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Globalisation or regionalisation of technological knowledge learning in multinational corporations

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Abstract: This study examines the relationship between a global or regional distribution of technological knowledge learning activities of large multinational corporations (MNCs) and firm performance. This study focuses on explorative and exploitative learning activities of the world's largest MNCs in the electronics and pharmaceutical industries between 1980 and 2018. Herfindahl index is adapted to measure globalisation vs. regionalisation as one continuous variable. We find that the regionalisation of exploration and exploitation are positively associated with firm innovative and financial performance. For innovative performance, the regionalisation of exploration and exploitation is particularly important for pharmaceutical firms. In contrast, the regionalisation of exploitation for electronics firms and the regionalisation of exploration for pharmaceutical firms contribute to firm financial performance. This study contributes to both the MNC and organisational learning literature and offers managerial implications on organising technological competence creating activities in large MNCs.

Keywords: regionalisation; globalisation; geographical distribution; technological knowledge learning; multinational corporations.

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1 Introduction

With the impacts of COVID-19 pandemic, international and domestic businesses have been experiencing fragility of global supply chains arising from material scarcity, production and transportation disruption, and labour shortages (Paul et al., 2021;

Semuels, 2021). Practitioners and academic researchers are revisiting strategies enhancing the resilience of supply chains in diverse industries, such as reshoring to reduce reliance on global sources (van Hoek and Dobrzykowski, 2021), sourcing from local regions (Bosley, 2021), moving firm cost structure further from tangible to intangible activities (Cheng et al., 2021). Much of the discussion centers on the benefits of regionalisation vs. globalisation on downstream supply chain activities including sales, procurement, manufacturing, etc. Yet, research and development (R&D), as an upstream activity along firm supply chain, has not been the focus of this trending debate, which motivates the current study. Specifically, we examine the globalisation or regionalisation of firm technological knowledge learning activities, and their relationships with firm performance.

We differentiate explorative and exploitive learning activities. Exploration refers to new knowledge search for solutions beyond a firm's current technical and social contexts, in contrast to exploitation through recombining current knowledge (Kogut and Zander, 1992; Levinthal and March, 1993; March, 1991; Nelson and Winter, 1982; Rosenkopf and McGrath, 2011). The widespread interests in exploration and exploitation can be attributed to the positive association of ambidexterity – a balance between exploration and exploitation – in sustaining firm performance (He and Wong, 2004; March, 1991; Mudambi and Swift, 2014). We follow Rugman and Verbeke (2004) and define globalisation and regionalisation based on the geographic distribution of technological knowledge learning activities. Globalisation of exploration refers to a balanced or even geographic distribution of firm exploratory activities; regionalisation of exploration refers to the regional concentration of such activities. By the same token, we define globalisation and regionalisation of exploitation. It is worth of noting that the current study is particularly interested in the distribution of technological knowledge learning activities across geographical boundaries but within organisational boundaries, namely the global or regional intra-firm distribution of exploration and exploitation. As one of the first attempts to exam the geographical distribution of such activities, this study focuses on firm technological competence creation activities operationalised by patent data. We acknowledge knowledge learning involves diverse activities beyond technological competence creation. By no means, we imply that technological competence creation fully represents technological knowledge learning or organisational learning.

This study investigates the world's largest multinational corporations (MNCs) in the electronics and pharmaceutical industries that are top ranked in 2018 Fortune Global 500. Large MNCs offer a fertile setting to study the geographical distribution of technological knowledge learning activities and their relationships with firm performance over time. We match focal firms' patent data from the US Patent and Trademark Office (USPTO) from 1980 and 2014 with firm-level data from *Compustat* and *Nexis Uni* databases between 1990 and 2018. Herfindahl Index is adapted to measure globalisation vs. regionalisation as one continuous variable.

