g., Cantwell and Mudambi, 2005; Gaur et al., 2019). This understanding therefore explains EMNE subsidiary performance remains both an empirical and a theoretical question. In addition, the limited empirical research that compares subsidiary performance between AMNEs and EMNEs cohorts has left space for much speculation of how EMNE subsidiaries differ from AMNE subsidiaries in their approaches to enhance performance. This deficit in our understanding fuels further debates about how a subsidiary in general benefits from parent MNEs and host environments in enhancing its performance.

Subsidiary performance is a construct, which is theoretically complex and methodologically challenging to measure. While subsidiaries may have different roles, profitability is the most common performance conceptualization and particularly suitable for subsidiaries that are profit oriented (Meyer et al., 2020). Such subsidiaries' abilities to generate income for parent MNEs, from the resources and capabilities available to them, are therefore important for investigation of a general explanation of subsidiary-level variations among AMNEs and EMNEs.

Extant studies have reported finding from AMNEs and highlighted that subsidiary performance variations can be explained by how they acquire, adapt and integrate resources and knowledge from the parent MNE (Papanastassiou et al., 2020) and subsidiary's host environment, especially host country technological richness and how host country intellectual property regimes (IPR) alter the extent of value appropriation by the subsidiary in a host location (Contractor et al., 2016; Distel et al., 2019; Gaur et al., 2019). The distinction among subsidiaries of AMNEs and EMNEs is particularly stark in terms of their parents' R&D resources and capabilities. While AMNEs have been observed to profit globally building upon comparatively superior technologies and strong innovative capabilities, EMNEs originated from relatively underdeveloped locations with lower level of technologies and innovative capabilities (Cuervo-Cazurra, 2008; Luo and Tung, 2007, 2018) and some have been observed to seek superior knowledge from foreign locations (e.g., Awate et al., 2015; Ramamurti and Singh, 2010; Ramamurti, 2016). It therefore remains unknown if EMNE subsidiaries performance is similarly influenced by parent MNE R&D intensity and host country environments. Thus, we argue that not all subsidiaries benefit equally from MNE R&D intensity and host country environments, but instead this depends on the cohort of subsidiaries of AMNEs and those of EMNEs

Previous studies show that MNE competence and host country environment can be source of competitive advantages for subsidiaries, enabling them to achieve better performance (Almeida and Phene, 2004; Contractor et al., 2016). However, subsidiary performance variations will depend also on how MNE competence (e.g., MNE R&D intensity) assists subsidiary to deal with host country environments. The distinction among subsidiaries of AMNEs and EMNEs is therefore emerging from how AMNE subsidiaries and EMNE subsidiaries reply on MNE competence differently to deal with host country environments. Our study thus differs from prior studies by examining the relative importance and the joint effects of MNE R&D intensity and host country environment on the performance of AMNE subsidiaries and EMNE subsidiaries separately.

We contribute to the literature that seeks a general explanation of international activities of MNEs originating from distinct home environments by examining subsidiaries of AMNEs and EMNEs, specifically (a) the extent to which profitability of all subsidiaries benefit from parent MNE R&D intensity and host country technological richness, and (b) the extent to which host country environments (e.g., host country technological richness, host country IPR distance) moderate the effects of MNE R&D intensity on subsidiary performance. Using the most comparable and comprehensive secondary data of MNEs and their subsidiaries available in

BvD database, we empirically tested the above relationships and effects using a dataset of 4978 overseas subsidiaries owned by 565 MNEs from two emerging markets (China and India) and four advanced markets (France, Germany, Italy and US) during 2006-2014.

4.2 Theoretical background

4.2.1 Parent MNE Competence

The internalization theory and the knowledge-based view put parent MNE competence at the heart of the explanation of subsidiary performance variations (Buckley and Casson, 1976; Dunning, 2015; Hennart, 1982). MNEs' proprietary knowledge, that is valuable, inimitable, rare and non-substitutable (Barney, 1991; Teece, 1986), enables their subsidiaries to successfully profit in foreign markets even after bearing the high cost of liability of foreignness. Internalization theory indicates that since knowledge transfer through external markets is impeded by market imperfections (Buckley and Casson, 1976), firms rely on the comparatively more efficient internal markets, which means that subsidiaries, in the first instance, exploit parent firm-specific advantages, specifically technologies, intellectual properties, production (Markusen, 1995) and capabilities (e.g., absorptive capacity and innovative capability; Cohen and Levinthal, 1990; Elia and Santangelo, 2017). Hence, MNE competence transferred across borders through internal networks (Buckley and Casson, 2009) has been suggested to produce better subsidiary performance (Hymer, 1976; Rugman and Verbeke, 2001).

The literature on MNE R&D intensity has suggested three mechanisms through which parent competence creates value to overseas subsidiary profitability. First, new knowledge (e.g., patents and other intangible assets) is applied in the products and processes of a subsidiary (Delios and Beamish, 2001). Previous studies theoretically and empirically suggest the important role of MNEs' knowledge (e.g., intangible assets) on enhancing subsidiary survival probability and profitability (e.g., Contractor et al., 2016; Delio and Beamish, 2001; Gaur et al., 2019). Second, greater overall absorptive capacity resulted from high MNE R&D intensity (Cohen and Levinthal, 1990) assists a subsidiary in its search, appreciation and application of external knowledge from the host location, leading to superior profitability (Gupta and Govindarajan, 2000). Especially the critical role of absorptive capacity on the performance of EMNE subsidiaries has been increasingly recognized in recent literatures (e.g., Nair et al., 2016; Song, 2014). Third, intensive R&D enhances a subsidiary's ability to protect and safeguard own knowledge from the threat of knowledge diffusion in host environments (Wadhwa et al., 2017), thus safeguarding its competitive advantages over rivals and profitability (Wadhwa et al., 2017; Zhao, 2006).

4.2.2 Host Country Environment

For income generating subsidiaries, host country environment, determines the external market that makes knowledge available for the use of the subsidiary (Birkinshaw and Hood, 1998; Cantwell and Mudambi, 2005), on the other hand, determines “the rules of game” that restrict the behaviours of the subsidiaries (North, 1990). Early research increasingly highlights the important role of host countries as knowledge providers to the subsidiaries, and thus subsidiaries thrive and stay competitive through strategically sourcing and internalizing knowledge embedded in the host environments (Alcacer, 2006; Wu et al., 2016), especially when income-generating subsidiaries rely on embeddedness to sustain competitive advantage. However, not all host locations are equally rich in technologies (Almeida and Kogut, 1999). Subsidiaries operated in technological-rich environments may have relatively greater chances to access and internalize knowledge and capabilities embodied in the local technical and administrative expertise (Almeida and Kogut, 1999) and local organizations (Zhang et al., 2010), therefore, have greater opportunities to combine the locally available knowledge and capabilities with internal competence to achieve better development.

Many countries use IPR to reward knowledge generators by clearly defining intellectual property (IP) over their knowledge and regulating how others may use it (Maskus, 1998). Since firms increasingly rely on patents and copyrights to protect their knowledge (Zhao, 2006), IPR is increasingly investigated and documented to facilitate value appropriation and benefit firm profitability (Barney, 2001). For MNEs and their subsidiaries, IPR distance, as measured by differences in IPR between the nation of the MNE parent and the country of its subsidiary, has been used in prior studies to capture the variation in subsidiary profitability (e.g., Contractor et al., 2016). As the standards of IPR differ between home and host countries, a stronger host country IPR relative to that of the home country may create barriers for involuntary knowledge leakage, e.g., increasing risks and costs of IP infringement (Somaya, 2012). Specifically, the monopoly power generates by IP protection may prevent other firms in the local markets from unintentionally using the subsidiary (and its parent MNE’s) knowledge and hence the subsidiary remains competitive over other firms (McCalman, 2005). However, previous studies documented an inconclusive effect of IPR distance on foreign subsidiary performance. The disadvantage of relative stronger IPRs lies in the resulted higher entry barriers to technological competition and reduced possibilities of accessing and integrating external knowledge for firms embedded within it (Gangopadhyay and Mondal, 2012).

4.2.3 Joint Effects of MNE Competence and Host Environments

Our earlier discussion shows that parent MNE R&D intensity and host country environment are key determinants of subsidiary profitability (e.g., Almeida and Phene, 2004;

Phene and Almeida, 2003; Contractor et al., 2016), while MNE R&D intensity not only has a stand-alone effect on subsidiary profitability because how MNE R&D influences subsidiary is determined by host country environment. Greater overall absorptive capacity resulted from MNE R&D contributes to competence development of overseas subsidiaries (Villalonga, 2004), which assists subsidiaries to better access, assimilate and apply external knowledge, and ultimately recombine internal and external knowledge to generate new knowledge (Cohen and Levinthal, 1990). However, not all host countries are equally rich in knowledge (Almeida and Kogut, 1999). In other words, not all host countries provide equal opportunities for the subsidiaries located within it to access and learn from external knowledge (Gulati, 1999). Thus, subsidiaries with strong parent R&D competence may benefit from technological-rich environments because of the availability of rich technologies and greater opportunities for embedded subsidiaries to learn from the external market (Almeida and Kogut, 1999). For example, Galanz, Chinese largest microwave manufacturer, has established an R&D unit in Washington (US) and thus gained access to and learned from local human talents (Deng, 2007).

Subsidiaries with strong MNE R&D competence may benefit from a weaker host IPR compared with their home countries. A weaker IPR at host location provides limited protections for firms' knowledge, which increases the likelihood of knowledge leakage (Nandkumar and Srikanth, 2015), and therefore MNEs become more careful about operating in such environment (McCalman, 2005). Consequently, MNEs are less confident in relying on the host environments to protect their knowledge and the important role of firms in protecting their own knowledge through building alternative internal mechanisms has been recognized (Zhao, 2006). When firms move to weaker IPR host environments, strong MNE R&D competence enables their subsidiaries to safeguard own knowledge through different mechanisms. First, subsidiaries may utilize technologies requiring strong complementary knowledge and resources. Specialized complementary assets (e.g., manufacturing capabilities) are crucial for the firms to finally commercialize own innovation (Teece, 1986). Since the value of knowledge and technologies is realized only with the combination of specialized complementary assets, the subsidiary's profitability may become less vulnerable to imitation by rivals from local markets (Anand and Galetovic, 2004). Second, MNEs with greater R&D competence may develop comprehensive R&D network. Specifically, R&D units are strategically distributed across locations facilitating the use of isolated mechanisms, which increases difficulties and costs for potential imitators to gain access to complementary knowledge that is globally distributed or located in strong IPR environments (Zhao, 2006). Third, more competent MNEs may also better strategically manage the distribution of inventors and managers in their R&D networks. For example, subsidiaries are shown to reduce the participation of host country inventors in the host R&D teams (Berry, 2017) and mobilize home country expatriates to host countries (Nankumar and Srikanth, 2015) in order to mitigate the threat of knowledge leakage.

4.2.4 Comparison between AMNE Subsidiaries and EMNE Subsidiaries

A widely accepted argument is that AMNEs create their competence at home and internalize to exploit their superior technologies and strong innovative capabilities. The competence of EMNEs has been subject to heated theoretical debates while limited empirical evidence has been generated to help draw conclusion. The limited literature has suggested that EMNEs overall are seen as technological laggards with a relatively lower knowledge stock at home (Cuervo-Cazurra, 2008) and their internationalization is rooted in their technological catch-up strategy with counterparts in the global markets (Awate et al., 2012; Kumaraswamy et al., 2012). Specifically, EMNEs have been found to strategically use overseas subsidiaries as learning vehicle to accumulate and internalize the external knowledge for the use of the whole EMNEs (Wu et al., 2016). For example, China National Bluestar Co. has acquired Elkem in Norway for $2 billion, which gives China National Bluestar production and management know-how in silicone industry that can be deployed in China (Alon et al., 2020). Hence, compared with AMNE subsidiaries, the primary roles of EMNE subsidiaries is to seek knowledge embedded in foreign locations from the from the onset of EMNEs' internationalization (Kedia et al., 2012).

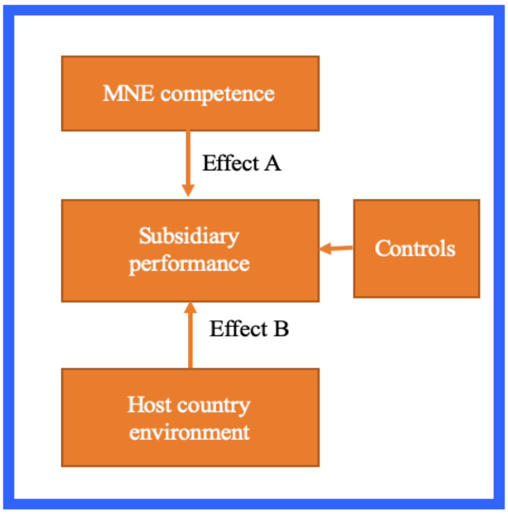
Both MNE competence (e.g., Contractor et al., 2016; Gaur et al., 2019) and a technological-rich host environment (e.g. Distel et al., 2019; Wu et al., 2016) have been found to determine subsidiary performance, however, limited literature has theoretically explored and empirically examined the relative importance of MNE competence and a technological-rich host environment on subsidiary performance. The limited literature so far suggests that the relative importance of MNE competence and a technological-rich host environment on subsidiary performance is influenced by the context in terms of subsidiary mandate - competence-creating or competence-exploiting subsidiary (Almeida and Phene, 2004). Our earlier discussion on the context of AMNE subsidiaries and EMNE subsidiaries distinguishes the different developmental trajectory of MNEs from different home country conditions, which results in the distinct methods of international expansion and consequently different strategic roles of the overseas subsidiaries (Hernandez and Guillén, 2018). Contrasting subsidiary role in MNE international expansion is powerful evidence of context and thus we argue that the relative importance of MNE competence and a technological-rich host environment on subsidiary performance varies depending on AMNE subsidiaries and EMNE subsidiaries.

The literature on MNE R&D intensity highlights three mechanisms through which parent MNE competence facilitates overseas subsidiary profitability, but not all of these mechanisms are realized depending on how an MNE's R&D intensity is positioned within the distribution. At the bottom of the spectrum - when a firm has a very low level of R&D intensity (compared with that of the population of MNEs) and has the awareness of its knowledge gap to competitors, increases in its R&D intensity will be more about enhancing absorptive capcity, which will assist their subsidiaries to better learn from host external markets (Cohen and Levinthal, 1990). Investment in R&D to produce new knowledge is generally risky and costly because of the higher level of uncertain existing on returns of R&D investment (Eisenhardt and Martin, 2000). Even if new knowledge has been generated, this small increment may not help create a significant outcome since the firm has lower levels of breadth and depth of knowledge portfolios (Awate et al., 2012). But a small increment in MNE R&D investment increases the chance of learning and absorbing existing external knowledge by the subsidiaries (Nair et al., 2016), leading to better subsidiary performance. By contrast, at the top of the spectrum - when a firm has a very high level of R&D intensity, increases in its R&D intensity will be more like an "offensive" strategy to generate new knowledge (García-Manjón and Romero-Merin, 2012). Because R&D investments of these MNEs are driven by their needs to advance own technologies frontiers in order to stay competitive in the competitive global economy and the new knowledge can be applied in the products and processes of their subsidiaries. Since AMNEs and EMNEs operate in the above contexts, specifically the cohort of EMNEs are generally positioned in the bottom of the spectrum, while the cohort of AMNEs are on the top of the spectrum (Cuervo-Cazurra, 2008), we argue that the role of MNE R&D intensity on subsidiary performance differs for AMNE subsidiaries and EMNE subsidiaries.

In summary, we seek to examine if there is a general explanation of the performance of subsidiaries of all MNEs which can explain the contrasting observations of AMNE subsidiaries and EMNE subsidiaries, we also expect that the analysis of two subsamples, AMNE subsidiaries and EMNE subsidiaries, will yield different patterns of the same general effects. Figure 4.1 represents our conceptual framework.

Figure 4.1 Conceptual framework

A general model



Comparison

1. For all MNE subsidiaries:

- compare if Effect A >, = or < Effect B
- examine the joint effect of MNE competence and host environment

2. Compare subsidiaries of AMNEs vs. subsidiaries of EMNEs with regard to the above effects

4.3 Hypotheses Development

4.3.1 A General Model of Subsidiary Profitability

Our starting point for a general explanation of subsidiary performance variations of all MNEs is to utilize determinants suggested by existing international business theories. Classic internalization theory explains why MNEs exist and suggests that MNEs accumulate competence (e.g., firm-specific resources and capabilities) which is valuable, imitable and easily transferrable within its internal networks of subsidiaries than exploitable using external market (Buckley and Casson, 1976; Dunning, 2015). Consequently, the internal transfer of MNE competence that are superior to those of other firms support the overseas subsidiaries to overcome the higher costs of the liability of foreignness (Gaur et al., 2019) and generate economic rents in distant subsidiary locations (Buckley and Casson, 2009). The literature on MNE R&D intensity highlights three mechanisms through which overseas subsidiary profitability is associated with MNE competence (see Chapter 4.2.1), we therefore argue subsidiaries with strong MNE R&D competence may be able to apply new knowledge created by their parent MNEs in their products and processes (García-Manjón and Romero-Merin, 2012), better understand and apply external knowledge from the host locations (Gupta and Govindarajan, 2000) and safeguard their own knowledge from unintentional knowledge leakage (Zhao, 2006), leading to greater profitability.

The premise underpinning the stream of studies on subsidiary performance is that overseas subsidiaries are enabled by parent MNEs' firm-specific advantages, while host countries are primarily seen as markets or sources of labour resources. However, host countries are increasingly seen as potential sources of new knowledge (Dunning, 1994). Overseas subsidiaries have started to seek knowledge and seize the potential development opportunities in the local environments (Andersson et al., 2005, Birkinshaw and Hood, 1998). Since a technological-rich environment represents the extent to which knowledge has been created within the environment, subsidiaries within technological-rich environments will have greater opportunities for accessing knowledge and capabilities from external local markets to create competitive advantages resulting in better performance. Hence,

Hypothesis 1: *MNE R&D intensity increases subsidiary performance (H1a), host country technological richness increases subsidiary performance (H1b).*

In a technological-rich environment, overseas subsidiaries benefit from MNE R&D intensity in terms of enhanced absorptive capacity because having access to rich knowledge and capabilities in the external market is not sufficient to learn from them (Cohen and Levinthal, 1990). In other words, when a technological-rich environment represents greater opportunities of new external knowledge and capabilities for the subsidiaries, a higher level of MNE R&D intensity enables the subsidiary to search and assimilate abundant external knowledge, integrate knowledge and capabilities from internal and external sources, and consequently enhance subsidiary profitability.

MNE internal competence and host country external IPR environment are alternative mechanisms for overseas subsidiaries to prevent unintentional knowledge leakages, protect own knowledge and sustain competitive advantages over rivals (Zhao, 2006). When firms move to stronger IPR environments, the fear of losing their proprietary knowledge is substantially reduces. In contrast, when relatively weaker IPR environments increases fears of unintentional knowledge leakages and to that extent highlights the importance of MNE internal competence in terms of the capabilities to protect proprietary knowledge. In other words, when the standard of IPR is perceived as low in the host country with a lower degree of knowledge protection, a higher level of MNE R&D intensity enables the subsidiary to protect existing knowledge from unintentional knowledge leakages. Additionally, only if the MNE is capable to protect their valuable knowledge at the weaker IPR host location, this valuable knowledge can then be allocated by MNEs to the subsidiaries to exploit it in the host markets, which creates values (economic rents) in the subsidiaries (Berry, 2017). Drawing on the above reasoning, we expect host technological environment and IPR distance will moderate the relationship between MNE R&D intensity and subsidiary performance. Hence, we have the following hypothesis:

> ***Hypothesis 2:*** *In a technological-rich environment, the benefits of MNE R&D intensity on subsidiary performance increase (H2a); while in a relatively weaker host intellectual property regime compared with the home country, the benefits of MNE R&D intensity on subsidiary performance increase (H2b).*

4.3.2 Comparison between AMNE Subsidiaries and EMNE Subsidiaries

As we seek for a general explanation of the performance variations of subsidiaries of all MNEs, our earlier discussion shows that parent MNE R&D intensity and the technological-rich host environment are key determinants of subsidiary profitability. However, the relative importance of MNE R&D intensity and host country technological richness on subsidiary performance is expected to be influenced by AMNE subsidiaries and EMNE subsidiaries. Early conceptualization of MNE suggested that firms internalize to exploit parent firm-specific advantages (Buckley and Casson, 1976), and therefore, parent competence transferred through internal networks has initially been suggested to produce better subsidiary performance (Hymer, 1976; Rugman and Verbeke, 2001). Recently, scholars suggest that some subsidiaries have evolved to acquire complementary technologies and knowledge embedded in their host countries (Almeida et al., 2002; Cantwell and Mudambi, 2005). However, compared with a technological-rich environment which provides greater learning opportunities for the subsidiaries, MNE R&D intensity still plays relatively more importance role to subsidiary profitability, because overseas subsidiaries primarily acquire knowledge from the host environments that is complementary to their existing core technologies, knowledge and capabilities derived in their home-country operations (Asakawa, 2001; Song and Shin, 2008).