Empirical results show that the regionalisation of exploration and exploitation are positively associated with firm innovative and financial performance. In other words, globalisation of technological knowledge learning may negatively impact firm performance. Moreover, the relationship between technological knowledge learning activities and firm performance dynamically varies across industries. Regionalisation of exploration and exploitation is particularly important for the innovative performance of pharmaceutical firms. In contrast, the regionalisation of exploitation among electronics firms and the regionalisation of exploration among pharmaceutical firms are more important in supporting firm financial performance.

Findings of this study contribute to the discussion of globalisation and regionalisation in the MNC literature. Rugman and Verbeke (2004) demonstrate the regionalisation of the world's largest MNCs in terms of international sales, which represent downstream activities along a supply chain. By focusing on knowledge learning activities associated with technological innovation, this study advances our understanding on whether an upstream supply chain activity of the MNC exerts a similar regionalised pattern, and whether regionalisation has evolved towards globalisation over the last two decades since the early work on the issue. The current study further contributes to the organisational learning literature by identifying the distribution of exploration and exploitation as a critical dimension of organisational learning and determinant of firm performance. The findings also have practical implications for managers on organising competence creating activities in large MNCs with a geographically dispersed organisational structure. With the global supply chain disruptions caused by the current COVID-19 pandemic, findings of the current study contribute to the debate of a timely issue, namely constructing resilient supply chain systems through a regional strategy.

2 Distribution: a missing piece

In response to the call for ambidextrous organisations (March, 1991), research in the last couple of decades has significantly advanced our understanding of the scope and depth of organisational learning. A widely accepted tenet is that to sustain performance, firms must engage in both exploitation and exploration, specifying the quality of organisational learning activities; meanwhile, they must maintain a balance between the two, pinpointing the essential quantity of organisational learning. Interestingly, the geographical distribution of exploration and exploitation has rarely been discussed explicitly in the organisational learning literature. The debate on ambidextrous mechanisms offers some implications without much clarity. Three major mechanisms include organisational or spatial separation (Benner and Tushman, 2003; Nielsen et al., 2018; O'Reilly and Tushman, 2004; Tushman and O'Reilly, 1996), temporal separation or transition (Boumgarden et al., 2012; Brown and Eisenhardt, 1997; Gibson and Birkinshaw, 2004; O'Reilly and Tushman, 2013), and contextual ambidexterity (Gibson and Birkinshaw, 2004).

Organisational separation recommends the division of an organisation into different, spatially separate subunits, dedicated to either exploration or exploitation (Benner and Tushman, 2003; O'Reilly and Tushman, 2004; Stettner and Lavie, 2014; Tushman and O'Reilly, 1996). Some argue that firms explore through parallel and isolated learning within each unit while exploiting through learning across units (Fang et al., 2010). Others advocate that firms maintain distinct activities within individual units dedicated to either exploration or exploitation (O'Reilly and Tushman, 2013). The former seems to implicitly suggest an evenly distributed exploration and exploitation among units whereas the latter implies a concentrated distribution of organisational learning within a few dedicated units. Yet, the different distributions and their performance implications have not been clarified in the literature.

Organisational separation mechanism suffers from important and persistent challenges, such as conflicting organisational routines, and resource distribution dilemma (Hansen et al., 2019; Laureiro-Martínez et al., 2015; Nielsen et al., 2018; Petruzzelli, 2014). To address these challenges, researchers extend their research settings across organisational boundaries and recommend cross-domain or inter-organisational ambidexterity (Bandeira-de-Mello et al., 2016; Gupta et al., 2006; Kauppila, 2010; Lavie et al., 2011; Lucena, 2016; Penney et al., 2020; Stettner and Lavie, 2014). Gupta et al. (2006), Lavie et al. (2011), Stettner and Lavie (2014), as well as Lucena (2016), show that firms benefit from the balance of exploration and exploitation across the internal organisation, alliance, and acquisition modes. Similar results are obtained in studies across technological and geographical domains (Petruzzelli, 2014), and international and domestic marketing domains (Karafyllia and Zucchella, 2017). Cross-domain ambidexterity clearly implies dedicated domains, instead of an even distribution of exploration and exploitation. However, cross-domain ambidexterity is mainly studied in the context of strategic alliances or inter-organisational relationships, limiting its implications on internal hierarchical structure (Lavie et al., 2010).

Temporal transition mechanism refers to the oscillating between exploration and exploitation over time (Boumgarden et al., 2012; Brown and Eisenhardt, 1997). Extant empirical efforts focus on the frequency, scale and speed of vacillation that impact the relationship between temporal oscillation and firm performance (Kang et al., 2017; Kang and Kim, 2020; Lavie et al., 2011; Mavroudi et al., 2020; Schilling et al., 2003; Stieglitz et al., 2016). Yet, the locale of exploration and exploitation is largely overlooked. Specifically, it is not clear whether the whole organisation or a few subunits should be dedicated to explorative activities during the episode of exploration (and vice versa for exploitation); and whether exploration and exploitation should be performed in the same subunit between exploratory and exploitative episodes (Luger et al., 2018).

Contextual ambidexterity literature insists that a firm can balance exploration and exploitation within a single organisational unit by nurturing discipline, support, and trust (Gibson and Birkinshaw, 2004; Stettner and Lavie, 2014). By focusing on the learning capabilities at the individual level (Gibson and Birkinshaw, 2004; Teece, 2007; Vahlne and Jonsson, 2017), contextual ambidexterity implies an evenly distributed exploration and exploitation within a firm. While the extant literature focuses largely on the legitimacy and viability of contextual mechanism (Benner and Tushman, 2003; Kauppila, 2010; O'Reilly and Tushman, 2008), the performance implications of an even distribution of organisational learning has yet to be discussed.

In sum, organisational separation literature debates on a concentrated distribution vs. an even distribution of exploration and exploitation. Contextual ambidexterity recommends an even distribution. Temporal ambidexterity leaves this perimeter open. Although different distributions may be implicitly discussed in the extant organisational learning literature, little consensus can be reached. It may be explained by the fact that exploration, exploitation, and ambidexterity are often defined and measured at the aggregated firm-level, without considering the intra-firm distribution of technological knowledge learning activities. For large organisations, however, distribution as such could be critical. For instance, with two homogenous firms, namely A and B, A generates two patents, one being 100% exploratory and one being 100% exploitative; meanwhile, B generates two patents, both being balanced with 50% exploratory and 50% exploitative knowledge. On one hand, the quality and value of balanced patents are much higher than those of un-balanced patents (Wang et al., 2017). On the other hand, this hypothetical scenario suggests that both firms would achieve a balance once exploration and exploitation are aggregated to the firm level. In this context, would the two firms have a similar firm-level performance? The key to the solution is the distribution of exploratory and exploitative activities within an organisation even when the system-level aggregation of such activities reaches a balance (Miller and Martignoni, 2016; Otero et al., 2020).

3 Intra-MNC distribution of organisational learning

In the debate on the very existence of the MNC, a consensus has been that the MNC exists because of its superior abilities in transferring knowledge across borders, although scholars emphasise different predecessors of such abilities, such as the transfer efficiency derived from the social processes within a firm (Kogut and Zander, 1993), market failures for the buying and selling of knowledge (Buckley and Casson, 1976; Rugman, 1980), or the lower costs due to intra-firm trust or less opportunistic behaviours (Hennart, 1982). With the superior abilities, conventional MNCs adopt an exploitation logic on internationalisation (Zander and Solvell, 2002), such as Hymer (1976) and Vernon (1966). In particular, the exploration of new knowledge was often located at the headquarters of the MNC, which resulted in new technologies and products in the home market. These outcomes were then further transferred, exploited, and appropriated throughout a network of worldwide operations.