Understanding the differences between AMNE and EMNE subsidiaries hinges on explaining the relative importance of MNE R&D intensity and host technological-rich environments on the profitability of MNE subsidiaries. The literature on EMNEs suggests that EMNEs overall are technological laggards with a relatively lower level of knowledge stock at home (Cuervo-Cazurra, 2008) and their subsidiaries are set to accumulate and internalize the external knowledge for the use of the whole MNE (Fu et al.,2018). Specifically, EMNEs may develop their competitive advantages by locating in technological centres such as Silicon Valley that provide a larger pool of superior knowledge, and EMNE subsidiaries are able to learn from the external knowledge they derive in host countries (Ramasamy et al., 2012) leading to better subsidiary performance. Additionally, the lack of technological competence in parent EMNEs raises the question of the mechanism through which MNE R&D intensity may influence on subsidiary performance. Intensive MNE R&D intensity may enhance a subsidiary's ability in its search, assimilation and application of external knowledge from host location. Drawing on the above reasoning, we expect that significant differences existing among AMNE and EMNEs subsidiaries, in terms of the relative importance of MNE R&D intensity and host country technological richness on subsidiary profitability. Hence, we have the following hypothesis:

> ***Hypothesis 3:*** *AMNE subsidiary performance is more strongly influenced by MNE R&D intensity than a technological-rich environment (H3a) while EMNE subsidiary performance is more strongly influenced by a technological-rich environment than MNE R&D intensity (H3b).*

The studies on AMNE subsidiaries describe a journey where overseas subsidiaries initially enabled by parent MNE competence before some of which start to acquire external knowledge within host location to develop competence (e.g., Awate et al., 2015; Cantwell and Mudambi, 2005). Additionally, being at the top of MNE R&D intensity spectrum, investment in MNE R&D is critical to create superior knowledge that very much shows an experimental role. Hence, the development of income-generating subsidiaries may rely more on the mechanism through which they apply the knowledge resulted directly from MNE R&D intensity rather than the mechanism through which they can better learn from the host countries. In contrast, subsidiaries of EMNEs primarily gain the roles to source and learn from the host locations (e.g., Mathews, 2006; Luo and Tung, 2007). In addition, being at the bottom of MNE R&D intensity spectrum, investment in MNE R&D is critical to enhance EMNEs' absorptive capacity to better assimilate and exploit external knowledge. Hence, the development of EMNE subsidiaries may rely more on the mechanisms through which greater absorptive capacity resulted from MNE R&D intensity assist them to better learn from the host locations in the first instance. We then hypothesize that the joint effect of MNE R&D intensity and a technological-rich host environment on the subsidiary performance varies in the context of AMNE subsidiaries and EMNE subsidiaries. Hence, we have the following hypothesis:

> ***Hypothesis 4a:*** *The joint effect of MNE R&D intensity and a technological-rich host environment is stronger for EMNE subsidiaries than for AMNE subsidiaries.*

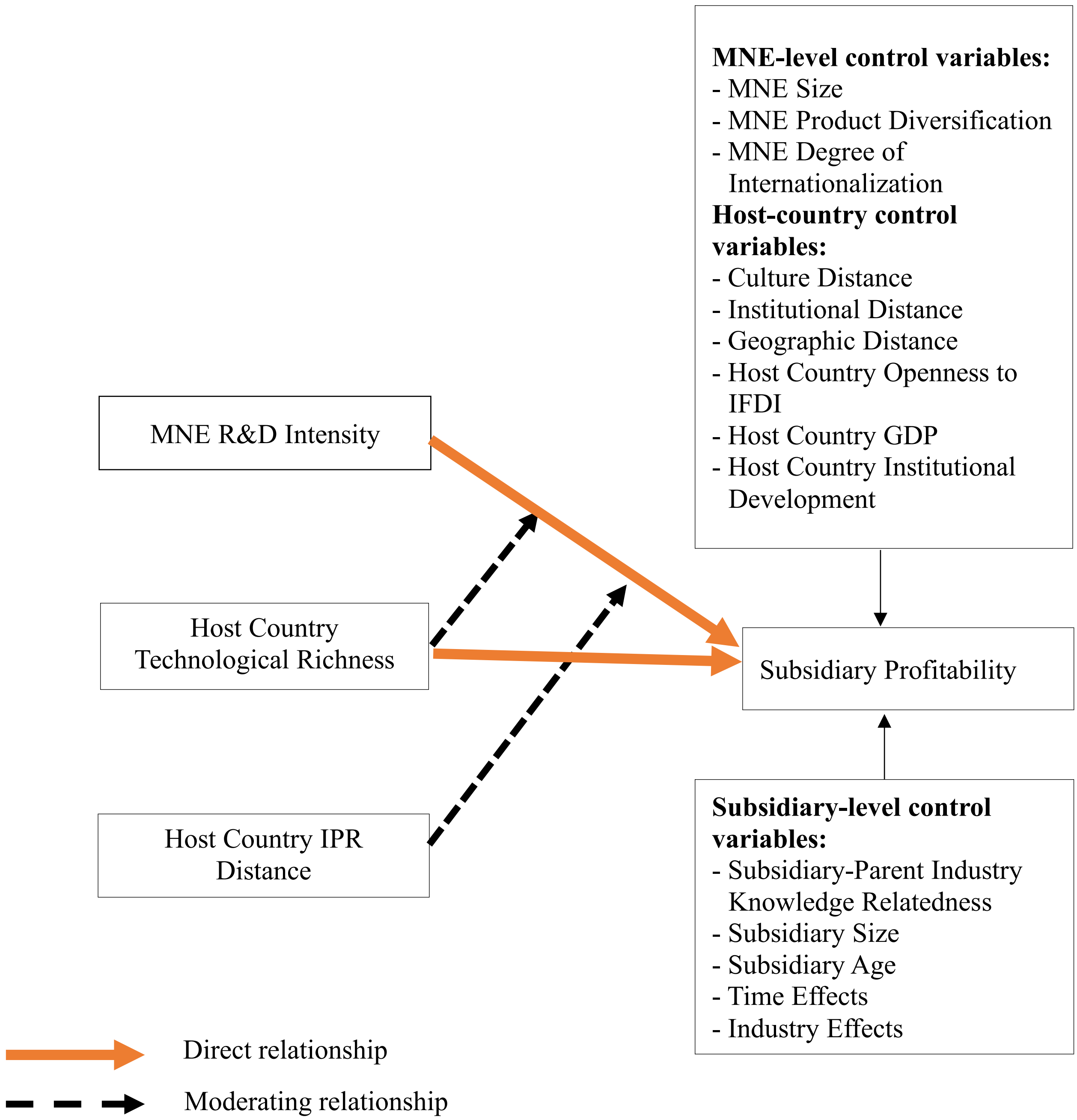
When AMNEs internalize to exploit and replicate their knowledge and capabilities in foreign locations, their proprietary and valuable knowledge has been transferred internally to their overseas subsidiaries (Buckley and Casson, 2009). AMNE subsidiaries are especially not willing to diffuse their knowledge to the local markets in order to sustain their competitive advantages over the local rivals (Anderson and Gatigno, 1986; Tian 2010). However, compared with EMNE subsidiaries, AMNE subsidiaries face a higher risk of unintentional knowledge leakages when operating in the host markets because AMNE subsidiaries have greater possibilities to be located in weaker IPR locations comparing to that of their home countries (see Figure 4.4). Operating in the relatively weaker IPR locations, AMNE subsidiaries strongly rely on the alternative internal mechanisms (details see Chapter 4.2.3) resulted from MNE R&D intensity to protect proprietary knowledge in order to sustain their competitive advantages.

When EMNEs internalize to seek, acquire and integrate technological knowledge from the host locations to achieve technological asset augmentation, the proprietary knowledge will be expected to flow from the overseas subsidiaries to their parent and other subsidiaries (Nair et al., 2016; Liu and Meyer, 2020). Therefore, EMNE subsidiaries have more knowledge to gain and less knowledge to lose when operating in host locations (Alcácer, 2006). Compared with AMNE subsidiaries, EMNE subsidiaries may face a lower level of risk of unintentional knowledge leakage in the host environments because they are more likely to be located in technological-rich environment to take advantages of the location (e.g., advanced countries, Buckley et al., 2014; Ramamurti, 2012) where is always accompanied with relative stronger IP protection compared with that of their home countries (see Figure 4.4). Hence, the joint effect of MNE R&D intensity and a weaker IPR is limited for the subsidiary performance of EMNEs.

> ***Hypothesis 4b:*** *The joint effect of MNE R&D intensity and a relatively weaker host intellectual property regime compared with the home country is stronger for AMNE subsidiaries than for EMNE subsidiaries.*

Figure 4.2 shows the framework we will test.

Figure 4.2 Analytical framework



4.4 Methods

4.4.1 Sample and Data

In order to test a general explanation of subsidiary profitability variations, we need a sample of subsidiaries from both cohorts of AMNEs and EMNEs. We therefore focused on subsidiaries of MNEs headquartered in two emerging markets (China and India) and four advanced markets (France, Germany, Italy and US). We chose subsidiaries of Chinese and Indian MNEs for a number of reasons. First, their home countries are the largest emerging economies with remarkable economic and technological growths in recent decades (Kafouros and Wang, 2015). Second, both countries witness significant boom in outward foreign direct investment (OFDI), R&D internationalization and global patenting activities (UNCTAD, 2005; WIPO, 2016; WIR, 2014), which corresponds to the evidence of global innovation by Chinese and Indian MNEs (Nair et al., 2016; He et al., 2017). Third, these subsidiaries may be subject to the influence of diverse home country conditions, specifically legal systems, with China following civil law while India common law. We focus on subsidiaries of MNEs from Western European countries and US for several reasons: (1) these home countries have been ranked highly in terms of firms conducting global innovation (GII, 2020) and OFDI, and their close trading relationships with the two emerging markets, (2) evidence of increasingly complex global innovation networks (Cantwell and Mudambi, 2005; Awate et al., 2015), and (3) a combination of different home country legal system with France, Germany and Italy following civil law while US common law.

Subsidiary research involving cross-country comparison can be very challenging because of the lack of comparable data. We chose Orbis - Bureau van Dijk database because it provides firm data of various countries, for a period of 10 years and reports the ownership structure of firms. We first selected subsidiaries that have a global ultimate owner (GUO; that directly or indirectly controls 50% or more of the subsidiary) located in the above six countries. Subsequently, we have identified 48,020 subsidiaries belonging to 17,909 MNEs, including 4,387 subsidiaries owned by 3,005 EMNEs and 43,633 subsidiaries owned by 14,904 AMNEs. We further selected the overseas subsidiaries and used the selected subsidiaries to identify and obtain data of the GUOs, i.e., MNEs. Afterwards, we excluded MNEs with unconsolidated data, with less than 50 employees, and those without any R&D expenditure during the entire examined time period. Therefore, we have selected 589 overseas subsidiaries owned by 228 EMNEs and 7,334 overseas subsidiaries owned by 617 AMNEs. We further excluded overseas subsidiaries without any business activities during the entire examined time period and subsequently we have selected 347 overseas subsidiaries owned by 129 EMNEs and 5,420 overseas subsidiaries owned by 463 AMNEs.

For each subsidiary and its parent MNE, Orbis provides subsidiary-level and MNE-level data we required in the analysis, such as financials, R&D, locations and ownership structure. The standard Orbis subscription provides up to ten years of data of each firm; hence we have chosen the maximum period available. Excluding incomplete observations, our full sample is a balanced panel data of 4978 overseas subsidiaries belongs to 565 MNEs, including 302 subsidiaries owned by 122 EMNEs and 4676 subsidiaries owed by 443 AMNEs. Data sources for key variables and control variables are summarized in Table 4.1.

Table 4.1 Source of data

Variables	Data sources
Subsidiary Profitability	Orbis BvD database
MNE R&D Intensity	Orbis BvD database
Host Country Technological Richness	Orbis BvD database
Host Country IPR Distance	Global Information Technology Report
MNE Size	Orbis BvD database
MNE Product Diversification	Orbis BvD database
MNE Degree of Internationalization	Orbis BvD database
Subsidiary Age	Orbis BvD database
Subsidiary Size	Orbis BvD database
Subsidiary-Parent Industry Knowledge Relatedness	Orbis BvD database
Culture Distance	Kogut and Singh (1988) index applied to Hofstede (2001) items
Institutional Distance	The worldwide Governance Indicators
Geographic Distance	CEPII Distances Dataset
Host Country GDP	World Bank
Host Country Openness to IFDI	World Bank
Host Country Institutional Development	The worldwide Governance Indicators

4.4.2 Measures

4.4.2.1 Dependent variable

Subsidiary Profitability is measured by return on equity (ROE) using net income after tax, forwarded by one year. ROE is one of the most commonly used accounting-based profitability measures in performance literatures (e.g., Kirca et al., 2016). This measure is particularly suitable for subsidiaries that are profit oriented (Meyer et al., 2020) and has benefit of capturing resources available for reinvestment in a firm (Miller and Lerblein, 1996). The forwarded measure of profitability reflects the time it takes for independent variables to exert their influences on subsidiary performance.

4.4.2.2 Independent and moderating variables

MNE R&D Intensity is the ratio of annual MNE R&D expenditure over its total sales. This measure has been widely used in the literatures of innovation-performance relationship of geographically dispersed organizations (e.g., Chen et. al., 2012; Heeley et al., 2007; Wang and Kafouros, 2009).

Host Country Technological Richness. Technological richness of the country where the subsidiary operates reflects the total technological knowledge embedded in the host country, which provides opportunities for subsidiaries located within it to access knowledge (Gulati, 1999). It is measured by the host country patent stock that is operationalized using perpetual inventory method (PIM) (Kafouros et al., 2012) based on the annual national patent application data.

Host Country IPR distance, calculated by subtracting the home IPR score from that of the host, captures the IPR distance and direction of the distance between subsidiary home and host countries. Hence, a positive value reflects relatively stronger IPR in the host environment. We also used alternative measure of a ratio of the IPR score of the host country over that of the home country and the results remain similar.

4.4.2.3 Control variables

We included a number of control variables specific to the subsidiary, to the parent MNE, to the country where the subsidiary operates, and to the home country. Subsidiary level controls first include Subsidiary Size to control for the effect arising from the size of a firm as larger subsidiaries tend to be allocated more resources by the parent and also have better access to external resources, leading to better performance (e.g., Wang and Kafouros., 2009). We measure subsidiary size by a dummy variable with value of 1 if the sales of the subsidiary are above the median of all sampled subsidiaries for each examined year.

Subsidiary Age controls for the aging effects as older firms may have the opportunity to accumulate resources and capabilities leading to better performance (e.g., Birkinshaw and Hood, 1998; Rabbiosi and Santangelo, 2013). Subsidiary age is operationalized as the difference between the observed year (9-years window from 2006 to 2014) and the year when the subsidiary is established. When the subsidiary is established during the examined time-period, we have recoded the negative values as 0.

Subsidiary-Parent Industry Knowledge Relatedness controls for the effect that stronger relatedness in the industry knowledge between the parent and subsidiary increases the capabilities of the subsidiary to better receive, assimilate and commercialize parent's technologies such as patents, which leads to better profitability (Fang et al., 2013). It is measured by a dummy variable that takes the value of 1 if the subsidiary operated in the same 2-digit Standard Industrial Classification (SIC) as the parent.

MNE-level factors have various impacts on subsidiary performance (e.g., Almeida and Phene, 2004; Cohen and Levin, 1990). MNE Size, total assets of the MNE, is used to control for the fact that larger parent makes a greater amount of internal resources for the use by its subsidiaries (Almeida and Phene, 2004). Accordingly, MNE Product Diversification controls for the effect of more diversified parents on the income streams of the subsidiaries (Hashai and Delio, 2012; Hitt et al., 1997). We measure MNE product diversification using the number of

2-digit SIC industries in which all subsidiaries of the MNE operate. MNE Degree of Internationalization to some extent reflects the level of internationalization experience and capabilities of the MNEs to overcome challenges of operating in multiple foreign locations (Fang et al., 2007). We operationalize this variable using the number of overseas subsidiaries.

We further control for the influence of host country environment on subsidiary performance (Fang et. al., 2007; Contractor et al., 2016). Culture Distance has been found to influence subsidiary performance (Contractor et al., 2016; Gaur et al., 2019). It is operationalized using Kogut and Singh (1988) index applied to the 4-dimensions provided by Hofstede (2001); we could not have included 6-dimensions of culture scores because of unavailable data of certain countries. Specially, we operationalize the cultural distance between home country f and host country j as

$$A_{fj} = \sum_{i=1}^{4} \{(I_{ij} - I_{if})^2 / V_i\} / 4 \tag{1}$$

where I_{ij} is the culture store for the ith dimension and jth country and V_i indicates the variance of the index of the ith dimension. Institutional Distance. When the institutional distance between home and subsidiary host country is greater, the overseas subsidiary faces higher liability of foreignness leading to difficulties of understanding and adapting to local environment (Higón and Antolín, 2012). We use six Worldwide Governance Indicators (WGIs) - voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption - and operationalize the distance measure using a Mahalanobis index (Berry et al., 2010). Geographic Distance as a control of spatial transaction costs that may negatively influence subsidiary profitability, is measured by the distance between capital cities of the parent and subsidiary's host country using the "great circle formula" from CEPII Distances database.

We further included controls specific to the focal subsidiary's host country. Host Country Openness to IFDI, the ratio of host country IFDI stock over host country GDP, controls for the effect of open host environment where the subsidiary may face stronger competition but also opportunities for learning from rivals (Gaur et al., 2019). Host Country GDP controls for the benefits of larger market size that presents more income-generating opportunities for the subsidiaries. Host Country Institutional Development, the annual mean of six WGIs of the host country in a given year, controls for benefits of high-quality host institutional conditions on reducing external market costs and subsequently enhancing subsidiary performance (Gaur et al., 2019). We took the average because these six indicators are highly correlated with a Cronbach alpha of 0.95.

Time and Industry Effects. We use a set of year and 2-digits industry dummies to control for the time and industry effects on subsidiary performance.

4.5 Analysis

Tables 4.2 and 4.3 report descriptive statistics and correlation matrix for subsidiaries. It is worth noting that parent MNE R&D intensity and host country IPR distance significantly varies for AMNE and EMNE subsidiaries lending support to our comparative research approach. To visualise the differences, we provide Figures 4.3 and 4.4 to show, respectively, the kernel distribution of MNE R&D intensity and IPR distance from host to home country for the sampled AMNE subsidiaries and EMNE subsidiaries.

Figure 4.3 Distribution of MNE R&D Intensity

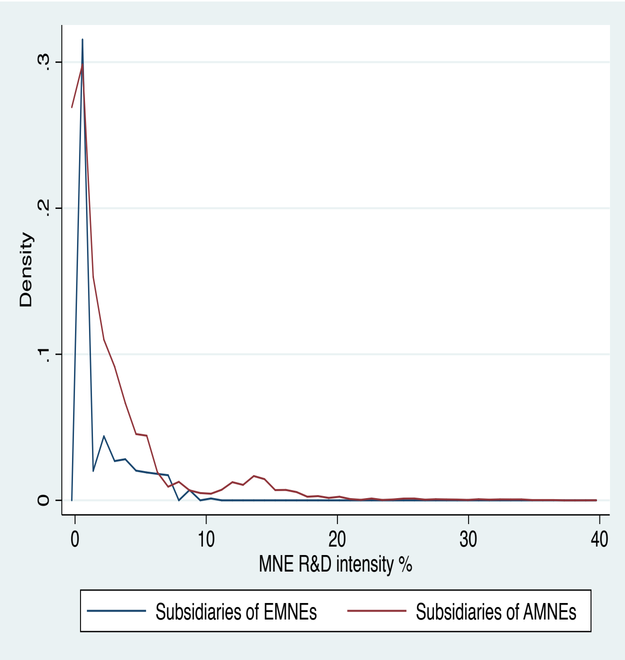


Figure 4.4 Distribution of IPR distance from host to home country

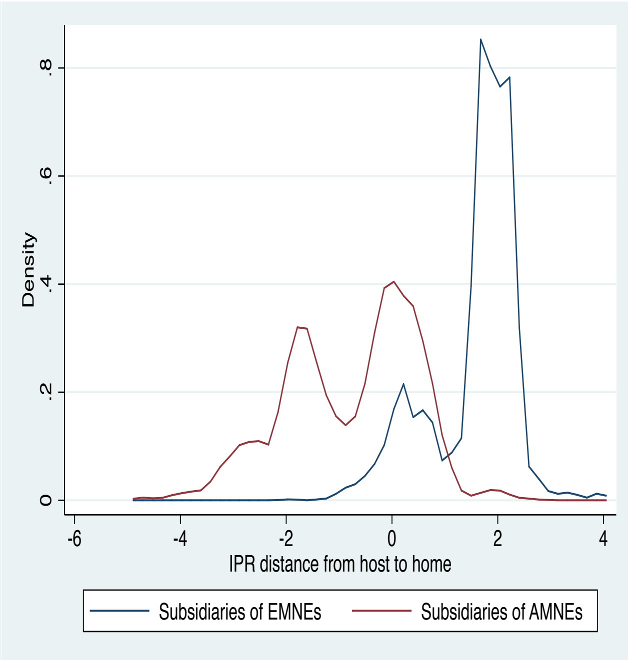


Table 4.2 Descriptive statistics

	All subsidiaries		EMNE subsidiaries		AMNE subsidiaries	
	Mean	SD	Mean	SD	Mean	SD
Subsidiary Profitability (t+1)	12.34	81.70	-2.58	88.07	13.19	81.24
MNE R&D Intensity	0.03	0.58	0.01	0.02	0.03	0.60
Host Country Technological Richness	31505.86	87582.35	34999.34	94503.75	31281.96	87116.25
Host Country IPR Distance	-0.64	1.31	1.41	1.06	-0.77	1.21
MNE Size	41,900,000.00	54,700,000.00	5,107,007.00	8,547,296.00	44,200,000.00	55,600,000.00
MNE Product Diversification	11.77	7.66	3.39	2.07	12.31	7.58
MNE Degree of Internationalization	59.92	56.16	9.21	10.59	63.17	56.33
Culture Distance	1.41	1.10	1.98	0.80	1.38	1.11
Institutional Distance	2.13	0.96	3.62	0.60	2.03	0.90
Geographic Distance	3263.05	3433.51	6637.38	1549.06	3046.77	3407.97
Host Country Openness to IFDI	0.48	0.57	0.43	0.35	0.49	0.58
Host Country GDP	1,800,000,000,000.00	1,750,000,000,000.00	2,260,000,000,000.00	1,800,000,000,000.00	1,770,000,000,000.00	1,740,000,000,000.00
Host Country Institutional Development	1.02	0.66	1.18	0.57	1.01	0.66
Subsidiary Size	0.58	0.49	0.60	0.49	0.58	0.49
Subsidiary Age	22.15	22.41	17.66	21.39	22.44	22.44
Subsidiary-Parent Industry Knowledge Relatedness	0.37	0.48	0.43	0.50	0.36	0.48
Number of observations	51849	51849	3123	3123	48726	48726

Note: For ease of reading, mean and standard deviations are statistics of variables in original form.

Table 4.3 Correlation matrix

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Subsidiary Profitability	1.00															
2	MNE R&D Intensity	0.06***	1.00														
3	Host Country Technological Richness	0.00	0.08***	1.00													
4	Host Country IPR Distance	-0.01*	0.05***	0.39***	1.00												
5	MNE Size	0.00	-0.09***	-0.08***	-0.27***	1.00											
6	MNE Product Diversification	0.01*	-0.26***	-0.10***	-0.30***	0.77***	1.00										
7	MNE Degree of Internationalization	0.03***	-0.23***	-0.12***	-0.33***	0.81***	0.88***	1.00									
8	Culture Distance	0.01*	-0.05***	0.05***	0.06***	0.06***	0.03***	0.07***	1.00								
9	Geographic Distance	-0.02**	0.22***	0.19***	0.21***	-0.25***	-0.30***	-0.31***	0.02***	1.00							
10	Institutional Distance	-0.02***	-0.03***	-0.11***	-0.17***	-0.08***	-0.13***	-0.13***	0.13***	0.33***	1.00						
11	Host Country Openness to IFDI	0.07***	-0.08***	-0.26***	0.04***	0.05***	0.04***	0.03***	-0.11***	-0.32***	-0.10***	1.00					
12	Host Country GDP	-0.07***	0.06***	0.36***	0.45***	-0.15***	-0.14***	-0.15***	-0.20***	0.08***	-0.31***	-0.47***	1.00				
13	Host Country Institutional Development	0.02***	0.01	0.28***	0.65***	-0.09***	-0.06***	-0.08***	-0.05***	-0.14***	-0.45***	0.20***	0.33***	1.00			
14	Subsidiary Size	-0.00	-0.00	0.06***	0.12***	0.05***	0.06***	0.06***	-0.06***	-0.06***	-0.19***	-0.01*	0.18***	0.18***	1.00		
15	Subsidiary Age	-0.00	0.00	0.04***	0.11***	0.21***	0.10***	0.12***	0.02***	-0.04***	-0.07***	-0.02***	0.11***	0.10***	0.17***	1.00	
16	Subsidiary-Parent Industry Relatedness	-0.02**	0.03***	0.01	-0.01	-0.09***	-0.17***	-0.10***	0.01*	0.03***	0.07***	-0.03***	-0.01	-0.06***	0.02**	0.07***	1.00

Note: Pearson correlation coefficients. ***p<0.001, **p<0.01, *p<0.05.

We calculated the variance inflation factor (VIF) for each variable across the models of full and sub-samples to identify potential multicollinearity. The average and maximum VIF across the models are below the acceptable level of 10 (Neter et al., 1985), representing no serious problems of multicollinearity. We followed the common practice (Aiken and West, 1991) and mean-centred the interaction variables, where they are continuous, to alleviate potential multicollinearity problems and increase the interpretability of the interaction terms (Aiken and West, 1991). All variables except dummies have been transformed using logarithm before entering the model. Because we theorize the determinants of subsidiary performance and our analysis includes time-invariant variables, we estimate the model using panel least squares (PLS) with random effects.