The changing global economic and political environments in the last half century shifted the landscape of the MNC's operations. Some host locations, including emerging economies lately (Luo, 2002; Ramamurti, 2016; Zhang, 2021; Zhang et al., 2014), have evolved to become important knowledge sources. To take advantage of these changes, contemporary MNCs have been moving away from conventional home country centric to geographically dispersed competence creation (Cantwell and Mudambi, 2005; Dunning, 1993, 1994, 1998). In the process at least some overseas subsidiaries have gradually evolved from a knowledge dependent of the parent to an effective knowledge creator and contributor of the MNC (Andersson and Forsgren, 2000; Birkinshaw and Hood, 1998; Chung and Alcacer, 2002; Kogut and Chang, 1991).

The prosperous of studies on subsidiary evolution around the turn of the century is an excellent example of this new development (Andersson and Forsgren, 2000; Birkinshaw et al., 1998; Gupta and Govindarajan, 1991; Pearce, 1999; White and Poynter, 1984). Likewise, recent studies show that firms that offshore more of their R&D activities to developing countries engage in greater exploration and experience better innovative performance (Lampert and Kim, 2019). These shifts add to the MNC's multinationality advantages (Andersson et al., 2007; Caner et al., 2017; Hall et al., 2005; Ibarra-Caton and Mataloni, 2018; Noorderhaven and Harzing, 2009; Schulz, 2001; Tsai, 2002), such as the access to and absorption of diversified and idiosyncratic knowledge (Bartlett and Ghoshal, 1986; Leiponen and Helfat, 2011), the knowledge exchange across MNC units (Kogut and Zander, 1992; Zander and Solvell, 2002), and the flexibility of allocating competence-creating activities across MNC units (Zander, 1998). In other words, on top of the worldwide exploitation that the MNC has pursued traditionally, contemporary MNCs are widely perceived to seek and engage in globally dispersed exploratory opportunities as well.

These developments, however, do not necessarily imply the globalisation of MNCs without incorporating the geographical distribution of MNC activities (Ghemawat, 2003; Rugman and Verbeke, 2004). Hence, we follow Rugman and Verbeke (2004) and define globalisation as an even geographic distribution of firm technological knowledge learning activities across regions and regionalisation as the regional concentration of such activities. The globalisation features an even distribution of dense regional technological knowledge learning activities within the MNC's global network, which is akin to a clustering structure in the social network literature. With localised pockets of dense connectivity (Burt et al., 2013; Schilling and Phelps, 2007; Yayavaram and Ahuja, 2008), this structure improves local network cohesion and knowledge flow efficiency, maintains distinctive and diversified knowledge pools within the global network (Braha and Yaneer, 2007; Guler and Nerkar, 2012; Reagans and McEvily, 2003; Schilling and Phelps, 2007; Yayavaram and Ahuja, 2008), and facilitates knowledge diffusion (Abrahamson and Rosenkopf, 1997; Centola, 2015; Magni et al., 2012; Reagans and McEvily, 2003).

Yet, globalisation cannot be taken for granted. Rugman and Verbeke (2004) demonstrate that majority of the world's largest MNCs are regionalised instead of globalised by studying the geographic distribution of their sales. The authors further clarify that regionalisation is not anti-globalisation but rather a phase along the globalisation process (Rugman and Oh, 2010). While Rugman's studies focus on sales, others discuss factors influencing MNC competence creation that may hinder the globalisation of organisational learning. For instance, Teece (1977) analysed 27 firm projects and estimated that the costs of technology transfer range from 2% to 59% of total project costs, pinpointing the high costs of globalised learning. Cantwell (2013) cautioned the newly emerged internal boundaries within the decentralised networks of the MNC as barriers of innovation. Zhang and Cantwell (2013) find that a corporate-level or subsidiary-level execution of regional vs. global technological knowledge search strategies determines strategy effectiveness in large MNCs. Kogut and Zander (1992) define combinative capability as the ability of synthesising and applying current and acquired knowledge, through which firms learn new skills and develop new capabilities. They stress that combinative capability is determined by the existing social relationships within a firm. Yet, globally dispersed social relationships are costly to build as even intra-firm relationships and trust must be cultivated and maintained through frequent social interactions across units (Tsai and Ghoshal, 1998). Moreover, Zander and Solvell (2002) imply that optimising sales and profits, rather than the learning and knowledge transfer, is often the main purpose of firm international expansion. Specifically, "internationalization decisions predominantly rest with managers under pressure from financial markets and competitors' activities, not with technical staff and engineers involved in the creation of new products and production processes" (Zander and Solvell, 2002).

On one hand, the globalisation of learning seems to be missing during the decision making process of the MNC, which may also entail high costs of knowledge transfer, breaking barriers, and social interactions. On the other hand, theoretical and empirical evidence projects that MNCs would benefit from seeking and acquiring strategic assets through upgraded subsidiaries worldwide (Bartlett and Ghosbal, 1987; Bartlett and Ghoshal, 1986; Ghoshal and Bartlett, 1988; Gupta and Govindarajan, 1991; Kogut and Chang, 1991; Makino et al., 2002; Trautwein, 1990; Winter, 1987). In this context, the regionalisation of organisational learning, i.e., a concentrated distribution of exploration and exploitation in one or a few regions, seems to be a viable strategic choice. The regional concentration of learning allows the access of the geographically local knowledge and capabilities. Meanwhile, the costs of coordinating knowledge transfer and facilitating social interactions within individual regions are relatively lower than on a global scale.

Extant literature offers some empirical evidence, although limited, supporting a concentrated distribution of business activities. Jansen et al. (2009) and Gambeta et al. (2019) show that physically and structurally separated subunits equipped with concentrated R&D resources produce more diverse innovation and search more geographically and technologically distant knowledge, i.e., more exploration. Vice versa, exploration tends to facilitate technological concentration (Krafft et al., 2014). Otero et al. (2020) find that alliances structurally concentrated within a limited number of geographically dispersed subunits are positively associated with firm ability to realise the potential knowledge recombination benefits of alliance portfolios. By the same token, Chen and Chu (2012) show that the development of resource concentration positively influences business group performance (Chatterjee and Wernerfelt, 1991; Markides and Williamson, 1994). In other words, a concentrated strategy of activities and resources often generates positive performance implications.

Moreover, the MNC network with a concentred distribution of technological knowledge learning activities in one or a few regions may be perceived as a partial clustering structure. It not only circumvents costly worldwide coordination, but also sustains geographically dispersed organisational learning and captures part of the clustering structure's firm performance benefits. Indeed, a key condition is the linkages between these regional clusters and the rest of the MNC. Without the linkages through knowledge transfer and exploitation across units, building distinctive and resourceful regional units may have a negative effect on intra-firm collaboration and knowledge exchange (Zander and Solvell, 2002), as well as firm performance (Birkinshaw et al., 1998; Solvell and Zander, 1998).

Zander and Solvell (2002) warned that it is very important to not confuse global exploiting and global exploring within the contemporary MNC. For instance, by studying exploratory and exploitative projects, Arranz et al. (2019) find that exploration projects tend to have a structure featuring sparse and diverse networks, which facilitate access to a range of information that increases the diversity of the firm's knowledge bases (Gilsing et al., 2008). In the case of exploitation projects, the structural characteristics are cohesive and tightly-integrated networks, which favour cooperation, sharing, and access to resources, all of which reinforce the firm's knowledge bases (Bjorvatn and Wald, 2018). Hence, the current study differentiates the distribution of exploration from that of exploitation. While both globalisation and regionalisation of organisational learning receive supports in the extant literature as discussed above, especially for exploratory activities, we hypothesise:

Hypothesis 1a Regionalisation of exploration is positively associated with firm performance.

Hypothesis 1b Globalisation of exploration is positively associated with firm performance.