Tables 4.4, 4.5 and 4.6 show our results. While Table 4.5 is a full-sample estimation, Table 4.5 and Table 4.6 report estimation results for sub-samples of AMNE subsidiaries and EMNE subsidiaries. In table 4.4, the coefficient of MNE R&D intensity is significant and positive in Column 2 (3.510; $p<0.001$) and the coefficient of host country technological richness is significant and positive in Column 3 (0.127; $p<0.001$) in full sample. Thus, H1 is supported. In Column 5-8, each variable on host country environments (i.e., host country technological richness and host country IPR distance) is introduced together with its interaction term with MNE R&D intensity. However, the interaction term of MNE R&D intensity and host country technological richness in Column 6 is insignificant, we cannot find support for our H2a. The coefficient of the interaction term MNE R&D Intensity and Host Country IPR distance in Column 8 is negative and significant (-1.377; $p<0.05$), supporting H2b. The results are robust when we use host country IPR or IPR distance from host to home country to capture host country IPR environment.

Table 4.5 reports the estimations results for Hypothesis 3 which examines the relative importance of MNE R&D Intensity and Host Country Technological Richness on Subsidiary Profitability. In the multiple regression model, we used the quantification of an individual regressor's contribution to the model to examine the relative importance of two individual regressors. We implemented the relative importance metric for accessing the relative importance of regressors and compared what an individual regressor can explain the variance for Subsidiary Profitability in addition to all other regressors (Grömping, 2006). In other words, when introducing an individual regressor as the last of the regressors, we ascribed the increase in R-squared to that regressor. Specifically, we introduced the variables MNE R&D Intensity and Host country Technological Richness as the last regressor, respectively. Regarding the comparison between AMNE subsidiaries and EMNE subsidiaries, the relative importance matric has been conducted for subsamples of AMNE subsidiaries and EMNE subsidiaries.

In Table 4.5, Column 1 and Column 5 are the baseline models for EMNE subsidiaries and AMNE subsidiaries, respectively. For EMNE subsidiaries, when we introduced MNE R&D Intensity as an additional regressor (Column 2), R-squared decreases by 0.001 (from 0.114 to 0.113). When we introduced variable Host country Technological Richness as an additional regressor (Column 3), R-square increases by 0.011 (from 0.114 to 0.125). Hence, EMNE subsidiary profitability is more strongly influenced by a technological rich environment than MNE R&D intensity. For AMNE subsidiaries, when we introduced MNE R&D Intensity as an additional regressor (Column 6), R-squared increase by 0.003 (from 0.0458 to 0.0487). When we introduced variable Host country Technological Richness (Column 7) as regressor, R-square increases by 0.002 (from 0.0458 to 0.0482). Since the unique variance caused by variable MNE R&D Intensity is beyond that caused by variable Host country Technological Richness, AMNE subsidiary performance is more strongly influenced by MNE R&D intensity than a technological rich environment, thus confirming H3.

Table 4.6 reports the estimation results for Hypothesis 4. Regarding the joint effect of MNE R&D Intensity and Host country Technological Richness, the coefficient is positive and significant for EMNE subsidiaries (6.965; $p<0.01$ in Column 3) but is insignificant for AMNE subsidiaries (Column 4). A Chow test confirms that these coefficients in Columns 5 and 6 are significantly different from each other. Furthermore, we graphed the confidence intervals for means in the sub-samples on this effect, as shown in Figure 4.5. These confidence intervals do not overlap, we can conclude this effect on EMNE subsidiaries and AMNE subsidiaries is statistically different, supporting H4a. Regarding the joint effect of MNE R&D intensity and Host Country IPR Distance, the coefficient is negative and significant for AMNE subsidiaries (-1.911; $p<0.01$ in Column 8), but is insignificant for EMNE subsidiaries (Column 7). Chow test confirms that these coefficients in Columns 7 and 8 are significantly different. Similarly, we graphed the confidence intervals for the means in the sub-samples on this effect, as shown in Figure 4.6. These confidence intervals overlap, which suggests that the difference between EMNE subsidiaries and AMNE subsidiaries is not statistically significant. Therefore, we cannot find support for H4b.

Table 4.4 Results (Dependent variable: Subsidiary Profitability)

	All subsidiaries									Subsidiaries of R&D intensive MNEs
Independent Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
H1a: MNE R&D Intensity		3.510***			3.475***	3.438***	3.572***	3.888***	3.783***	3.331***
		(0.776)			(0.774)	(0.777)	(0.779)	(0.741)	(0.743)	(0.777)
H1b: Host Country Technological Richness			0.127***		0.125***	0.124***			0.118***	0.091**
			(0.029)		(0.028)	(0.029)			(0.029)	(0.031)
Host Country IPR Distance				0.096+			0.107*	0.102*	0.083	0.118*
				(0.052)			(0.052)	(0.052)	(0.052)	(0.057)
H2a: MNE R&D Intensity * Host Country Technological Richness						0.160			0.411	0.291
						(0.419)			(0.443)	(0.449)
H2b: MNE R&D Intensity*Host Country IPR Distance								-1.377*	-1.536*	-1.396+
								(0.701)	(0.743)	(0.770)
MNE Size	-0.096**	-0.125***	-0.097**	-0.098**	-0.126***	-0.126***	-0.128***	-0.127***	-0.127***	-0.135***
	(0.031)	(0.032)	(0.031)	(0.031)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.035)
MNE Product Diversification	-0.075	-0.025	-0.080	-0.076	-0.030	-0.030	-0.025	-0.021	-0.026	0.053
	(0.091)	(0.091)	(0.091)	(0.091)	(0.091)	(0.091)	(0.091)	(0.091)	(0.091)	(0.106)
MNE Degree of Internationalization	0.200**	0.226***	0.203**	0.215***	0.229***	0.230***	0.244***	0.240***	0.241***	0.187*
	(0.063)	(0.063)	(0.063)	(0.064)	(0.063)	(0.063)	(0.064)	(0.064)	(0.064)	(0.073)
Culture Distance	-0.002	0.009	-0.010	-0.017	0.000	0.002	-0.008	-0.015	-0.017	-0.032
	(0.030)	(0.030)	(0.030)	(0.031)	(0.030)	(0.030)	(0.031)	(0.031)	(0.031)	(0.034)
Geographic Distance	0.001	-0.018	-0.026	-0.017	-0.044	-0.045	-0.038	-0.036	-0.057+	-0.068*
	(0.030)	(0.030)	(0.031)	(0.032)	(0.031)	(0.031)	(0.032)	(0.032)	(0.032)	(0.035)
Institutional Distance	0.062	0.081	0.070	0.045	0.089	0.089	0.062	0.057	0.067	0.092
	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)	(0.070)
Host Country Openness to IFDI	0.214***	0.222***	0.247***	0.179**	0.255***	0.255***	0.184**	0.183**	0.222**	0.131+
	(0.064)	(0.063)	(0.064)	(0.067)	(0.064)	(0.064)	(0.067)	(0.067)	(0.068)	(0.074)
Host Country GDP	-0.167***	-0.164***	-0.195***	-0.198***	-0.191***	-0.190***	-0.198***	-0.200***	-0.219***	-0.239***
	(0.036)	(0.036)	(0.036)	(0.040)	(0.036)	(0.036)	(0.040)	(0.040)	(0.040)	(0.044)
Host Country Institutional Development	0.107+	0.104+	0.042	0.034	0.040	0.040	0.022	0.030	-0.017	-0.051
	(0.063)	(0.062)	(0.064)	(0.074)	(0.064)	(0.064)	(0.074)	(0.074)	(0.074)	(0.078)
Subsidiary Age	0.126***	0.126***	0.132***	0.126***	0.131***	0.131***	0.126***	0.124***	0.130***	0.159***
	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.041)
Subsidiary Size	0.050	0.052	0.050	0.046	0.052	0.053	0.048	0.046	0.047	0.037
	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.061)
Subsidiary-Parent Industry Relatedness	-0.015	-0.028	-0.013	-0.013	-0.026	-0.027	-0.026	-0.026	-0.026	0.089
	(0.087)	(0.086)	(0.086)	(0.087)	(0.086)	(0.086)	(0.086)	(0.086)	(0.086)	(0.097)
Time Effects	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included
Industry Effects	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included
Constant	5.922***	6.143***	7.359***	7.359***	7.554***	7.553***	6.758***	6.736***	7.972***	8.133***
	(0.663)	(0.664)	(0.740)	(0.740)	(0.740)	(0.740)	(0.731)	(0.732)	(0.788)	(0.871)
Observations	31,930	31,930	31,930	31,930	31,930	31,930	31,930	31,930	31,930	25632
Number of subsidiaries	4,978	4,978	4,978	4,978	4,978	4,978	4,978	4,978	4,978	4184
R^2	0.045	0.049	0.047	0.047	0.051	0.051	0.049	0.049	0.051	0.051
VIF average	1.39	1.40	1.40	1.44	1.41	1.41	1.44	1.44	1.45	1.50
VIF max	6.46	6.53	6.46	6.62	6.53	6.54	6.71	6.72	6.72	6.98

Note: Standard errors are in parentheses. ***p<0.001, **p<0.01, *p<0.05, +p<0.1.

Table 4.5 Results (Dependent variable: Subsidiary Profitability)

Independent variables	(1) EMNE subsidiaries	(2) EMNE subsidiaries	(3) EMNE subsidiaries	(4) EMNE subsidiaries	(5) AMNE subsidiaries	(6) AMNE subsidiaries	(7) AMNE subsidiaries	(8) AMNE subsidiaries
H3: MNE R&D Intensity		2.285		2.023		2.979***		2.943***
		(5.152)		(5.184)		(0.795)		(0.793)
H3: Host Country Technological Richness			0.399**	0.398**			0.120***	0.118***
			(0.142)	(0.142)			(0.029)	(0.029)
MNE Size	-0.030	-0.035	-0.056	-0.060	-0.105**	-0.132***	-0.105**	-0.132***
	(0.118)	(0.118)	(0.116)	(0.116)	(0.032)	(0.033)	(0.032)	(0.033)
MNE Product Diversification	-0.463	-0.456	-0.583	-0.576	-0.111	-0.059	-0.112	-0.060
	(0.579)	(0.580)	(0.569)	(0.569)	(0.092)	(0.093)	(0.092)	(0.092)
MNE Degree of Internationalization	0.315	0.317	0.439	0.440	0.190**	0.219***	0.189**	0.218***
	(0.324)	(0.324)	(0.317)	(0.318)	(0.064)	(0.064)	(0.064)	(0.064)
Culture Distance	1.024*	0.987*	1.240**	1.206*	0.039	0.040	0.031	0.031
	(0.464)	(0.479)	(0.461)	(0.477)	(0.031)	(0.031)	(0.031)	(0.031)
Geographic Distance	-1.368*	-1.358*	-1.051+	-1.044+	0.041	0.019	0.015	-0.007
	(0.627)	(0.634)	(0.577)	(0.585)	(0.031)	(0.031)	(0.031)	(0.031)
Institutional Distance	-1.850+	-1.835+	-1.764+	-1.750+	0.141*	0.144*	0.149*	0.152*
	(0.982)	(0.983)	(0.970)	(0.971)	(0.064)	(0.064)	(0.064)	(0.064)
Host Country Openness to IFDI	0.363	0.367	0.446	0.449	0.265***	0.263***	0.295***	0.293***
	(0.315)	(0.315)	(0.306)	(0.307)	(0.066)	(0.066)	(0.067)	(0.067)
Host country GDP	-0.175	-0.174	-0.335+	-0.334+	-0.131***	-0.135***	-0.157***	-0.160***
	(0.206)	(0.206)	(0.200)	(0.200)	(0.037)	(0.037)	(0.037)	(0.037)
Host Country Institutional Development	-0.196	-0.188	-0.368	-0.361	0.135*	0.128*	0.072	0.066
	(0.340)	(0.341)	(0.340)	(0.341)	(0.064)	(0.064)	(0.066)	(0.065)
Subsidiary Age	0.047	0.046	0.048	0.047	0.132***	0.133***	0.138***	0.140***
	(0.142)	(0.142)	(0.142)	(0.142)	(0.038)	(0.038)	(0.038)	(0.038)
Subsidiary Size	0.101	0.100	0.070	0.069	0.054	0.056	0.054	0.057
	(0.224)	(0.224)	(0.223)	(0.223)	(0.058)	(0.058)	(0.058)	(0.058)
Subsidiary-Parent Industry Relatedness	-0.802+	-0.799+	-0.842+	-0.839+	0.006	-0.003	0.010	0.001
	(0.447)	(0.447)	(0.439)	(0.439)	(0.089)	(0.089)	(0.089)	(0.088)
Time Effects	Included	Included	Included	Included	Included	Included	Included	Included
Industry Effects	Included	Included	Included	Included	Included	Included	Included	Included
Constant	19.650***	19.605***	21.728***	21.678***	5.396***	5.698***	6.745***	7.024***
	(5.702)	(5.744)	(5.447)	(5.505)	(0.683)	(0.687)	(0.760)	(0.762)
Observations	1,730	1,730	1,730	1,730	30,200	30,200	30,200	30,200
Number of subsidiaries	302	302	302	302	4,676	4,676	4,676	4,676
R^2	0.114	0.113	0.125	0.125	0.0458	0.0487	0.0482	0.0510
VIF average	1.71	1.70	1.74	1.74	1.39	1.39	1.40	1.41
VIF max	6.14	6.14	6.16	6.16	5.59	6.04	5.59	6.04

Note: Standard errors are in parentheses. ***p<0.001, **p<0.01, *p<0.05, +p<0.1.

Table 4.6 Results (Dependent variable: Subsidiary Profitability)

	All subsidiaries										Subsidiaries of R&D intensive MNEs	
Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	EMNE subsidiaries	**AMNE subsidiaries**	**EMNE subsidiaries**	**AMNE subsidiaries**	**EMNE subsidiaries**	**AMNE subsidiaries**	**EMNE subsidiaries**	**AMNE subsidiaries**	**EMNE subsidiaries**	**AMNE subsidiaries**	**EMNE subsidiaries**	**AMNE subsidiaries**
H3: MNE R&D Intensity			-0.282	2.941***	2.205	2.972***	2.444	3.460***	2.234	3.217***	-2.295	2.789***
			(4.987)	(0.797)	(5.133)	(0.793)	(5.189)	(0.742)	(12.164)	(0.752)	(5.116)	(0.779)
H3: Host Country Technological Richness			0.387**	0.118***					0.552***	0.108***	0.345*	0.084**
			(0.145)	(0.029)					(0.163)	(0.029)	(0.201)	(0.031)
Host country IPR Distance					-0.030	0.167**	-0.030	0.163**	-0.288	0.147**	0.275	0.166**
					(0.359)	(0.053)	(0.359)	(0.053)	(0.409)	(0.054)	(0.638)	(0.058)
H4a: MNE R&D Intensity * Host Country Technological Richness			6.965**	0.014					7.108*	0.323	2.936*	0.287
			(2.594)	(0.416)					(2.766)	(0.439)	(2.972)	(0.451)
H4b: MNE R&D Intensity*Host Country IPR Distance							-3.561	-1.911**	-4.210	-2.032**	0.725	-1.752*
							(6.037)	(0.727)	(7.783)	(0.774)	(9.632)	(0.801)
MNE Size	-0.030	-0.105**	-0.060	-0.132***	-0.036	-0.137***	-0.036	-0.134***	-0.061	-0.134***	-0.086	-0.140***
	(0.118)	(0.032)	(0.116)	(0.033)	(0.118)	(0.033)	(0.119)	(0.033)	(0.117)	(0.033)	(0.197)	(0.036)
MNE Product Diversification	-0.463	-0.111	-0.591	-0.060	-0.451	-0.067	-0.454	-0.065	-0.567	-0.066	-0.333	-0.005
	(0.579)	(0.092)	(0.572)	(0.092)	(0.584)	(0.093)	(0.584)	(0.093)	(0.576)	(0.092)	(0.790)	(0.106)
MNE Degree of Internationalization	0.315	0.190**	0.430	0.218***	0.314	0.243***	0.314	0.235***	0.415	0.233***	0.464	0.188*
	(0.324)	(0.064)	(0.318)	(0.064)	(0.325)	(0.065)	(0.326)	(0.065)	(0.319)	(0.065)	(0.446)	(0.074)
Culture Distance	1.024*	0.039	1.275**	0.031	0.995*	0.020	0.989*	0.013	1.311**	0.010	0.566	0.006
	(0.464)	(0.031)	(0.472)	(0.031)	(0.482)	(0.032)	(0.482)	(0.032)	(0.477)	(0.032)	(0.721)	(0.034)
Geographic Distance	-1.368*	0.041	-0.942	-0.007	-1.362*	-0.007	-1.345*	-0.000	-0.940	-0.021	-1.744*	-0.042
	(0.627)	(0.031)	(0.616)	(0.031)	(0.632)	(0.032)	(0.640)	(0.032)	(0.623)	(0.033)	(0.870)	(0.035)
Institutional Distance	-1.850+	0.141*	-1.791+	0.152*	-1.826+	0.126+	-1.844+	0.123+	-1.739+	0.131*	-2.243	0.163*
	(0.982)	(0.064)	(0.970)	(0.064)	(0.993)	(0.064)	(0.995)	(0.064)	(0.980)	(0.064)	(1.419)	(0.072)
Host Country Openness to IFDI	0.363	0.265***	0.536+	0.293***	0.374	0.208**	0.372	0.210**	0.578+	0.244***	0.382	0.170*
	(0.315)	(0.066)	(0.306)	(0.067)	(0.324)	(0.069)	(0.324)	(0.069)	(0.318)	(0.070)	(0.475)	(0.076)
Host Country GDP	-0.175	-0.131***	-0.318	-0.160***	-0.166	-0.185***	-0.167	-0.185***	-0.275	-0.202***	-0.510+	-0.210***
	(0.206)	(0.037)	(0.200)	(0.037)	(0.224)	(0.041)	(0.225)	(0.041)	(0.215)	(0.041)	(0.270)	(0.045)
Host Country Institutional Development	-0.196	0.135*	-0.402	0.066	-0.170	0.003	-0.152	0.013	-0.258	-0.031	-0.773+	-0.054
	(0.340)	(0.064)	(0.343)	(0.065)	(0.407)	(0.075)	(0.413)	(0.075)	(0.406)	(0.075)	(0.461)	(0.079)
Subsidiary Age	0.047	0.132***	0.032	0.140***	0.048	0.133***	0.048	0.130***	0.036	0.135***	-0.081	0.162***
	(0.142)	(0.038)	(0.143)	(0.038)	(0.142)	(0.038)	(0.142)	(0.038)	(0.143)	(0.038)	(0.218)	(0.041)
Subsidiary Size	0.101	0.054	0.095	0.057	0.101	0.050	0.102	0.047	0.107	0.049	0.001	0.042
	(0.224)	(0.058)	(0.225)	(0.058)	(0.225)	(0.058)	(0.225)	(0.058)	(0.227)	(0.058)	(0.394)	(0.062)
Subsidiary-Parent Industry Relatedness	-0.802+	0.006	-0.861+	0.001	-0.798+	-0.002	-0.790+	-0.004	-0.849+	-0.003	-1.254+	0.141
	(0.447)	(0.089)	(0.441)	(0.089)	(0.447)	(0.089)	(0.449)	(0.089)	(0.442)	(0.089)	(0.698)	(0.098)
Time Effects	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included

Industry Effects	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included
Constant	19.650***	5.396***	20.642***	7.024***	19.539***	6.589***	19.419***	6.526***	19.419***	6.526***	30.324***	7.782***
	(5.702)	(0.683)	(5.822)	(0.762)	(5.809)	(0.753)	(5.865)	(0.755)	(5.865)	(0.755)	(7.889)	(0.891)
Observations	1,730	30,200	1,730	30,200	1,730	30,200	1,730	30,200	1,730	30,200	778	24,853
Number of subsidiaries	302	4,676	302	4,676	302	4,676	302	4,676	302	4,676	214	3,969
R^2	0.114	0.0458	0.124	0.0510	0.113	0.0492	0.114	0.0500	0.114	0.0500	0.107	0.0521
VIF average	1.71	1.39	1.73	1.40	1.82	1.43	1.80	1.43	1.83	1.44	2.16	1.49
VIF max	6.14	5.59	6.16	6.06	6.26	6.17	6.26	6.19	6.26	6.20	5.80	6.63

Note: Standard errors are in parentheses. ***p<0.001, **p<0.01, *p<0.05, +p<0.1.

Figure 4.5 Confidence intervals of the mean differences in terms of the joint effects of MNE R&D Intensity and Host Country Technological Richness

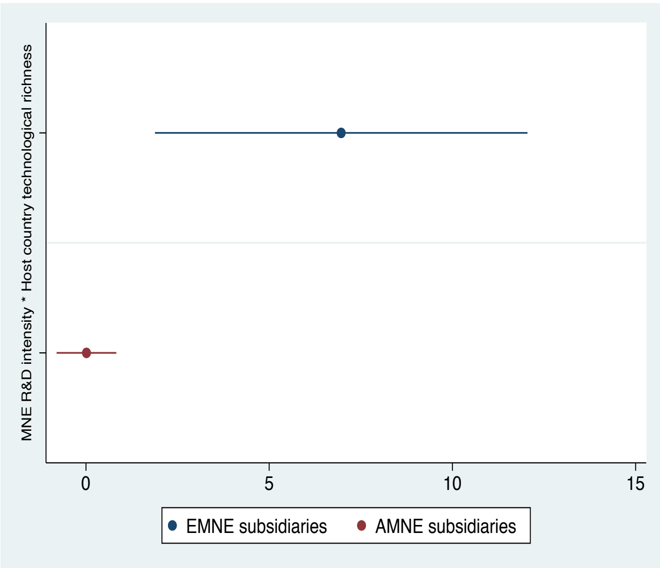
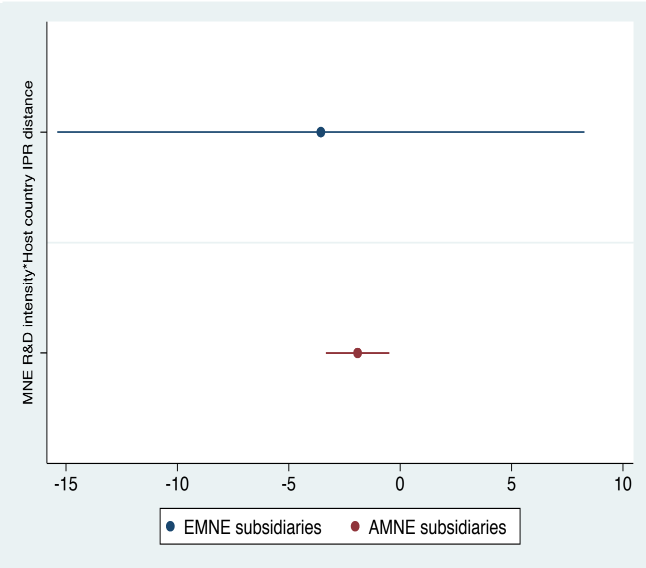


Figure 4.6 Confidence intervals of the mean differences in terms of the joint effect of MNE R&D Intensity and Host Country IPR Distance



4.5.1 Robustness Checks

We also tested the robustness of the hypotheses by checking the same effects using subsidiaries belonging to MNEs which have recorded non-zero R&D expenditure for the full sample estimation (Table 4.4, Column 10) and subsample estimation (Table 4.5, Columns 13 and 14), and the results remain qualitatively unchanged. The results above are robust when we use ROA to measure the subsidiary performance.

In addition to host country environments and MNE R&D intensity, entry mode is expected to influence subsidiary performance, even though the actual effects can be complex for AMNEs and EMNEs (Awate et al., 2015; Wang et al., 2018). We thus included an additional variable - entry mode into the models (direct effects and also the joint effects). We identified the entry mode of each subsidiary by matching our data with the Zephyr BvD database, which provides data on M&As. We measure subsidiary entry mode by a dummy variable that taking the value of 1 if the subsidiary is acquired. Table 4.7 reports our results for the additional analysis.

While Columns 1-3 in Table 4.7 examine the direct effect of entry mode on subsidiary performance, Columns 4-6 test the moderating effect of entry mode on the relationship between MNE R&D intensity and subsidiary performance. All these effects are examined for the full-sample, the sub-samples of AMNE subsidiaries and EMNE subsidiaries, respectively. Because of the complex effects of entry mode on subsidiary performance, we find an insignificant effect of entry mode on subsidiary performance both in a full-sample estimation and subsample estimations. We illustrate the interaction effects in Columns 4-6, showing an insignificant moderating role of entry mode.

Table 4.7 Results of robustness check (Dependent variable: Subsidiary Profitability

Independent variables	(1) **Full sample**	(2) **EMNE subsidiaries**	(3) **AMNE subsidiaries**	(4) **Full sample**	(5) **EMNE subsidiaries**	(6) **AMNE subsidiaries**
Entry Mode	-0.049 (0.099)	0.082 (0.413)	0.029 (0.101)	0.088 (0.115)	0.133 (0.426)	0.175 (0.121)
MNE R&D Intensity				4.233*** (0.803)	5.587 (8.567)	3.731*** (0.814)
MNE R&D Intensity*Entry Mode				-4.436+ (2.291)	-6.405 (9.243)	-4.751+ (2.490)
MNE Size	-0.096** (0.031)	-0.030 (0.119)	-0.105** (0.032)	-0.127*** (0.032)	-0.037 (0.119)	-0.135*** (0.033)
MNE Product Diversification	-0.073 (0.091)	-0.466 (0.582)	-0.112 (0.092)	-0.022 (0.091)	-0.481 (0.586)	-0.058 (0.092)
MNE Degree of Internationalization	0.198** (0.063)	0.326 (0.339)	0.191** (0.064)	0.229*** (0.063)	0.340 (0.340)	0.225*** (0.064)
Culture Distance	-0.002 (0.030)	1.027* (0.465)	0.040 (0.031)	0.008 (0.030)	1.003* (0.478)	0.039 (0.031)
Geographic Distance	0.000 (0.030)	-1.378* (0.638)	0.041 (0.031)	-0.021 (0.030)	-1.336* (0.661)	0.016 (0.031)
Institutional Distance	0.063 (0.062)	-1.848+ (0.984)	0.141* (0.064)	0.081 (0.062)	-1.858+ (0.989)	0.143* (0.064)
Host Country Openness to IFDI	0.213*** (0.064)	0.366 (0.316)	0.265*** (0.066)	0.222*** (0.063)	0.380 (0.318)	0.263*** (0.066)
Host Country GDP	-0.167*** (0.036)	-0.170 (0.208)	-0.131*** (0.037)	-0.163*** (0.036)	-0.168 (0.208)	-0.135*** (0.037)
Host Country Institutional Development	0.108+ (0.063)	-0.195 (0.340)	0.135* (0.064)	0.105+ (0.062)	-0.181 (0.342)	0.128* (0.064)
Subsidiary Age	0.127*** (0.037)	0.043 (0.146)	0.131*** (0.038)	0.123*** (0.037)	0.041 (0.146)	0.130*** (0.038)
Subsidiary Size	0.050 (0.056)	0.098 (0.226)	0.053 (0.058)	0.051 (0.056)	0.110 (0.231)	0.054 (0.058)
Subsidiary-Parent Industry Relatedness	-0.015 (0.087)	-0.799+ (0.449)	0.006 (0.089)	-0.034 (0.086)	-0.799+ (0.450)	-0.010 (0.089)
Time Effects	Included	Included	Included	Included	Included	Included
Industry Effects	Included	Included	Included	Included	Included	Included
Constant	5.935*** (0.664)	19.644*** (5.699)	5.388*** (0.684)	6.163*** (0.664)	19.332*** (5.841)	5.718*** (0.687)
Observations	31,930	1,730	30,200	31,930	1,730	30,200
Number of subsidiaries	4,978	302	4,676	4,978	302	4,676
R^2	0.0447	0.113	0.0458	0.0492	0.113	0.0495
VIF average	1.39	1.71	1.38	1.40	1.75	1.40
VIF max	6.50	6.18	5.98	6.58	6.22	6.0

Note: Standard errors are in parentheses. ***p<0.001, **p<0.01, *p<0.05, +p<0.1.

4.6 Discussion and Conclusion

The objective of this paper is to explore if there is a general explanation of subsidiary performance variations resulted by variations in MNE R&D intensity and host country environment. Based on the fairly developed literature of AMNEs and limited literature of EMNEs, we proposed and examined four sets of hypotheses. We found support for our predictions that MNE R&D intensity and host country technological richness are the key determinants of subsidiary profitability, and stronger host country IPRs reduce the benefits from MNE. However, we cannot find support for Hypothesis 2a which shows that a technological-rich environment increases the benefits from MNE R&D intensity on subsidiary profitability. This can be possibly because the development of income-generating overseas subsidiaries is a complicated process, especially studies on subsidiary development describe different journeys for AMNE subsidiaries and EMNE subsidiaries (Awate et al., 2015). The results indicate that what matters is not only the mechanisms through which the overseas subsidiaries are enabled by the MNEs to better learn from the host counties, but also how the roles of the overseas subsidiaries develop over time. Therefore, it would be interesting to conduct inductive research to better explore the development process of income-generating subsidiaries in order to better understand the roles of overseas subsidiaries, the complex mechanisms through which the overseas subsidiaries are enabled by the knowledge of their parent MNEs and the mechanisms through which the overseas subsidiaries are enabled by MNE capabilities to better learn from the host countries.

We further found the effects of these key factors on subsidiary performance vary in the AMNE subsidiary and EMNE subsidiary cohorts. Specifically, AMNE subsidiaries rely more on internal competence (MNE R&D), while EMNE subsidiaries rely more on external competence (host technological-rich environment). Additionally, EMNE subsidiaries are more influenced by the joint effects of MNE R&D intensity and a technological-rich host environment than AMNE subsidiaries, while the joint effect of MNE R&D intensity and a weaker IPR on subsidiary profitability is not statistically different between the cohort of AMNE subsidiaries and EMNE subsidiaries. This finding differs from our theoretical prediction but in line with some empirical evidence showing that some of EMNEs increasingly become global competitors with superior technologies such as Chinese telecommunication equipment manufacturer Huawei or Brazilian airplane manufacturer Embraer (Cuervo-Cazurra, 2012) and these innovative EMNEs have exploited and protected their technologies in the foreign markets (Pereira et al., 2021).

Since our data is not able to capture the technological development of EMNEs, future research will benefit from large scale longitudinal studies of a range of these EMNEs in terms of how they develop technologies and capabilities to protect their technologies in weaker IPR host environments.

We contribute to the literature exploring contingent effects of MNE competence on subsidiary performance by demonstrating that such contingent approach is not appropriate without careful scrutiny of firm distribution. Our comparative analysis reveals significant differences between subsidiaries of cohorts of MNEs that are at different ends of distribution in terms of MNE R&D intensity. Our findings point to the need to address the fact that distinct motives for MNEs to conduct R&D exist and affect how MNE subsidiaries will benefit from MNE R&D intensity. Thus, a general framework explaining MNE competence on subsidiary performance conceptualise contexts more rigorously.

We contribute to the literature on subsidiary performance by demonstrating the relative importance of MNE competence and host country technological richness on subsidiary performance varies between AMNE subsidiaries and EMNE subsidiaries. Our study also goes beyond works on subsidiary that focused on the effects of MNE competence and host country environment by adopting a finer perspective that considers the joint effects of MNE competence and host country environments on subsidiary profitability and how these joint effects differ between AMNE subsidiaries and EMNE subsidiaries. We thus add to the large body of studies on determinants of subsidiary performance and explain the mechanisms through which AMNE and EMNE subsidiaries benefit from their MNE competent and the external host markets.

Our research contributes to the valuable efforts seeking a general explanation of firm internationalization and development (e.g., Hernandez and Guillén, 2018) by showing that the principle of MNE competence and host environment influencing subsidiary profitability stands the test when parent MNEs are from distinctive home economies and conditions.

There are several limitations in our research, some of which open avenues for future research. First, although the size and internationalization strategies make China and India as appropriate emerging countries for our analysis, we should recognize the different characteristics exist between emerging countries. Future research may expand into other emerging market firms to provide more complete capture of EMNEs globally. Second, in addition to MNE R&D intensity, with better data availability, MNE absorptive capacity may be captured using other measurements such as the number of engineers in the R&D

centres. Third, this chapter only focus on the determinants of subsidiary performance, but MNE R&D intensity appears to be not an appropriate variable to determine EMNE subsidiary performance and further to capture the innovation process of EMNEs. Therefore, EMNEs' development process (especially the internal knowledge management process) is still under-researched, it will be interesting to explore from a technological development point of view by including some more detailed factors such as subsidiary patenting activities. In the next chapter, we are going to go deeper to investigate why AMNEs and EMNEs are different in their technology development processes based on the technologies owned by their innovative subsidiaries and whether there is a general explanation of the MNE technology development. There is still much more to be explored regarding a general explanation of the MNE technology development and how overseas subsidiaries play a role. This research is only the first step towards it and future research pursuing this perspective will produce important contributions.

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Chapter 5: A Taxonomy of Technological Integration and Diversification of Multinational Enterprises and the Acquisition by Emerging Market and Advanced Market Firms

ABSTRACT

We develop a taxonomy to describe how technological integration and diversification strategies of Multinational Enterprises (MNEs) differ at the level of technologies owned by their innovative overseas subsidiaries (ioSubs). Studying technology portfolios owned by individual ioSubs, we identify four clusters of ioSubs - Lone Wolf Exploration, Networked Exploitation, Mass Exploration, and Super Integration. We describe each cluster and hypothesize how the likelihood of acquisition differs across these clusters and differs for EMNE ioSubs and AMNE ioSubs, respectively. We found that acquisition is most likely in Lone Wolf Exploration and Mass Exploration clusters and EMNEs are more likely than AMNEs to acquire ioSubs in Mass Exploration cluster.

Keywords: technology development, patents, technological integration, technological diversification, emerging markets, MNE

5.1 Introduction

Technological development is the battle ground for firms to gain competitive advantages. Particularly, multinational enterprises (MNEs) from emerging markets (EMNEs) and advanced markets (AMNEs) have increasingly distributed their technological activities across borders to become networked and embedded (Papanastassiou et al., 2020). While many firms utilize global innovation, their performance varies greatly because innovative overseas subsidiaries contribute differently to the development of the MNE as a whole (Elia et all., 2020; Phene and Almeida, 2008). However, we have limited understanding of how technologies owned by subsidiaries enable the parent MNEs to pursue differing modes of development.

An innovative overseas subsidiary (ioSub), in this research, is an overseas unit with the capability to independently or jointly own technologies (e.g., patents) that are valuable to the parent MNE. Typically, an ioSub owns at least one patent which it generated or acquired (De Marco et al., 2017). The ways in which ioSubs acquire and develop technologies in specific technological field and the ways in which their technologies are integrated with technologies of peer ioSubs of the same MNE influence not only subsidiary performance but, more importantly, the strategic values of an MNE's global innovation efforts (Buckley and Casson, 1976, 2009; Cantwell and Mudambi, 2005). While ioSubs are often located in advantageous places such as those advanced markets offering access to global knowledge reservoirs (Cantwell and Piscitello, 2000; Wu et al., 2016), not all MNEs possess ready and efficient globally dispersed innovation networks and managerial capabilities. Therefore, MNEs with different types of capabilities and networks may instinctively have ioSubs generating technologies of certain characteristics, as a result of the particular developmental mode an MNE pursues. With the objective of understanding the technological development of a wide range of MNEs, this research examines the technology portfolios of ioSubs belonging to MNEs from distinctive home country conditions that may have resulted in the firms possessing differentiated networks and innovation capabilities in the first place.

Among studies of MNE strategies, the Bartlett-Ghoshal typology specifically recognized the roles of ioSubs in supporting parent MNEs' strategic balancing between global integration and local responsiveness (e.g., Bartlett and Ghoshal, 1989; Roth and Morrison, 1990; Harzing, 2000). Advancement in this stream of research has seen further theorisation and testing of different types of subsidiary roles in internal knowledge flow management (e.g., Gupta and Govindarajan, 1991; Harzing and Noorderhaven, 2006) and different types of subsidiary mandates in MNE R&D internationalization and innovation competence development (e.g., Cantwell and Mudambi, 2005; Giuliani et al., 2014). While previous studies took the valuable perspective of innovation input such as R&D activities and R&D intensity of subsidiaries, the innovation outcome perspective of ioSubs is relatively less well understood. Specifically, how and to what extent are technology portfolios of individual ioSubs integrated or diversified? What parent MNE strategies have enabled ioSubs to build up a stock of technologies? Do ioSubs of EMNEs have similarly integrated or differentiated technology portfolios to those of AMNEs and why (not)? Answers to these questions are important as they enable a more nuanced understanding of the ways in which MNEs secure technological ownerships (and hence competitive advantages) using subsidiaries.

International business theories suggest that firms develop technological advantages at home first before exploiting them in overseas markets and subsequently using ioSubs to create technological competence (Cantwell and Mudambi, 2005). However, emerging markets are known to be less technologically developed, a condition which presents considerable challenges for firms from these home environments to innovate and acquire advanced technologies (Awate et al, 2015; Aulakh, 2007; Rugman, 2009). Particularly, studies have suggested that EMNEs do not generally have technological advantages before internationalization (Mathews, 2006; Luo and Tung, 2007, 2018), and they develop technologies using global innovation (Elia et al., 2020; Nair et al., 2016). This appears to contradict the classical model of AMNEs and extant literature thus raised the important question of how to reconcile observations of EMNEs with those of AMNEs (Cuervo-Cazurra, 2012; Hernandez and Guillén, 2018), particularly at the level of technology portfolios owned by ioSubs. Furthermore, theories suggest that MNEs internalize and exploit their technological resources and capabilities during the earlier stage of internationalization (Buckley and Casson, 1976). Since EMNEs and AMNEs differ in terms of home conditions which change how they may initiate innovation in ioSubs, the resources and capabilities internalized and exploited may therefore differ. Incorporating such differences in the analysis of ioSubs' technology portfolios and their characteristics provides valuable opportunities for exploring a unifying explanation of MNE technological development.

This research contributes to the MNE and innovation literature by (1) proposing a taxonomy to describe how technological integration and diversification strategies of MNEs differ at the level of technologies owned by their ioSubs, and (2) explaining the differences in the likelihood of AMNEs and EMNEs using acquisition to pursue certain technological strategy. We achieve these by first examining the patent portfolios owned by ioSubs of EMNEs and AMNEs, which enables us to measure each ioSub's degrees of technological integration - the degree of commonality (Stuart and Podolny, 1996) shared by subsidiaries of the same MNE in their patent portfolios - and technological diversification - the extent to which the subsidiaries own patents across different technological fields. Based on these two constructs, we use exploratory cluster analysis to group these ioSubs. Because MNEs internalize inefficient external markets (Buckley and Casson, 1976; Meyer and Estrin, 2014), ioSubs' presence in a specific group reflects a certain technological strategy the parent firm pursues. We subsequently developed the Taxonomy of Technological Integration and Diversification of MNEs. Drawing on the extant literature and theoretical reasoning of acquisition and MNEs' technological development, we then use the Taxonomy to predict variations in the likelihood of ioSubs being acquisitions across clusters. A critical area of investigation and debate in the literature investigating differences between EMNEs and AMNEs (e.g., Alon et al., 2020) is what entry modes have facilitated technology acquisition during internationalization. Use the Taxonomy we hence specifically tested if the status of the ioSubs as being acquisitions vis-à-vis greenfield is more likely to be associated with EMNEs than AMNEs.

Our empirical analyses rely on a sample of 36,438 patents of 143 ioSubs belonging to 20 EMNEs (from China and India) and 31 AMNEs (from France, Germany, Italy and US) during the period of 2006-2014. Our findings show that there are four clusters of ioSubs in the Technological Integration and Diversification Taxonomy: Lone Wolf Exploration (low technological integration and low technological diversification), Networked Exploitation (high technological integration and low technological diversification), Mass Exploration (low technological integration and high technological diversification), and Super Integration (high technological integration and high technological diversification). Using the Taxonomy, we are able to predict and empirically show that there are indeed variations in the likelihood of acquisition between clusters and between the cohorts of EMNE ioSubs and AMNE ioSubs.

5.2 Theoretical Background

5.2.1 MNE Technology Development and Subsidiary Technological Integration

Technological connectedness between subsidiaries is considered in the international business literature (e.g., Bartlett and Goshal, 1989) as a fundamental form of internal integration of an MNE. Specifically, parent MNEs use organizational mechanisms for coordination and control in order to develop technological linkages across geographically dispersed subsidiaries, creating cross-border intrafirm lateral flows of resources and capabilities within the firm (Kobrin, 1991; Keupp et al., 2011; Zeng et. al., 2018). Parent MNEs may also regulate subsidiaries' innovative, particularly patenting, activities to align them with particular technological objectives (Cray, 1984; Kim et al., 2003; Zeng et al., 2018).

Intrafirm flows of resources and capabilities within MNEs enable parents to shape subsidiary level technological activities. Resources refer to the parent MNE's intellectual capital, particularly technologies and know-how which are valuable, rare, inimitable and non-substitutable (Barney, 1991), and capabilities implicate the abilities of the parent MNE as a whole as well as those of its subsidiaries to create and sustain competitiveness in the internationalization process (Teece et al., 1997; Teece, 2007, 2014). Since subsidiaries may innovate and patent replying heavily on their parents' internal networks for resources and capabilities (Almeida and Phene, 2004; Phene and Almeida, 2008), this dependency shapes the extent to which a subsidiary's technological fields overlap with that of other subsidiaries of the same MNE (Phene and Almeida, 2003). Furthermore, subsidiaries may possess idiosyncratic resources and capabilities (Andersson and Forsgren, 2000), which are then combined with further resources and capabilities in an MNE' internal network, the degree of technological overlap among subsidiaries may therefore vary from one subsidiary to another, which in turn creates variations between MNEs. Following the above reasoning, such variations are results of idiosyncrasy of MNEs' internal resources and capabilities and their strategy choices in how to integrate through coordination and control.

In summary, *Subsidiary Technological Integration* emerges as a dimension of MNE technology development and refers to the degree of commonality shared by subsidiaries of the same MNE in their technology portfolios. The average degree of technological integration across subsidiaries of an MNE thus reflects a particular technological strategy of the parent firm, as a result of how the parent MNE uses coordination and control to shape the dependency of subsidiaries on each other.

5.2.2 MNE Technology Development and Subsidiary Technological Diversification

Technological diversification among subsidiaries is a significant characteristic of MNEs' innovation (e.g., Verbeke et al., 2018; Zander, 1997). As geographically distributed subsidiaries increasingly become embedded (Castellani and Zanfei, 2006), MNEs have been able to tap into host country knowledge bases (Colakoglu et al., 2014) and develop new technologies responsive to local markets (Delios et al., 2008), creating flows of resources and capabilities from host locations (and markets) into the internal networks of subsidiaries (Phene and Almeida, 2008). Specifically, parent MNEs may set specific target of learning from an external market and encourage their ioSubs to align with them through sourcing innovative resources and capabilities from locations with distinct technological profiles (Isaac et al., 2019; Zander, 1997; Phene and Almeida, 2008).

When reliance on parents for resources and capabilities is not sufficient for innovation that needs to be responsive to local market conditions, subsidiaries may turn to external host markets for resources and capabilities (Kogut and Zander, 1993; Asmussen et al., 2009). Such host locations typically have distinctive technological profiles compared with those of other host locations of the same MNE, as well as those of the firm's home country. Furthermore, innovation generated through this process by an ioSub will instinctively contribute to shaping its technological position relative to those of its rivals (Stuart and Podolny, 1996). Therefore, an ioSub's technology portfolio may diversify as a result of the resources and capabilities, external and internal, which it relied on, and the technological change caused by local rivals' search and innovative efforts (Ryan et al., 2018). In other words, as MNEs develop to have a stronger focus on local responsiveness and learning from foreign markets, their ioSubs may diversify technologically. This technological diversification at the subsidiary level may indeed vary, while an increasing presence of technologically diversified ioSubs within a firm vertebrate the MNE-level technological diversification documented in the large body of literature (Blomkvist et al., 2010; Phene and Almeida, 2003).

Subsidiary Technological Diversification thus emerges as an additional dimension of MNE innovation and refers to the extent to which the subsidiaries develop technologies across different technological fields. The average degree of technological diversification across ioSubs of an MNE thus reflects a particular technological strategy of the parent firm, as a result of how the parents' internal resources and control and host locations' technological profiles and competition drive the technological differentiation among subsidiaries.

5.2.3 MNEs' Exploitation Orientation in Technology Development

MNE's exploitation orientation in technology development refers to parent firms' strategic focus of leveraging own resources and capabilities to optimize technological outcomes through replication and refinement. MNEs often search for efficiencies (e.g., economics of scale) in dispersed innovation (Delios and Beamish, 2001) by leveraging resources and capabilities during their geographic dispersion (Delio and Beamish, 1999; Chen et al., 2012). MNE's resources and capabilities may have been developed at the headquarters

(HQs) (Cantwell and Mudambi, 2005), or in locations where their ioSubs operate (Asakawa, 2001; Kuemmerle, 1999; Von Zedtwitz, 2004). Creating resources and capabilities in one location is strategically significant because it can generate competitive advantages to be exploited by the MNE in new locations and markets through internal integration and coordination among subsidiaries (Dunning, 1993; Buckley and Casson, 1976; Hymer, 1976).

Internalisation theory explains that when marginal reinvestment in an existing local market exceeds the marginal profits, deploying existing resources and capabilities in a different geographic market will generate higher returns (Teece, 1984) without depreciating the value of resources from existing markets (Delio and Beamish, 2001; Morck and Yeung, 1998). By the same token, the global innovation literature (e.g., Keupp et al., 2011; Mudambi, 2002) suggests that resources, knowledge, and capabilities generated by subsidiaries in one location can become valuable inputs for innovation of subsidiaries in other locations. For example, Phene and Almeida (2008) argues that knowledge absorbed from peer subsidiaries significantly contributes to the scale and quality of a subsidiary's innovation outcome. Replication and refinement may take place in existing locations (March, 1991; Lavie et al., 2010) or new locations (Ramachandran et al., 2019), achievable in innovative activities within existing subsidiaries (Andriopoulos and Lewis, 2009) or new subsidiaries (Chen et al., 2012). Specifically, overseas subsidiaries may first patent in technology classes that are similar to those of HQs because they have benefited mainly from knowledge transfer by parents; while many maintain a high degree of overlap with HQs, a small number of them, over time, becomes more innovative by expanding into new technology classes (Awate et al., 2015). The above discussion suggests that stronger exploitation orientation is associated with a higher degree of *Subsidiary Technological Integration*. The MNE's orientation to exploit its resources and capabilities in new locations creates the intrafirm knowledge flows (Teece, 2014). This intrafirm flow of resources and capabilities thus shape the technological activities of the subsidiaries, resulting in a higher degree of technological interdependence between HQ and subsidiaries and among subsidiaries.