The extant literature is largely consistent in suggesting that exploitation should be widely dispersed among the MNC's worldwide operations. For instance, Buckley and Casson (1976) specify that "…[knowledge] exploitation is logically an international operation; thus unless comparative advantage or other factors restrict production to a single country, internalization of knowledge will require each firm to operate a network of plants on a worldwide basis". Rugman (1980) offers a similar argument. Zander and Solvell (2002) summarise the MNC's traditional internationalisation pattern to be a localised exploration for international exploitation, in which innovation and upgrading remain a predominantly local process in the home market while results are exploited by means of one-way transfer of technology throughout the international network of sales and manufacturing units (Dunning, 1988; Hymer, 1976; Vernon, 1966). For contemporary MNCs, it is reasonable to expect that MNC widely dispersed exploitation continues although globalised exploration is still subject to debate.

Recent discussion on multinationality advantages sheds further lights on the speed and scope of knowledge exploitation within the MNC network. After tapping into idiosyncratic and non-overlapping knowledge in geographically dispersed locations, the MNC's inter-unit knowledge exploitation, by taking advantage of what a firm does better than market (Buckley and Casson, 1976; Hennart, 2000; Kogut and Zander, 1993), would significantly increase the knowledge recombination of the MNC, i.e., a knowledge advantage (Kogut and Zander, 1992).

With the increasingly advanced technologies and globalised competition, the speed of knowledge dissemination is accelerating and the product life cycle in knowledge-intensive industries is further shortened (Katila and Ahuja, 2002). This would eventually render the MNC's knowledge advantage. Hence, the speed and scope of knowledge exploitation through intra-MNC and inter-unit knowledge exchanges is critical for the MNC's multinationality advantages (Zhang et al., 2019). The broad and fast knowledge distribution and exploitation within the MNC allows a quick exhaustion of recombination possibilities to shorten a technology's life cycle and thereby rent-harvesting before competitors effectively react (Yayavaram and Ahuja, 2008; Zhang et al., 2019). Consequently, we expect:

Hypothesis 2 Globalisation of exploitation is positively associated with firm performance.

4 Data and method

4.1 Data and sample

This study combines patent data from the USPTO with firm-level data from *Compustat* and *Nexis Uni* databases. Our analyses focus on technological knowledge learning activities between 1980 and 2014, and firm performance between 1985 and 2018. Since we have a keen interest in the geographic distribution of technological knowledge learning activities, it is essential to analyse large firms with geographically dispersed organisational structure. Hence, the world's largest MNCs in the electronics and pharmaceutical industries ranked top in 2014 Fortune Global 500 list are extracted.

The industrial choice considers organisational learning contingencies, such as environmental dynamics and product life cycles. The pharmaceutical industry enjoyed high investments in 1980s and correspondingly high financial performance in the 1990s, due to the birth of biotechnology industry in 1970s. Yet, the turn of the century marked drastic changes and turbulences, including legal and regulatory changes, research productivity issues, and biotech paradox (Malerba and Orsenigo, 2015). In contrast, the electronics industry, especially its semiconductor sector, has been experiencing fast growth with intensified R&D investments, as well as greater internationalisation since 1980s (Almeida, 1996; Gupta et al., 2006; Phene and Almeida, 2008). In other words, both industries feature fast changing environments with potentially different performance implications. The industries also have significantly different product life cycles. The pharmaceutical industry has an average around 10-year product life cycle (Bauer and Fisher, 2000; Teramae et al., 2020). The electronics and related industries have a much shorter product life cycle of around 5 years (Katila, 2002; Oh et al., 2015). Moreover, our industry choice considers the analytical validity of employing patent data in terms of patenting tendency and consistency (Cantwell, 2006).