5.2.4 MNE's Exploration Orientation in Technology Development

MNEs' exploration orientation in technology development refers to parent firms' strategic focus of departing from the firm's current store of knowledge and technological fields to conduct distant search of internal and external knowledge across technologies, markets and borders to create new competence. Previous studies observed firms' tendencies towards searching knowledge in the neighbourhood of its current knowledge (Nelson and Winter, 1982;

Stuart and Podolny, 1996). By focusing on “local” search, the firm acquires similar knowledge and technologies, thus becoming specialized in its current domain (Leonard- Barton, 1992). However, firms may consequently fall into the so called ‘competency traps’ (Levitt and March, 1988) because of a lack of competitiveness when rapid changes occur in the technological environments. It’s been argued that rapidly changing global technological environments require firms to enhance their dynamic capabilities, to discovery new opportunities in order to sustain their competitive advantages (Teece, 2007, 2014). Specifically, firms may sustain their competitive advantages by moving away from local search and reconfiguring their technology portfolios (Rosenkopf and Nerkar, 2001; Stuart and Podolny, 1996). For example, firms are found to search across technological as well as spatial boundaries in order to overcome the narrow search horizon (Rosenkopf and Nerkar, 2001) because tacit knowledge transfer is spatially bound (Polanyi, 1966; Gertler, 2003). Thus, MNEs use ioSubs as strategic vehicles to conduct distant search and exploration during technology portfolio development.

Since exploration requires deviating from the status quo, MNEs may strategically encourage subsidiaries to tap into foreign knowledge bases (Colakoglu et al., 2014), and embed in host country environments through contacts with local business ecosystems of competitors, suppliers, organizations or customers (Teece, 2007). IoSubs may subsequently search and acquire knowledge from host locations (Phene and Almeida, 2003) and explore novel ways of combining internal and external knowledge when generating new technologies (Cantwell and Mudambi, 2005). Since technological profiles of countries differ (Zander, 1997), home and host countries may offer different technological opportunities to MNEs (Teece, 2007). Subsidiaries conducting strategic exploration therefore may innovate in new technological fields encompassing expertise from the host locations (Granstrand et al., 1997), without restricting their research to existing technological fields of subsidiaries of the same MNE. In other words, MNEs’ exploration orientation is likely to be stronger when the MNE has a lower degree of *Subsidiary Technological Integration*.

5.3 Study 1: Developing the Technological Integration and Diversification Taxonomy

5.3.1 The Technological Integration-Diversification Taxonomy

Since there have been insufficient studies using and comparing cohorts EMNE ioSubs and AMNE ioSubs, we start with an exploratory analysis of technologies owned by these ioSubs. While a range of technologies have been developed and owned by ioSubs, to find a comparable measure for both cohorts EMNE ioSubs and AMNE ioSubs, we have chosen to capture a subset of these technologies, patents. Competition in patenting is in the forefront of MNEs' strategic manoeuvre aimed at securing competitive advantages and therefore a valuable context for empirical investigation.

We use two dimensions suggested from extant theoretical reasoning, *Subsidiary Technological Integration* and *Subsidiary Technological Diversification*. Following prior studies (e.g., Diestre and Rajagopalan, 2012; Frankort, 2016), *Subsidiary Technological Integration* is measured by the ratio of patent classes overlapped with those of peers over the total number of patent classes of an ioSub. *Subsidiary Technological Diversification* is measured by a Hirschman-Herfindahl index. Details of data and measures are reported in the Methodology section. We have developed the Technological Integration-Diversification Taxonomy, which distinguishes four groups of ioSubs with differing degrees of technological integration and diversification. Since MNE may strategically use their ioSubs to develop their technologies, ioSubs in each cluster represents their MNEs' technological development strategies. We identify four clusters of ioSubs - Lone Wolf Exploration, Networked Exploitation, Mass Exploration and Super Integration.

Cluster 1: Lone Wolf Exploration

ioSubs in Cluster 1 are focused and autonomous innovators, with lower degrees of *Subsidiary Technological Integration* and *Subsidiary Technological Diversification*. We term this Lone Wolf Exploration, which refers to an MNE's strategic use of specialist ioSubs - that own technologies (patents) in a small number of fields - to advance the parent's technological advantage into new fields where there is currently small degree of overlap among peer subsidiaries of the same firm. Presence of ioSubs in this group reflects a niche exploration approach by MNEs, as their specialist units retain authority in a technology field in which peer subsidiaries of the same firm rarely compete (internally and externally).

Lone Wolf Exploration is particularly beneficial when competition focuses on a small number of specialized technologies (e.g., iron, steel, and welding) that change slowly over time (Zander, 1997), and autonomous innovation overseas may therefore enable MNEs to better embed in host locations where their ioSubs draw specialist local knowledge, expertise, capabilities and resources to build competence for the firm as a whole (Frost et al., 2002). This group of ioSubs may benefit MNEs' early-stage development when the firm does not yet have a large portfolio of technological expertise, resources and capabilities, and there is, at the same time, very limited stock of these resources and capabilities in the firm's home country. Such conditions may occur more often for firms from emerging markets (Rui and Yip, 2008). The strategic value of Lone Wolf Exploration is therefore to mitigate the disequilibrium between the imperative needs of the firms to augment their resources and capabilities (Luo and Tung, 2007) and the lack of resources and capabilities stock in the firms' home countries (Cuervo-Cazurra and Genc, 2008).

Cluster 2: Networked Exploitation

ioSubs in Cluster 2 are networked specialists, with greater *Subsidiary Technological Integration* and lower *Subsidiary Technological Diversification*. We term this Networked Exploitation, which refers to an MNE's strategic use of specialist ioSubs to develop highly exploitable technologies (patents with greater overlapping with those of peer ioSubs of the same MNE). This strategy reflects a networked approach to exploitation by MNEs, where ownership of exploitable technologies is distributed within a firm's internal network, facilitating intra-firm exchange of knowledge, expertise, resources, and increasing the likelihood of application of these technologies not only in individual markets but across subsidiaries in multiple locations and markets (Keupp et al., 2011; Mudambi, 2002).

Through internal coordination and investments distributed to specialist ioSubs, MNEs are equipped to utilize new opportunities and complementary assets embedded in host locations (Teece, 2007, 2014) and then mobilize these benefits within their internal networks, especially to peer ioSubs with greater technology overlap (Phene and Almeida, 2003). The process leads to augmented resources and capabilities of the MNE as a whole (Awate et al., 2015; Papanastassiou et al., 2020). The home-base augmenting benefits suggest that ioSubs in this group may be more prevalent in the early stage of MNE development when the firm does not yet have a large portfolio of technological expertise, resources and capabilities. For such firms to succeed in a certain technological environment, strategies of augmenting own capabilities and obtaining resources is key (Teece, 2007). Specifically, Stuart and Podolny (1996) showed that innovative firms develop networked innovative capabilities while concentrating on patenting in the technological fields where the firm has previously patented. Networked Exploitation thus enables MNEs to specialize in a smaller number of technological fields using overseas resources brought in by ioSubs, increasing chances to win technology competition within individual fields (Zander, 1997). We should also note that, as MNEs develop, this strategy may not meet all the needs of firm growth because of the limitations of exploitation in rapidly changing technological environment.

Cluster 3: Mass Exploration

In Cluster 3 ioSubs are pluralists, with lower degrees of *Subsidiary Technological Integration* and higher degrees of *Subsidiary Technological Diversification*. We term this Mass

Exploration, which refers to an MNE's strategic use of ioSubs to develop technologies (patents) in a diverse range of technological fields that have limited commonality with those of peer ioSubs of the same firm. This strategy reflects an expansive exploration approach by MNEs, where ioSubs utilize new technological opportunities in host locations to create a wider range of technology portfolios for the parent firm.

Since technological change is a result of simultaneous search by a population of firms conducting innovation (Stuart and Podolny, 1996), MNEs need to safeguard their technological positions (Quintana-García and Benavides-Velasco, 2008) and often address competitions in multiple technological fields (Nelson, 1959). The benefits of ioSubs in this group lie in the geographically distributed diverse search, which enables their parents to acquire knowledge and expertise from host locations systematically, e.g., through knowledge spillovers (Cantwell and Piscitello, 2002), recruiting local experts (Li et al., 2013), acquiring innovative start-ups (Chen et al, 2021), and collaboration with local entities (Un and Rodríguez, 2018). Being one of the high-risk and high-commitment options, Mass Exploration may be more prevalent among established MNEs, because of the requirement of diversifying not only in the technologic dimension but also in the geographic dimension. As MNE develop, this strategy may not, again, meet all the needs of growth because of the rapid changes in technologies and customer needs (Day and Schoemaker, 2016; Teece, 2007; Zander, 1997). In other words, exploration with limited integration alone may not build sustainable competitive advantage and this strategy is of a rather transitional nature.

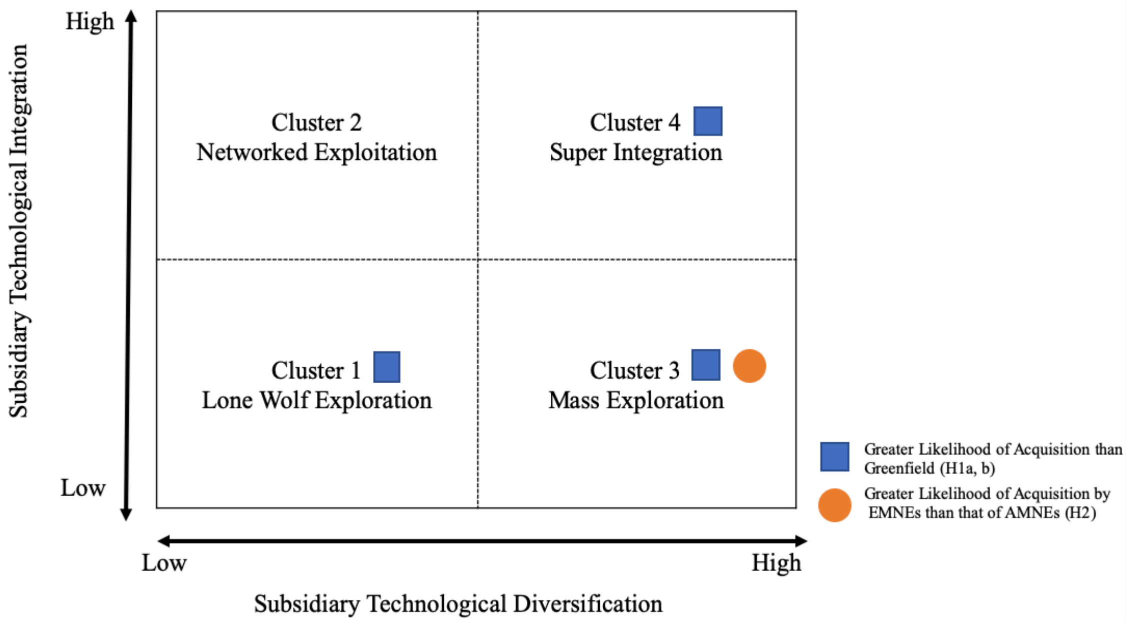
Cluster 4: Super Integration

In Cluster 4 ioSubs are comprehensive integrators, with higher degrees of both *Subsidiary Technological Integration* and *Subsidiary Technological Diversification*. We term this Super Integration, which refers to an MNE's strategic use of ioSubs to develop technologies (patents) in a diverse range of technological fields that also have strong commonality with those of peer ioSubs of the same firm. This strategy reflects an advanced combination of exploration and exploitation approaches by MNEs, where a diverse set of capabilities and technologies is accumulated through an internalisation process of MNE to exploit the outcomes of the cross-fertilization of ideas, resources, and opportunities across ioSubs of the same firm. For example, Berry (2014) showed that MNEs benefit from the collaborative and combinative knowledge generation within the MNEs through the internal multi-country inventors' collaboration.

Super Integration is particularly beneficial for harnessing subsidiary level technological diversification through strong internal coordination and control mechanisms. Technological competition has shifted towards complex technologies and bundling of multiple technologies to address customers' needs (Day and Schoemaker, 2016; Teece, 2007; Zander, 1997) and to generate new perspectives of existing technologies and its refinement (Zhou and Li, 2010). MNEs thus may face technological threats that vary from one local market to another. Extant literature shows that this is a significant challenge requiring strong integration, which may be achieved through careful orchestration of internal integration in terms of knowledge transfer (Zeng et al., 2018), incentive policies (Awate et al., 2015), balancing between subsidiary autonomy and HQ control (Kim et al., 2003), the mobility of innovation personnel (Madsen et al., 2003), competition and collaboration between subsidiaries (Berry, 2014). In other words, MNEs with ioSubs in this group possess a sophisticated bundle of geographically dispersed resources and capabilities (Zeng et al., 2018; Barlett and Ghoshal, 1989; Cantwell, 1989) that are capable of better adapting to changing environments. Super Integration thus may be more prevalent in the more advanced stage of MNE development after initial exploitation and exploration.

To summarize, the Taxonomy distinguishes four groups of ioSubs with differing degrees of technological integration and diversification. Figure 5.1 presents the Taxonomy, as well as hypothesized differences among the four groups, and further between AMNEs and EMNEs, in terms of the likelihood of certain entry modes (the status of the ioSubs as being greenfield investment or acquisition) associated with specific technological strategies. The next section articulates these hypotheses.

Figure 5.1 The Technological Integration and Diversification Taxonomy



5.4 Study 2: Using the Taxonomy to Understand Acquisition in Technological Development

5.4.1 Acquisition and MNE Technological Development

International Business theories suggest that firms develop competitive advantages, often proprietary technologies, before initiate internationalisation (Buckley and Casson, 1976; Dunning and Lundan, 2008), that essentially involves transfer of proprietary technology using overseas subsidiaries to overcome market failures (Buckley and Casson, 1976; Rugman, 1981, 1986). A prominent decision is then whether to set up a new venture (greenfield investment) or acquire equity in an existing firm (acquisition) (Barkema and Vermeulen, 1998). Greenfield investments are efficient for exploiting firm-specific advantages that are deeply embedded in the organization and labour force (Yoshida, 1987) and difficult to separate from the parent organization (Hennart and Park, 1993). Specifically, greenfield subsidiary is associated with setting a new venture from scratch, hiring and training new employees, purchasing resources they need form the external markets and gradually building linkages with local business ecosystem (Alon et al., 2020). In contrast, acquisitions enable acquiring a local firm's technologies, employees, market power, legal permission, local market knowledge, and business linkages with local organizations (Hennart, 1988). Acquisitions provide almost instant embeddedness (Kappen, 2011).

One issue with extant studies is the assumption that most firms are able to develop proprietary technologies at home in the first instance, with a potential home market for them. This may be true when home country conditions offer sufficient technological opportunities enabling the early technology development (e.g., Cantwell and Mudambi, 2005; Hennart and Park ,1993). Yet, innovative MNEs have emerged from many parts of the world where home countries are technologically inferior. The expectation that MNEs exploit home-grown proprietary technologies through internalizing resources and capabilities across borders therefore becomes inadequate. In other words, when acquired ioSubs are preferred over greenfield ioSubs for integration or diversification of parents' technology portfolios remains less understood.

MNEs with stronger exploitation orientation are less likely to prefer acquisition, which may incur higher costs of integration compared with greenfield such as the difficulties and costs of transferring firms' capabilities into the acquired firms. (Barkema and Vermeulen, 1998; Gupta et al., 2006). By contrast, MNEs with stronger orientation towards exploring new technological fields that have promising local applications are more likely to prefer acquisition, allowing rapidly taking over of bundled assets including technologies and patents (Mutinelli and Piscitello, 1998), strategic resources (Deng, 2009), globally known brands (Buckley et al., 2016), skilled innovation teams with expertise in specific technological fields (Awate et al., 2015) and local business linkages with local collaborators, suppliers, and customers (Kappen, 2011). For example, Cisco system, an American technology conglomerate specialised in high-technology services and products, has acquired Hungry-based Banzai Cloud, specifically for their complete knowledge in end-to-end cloud-native application development (Centoni, 2020; Jose, 2021).

Furthermore, acquisitions offer innovative ideas and experiences in specialist areas, and organizational innovative capabilities that would be difficult to gain from internal development or market transactions through greenfield investments (Kumar et al., 2020). Acquisitions also offer access to core and valuable technologies which is difficult to gain through greenfield investment using market transaction, because firms are generally unwilling to sell or license their core technologies in case of losing competitive advantages in the local markets (Casson and Wadeson, 2018). More importantly, acquisition induced embeddedness into a local business ecosystem will normally enable acquiring firms to be firmly embedded in the local context with a strong position in the local business linkages (Anderson et al., 2015), access to local technological knowledge spillovers through the linkages (Pu and Soh, 2017), deeply understand host markets and local customers, and subsequently enhance responsiveness to local opportunities (Kappen, 2011).

Conversely, while comparative more efficient for exploitation, for exploration purpose, greenfield is an incremental and time-consuming approach in terms of developing linkages with local organizations (Chatterjee, 1990), and facing stronger liability of foreignness (Zaheer, 1995), incurring higher costs of operating in a foreign market (Madhok, 1997), e.g., excessive costs of using the external markets to find and negotiate with appropriate partners and employees (Williamson, 1985) and costs of developing collaborative local ties (Zaheer and Mosakowski, 1997).

5.4.2 The Likelihood of Acquisition in Four Clusters of ioSubs

According to the Taxonomy, as focused and autonomous innovators, ioSubs in Lone Wolf Exploration Cluster are likely to be less embedded within parent MNEs in terms of technological development than in their host locations. Being an overseas explorative unit, their strategic values lie in meeting the need of parents to augment resources and capabilities which could not be realized in parents' home countries. Instant embeddedness through acquisitions therefore is more likely to give rise to ioSubs in this cluster, because of the bundle of resources and capabilities that can be used for search within the host environment.

Accordingly, as pluralists, ioSubs in Mass Exploration Cluster are likely to be also less embedded within parent MNEs in terms of technological development than in their host locations. While technological changes drive firms to innovate beyond their existing technological domains (Teece, 2014; Zander, 1997), firms conducting exploration in large scale will more likely avoid options requiring lengthy setup time and generating technologies that do not immediately have commercial potential for identifiable markets. Acquisitions offers better responsiveness to acquired firms' existing markets, and hence are more likely to give rise to ioSubs in this cluster.

Turning to ioSubs in Networked Exploitation Cluster, as specialists, these units with highly exploitable technologies provide parents the advantage to employ technological assets simultaneously across geographic markets. The networked nature of these units' technology portfolios increases risks of appropriation by external organizations when transfer process is not carefully managed and monitored. Subsequently, greenfield with the benefits of enhancing efficiencies (Meyer et al., 2009) and facilitating transfer of core resources and capabilities across borders (Blomkvist et al., 2014; Teece, 2014) is more likely to give rise to ioSubs in this cluster. By contrast, acquisition involves integration processes that are likely to be lengthy, uncertain, and costly (Hennart and Park, 1993). In some cases, knowledge transfer between acquired firms and the rest of the MNE becomes unproductive because of trust issues (Awate et al., 2015; Tian et al., 2021), resulting in difficulties of developing linkages between the acquired firms and other geographically dispersed ioSubs (Kim et al., 2003; Zeng et al., 2018). In other words, likelihood of acquisition is smaller in the Networked Exploitation Cluster.

The fourth cluster in the Taxonomy is Super Integration, where ioSubs explore as well exploit technologically as comprehensive innovators. Because of the requirements of both diversified and integrated technology portfolios, ioSubs in this cluster are more likely to be present in a developed stage of MNEs. For MNEs pursuing systematic technological integration, both greenfield and acquisition will likely to be viable options, with each offering advantages to increase embeddedness, responsiveness and efficiency through coordination with peer ioSubs of the same firm. As MNEs and their ioSubs possess idiosyncratic resources and capabilities, the conditions under which acquisition is preferred over greenfield or vice versa will likely to be determined by how an MNE's technological positions have been shaped by such idiosyncrasy prior a decision for a new ioSub. In other words, the likelihood of acquisition in the Super Integration cluster can be either greater or smaller.

Following the above reasoning, we therefore expect that the likelihood of acquisition is greater in the clusters 1 and 3 than in cluster 2, while competing expectations exist for cluster 4. We propose the following hypotheses:

> ***Hypothesis 1a:*** *The likelihood of acquisition by MNEs is greater for ioSubs in the Lone Wolf Exploration and Mass Exploration clusters than for those in the Networked Exploitation and Super Integration clusters.*

> ***Hypothesis 1b:*** *The likelihood of acquisition by MNEs is greater for ioSubs in the Lone Wolf Exploration, Mass Exploration, and Super Integration clusters than for those in the Networked Exploitation cluster.*

5.4.3 The Likelihood of Acquisition by EMNEs

The above reasoning suggests acquisition is prevalent by MNEs when their ioSubs are in the Mass Exploration cluster conducting exploration in large scale. However, limited literature explores the influence of home country environment on the likelihood of acquisitions by MNEs, when their ioSubs are used to diversify their technology portfolios. The transaction cost theory suggests that the comparative costs of conducting greenfield investment as opposed to acquisition depend on home country environment, which can differ significantly as in the case of advanced vis-à-vis emerging markets, and parent firm-specific characteristics. This framework is useful for examining the differences between EMNEs and AMNEs in the likelihood of using acquisition to set up ioSubs described in the Mass Exploration cluster.

Firms that internationalize possess a unique set of advantages grounded in home country environments (Jackson and Deeg, 2008) and these advantages can be exploited to mitigate the barriers of operating in foreign markets using greenfield investments, and conversely a lack of these advantages may lead to higher likelihood of acquisition. When a home country is more integrated with global economy, it may develop greater trade and investment linkages with other countries, resulting in better coordinated cross-border mechanisms (e.g., coordinated macroeconomic policies, international cooperation groups and associations) (Gao, 2005). These linkages between the home and other countries promote market information exchanges across borders, facilitate the firms' understanding of the foreign markets (Buckley and Pearce, 1979), which in term lower the likelihood of acquisition and make greenfield comparatively more cost effective. Additionally, these coordinated mechanisms allow firms to rapidly and effectively develop collaborative relationships with overseas business ecosystems (Buckley et al., 2012). Compared with advanced markets that have had a long history of integration with global economy, emerging markets have started their integration only during recent decades (Kumaraswamy et al., 2012; Zhao and Hsu, 2007) and have therefore limited time to develop linkages and coordinated cross-border mechanisms at a scale that advanced markets have achieved. Summarizing, the above differences in home country conditions lead to comparatively lower costs of using greenfield to expansively explore and utilize new technological opportunities in host locations for AMNEs compared with EMNEs because their home country conditions allow them to understand the local markets, develop business linkages with local organizations and form collaborative relationships with local firms or universities with lower costs.

The literature on overseas acquisition by EMNEs cohobates these home country differences and their impact on firms. Specifically, the strategic intent perspective suggests that overseas acquisition has been used by EMNEs to achieve specific goals, including acquiring strategic assets, to compensate for their competitive disadvantages, to exploit their competitive advantages on non-technological fronts, to utilize institutional incentives and avoid institutional constraints (Rui and Yip, 2008; Elia and Santangelo, 2017). The springboard internationalization perspective suggests that EMNEs are motived to seek strategic assets from the onset of their outward direct investment, and acquisition provides speedy access to the resources embedded in the host countries that would be difficult to obtain from internal development or market transactions (Kumar et al., 2020; Luo and Tung, 2007). The strategic entrepreneurship perspective suggests that EMNEs utilize overseas acquisitions to overcome the "liability of emergingness" (LOE) - additional disadvantages suffered by EMNEs because of their origins from emerging economies (Madhok and Keyhani, 2012).

Empirical evidence further sheds light on the extent to which home country conditions have been shaping EMNEs' overseas acquisitions with an expansive exploration approach. For example, acquisitions are found to enable EMNEs to gain access to industry's state-of-the-art technologies which had been difficult to access through greenfield investment using market transactions (Casson and Wadeson, 2018). EMNEs have been found to be technological laggards proactively trying to catch-up but gaining access to valuable industry specific technologies proved to be challenging (Awate et al., 2015). Specifically, AMNEs were found often unwilling to export their technologies despite of strong demand from EMNE buyers and their potential application in emerging markets (Berry, 2017). Subsequently, EMNEs have resorted to gain access to the key technologies through acquiring the whole foreign firm (Kedia et al., 2012). Chinese firms with an "less than world class" image in the advanced markets have been found to overcome liability of emergingness by acquiring local advanced firms (Madhok and Keyhani, 2012).

Parent firm-specific characteristics, specifically capabilities and internationalization experiences (e.g., Barkema and Vermeulen, 1998; Hennart and Park, 1993), may also influence the comparative costs of acquisition vis-à-vis greenfield. First, parent MNEs with richer internationalization experiences and greater capabilities are more likely to have accumulated the requisite knowledge for establishing new ventures from scratch and further seizing new technological opportunities in the foreign markets (Hennart and Park, 1993), e.g., increased ease with building linkages with local firms or universities in the foreign markets to benefit from local knowledge spillovers (Al-Laham and Souitaris, 2008), more efficient interactions with local organisations and customers to better understand the local markets (Slangen and Hennart, 2007), and more efficient process to select and negotiate with appropriate local partners and skilled employees to benefit from their resources, knowledge and capabilities (Hennart and Park, 1993). These advantages reduce the comparative costs of greenfield, which, in average circumstances, would be much harder and take much longer time to nurture such linkages and interactions. Furthermore, more experienced and capable parent firms are more likely to secure high-quality resources and capabilities abroad, again reducing the comparative costs of greenfield vis-à-vis acquisition. Such firms may have stronger ability to identify valuable resources and capabilities embodied in local organisations and engineers because of their experience and fine-tuned routines, and access to informal networks within the industry or technological domains (Collis, 1994). For example, the firm's current larger pool of employee competencies will help them to hire local engineers in the foreign markets with the desired skills and knowledge (Minbaeva et al., 2003). AMNEs are often considered "mature MNEs" with a longer history of international expansion, and they have been found to accumulate extensive internationalization experiences and capabilities (Dunning, 1993). Comparatively, EMNEs are seen as "infant MNEs" with often limited internationalization experiences and capabilities (Cuervo-Cazurra, 2012; Ramamurti, 2012). These parent firm level differences suggest that the comparative costs of greenfield vis-à-vis acquisition are higher for EMNEs but lower for AMNEs since capabilities and experiences take time to accumulate.

Drawing from the above reasoning, because of differences in home country environments and parent firm specific characteristics, the likelihood of acquisition to give rise to EMNE ioSubs in Mass Exploration cluster is greater than that of AMNE ioSubs. While there is relatively rich empirical evidence of successful technological integration and diversification in AMNEs ioSubs (e.g., Cantwell and Mudambi, 2005; Awate et al., 2015), we have limited evidence from EMNEs ioSubs, with existing evidence pointing to their struggle to catch up after acquisition despite serious attempts of integration (Awate et al., 2015). Based on existing literature, we expect that the likelihood of acquisition by EMNEs to be greater than that of AMNEs in Mass Exploration cluster. We propose the following hypothesis:

> ***Hypothesis 2:*** *The likelihood of acquisition by EMNEs is greater than that of AMNEs for ioSubs in Mass Exploration cluster.*

5.5 Methodology

5.5.1 Sample and Data

In order to develop the Taxonomy to provide a better understanding of technological integration and diversification of a wide range of firms, we have chosen to focus on ioSubs owned by MNEs from two large emerging markets (China and India) and four advanced markets (France, Germany, Italy and US) during 2006 and 2014. We chose Chinese and Indian MNEs for a number of reasons: (1) their home countries have remarkable economic and technological growth in recent decades (OECD, 2020; GII, 2020), and are some of the worlds' largest markets for application of technologies, (2) their outward investments have been carried out by significant portfolios of subsidiaries (UNCTAD, 2005; WIR, 2014), (3) evidence of increasing overseas acquisitions by these MNEs (Awate et al., 2015; Deloitte, 2017), (4) evidence of their distributed overseas R&D activities and patenting (Awate et al., 2015; WIPO, 2016), (5) significant differences in their home country legal systems with China following civil law and India common law, and (6) an increasing body of literature on investment and entry mode choices of firms from these two countries (Alon et al., 2020; Elia et al., 2020; Li et al., 2017), enabling a better comparison between this study and the current knowledge. Accordingly, our choice of subsidiaries owned by MNEs from Western European countries and the US is also motivated by several important reasons: (1) these home countries are top ranked in terms of global innovation (GII, 2020) and world intellectual property outputs (WIPO, 2016), and have given rise to many successfully established MNEs, (2) these home countries represent a combination of different legal systems, with France, Germany and Italy following civil law and US common law, and (3) these MNEs are important players in overseas acquisitions (Cantwell and Mudambi, 2005; Demirbag et al., 2008).

Subsidiary research involving cross-country comparison faces the challenge of lack of comparable data. We chose Orbis Bureau van Dijk database because it holds firm data of various countries, for a period of up to 10 years, and reports the ownership relations between firms. We first selected subsidiaries that have a global ultimate owner (GUO; that directly or indirectly controls 50% or more of the subsidiary) located in the above six countries, and then used them to identify GUOs, i.e., parent MNEs. Subsequently, we have identified 48,020 subsidiaries belonging to 17,909 MNEs, including 4,387 subsidiaries owned by 3,005 EMNEs and 43,633 subsidiaries owned by 14,904 AMNEs. We then excluded those GUOs with less than 50 employees, those with only one overseas subsidiary, and those with only unconsolidated data. We subsequently used this refined list of GUOs to obtain MNE level data and their majority owned (50% or more directly or indirectly controlled) subsidiaries.

Since the Taxonomy relies on description of technology portfolios of selected ioSubs and their establishment history, we next excluded subsidiaries that do not hold any patents. Subsequently, we have selected 466 overseas subsidiaries belonging to 146 MNEs, including 105 overseas subsidiaries owned by 31 EMNEs and 361 overseas subsidiaries owned by 115 AMNEs. Afterwards, using the refined list of ioSubs, we collected subsidiary-level data (financials, R&D and locations) from Orbis, subsidiary specific M&A data from Zephyr, and data of individual patents owned by the subsidiaries from Orbis Intellectual property (Orbis IP). For each ioSub, Orbis IP provides data on the firm' patent portfolios in all patent offices (including national Patent Office, USPTO, PCT and EPO). We then collected data from each patent document for information of applicant firms, inventors, and patent class. To identify acquisition, we used Zephyr to first obtain data on acquisition transactions of each MNE, and then selected its completed transactions before or during the examined time period. For these transactions, we then identified acquired firms' names and identifiers that are eventually matched with the list of sampled ioSubs. Our models also include home and host country specific variables, for which the data sources, together with the above databases details, are reported in Table 5.1.

Excluding missing observations, our full sample is a balanced panel data of 143 ioSubs (90 of AMNEs and 53 of EMNEs), distributed across 18 host countries (discussed later in Figure 4). It is worth noting that while the most targeted host locations are advanced markets, our sample also captures ioSubs distributed in emerging markets (e.g., Brazil, India).

Table 5.1 Sources of data

Variables	Data Sources
Acquisition	Zephyr database
Subsidiary Technological Diversification	Orbis IP database
Subsidiary Technological Integration	Orbis IP database
MNE R&D Stock	Orbis BvD database
MNE Degree of Internationalization	Orbis BvD database
MNE Size	Orbis BvD database
Subsidiary Location Rank	Orbis BvD database, OECD REGPAT database
Subsidiary Age	Orbis BvD database
Subsidiary Size	Orbis BvD database
Host Country Domestic Technology Intensity	World Development Indicators
Host Country Openness to IFDI	World Bank
Culture Distance	Kogut and Singh (1988) index applied to Hofstede (2001) items
IPR Distance	Global Information Technology Report
Headquarter Provincial Government Expenditure on R&D	Regional statistical data of various countries
Home Country IFDI	OECD statistics

5.5.2 Measures

5.5.2.1 Subsidiary Technological Integration and Diversification

The two key constructs of the Taxonomy are operationalized using information from each ioSub's patent portfolio. Subsidiary Technological Integration is measured by the degree of patent class overlap between subsidiary i and peer subsidiaries of the same MNE:

$$A_i = \frac{\left(\sum_{j=1}^{K}\left[\frac{Q_{ji}}{Q_i}\right]\right)}{K} \tag{1}$$

where A_i is Subsidiary Technological Integration for subsidiary i; K is the total number of peer subsidiaries one subsidiary i has in the same MNE during the examined period; j is a given peer subsidiary; Q_{ji} is the number of shared 3-digit IPC classes of subsidiary i with peer subsidiary j; Q_i is the total number of 3-digit IPC classes in which subsidiary i owns patents during the examined period.

Subsidiary Technological Diversification is measured by the inverse of a Hirschman-Herfindahl index that reflects the degree of concentration of 3-digit IPC classes in an ioSub's technology portfolio during the examined period (Zhang et al., 2010):

$$E_i = 1 - \sum_{r=1}^{N} \left[\frac{L_{ri}}{L_i}\right]^2 \tag{2}$$

where E_i is Subsidiary Technological Diversification for subsidiary i; N is the total number of 3-digit IPC classes in which subsidiary i owns patents; r is a given 3-digit IPC class; L_{ri} is the number of patents subsidiary i owns in IPC class r; L_i is the total number of patents the subsidiary i owns during the examined period.

5.5.2.2 Dependent variable

Acquisition is a dummy variable that takes the value of 1 for acquisition and 0 for greenfield investment. As discussed in the previous section, an ioSub's status as an acquired firm is confirmed if the subsidiary's name appears in the list of completed deals by its parent MNE during the examined period.

5.5.2.3 Independent variable

Following the development of the Taxonomy, each ioSubs are categorized to a certain cluster. The focal independent variables are therefore cluster-specific dummy variables taking the value of 1 if an ioSub is in a specific cluster, and 0 otherwise.

5.5.2.4 Control variables

We control for a number of MNE-level variables that may influence the likelihood of acquisition. As greenfield investment is more efficient than acquisition for larger MNEs because of their greater resources to operate in the foreign environment (Kogut and Singh, 1988; Demirbag et al., 2008), we control for MNE size, measured as a dummy variable taking the value of 1 if the parent MNE sales is larger than the median sales of the sampled MNEs for each examined year. MNE Degree of Internationalization reflects parent firms' internationalization experiences and capabilities, which, as discussed earlier, reduces the comparative costs of greenfield vis-à-vis acquisition (Caves and Mehra, 1986; Alon et al., 2020). We measure this variable using the number of overseas subsidiaries owned by parent MNE. MNE R&D stock reflects firms' technological capabilities, greater of which facilitates the exploitation of organization-based technologies in new ventures (Brouthers and Brouthers, 2000; Hennart and Park, 1993). MNE R&D stock is operationalized using the perpetual inventory method (PIM) (Kafouros et al., 2012) based on annual MNE R&D expenditure.

To account for location advantages of host countries that may influence acquisition choice (Brouthers and Brouthers, 2000; Demirbag et al., 2008), we included a number of host country-specific variables. Host Country Domestic Technology Intensity, the ratio of host country annual R&D expenditure over its GDP, captures host country technological resources that may motivate MNE's technology acquisition (Anand and Delios, 2002). Host Country Openness to Inward Foreign Direct Investment (IFDI), the ratio of annual host country IFDI stock over its GDP, may reduce likelihood of acquisition but increase greenfield investments because of lower barriers for foreign firms' entry to more opened host market (Dikova and Brouthers, 2016; Kafouros and Wang, 2015).

Culture Distance refers to the difference in culture between the host country of a subsidiary and its parent home country, a determinant of MNE entry mode choice (Tihanyi et al., 2005). Longer culture distance may increase likelihood of acquisition because of the risks and costs of managing cross-cultural linkages (Brouthers and Brouthers, 2000). Culture Distance is operationalised using the four dimensions (power distance, uncertainty avoidance, masculinity/femininity and individuality) of Hofstede (2001). Specifically, the distance (B_{mli}) between ioSub i's host country l and parent home country m is calculated as:

$$B_{mli} = \frac{\sum_{q=1}^{4} \left\{ \frac{\left(I_{qmi} - I_{qli}\right)^2}{V_q} \right\}}{4} \tag{3}$$

where I_{qm} is the culture store for the qth dimension of country m and V_q is the variance of the index of the qth dimension.

Host Country IPR Distance refers to the differences in intellectual property regime (IPR) between the host country and the parent home country of the subsidiary. It is calculated as the ratio of host country IPR score over home country IPR score from Global Information Technology Report. Greater IPR distance may increase likelihood of acquisition because of the risks and costs of managing business, innovating, acquiring and generating patents within an unfamiliar IPR environment (Oxley, 1999; Zhao, 2006).

We further included subsidiary-level controls. Awate et al. (2015) reported that an EMNE aiming to catch-up with the rival AMNE tends to focus on strategic locations to gain competitiveness of the country in certain technology area. We hence controlled for Subsidiary Location Rank of the host country in the specific 3-digits IPC class. We firstly calculated the rank of each country in a specific 3-digit IPC class using a count of all patents of this country filed under Patent Co-operation Treaty (PCT) from OECD REGPAT database. Specifically, we built the technological rank of 215 countries in 103 technological fields. Next, we identified the primary technological field of the subsidiary by examining individual subsidiary patents to find the most targeted 3-digit IPC class by the ioSub. In other words, a subsidiary's primary technological field is the 3-digit IPC in which the subsidiary owns the largest proportion of its patents during the examined period. Finally, we matched the ioSub's location and its primary technological field with the country's rank in a specific technological field.

Subsidiary size, measured by subsidiary total assets in a given year, reflects the size of parent's investment and may influence the likelihood of acquisition (Brouthers and Brouthers, 2000; Caves and Mehra, 1986). As subsidiaries with longer business histories are more likely to be targeted for acquisition, we controlled for Subsidiary Age, measured by the difference between the observation year and the recorded year of establishment of the ioSub. We further controlled for the time and industry effects using a set of year and 2-digit industry dummies.

5.6 Analysis and Results of Study 1

Our exploratory analysis was carried out in two steps. We first conducted a nonparametric analysis to examine the distribution of *Subsidiary Technological Integration* and *Subsidiary Technological Diversification* for all ioSubs of EMNEs and AMNEs, respectively. In order to achieve that, we collected data of patents for each ioSub during the period 2006-2014, and calculated, for each ioSub, the two key constructs using all patents owned by the unit through the examined time duration. Although measures of the two key constructs may show variations over time, we consider that MNEs' technological strategies as reflected by in the technology portfolios of subsidiaries in the two dimensions are not fickle, and accordingly we used cross-sectional subsidiary-level measures. The Kernel density plots of ioSubs' *Subsidiary Technological Integration* and *Subsidiary Technological Diversification* reported in Figures 5.2 and 5.3, respectively, show that there are visibly differing trajectories for EMNE and AMNE lines in each figure. Specifically, in Figure 5.2, *Subsidiary Technological Integration* density first increases, reaching the peak of 0.34 (AMNE ioSubs) and 0.49 (EMNE ioSubs), and decreases. For the decreasing part, both AMNE and EMNE density lines appear to have momentarily slowed down at the point of 0.76 (AMNE ioSubs) and 0.8 (EMNE ioSubs), before decreasing again rapidly. In Figure 5.3, *Subsidiary Technological Diversification* visually increased first, reaching the first peak at 0.11 (AMNE ioSubs) and 0.20 (EMNE ioSubs), before decreasing. At 0.22 (AMNE ioSubs) and 0.30 (EMNE ioSubs) both density lines start to increase, reaching the second peak of 0.68 (AMNE ioSubs) and 0.75 (EMNE ioSubs), before decreasing once again. Patterns from both figures point to 4 possible trajectories in each dimension, suggesting that there are four possible groups of ioSubs across the range of MNEs under investigation.

Figure 5.2 Distribution of Subsidiary Technological Integration

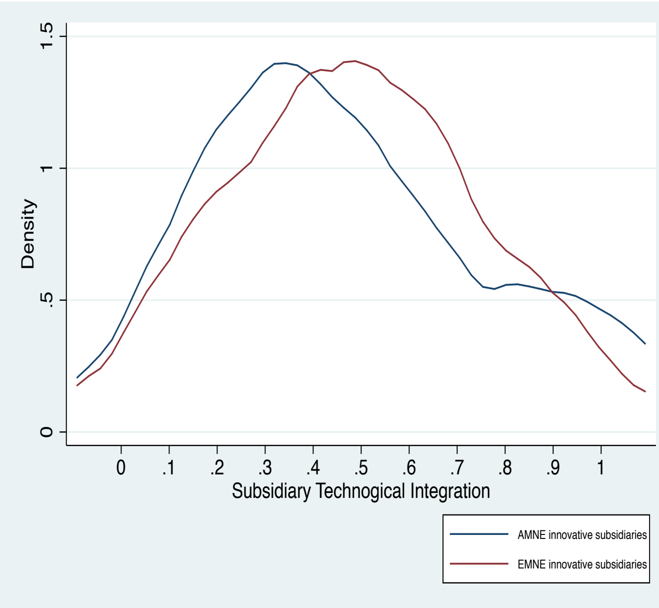
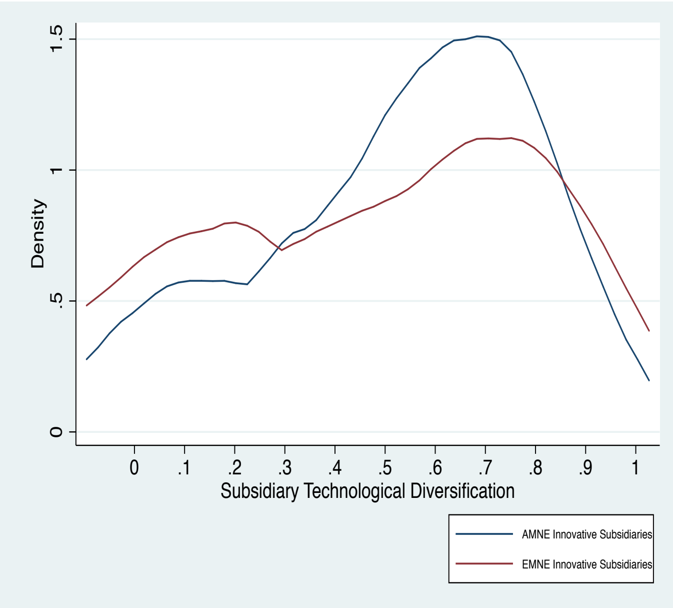


Figure 5.3 Distribution of Subsidiary Technological Diversification



To develop the Taxonomy, we next used the two key constructs - *Subsidiary Technological Integration* and *Subsidiary Technological Diversification* – to form groupings of ioSubs in cluster analysis. We used a k-means clustering technique to minimize the within-cluster variances (using squared Euclidian distances) to establish the cluster solutions (MacQueen, 1967). This is achieved using the software, Stata, and its cluster kmeans command. Incorporating the descriptive analysis above, we have decided on a four-cluster solution. To confirm the validity of the outcome, we used discriminant analysis, which shows that, of the ioSubs classified by the cluster analysis, the discriminant functions correctly predicted 100% of the membership of Cluster 1, and 94% of Cluster 2, 100% of Cluster 3, and 100% of Cluster 4. These results show that there is reasonable discrimination in the four clusters (Hair et al. 1992). A further test of the validity of the outcome is provided in order to examine the industry-specific effects. We used a Chi-square analysis, which shows that there is no significant variation in the proportion of industries (chi-square: 41.998, df: 39, p=0.383) across clusters classified by the cluster analysis.

Cluster differences on each construct were assessed via a multivariate analysis of variance. Results in Table 5.2 show that, in terms of *Subsidiary Technological Integration,* Cluster 4 has greater degree of integration than Clusters 1 and 3, and Cluster 2 greater than Clusters 1 and 2. In terms of *Subsidiary Technological Diversification*, results in Table 5.1 show that Cluster 4 has significantly ($p<0.001$) greater degree of diversification than Clusters 1 and 2, and Cluster 3 greater than Clusters 1 and 2. Overall, Cluster 4 has a significantly ($p<0.001$) higher degree of both *Subsidiary Technological Integration* and *Subsidiary Technological Diversification*, while Cluster 1 has a significantly ($p<0.001$) lower degree of both constructs. Cluster 2 has significantly ($p<0.001$) greater *Subsidiary Technological Integration* but lower *Subsidiary Technological Diversification*, while Cluster 3 has significantly ($p<0.05$) greater *Subsidiary Technological Diversification* but lower *Subsidiary Technological Integration*. In order to check if the clusters remain stable when we examine EMNE ioSubs and AMNE ioSubs, respectively, we conducted further ANOVA tests using the sub-samples. The results in Table 5.2 confirm the validity of the four clusters for sub-samples. Specifically, Table 5.2 results show significant differences on two key constructs for each of the sample subsamples, following the same pattern as the full sample ioSubs results.

Table 5.2 Means and F values for four clusters of ioSubs

	Variables	**Cluster 1**	**Cluster 2**	**Cluster 3**	**Cluster 4**	**F value**	**Significant difference**
All ioSubs	**Number of Subsidiaries**	41	16	31	55		
	Subsidiary Technological Integration	0.34	0.92 (High)	0.30	0.72 (High)	111.36***	Cluster4>Cluster1, Cluster4>Cluster3, Cluster2>Cluster1, Cluster2>Cluster3
	Subsidiary Technological Diversification	0.25	0.10	0.64 (High)	0.93 (High)	148.63***	Cluster4>Cluster1, Cluster4>Cluster2, Cluster3>Cluster1, Cluster3>Cluster2
AMNE ioSubs	**Number of Subsidiaries**	21	11	18	40		
	Subsidiary Technological Integration	0.32	0.95 (High)	0.29	0.72 (High)	80.97***	Cluster4>Cluster1, Cluster4>Cluster3, Cluster2>Cluster1, Cluster2>Cluster3
	Subsidiary Technological Diversification	0.26	0.14	0.60 (High)	0.72 (High)	85.96***	Cluster4>Cluster1, Cluster4>Cluster2, Cluster3>Cluster1, Cluster3>Cluster2
EMNE ioSubs	**Number of Subsidiaries**	20	5	13	15		

Subsidiary Technological Integration	0.36	0.86 (High)	0.30	0.72 (High)	30.19***	Cluster4>Cluster1, Cluster4>Cluster3, Cluster2>Cluster1, Cluster2>Cluster3
Subsidiary Technological Diversification	0.23	0.02	0.71 (High)	0.76 (High)	68.11***	Cluster4>Cluster1, Cluster4>Cluster2, Cluster3>Cluster1, Cluster3>Cluster2

Significance of differences between variables: ***p<0.001, **p<0.01, *p<0.05.