Existing studies have conceptually defined and empirically operationalised exploration and exploitation in terms of technological innovation and knowledge search (Andriopoulos and Lewis, 2009; Chou et al., 2018; He and Wong, 2004; Jansen et al., 2005; Kang et al., 2017; Kang and Kim, 2020; March, 1991; Mudambi and Swift, 2011; Rosenkopf and Nerkar, 2001; Tushman and O'Reilly, 1996), for which patents and citations are objective and reliable measures (Griliches, 1990; Katila, 2002; Rosenkopf and Nerkar, 2001; Sampson, 2007; Stuart and Podolny, 1996). Patent data from the USPTO provide a quality guarantee and a standard for comparison across firms and over time because of the patent screening and legal procedures enforced by the USPTO (Cantwell, 2006). Since the USA is the largest and technologically the most developed market of the world, many large firms apply for US patents for those inventions that they believe may have the greatest impacts (Archibugi, 1992; Cantwell, 2006). In other words, patent measures offer strong and clear performance implications (Bloom and van Reenen, 2002; DeCarolis and Deeds, 1999; Griliches, 1990; Hall et al., 2005; Kang et al., 2017). Meanwhile, studies have proved the validity of patent data in measuring organisational learning activities (Duguet and Macgarvie, 2005; Jaffe et al., 2000; Katila, 2002; Rosenkopf and Nerkar, 2001; Stuart and Podolny, 1996; Zhang, forthcoming) (for a detailed review on patent and patent citation statistics, see Cantwell and Molero, 2003).

The Standard Country or Area Codes (M49) of the UN Statistics Division are employed to operationalise geographical regions. The codes are based on continental regions, including Africa, Americas, Asia, Europe, and Oceania. They "are further subdivided into sub-regions and intermediary regions drawn as to obtain greater homogeneity in sizes of population, demographic circumstances and accuracy of demographic statistics" (UN Statistics Division).

The distribution of technological knowledge learning activities is measured across 17 sub-regions.

For focal firms between 1980 and 2014, 234,026 patents are extracted. Pharmaceutical firms account for 47,159 patents, which are about 20% of all sample patents, and electronic firms account for the rest 186,867 patents. 13.63% of electronics firm patents are overseas subsidiary inventions, i.e., patents have at least one inventor located in an overseas subsidiary. 47.68% of pharmaceutical firm patents are overseas subsidiary inventions. In other words, pharmaceutical firms use overseas subsidiaries for technological innovation to a much larger extent than electronics firms. Novartis, Roche and Sanofi dominate this trend. Over the study period, Novartis possesses 3,378 overseas subsidiary patents out of 4,089 total patents; Roche has 5,347 overseas subsidiary patents out of 6,910 total patents; Sanofi has 9,998 overseas subsidiary patents out of 13,405 total patents. Extracted patents are concentrated in the triad area: North America – 23.55%, Europe – 19.87%, and Eastern Asia – 56.2%. While this could be that our sample firms are originated from those regions, same geographical patterns are observed for subsidiary patents only, tentatively indicating the regionalisation of organisational learning.

4.2 Variables

4.2.1 Dependent variable

- *Innovative performance* is measured by the annual number of patents granted to each focal firm in year *t*. Since the annual number of patents may fluctuate significantly, a 3-year moving average is adopted.
- *Financial performance* is measured by Tobin's Q, which is the ratio of the market value of a firm's assets to the replacement cost of its assets. If the firm is worth more than its value based on what it would cost to rebuild it, then excess profits are earned. Therefore, the higher the Tobin's Q, the better the performance. Tobin's Q also has the advantage of capturing market expectations of knowledge creation competitiveness (Kang et al., 2017; Levitas and McFadyen, 2009; Megna and Klock, 1993). A 3-year moving average is adapted to smooth annual fluctuations.

4.2.2 Independent variables

We use backward citations to measure firm exploratory and exploitative efforts.

Backward citations of a patent are all the 'prior art' that the patented invention draws upon and determine the legal boundaries of the property rights to the invention (Jaffe et al., 1993). Hence, citations suggest technological knowledge linkages between citing and cited patents. We define exploratory citations as a firm's citations to patents not granted to or previously cited in the last 5 years by the same firm (Caner et al., 2017; Katila and Ahuja, 2002). Ahuja and Lampert (2001) justify the use of a 5-year window given the shortened product life cycle and accelerated innovation rates in high-tech industries. A similar argument can be found in Fleming and Sorenson (2004) and Alnuaimi and George (2016). In a similar vein, exploitative citations are a firm's citations to patents previously cited in the past 5 years or owned by the same firm (Katila and Ahuja, 2002).