5.7 Analysis and Results of Study 2

Given the dichotomous nature of our dependent variable, Acquisition, we used Probit regression analysis for hypothesis testing. This approach is widely used in recent studies estimating MNE entry mode choice between greenfield and acquisition (Chen et al., 2017; Demirbag et al., 2008). Because of the presence of negative values, we used the inverse hyperbolic sine transformation which is interpreted in the same way as a standard logarithmic transformation (Di Cintio et al., 2017) to transform all the variables except dummies before entering them into the model.

5.7.1 Descriptive Analysis

Our overall sample is composed of 39 (27.3%) acquired subsidiaries and 104 (72.7%) greenfield subsidiaries which is consistent with the proportion of acquisitions in the existing studies of MNE establishment mode strategy (e.g., Chen et al., 2017). In our sample, EMNEs report slightly higher likelihood of acquisition (32.1%) than AMNEs (24.4%). The overall pattern suggests that more overseas acquisitions have been done by EMNEs than by AMNEs.

Table 5.3 contains the descriptive statistics for all variables used in Study 1 and Study 2, for the full sample of ioSubs, and the sub-samples of EMNE ioSubs and AMNE ioSubs, respectively. Both subsamples seem to have similar average degrees of Subsidiary Technological Integration and Subsidiary Technological Diversification. The cluster-specific dummy variables show that EMNE ioSubs seem to be more prevalent in Cluster 1 Lone Wolf Exploration, Cluster 2 Networked Exploitation, and Cluster 3 Mass Exploration, compared with AMNE ioSubs. The Acquisition variable also seems to have a mean greater for EMNE ioSubs than for AMNE ioSubs. A sub-sample breakdown of the descriptive of Acquisition, reported in Table 5.4, shows that on average there are a greater number of acquired ioSubs by EMNEs than by AMNEs, and there are variations across four clusters of the Taxonomy.

From Table 5.3 we can also see that the mean of Subsidiary Location Rank is greater for EMNE ioSubs than for AMNE ioSubs. To take a detailed look at ioSub locations, Figure

5.4 shows that our sampled ioSubs are distributed widely, across 18 countries including advanced and emerging markets. Figure 5.5 shows the kernel distribution of the Subsidiary Location Rank variable for the two subsamples. While both subsamples follow similar pattern, EMNE ioSubs seem to distribute towards more of the top 25 locations, AMNE ioSubs seem to be distributed more widely across locations of various ranks. Table 5.5 reports correlation matrix of all variables concerned in our analysis.

Figure 5.4 Distribution of sampled ioSubs across host countries

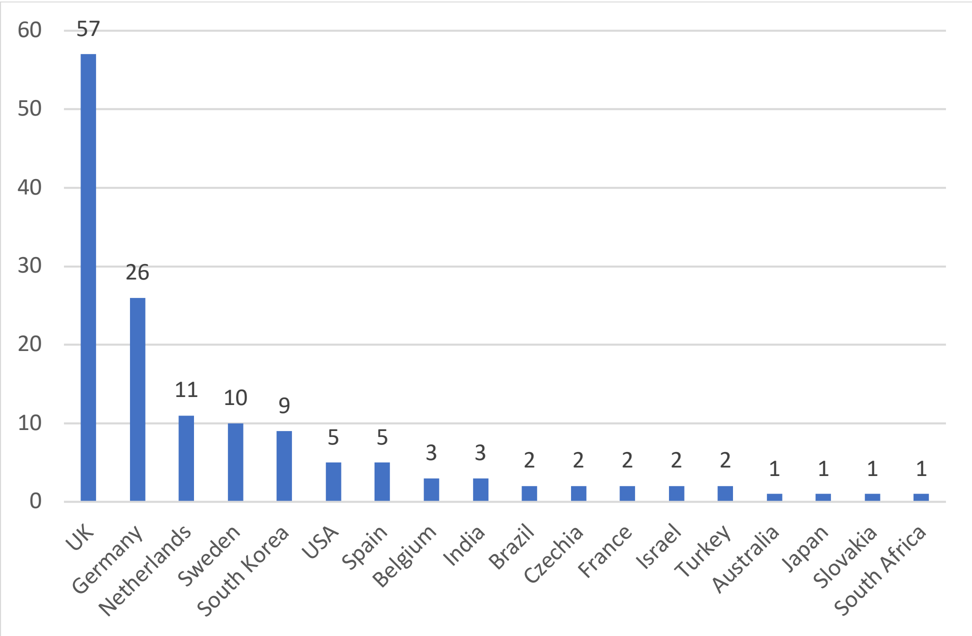


Figure 5.5 Distribution of the location rank of the host countries of ioSubs

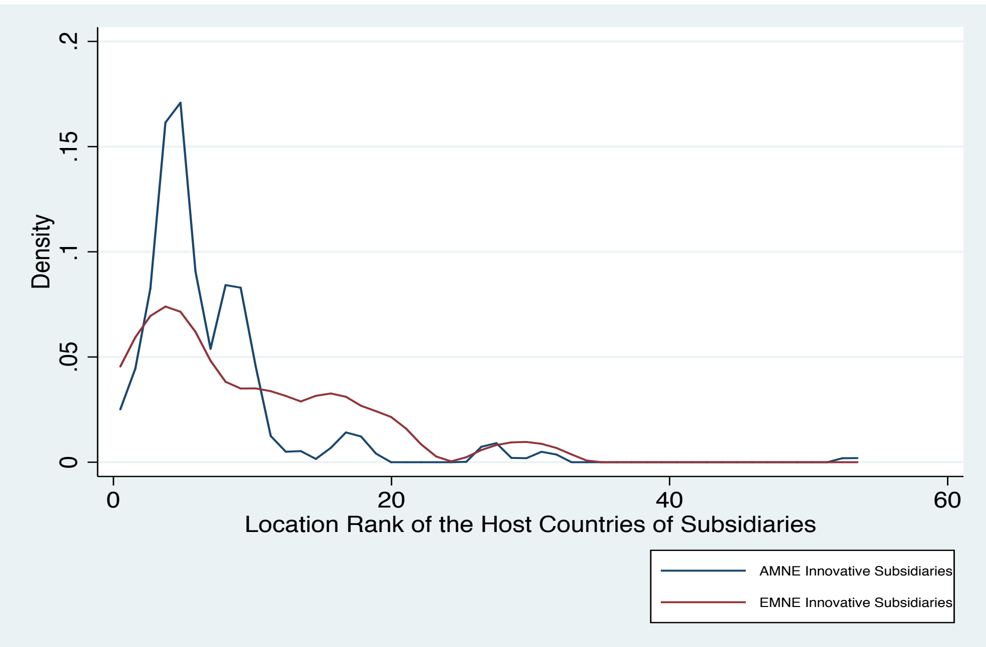


Table 5.3 Descriptive statistics

	All ioSubs		EMNE ioSubs		AMNE ioSubs	
	Mean	SD	Mean	SD	Mean	SD
Acquisition	0.273	0.446	0.328	0.470	0.255	0.436
Subsidiary Technological Diversification	0.456	0.266	0.492	0.263	0.442	0.272
Subsidiary Technological Diversification	0.510	0.288	0.477	0.314	0.519	0.268
Cluster 1 Lone Wolf Exploration	0.304	0.460	0.380	0.486	0.266	0.442
Cluster 2 Networked Exploitation	0.087	0.281	0.099	0.299	0.097	0.296
Cluster 3 Mass Exploration	0.215	0.411	0.278	0.449	0.185	0.389
Cluster 4 Super Integration	0.394	0.489	0.242	0.429	0.452	0.498
MNE R&D Stock	2,130,003	4,710,205	132,482.5	234,954.5	3,376,071	5,809,150
MNE's Degree of Internationalization	39.726	47.744	11.928	13.577	58.308	54.804
MNE Size	17,400,000	24,000,000	7,387,178	10,800,000	24,600,000	28,800,000
Subsidiary Location Rank	7.994	6.892	9.482	7.333	7.032	6.467
Subsidiary Age	31.444	27.934	28.868	30.831	34.387	27.016
Subsidiary Size	1,408,119	6,755,628	1,726,584	4,407,606	1,447,303	8,468,366
Host Country Domestic Technology Intensity	2.145	0.774	2.085	0.714	2.139	0.799
Host Country Openness to IFDI	0.439	0.257	0.510	0.353	0.392	0.165
Culture Distance	1.457	1.135	2.166	0.818	0.977	1.077
IPR Distance	1.188	0.278	1.444	0.236	1.021	0.138
Headquarter Provincial Government Expenditure for R&D	0.005	0.007	0.008	0.009	0.002	0.003
Home Country IFDI	0.017	0.008	0.024	0.009	0.013	0.004
Number of Observations	1051	1051	363	363	568	568

Note: the values are the original form of variables.

Table 5.4 Distribution of sampled ioSubs across four clusters by acquisition

	Full sample			AMNEs			EMNEs		
	Number of ioSubs	Ratio of ioSubs in each cluster over total number of ioSubs	Ratio of acquired ioSubs	Number of ioSubs	Ratio of ioSubsin each cluster over total number of ioSubs	Ratio of acquired ioSubs	Number of ioSubs	Ratio of ioSubs in each cluster over total number of ioSubs	Ratio of acquired ioSubs
Cluster 1 Lone Wolf Exploration	41	0.29	0.34	21	0.23	0.29	20	0.38	0.40
Cluster 2 Networked Exploitation	16	0.11	0.19	11	0.12	0.18	5	0.09	0.20
Cluster 3 Mass Exploration	31	0.22	0.35	18	0.20	0.33	13	0.25	0.38
Cluster 4 Super Integration	55	0.38	0.20	40	0.44	0.20	15	0.28	0.20
Total	143	1.00	0.27	90	1.00	0.24	53	1.00	0.32

Table 5.5 Correlation matrix

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Acquisition	1.00																	
2	Subsidiary Technological Diversification	-0.11***	1.00																
3	Subsidiary Technological Diversification	0.04	-0.11***	1.00															
4	Cluster 1 Lone Wolf Exploration	0.09**	-0.62***	-0.28***	1.00														
5	Cluster 2 Networked Exploitation	-0.07*	-0.47***	0.50***	-0.20***	1.00													
6	Cluster 3 Mass Exploration	0.12***	0.26***	0.53***	-0.35***	-0.16***	1.00												
7	Cluster 4 Super Integration	-0.14***	0.64***	-0.48***	-0.53***	-0.25***	-0.42***	1.00											
8	MNE R&D Stock	-0.01	0.14***	-0.04	-0.08**	-0.08**	-0.04	0.16***	1.00										
9	MNE’s Degree of Internationalization	-0.09**	0.16***	-0.20***	-0.03	-0.21***	-0.19***	0.31***	0.45***	1.00									
10	MNE Size	-0.08**	0.25***	-0.07*	-0.08*	-0.19***	-0.02	0.21***	0.49***	0.72***	1.00								
11	Subsidiary Location Rank	-0.03	-0.23***	0.09**	0.13***	0.12***	-0.03	-0.17***	-0.04	0.04	0.10**	1.00							
12	Subsidiary Age	0.15***	0.02	-0.15***	0.05	-0.12***	-0.17***	0.16***	0.20***	0.30***	0.21***	0.12***	1.00						
13	Subsidiary Size	-0.02	0.36***	-0.17***	-0.20***	-0.16***	-0.01	0.29***	0.12***	0.24***	0.40***	0.02	0.07*	1.00					
14	Host Country Domestic Technology Intensity	0.05	0.04	-0.14***	-0.03	-0.16***	-0.01	0.12***	0.05	0.08*	0.02	-0.43***	0.04	-0.15***	1.00				
15	Host Country Openness to IFDI	-0.08**	-0.20***	-0.01	0.25***	-0.06*	-0.19***	-0.04	-0.10***	-0.05	-0.08*	0.40***	0.14***	0.01	-0.22***	1.00			
16	Culture Distance	0.06*	-0.05	-0.02	0.10**	-0.06	0.03	-0.08**	-0.29***	-0.10**	0.04	0.19***	0.03	0.06	0.32***	0.16***	1.00		
17	IPR Distance	0.02	0.04	-0.00	0.11***	-0.11***	0.00	-0.04	-0.53***	-0.46***	-0.32***	-0.17***	-0.14***	0.08**	0.03	0.33***	0.29***	1.00	
18	Headquarter Provincial Government Expenditure for R&D	0.08*	0.11***	0.17***	-0.07*	-0.01	0.33***	-0.21***	-0.30***	-0.41***	-0.10**	-0.02	-0.18***	0.07*	0.02	-0.06*	0.44***	0.28***	1.00
19	Home Country IFDI	0.04	-0.09**	0.06	0.09**	0.07*	0.05	-0.17***	-0.60***	-0.58***	-0.34***	0.02	-0.23***	-0.10**	-0.03	0.06	0.35***	0.52***	0.50***

Note: Pairwise correlation coefficients. ***p<0.001, **p<0.01, *p<0.05.

5.7.2 Hypotheses Testing

We tested hypotheses in a series of panel estimation utilizing Probit model with random effect. To detect potential multicollinearity problems, we computed the Variance Inflation Factors (VIF). Given that the average and maximum VIF across the models are below the conventional threshold of 10, we can rule out the serious problems of multicollinearity in our analysis. Table 5.6 presents our results for a full-sample estimation. Column 1, our baseline mode, includes all control variables. Because the four cluster-specific dummies are mutually exclusive, we could only include 3 dummies once. Hence Column 2 reports results of Clusters 1, 2, and 3, and Column 3 Clusters 1, 3, and 4. Hypotheses 1a, b posit that the likelihood of acquisition differs across the four clusters of the Taxonomy, with Hypotheses 1a predicting the differences between Clusters 1, 3, and Clusters 2, 4 and Hypotheses 1b predicting the differences between Clusters 1, 3, 4 and Cluster 2. Columns 2 and 3 show that the coefficients of Cluster 1 (0.560; $p<0.001$ in Column 2, and 0.410; $p<0.05$ in Column 3) and Cluster 3 (0.809; $p<0.001$ in Column 2, and 0.659; $p<0.01$ in Column 3) are significant and positive while the coefficients of Cluster 2 (0.150; $p=0.506$ in Column 2) and Cluster 4 (-0.150; $p=0.506$ in Column 3) are insignificant. Thus, Hypothesis 1a is supported and Hypothesis 1b rejected.

In order to test Hypothesis 2 that there are differences between EMNE ioSubs and AMNE ioSubs in terms of the likelihood of acquisition, we carried out subsample estimation using the Column 2 of Table 5.6. Table 5.7 reports these results. Columns 1 and 2 contain only control variables for the two subsamples, as baseline estimations. Columns 3 and 4 examine the hypothesized effects for the sample of EMNE ioSubs and AMNE ioSubs, respectively. In Column 3, the coefficients of Cluster 3 (4.762; $p<0.001$) is significant and positive. In Column 4, the coefficient of Cluster 3 (1.245; $p<0.001$) is significant and positive. We graphed the confidence intervals for the means of two sub-samples on this effect, as shown in Figure 5.6, which shows that the confidence intervals between two subsamples do not overlap for the Cluster 3, confirming significant differences between EMNE ioSubs and AMNE ioSubs on the effects of Cluster 3, i.e., Hypothesis 2 is supported.

Table 5.6 Full sample results (Dependent variable: Acquisition)

	(1)	(2)	(3)	(4) Robustness	(5) Robustness
H1a, b: Cluster 1 Lone Wolf Exploration		0.560*** (0.133)	0.410* (0.209)		0.567*** (0.134)
H1a, b: Cluster 2 Networked Exploitation		0.150 (0.225)			0.155 (0.227)
H1a, b: Cluster 3 Mass Exploration		0.809*** (0.149)	0.659** (0.213)		0.750*** (0.156)
H1a, b: Cluster 4 Super Integration			-0.150 (0.225)		
MNE R&D Stock	0.012 (0.015)	0.015 (0.015)	0.015 (0.015)	0.014 (0.015)	0.019 (0.016)
MNE Degree of Internationalization	-0.194** (0.063)	-0.115+ (0.066)	-0.115+ (0.066)	-0.103 (0.072)	-0.045 (0.074)
MNE Size	0.009 (0.170)	-0.149 (0.175)	-0.149 (0.175)	-0.125 (0.177)	-0.245 (0.181)
Subsidiary Location Rank	-0.132 (0.088)	-0.160+ (0.090)	-0.160+ (0.090)	-0.102 (0.089)	-0.144 (0.091)
Subsidiary Age	0.282*** (0.054)	0.347*** (0.058)	0.347*** (0.058)	0.303*** (0.055)	0.362*** (0.059)
Subsidiary Size	-0.060+ (0.033)	-0.020 (0.035)	-0.020 (0.035)	-0.075* (0.033)	-0.029 (0.035)
Host Country Domestic Technology Intensity	0.539** (0.209)	0.636** (0.218)	0.636** (0.218)	0.611** (0.210)	0.685** (0.218)
Host Country Openness to IFDI	0.004 (0.299)	0.089 (0.310)	0.089 (0.310)	0.094 (0.302)	0.130 (0.311)
Culture Distance	0.099 (0.102)	0.047 (0.105)	0.047 (0.105)	-0.031 (0.110)	-0.052 (0.114)
IPR Distance	-0.590 (0.422)	-0.671 (0.440)	-0.671 (0.440)	-0.635 (0.438)	-0.804+ (0.454)
Headquarter Provincial Government Expenditure for R&D				31.463*** (9.481)	21.298* (10.136)
Home Country IFDI				1.931 (9.738)	7.552 (10.033)
Year Effects	Included	Included	Included	Included	Included
Industry Effects	Included	Included	Included	Included	Included
Constant	-0.354 (0.811)	-1.818* (0.905)	-1.669+ (0.861)	-0.723 (0.829)	-2.098* (0.923)
Number of Observations	1,051	1,051	1,051	1,051	1,051
Number of Subsidiaries	143	143	143	143	143
Pseudo-R:	0.155	0.186	0.186	0.165	0.191
Chi-squared	191.4	229.3	229.3	202.7	235.1
Prob Wald:	0	0	0	0	0
VIF average	1.91	1.93	2.14	2.05	2.08
VIF max	3.65	3.99	4.62	4.88	5.17

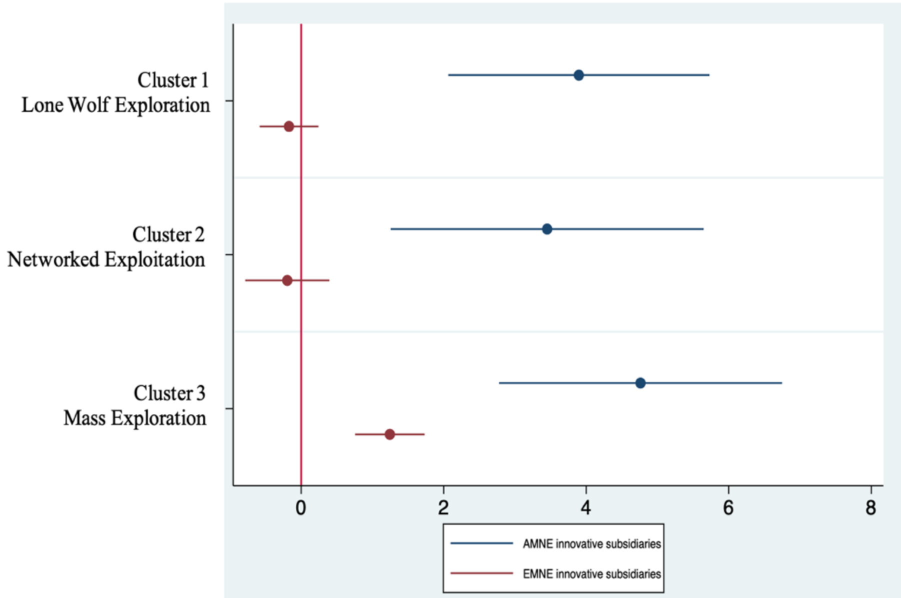
Note: Standard errors in parentheses. ***p<0.001, **p<0.01, *p<0.05, +p<0.1.

Table 5.7 Subsample results (Dependent variable: Acquisition)

	(1) EMNE ioSubs	(2) AMNE ioSubs	(3) EMNE ioSubs	(4) AMNE ioSubs
H2: Cluster 1			3.897***	-0.171
Lone Wolf Exploration			(0.935)	(0.211)
H2: Cluster 2			3.452**	-0.195
Networked Exploitation			(1.121)	(0.302)
H2: Cluster 3			4.762***	1.245***
Mass Exploration			(1.013)	(0.249)
MNE R&D Stock	0.053*	0.038	0.129***	0.020
	(0.023)	(0.036)	(0.035)	(0.082)
MNE Degree of	-0.825***	0.061	-0.681***	0.278+
Internationalization	(0.162)	(0.126)	(0.199)	(0.143)
MNE Size	-0.936***	0.287	-1.222***	0.266
	(0.282)	(0.262)	(0.302)	(0.289)
Subsidiary Location Rank	0.620*	-0.843***	0.782**	-1.158***
	(0.255)	(0.150)	(0.293)	(0.183)
Subsidiary Age	0.578***	0.279**	1.095***	0.287**
	(0.132)	(0.090)	(0.219)	(0.100)
Subsidiary Size	0.442***	-0.373***	0.609***	-0.416***
	(0.088)	(0.062)	(0.100)	(0.075)
Host Country Domestic	4.460***	0.165	3.919***	-0.116
Technology Intensity	(0.733)	(0.304)	(0.779)	(0.348)
Host Country Openness	-1.062+	0.689	-1.824**	0.652
to IFDI	(0.571)	(0.699)	(0.632)	(0.779)
Culture Distance	-2.218***	0.012	-0.786	-0.090
	(0.587)	(0.159)	(0.667)	(0.169)
IPR Distance	-0.587	-3.571**	-1.002	-3.566**
	(1.089)	(1.137)	(1.331)	(1.235)
Year Effects	Included	Included	Included	Included
Industry Effects	Included	Included	Included	Included
Constant	-8.110***	6.811***	-17.736***	6.951***
	(2.014)	(1.731)	(3.337)	(1.939)
Number of observations	363	568	363	568
Number of subsidiaries	46	80	46	80
Pseudo-R:	0.510	0.212	0.589	0.269
Chi-squared	234.2	137.1	270.5	173.6
Prob Wald:	0	0	0	0
VIF average	2.29	2.33	2.49	2.34
VIF max	3.84	4.74	4.69	5.10

Note: Standard errors in parentheses. ***p<0.001, **p<0.01, *p<0.05, +p<0.1.

Figure 5.6 Confidence intervals of the mean differences between three clusters in terms of the likelihood of acquisition



5.7.3 Robustness Checks

Although we have controlled for parent MNE and host country factors with the expectation that these capture a combination of firm and country specific advantages that shaping the decisions of acquisition vis-à-vis greenfield, some may want to see how home location factors exert effects that may have complex and qualitative difference for AMNE and EMNE innovation (Cuervo-Cazurra, 2008). We therefore included two variables as additional regressors in our full-sample estimation (Columns 4 and 5 in Table 5.6) and sub-sample estimation (Table 5.8): Headquarter Provincial Government Expenditure on R&D is the ratio of governmental R&D expenditure over GDP in the sub-national region[5] where the headquarter of the parent MNE is located; Home Country IFDI is the parent MNE's home country inward foreign direct investment (IFDI) flow over its GDP in a given year. The full sample results in Table 5.6 show that the coefficient of Headquarter Provincial Government Expenditure for R&D is significant and positive while the coefficient of Home Country IFDI is insignificant. Inclusion of these variables have not changed the conclusion about the hypothesized effects in hypothesis 1a, b. Sub-sample estimation in Table 5.8 shows that the coefficients of Headquarter Provincial Government Expenditure for R&D are significant and positive for both EMNE ioSubs and AMNE ioSubs, while the coefficient of Home Country IFDI is negative and

[5] Because of data limitation, sub-national regions are not all at the same disaggregated level across the examined countries.

significant for EMNE ioSubs ($p<0.05$) and insignificant for AMNE ioSubs. Similar to the full sample, inclusion of these variables has not changed the conclusion about the hypothesized effects in hypothesis 2.

Table 5.8 Results of robustness check (Dependent variable: Acquisition)

	(1) EMNE ioSubs	(2) AMNE ioSubs	(3) EMNE ioSubs	(4) AMNE ioSubs
Cluster 1 Lone Wolf Exploration			4.268***	-0.067
			(0.988)	(0.222)
Cluster 2 Networked Exploitation			3.625**	-0.346
			(1.289)	(0.314)
Cluster 3 Mass Exploration			4.691***	1.077***
			(1.055)	(0.255)
MNE R&D Stock	0.095**	-0.067	0.138***	-0.057
	(0.031)	(0.084)	(0.037)	(0.090)
MNE Degree of Internationalization	-0.888***	0.110	-0.906***	0.268+
	(0.206)	(0.138)	(0.265)	(0.146)
MNE Size	-1.478***	0.153	-1.466***	0.143
	(0.335)	(0.302)	(0.339)	(0.309)
Subsidiary Location Rank	0.396	-0.222	0.629*	-0.514*
	(0.253)	(0.201)	(0.300)	(0.239)
Subsidiary Age	0.682***	0.322***	1.295***	0.312**
	(0.143)	(0.096)	(0.256)	(0.102)
Subsidiary Size	0.461***	-0.440***	0.667***	-0.491***
	(0.095)	(0.071)	(0.111)	(0.081)
Host Country Domestic Technology Intensity	4.216***	0.438	3.480***	0.230
	(0.703)	(0.325)	(0.783)	(0.368)
Host Country Openness to IFDI	-0.995+	-0.606	-2.013**	-0.517
	(0.585)	(0.782)	(0.655)	(0.865)
Culture Distance	-1.613**	-0.466*	-0.176	-0.561**
	(0.611)	(0.194)	(0.732)	(0.207)
IPR Distance	-1.562	0.183	-1.601	0.018
	(1.227)	(1.423)	(1.427)	(1.497)
Headquarter Provincial Government Expenditure for R&D	63.863***	351.006***	60.774**	343.065***
	(18.138)	(68.040)	(22.582)	(74.772)
Home Country IFDI	-63.194*	-0.751	-74.278*	-2.504
	(27.326)	(21.616)	(34.186)	(22.992)
Year Effects	Included	Included	Included	Included
Industry Effects	Included	Included	Included	Included
Constant	-6.348**	3.043	-16.207***	3.624
	(2.104)	(2.075)	(3.452)	(2.237)
Number of Observations	363	568	363	568
Number of Subsidiaries	46	80	46	80
Pseudo-R:	0.548	0.261	0.613	0.307
Chi-squared	251.7	168.6	281.4	197.9
Prob Wald:	0	0	0	0

VIF average	2.53	2.33	2.75	2.61
VIF max	5.01	4.74	5.54	5.11

Note: Standard errors in parentheses. ***p<0.001, **p<0.01, *p<0.05, +p<0.1.

5.8 Discussion and Conclusion

The objective of our study is to find a unifying explanation of MNE technological development. We achieved this by first gaining a better understanding of the technology portfolios owned by AMNE ioSubs and EMNE ioSubs. This led to the development of the Technological Integration and Diversification Taxonomy, which describes four clusters of ioSubs with distinct characteristics. Our development of the Taxonomy extends the existing MNEs typology literature which recognizes the roles of innovative subsidiaries (Awate et al., 2015; Cantwell and Mudambi, 2005; Bartlett and Ghoshal, 1989). Distinguished from extant studies that mainly used an input perspective or focused on innovative as well as non-innovative subsidiaries, we adopted an innovation outcome perspective. We showed that ioSubs play distinctively different roles because of how their technology portfolios are *technologically* integrated with or diversified away from those of the rest of the parent firms. Specifically, we showed that exploration by ioSubs *at the technology level* can take place with a lower degree of integration (Lone Wolf Exploration cluster) or a higher degree of integration (Mass Exploration cluster). We also showed that exploitation by ioSubs at the technology level takes place with a lower degree of diversification (Networked Exploitation cluster), while a further distinctive cluster of ioSubs were found to have higher degrees of both diversification and integration (Super Integration cluster). Given that these clusters were identified for ioSubs belonging to parent MNEs from markedly different home country conditions, the Taxonomy offers a general explanation of technological development of MNEs achieved by subsidiary level innovation outputs.

To achieve our objective, we further incorporated the Taxonomy to hypothesize a critical mechanism of MNE's technological development, the acquisition vis-à-vis greenfield establishment of overseas innovative subsidiaries owning significant technologies (patents). Investigating the likelihood of acquisition, we showed that it is most likely to occur in the Lone Wolf Exploration and Mass Exploration clusters than in the Networked Exploitation and Super Integration clusters. Our findings provide evidence of the important association between acquisition and MNEs' technological exploration across firms from a range of locations and home country conditions. We therefore contribute to the literature of comparison between EMNEs and AMNEs during their technological development (e.g., Awate et al., 2015; Thakur-

Wernz and Samant, 2019) by clarifying that acquisition is adopted by a range of MNEs, and its likelihood differs among clusters of the Taxonomy, i.e., at the technology portfolio-level in terms of diversification and integration. This contrasts with studies that suggest that likelihood of acquisition may differ between emerging and mature industries where acquisition targets availability may vary (e.g., Awate et al., 2015).

The last step we carried out to achieve our objective was to hypothesize the likelihood of acquisition by EMNEs vis-à-vis AMNEs across the clusters of the Taxonomy. We showed that EMNE ioSubs are more likely than AMNE ioSubs to have been acquired in Cluster 3. We can further observe that EMNE ioSubs are more likely than AMNE ioSubs to have been acquired across three clusters: Clusters 1, 2 and 3. Thus, our finding significant differences across the board confirms that the comparative costs of acquisition vis-à-vis greenfield are lower for EMNEs but higher for AMNEs because capabilities and experiences take time to accumulate and subsequently EMNEs use acquisition as a compensatory option (Luo & Tung, 2007) that, as our Taxonomy results show, have enabled EMNEs to carry out technology development in a similar way to that of AMNEs.

Our study has some limitations that opens avenue for future research. First, while home countries of sampled subsidiaries have been chosen because of large variations in their attributes, future research may benefit from widening home country choices in order to provide more generalizable conclusions by including extreme cases, especially because emerging markets largely exhibit significant variations. Second, because EMNEs came onto the global stage fairly recently and experience and knowledge accumulation take time, contemporary studies generally do not yet have enough time to properly observe the consequence of their behaviours, including acquisition. Future research will benefit from large scale longitudinal studies of a range of these EMNEs and their counter parts AMNEs, in terms of the paths these firms would have taken to move from one strategic position (cluster) described in the Taxonomy to another. Such research will also shed light on the stages through which EMNEs catch-up with AMNEs at the technology portfolio level using their subsidiaries.

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Chapter 6 Discussion and Conclusion

This chapter is organized as follows. In the next section, we briefly summarize the key findings of each paper in this thesis. This is followed by our introduction of the theoretical and practical implications of the thesis in general and of each paper separately. We then describe the limitations and the directions for future study of thesis in general and of each paper separately.

6.1 Summary of the Thesis

We start the discussion and conclusion chapter of this thesis with a summary of the key findings in above three papers.

6.1.1 Chapter 3- Paper 1

Global innovation is a battle ground for advanced (AMNEs) and emerging market multinational enterprises (EMNEs). Although existing research provides useful insights into why global innovation enhances firms' innovation outputs (e.g., Elia et al., 2020; García-Manjón and Romero-Merino, 2012; Juhász and Lengyel, 2017), we still have limited knowledge on how this effect varies in the AMNEs and EMNEs cohorts. The starting point of this study is the comparative analysis revealing the differences in MNE global innovation trajectories between AMNEs and EMNEs. First, we found that although MNE R&D intensity on average has limited effect on innovation outputs (patents number), its benefits are significant for EMNEs but not AMNEs. Second, we provided evidence that AMNEs and EMNEs follow the different innovation model: EMNEs are more likely to employ a subsidiary-led innovation model. More specifically, our results showed the effects of geographic dispersion of overseas subsidiaries are stronger for EMNEs than for AMNEs.

6.1.2 Chapter 4- Paper 2

The objective of this paper is to explore if there is a general explanation of subsidiary performance variations resulted by variations in parent MNE R&D intensity and host country environments. Based on the fairly developed literature of AMNEs and limited literature of EMNEs, we expected these effects to vary in the AMNE subsidiaries and EMNE subsidiaries. We found support for our predictions that there is beneficial role of parent MNE R&D intensity and a technological-rich host environment on subsidiary profitability, while strong host country intellectual property regime (IPR) reduces the benefits from parent MNE. We further found that AMNE subsidiaries rely more on internal competence (MNE R&D), while EMNE subsidiaries rely more on external competence (host technological-rich environment). Additionally, EMNE subsidiaries are more influenced by the joint effects of MNE R&D intensity and a technological-rich host environment than AMNE subsidiaries.

6.1.3 Chapter 5- Paper 3

The objective of this paper is to explore if there is a general explanation of MNE technological development and how innovative overseas (ioSubs) subsidiaries contribute to the development of the MNE as a whole (Elia et al., 2020; Phene and Almeida, 2008). We achieved this by examining the technologies of ioSubs belonging to MNEs from distinct home country conditions (e.g., AMNEs and EMNEs). We first proposed a Technological Integration-Diversification taxonomy building upon two constructs: Subsidiary Technological Integration (the degree of commonality shared by subsidiaries of the same MNE in their patent portfolios) and Subsidiary Technological diversification (the extent to which the subsidiaries own patents across different technological fields). We identified four clusters of ioSubs: Lone Wolf Exploration, Networked Exploitation, Mass Exploration and Super Integration. We next examined how the likelihood of acquisition differs across these clusters and differs for EMNE ioSubs and AMNE ioSubs, respectively. We found that acquisition is most likely in Lone Wolf Exploration and Mass Exploration clusters and EMNEs are more likely than AMNEs to acquire ioSubs in Mass Exploration cluster.

6.2 Contributions and Implication of the Study

This thesis goes beyond MNEs' global innovation that focused on either the observations from advanced markets (Cantwell and Mudambi, 2005) or the importance of understanding global innovation by EMNEs (Elia et al., 2020) by contributing to a general explanation of MNE global innovation. Previous research has considered the contingent effects of firm-specific and country-specific factors on the relationship between global innovation and MNE innovation outputs (Becker and Dietz, 2004; Yam et. al., 2011), but this approach ignores the differences between two cohorts of MNEs that are originated from distinct host country developmental trajectories. Our analysis in the first paper contributes to a general theory that integrates and explains global innovation activities of AMNEs and EMNEs by demonstrating that EMNEs and AMNEs may follow different global innovation models. Extant studies have explored how subsidiaries benefit from their parent MNE and host country environments (Almeida and Phene, 2004; Phene and Almeida, 2008), but this approach neglects the differences between subsidiaries belong to different cohorts of MNEs. The second paper of this thesis contributes to a general explanation of MNE global innovation by suggesting that EMNEs and AMNEs operate in host environments differently. Prior research has considered different MNE strategies (Awate et al., 2015; Cantwell and Mudambi, 2005), but little research has examined how MNEs from distinct home country conditions may develop their technologies differently. Our analysis in the third paper contributes to a general explanation of MNE technologcial development by examining the technologies owned by innovative subsidiaries (ioSubs) of the MNEs.

This thesis has practical implications for managers of EMNEs. In particular, our analysis in the first paper suggests that AMNEs and EMNEs employ different innovation models and it turns out that MNE R&D intensity and geographic dispersion of overseas subsidiaries might be more beneficial for EMNEs than for AMNEs. Managers of EMNEs should therefore pay more attention to the strategic decision on R&D investment and those projects that are aimed at making investments in multiple locations. With respect to subsidiary performance variations, our analysis in the second paper shows that compared with AMNE subsidiaries, EMNE subsidiary performance relies more on a host technological-rich environment and MNE R&D intensity to learn from the technological-rich environment. Thus, managers of EMNEs should first focus on the location choice of their subsidiaries especially making location choices that exhibit a high level of knowledge stock, and then consider making R&D investment to enhance their absorptive capacity to better learn from the technological-rich environments. Our analysis on the technology development of AMNEs and EMNEs in the third paper shows EMNEs are more likely than AMNEs to acquire ioSubs in Mass Exploration cluster. Mangers of EMNEs that are oriented to technological exploration in their technology development should consider more carefully those projects that are aimed to making greenfield investments.

This thesis also highlights some implications for policy makers in emerging markets. Global innovation has been viewed as a key strategy for EMNEs and emerging countries to gain competitive advantages and quickly catch-up with AMNEs and advanced markets (e.g., Awate et al., 2012; Ramamurti and Singh, 2010). Thus, the national policy makers in emerging markets should provide support for their firms' global innovation activities and shift their focus from single financial support towards multi-dimension encouragement of competence building of EMNEs through global innovation (Wang et al., 2018). Furthermore, EMNEs are suggested to prefer acquiring ioSubs in Mass Exploration Cluster. The implications for the policy maker can be that they should design the policies to support EMNEs' overseas acquisitions when there are increasing legal restrictions and obstacles encountered by EMNEs in the foreign countries (Deloitte, 2007; Kharpal, 2020).

6.2.1 Chapter 3- Paper 1

We contribute to the growing international business and global innovation literatures on the effects of firms-specific (e.g., In-house R&D, international expansion) on MNE innovation performance (e.g., Elia et al., 2020; Giuliani et al., 2014) by demonstrating that such contingent approach is not appropriate without careful scrutiny of firm distribution. While global innovation literatures have been mainly oriented at understanding the mechanism through which MNEs are able to enhance their innovativeness (e.g., García-Manjón and Romero-Merino, 2012; Juhász and Lengyel, 2017; Lo and Chung, 2010), we show that the effectiveness of these mechanisms in enhancing innovation performance is different between two cohorts of MNEs that are at different ends of developmental spectrum. Our findings point to the need to address the fact that distinct home country developmental trajectories exist and affect how MNEs effectively conduct global innovation. Our contribution also stands in understanding the global innovation strategies in a scenario characterized by growing global innovation activities by EMNEs by demonstrating that EMNEs employ different innovation model from that of AMNEs in order to become innovative and catch-up with AMNEs technologically. Thus, a general framework explaining MNE global innovation conceptualises contexts more rigorously.

Our study has implications for how we can understand the roles of headquarters and portfolio of overseas subsidiaries in shaping the innovativeness of MNEs including AMNEs and EMNEs. We suggest that the temporal sequences of headquarter and subsidiary mandate differs between cohorts of firms, depending on how their home environments have shaped global innovation decisions in the first place. Specially, our analysis shows that the global innovation strategy of EMNEs contrasts that of the AMNEs and EMNEs rely more on their overseas subsidiaries to seek global superior knowledge in order to leapfrog the stage of knowledge development at home and become more innovative (Luo and Tung, 2007; Awate et al., 2015). We thus add to the large body of studies on the development of MNE global innovation strategies by demonstrating that a global dispersed portfolio of subsidiaries is becoming a strategic tool for firms to gain competitive advantages, especially in the early stage of development of an EMNE but in the later stage of development of an AMNE.

6.2.2 Chapter 4- Paper 2

Our study goes beyond subsidiary performance work that either focused on the effects of parent MNE-specific factors (e.g., Contractor et al., 2016; Tian and Slocum, 2014) or the effects of host country-specific factors (e.g., Almeida and Phene, 2004; Shirodkar and Konara, 2017) by suggesting the need to examine these effects under careful scrutiny of firm distribution. Our comparative analysis reveals significant differences between the AMNE subsidiaries and

EMNE subsidiaries in their approaches to enhance performance and our results show that the distinct home country developmental trajectories exist and affect how overseas subsidiaries effectively create their competence to achieve better performance. The results also allow us to contribute to another stream of literature, i.e., the EMNE studies. Our study offers a new insight on the specific role of a technological-rich environment for EMNE subsidiary performance, by showing that EMNE subsidiaries rely more on the external competence rather than their parent MNE internal competence (MNE R&D), which contrasts the subsidiary development of AMNE subsidiaries. Thus, a general framework explaining subsidiary performance conceptualise contexts more rigorously.

In this study, we attempted to show that the variation in subsidiary performance is actually shaped by MNE competence, by host country environment, and by how MNEs support the subsidiaries to deal with the host environments. In other words, not all subsidiaries benefit from a technological-rich environment depending on how the MNEs' competence support them to absorb, assimilate and apply the external knowledge embedded in the host environments. Not all subsidiaries are constrained by a weak IPR environment depending on how the MNEs' competence support them to protect their knowledge from unintentional knowledge in the weak IPR environment. Overall, our conceptual model shifts the focus of the subsidiary performance literature from the effects of MNE internal competence and host external environments to the joint effects of MNE internal competence and host external environment.

6.2.3 Chapter 5- Paper 3

In this study, we aim to find a unifying explanation of MNE technological development. In order to achieve this, we examined the technology portfolios owned by AMNEs ioSubs and EMNE ioSubs and we therefore contribute to the existing MNEs typology literature (e.g., Barlett and Ghoshal, 1989; Cantwell and Mudambi, 2005) by developing the Technological Integration and Diversification Taxonomy incorporating an innovation outcome perspective. We showed that ioSubs play distinctly different roles because of how their technology portfolios are technologically integrated with or diversified away from those of the rest of the parent firms. We further identified four clusters of ioSubs - Lone Wolf Exploration, Networked Exploitation, Mass Exploration, and Super Integration.

In order to achieve our objective, we further used the Taxonomy to hypothesize a critical mechanism of MNE's technological development, the acquisition vis-à-vis greenfield establishment of ioSub, especially we examine how the likelihood of acquisition differs across these identified clusters and differs for EMNE ioSubs and AMNE ioSubs. Our findings suggest that acquisition is associated with MNEs' technological exploration, we therefore contribute to the literature of MNE entry mode choice by clarifying that acquisition is adopted by a range of MNEs, and its likelihood differs among clusters of the Taxonomy. Our results also show that the comparative costs of acquisition vis-à-vis greenfield are lower for EMNEs but higher for AMNEs because capabilities and experiences take time to accumulate.

6.3 Limitation of the Study and Future Research

This section discusses some limitations that must be considered when we interpret our findings on global innovation in this thesis and suggests the directions for future studies. The comparison between AMNEs and EMNEs builds upon sampled AMNEs from large advanced economies and sampled EMNEs from two largest emerging countries, which may affect the comparison due to sectoral coverage, distribution of firms in terms of firm size, and types of firms (e.g., family firms or state-owned firms). In addition, emerging markets largely exhibit significant variations, as a result, our sampled EMNEs originated from two particularly large and diversified emerging markets (China and India) prevent our study from observing the phenomenon of firms from other emerging markets with idiosyncratic characteristics. This limitation opens avenues for future research in comparison of global innovations of AMNEs and EMNEs from more diverse countries such as AMNEs from Organisation for Economic Co-operation and Development (OECD) countries and EMNEs from The Association of Southeast Asian Nations (ASEAN) countries. In addition, a comparative study of global innovations among emerging markets can be conducted to provide more complete picture of the comparative studies (e.g., Cooke et al., 2014; Nicholson and Salaber, 2013).

Although our sampled MNEs operates in a set of industrial sectors, the roles of industrial contexts on MNEs' global innovation activities are still unobserved. Existing research compares the characteristics of distinct industries (e.g., high-tech sectors vs. non-high-tech sectors, Elia and Santangelo, 2017; manufacturing vs. service sectors, Forsman, 2011) and examines the effects of the industrial context on firms' innovative activities (Elia and Santangelo, 2017; Forsman, 2011). Therefore, it would be interesting to explore the role of industrial context on MNE global innovation and especially compare the global innovation strategies of MNEs operating in different industrial sectors (e.g., high-tech sectors vs. non-high-tech sectors, manufacturing vs. service sectors).

6.3.1 Chapter 3- Paper 1

This study has several limitations that need to be considered. First, our measurement of the variable MNEs' innovation outputs, using MNE patent counts, may only capture the patent outcomes of MNEs innovative activities, however, not all knowledge and capabilities are patentable and not all firms are actively engaged in patenting activities (Jin et al., 2019). Future studies, using different measures of innovation outputs, may be able to provide a more complete picture of effects of MNEs' global innovation on innovative outputs. In particular, new product (e.g., number of new products, new products sales) is one of the most important measurements of innovation outputs, which often represents the physical embodiment of knowledge creation (Liu and Zou, 2008; Li et al., 2018). Furthermore, extant literatures argue that patent application and new product are complementary measures of innovation outputs (Jin et al., 2019; Levin et al., 1987). Second, we were not able to capture the variations of subsidiary geographical dispersion in an MNE over time due to Orbis database offering. Future studies may employ a time-variant construct to capture the foreign expansion of MNEs over time. Third, our empirical analysis was not able to capture the distinct effects on different types of innovations (e.g., product and process innovation, Haneda and Ito, 2018; radical and incremental innovation, Ettlie et al., 1984). Future studies may attempt to explore the effects of MNE R&D, headquarter-led and subsidiary-led innovation on different types of MNE innovation and the data on different types of innovation is more easily to be gained through national innovation survey (e.g., Frenz and letto-Gillies, 2009; Kim and Lui, 2015).

6.3.2 Chapter 4- Paper 2

There are a few limitations to this study. First, our use of MNE R&D intensity, as a proxy for MNE competence, may only partially capture MNEs' competence on learning from the host environments and managing in weaker IPR environments. Future studies, using different measures of MNE competence may be able to capture the mechanisms through which MNEs support the subsidiaries to learn from the technological rich environments and protect their knowledge from unintentional knowledge leakage in poor IPR host environments (Nandkumar and Srikanth, 2015; Zhao, 2006). Second, although this study explores the effects of MNE R&D intensity on subsidiary performance, it would be interesting to consider the MNE as the global distributed knowledge networks and incorporate the variables of internal knowledge flows to subsidiaries (Almeida and Phene, 2004) and corporate embeddedness of subsidiaries (Ciabuschi et al., 2014) to explain how MNEs competence influence the performance of subsidiaries. Future studies can explore how these factors (e.g., corporate embeddedness of subsidiary) may moderate the relationship between MNE competence and subsidiary performance in order to disentangle more in depth the mechanisms through which MNEs support the development of their overseas subsidiaries.

6.3.3 Chapter 5- Paper 3

Because EMNEs start their journey of internationalization fairly recently, contemporary studies do not yet have enough time to properly observe and examine internationalization and innovation behaviours of EMNEs including their acquisition. Future studies pursuing this perspective will benefit form large scale longitudinal studies of a range of these EMNEs and their counter parts AMNEs and advance this stream of literatures by predicting the technologically developmental path of AMNEs and EMNEs in terms of how these firms would have taken to move from one strategic cluster described in the Taxonomy to another. Despite these limitations, we believe that our paper provides contributions to a general explanation of MNE technological development.

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