To measure the distribution of technological knowledge learning activities across regions, we adapt Herfindahl index, a common measure of market concentration, on exploration/exploitation shares:

$$HHI = s_1^2 + s_2^2 + s_3^2 + \ldots + s_n^2 \quad (1)$$

where s_n is region *n*'s share in the overall exploratory or exploitative citations of a firm. Specifically, a region's exploratory citation share is the number of a firm's exploratory citations in the region divided by the firm's total exploratory citations in year *t*. *Geographical concentration of exploration* is the HHI of all region's exploratory citation shares of a firm in year *t*, indicating to what extent a firm's new or explorative knowledge is concentrated within one or a few regions. It is worth of noting that we measure globalisation and regionalisation of organisational learning as one continuous variable. A high value of *geographical concentration of exploration* indicates regionalisation, and a low value suggests globalisation. By the same token, the HHI of all regional exploitative citation shares of a firm in year *t* is calculated to measure *geographical concentration of exploitation*. It is worth of stressing that our measure focuses on the geographical distribution of technological competence creation activities, which differs from any previous scale and scope measures (Ahuja and Lampert, 2001; Caner et al., 2017; Katila and Ahuja, 2002).

4.2.3 Control variables

Since we are interested in the distribution of learning activities, we control exploration, exploitation and ambidexterity of a firm. By following Katila and Ahuja (2002), we construct $Exploration_{it}$ as the proportion of exploratory citations in firm *i*'s total citations in year *t*.

$Exploitation_{it}$ is measured by the number of exploitative citations divided by firm *i*'s total citations in year *t* (Katila and Ahuja, 2002). The interaction between exploration and exploitation is adopted to measure ambidexterity (Gatti et al., 2015; Gibson and Birkinshaw, 2004; Guisado-González et al., 2017; He and Wong, 2004; Ho et al., 2020; Katila and Ahuja, 2002; Lavie et al., 2011; Stettner and Lavie, 2014).

$$Exploration_{it} = \frac{\sum_{t-5}^{t-1} patents\ not\ previously\ granted\ or\ cited_{it}}{total\ citations_{it}} \tag{2}$$

$$t = 1980 \ldots 2014$$

We further control for firm-level competence building capabilities (Lane and Lubatkin, 1998; Levinthal and March, 1993; Rosenkopf and Nerkar, 2001; Zhang, 2016) by firm *patent stock* and *R&D intensity*. What drives exploration is not just what a firm can do, but also what it can afford to do (costs) (Lampert and Kim, 2019). We hence control for a firm's previous financial performance by its *ROA*, *earning per share* (i.e., net income/shares outstanding), and *debt* ratio (i.e., long-term debt/total assets). Since firm size and age would impact the relationship in question (Suzuki, 2019), we control for *firm size* that is captured by the log of the annual number of employees. *Firm age* is measured by the log of the difference between the founding year of a firm and a focal year. Lastly, we include an industry dummy with the electronics industry as the baseline category, firm dummies, and year dummies. Alternative variable measures are discussed and tested in robustness tests.

4.3 Method

Since *innovative performance* is measured by patent counts that take only non-negative integer values, both Poisson and negative binomial analyses are appropriate to model count variable (Hausman et al., 1984; Henderson and Cockburn, 1996). An important assumption of Poisson model is conditional variance equals conditional mean. When variance exceeds mean for innovative performance, the computed standard errors would be underestimated if a Poisson model were employed. This would lead to spuriously high level of significance although coefficients are estimated consistently (Hausman et al., 1984). Instead, a Negative Binomial analysis is an appropriate model to reduce data over-dispersion (Hausman et al., 1984; Rosenkopf and Nerkar, 2001). *Innovative performance* has a variance of 708,680 that is larger than its mean of 872. The conditional variances of the variable by firms are also consistently larger than their means. A likelihood ratio test that alpha equals zero–the likelihood ratio test comparing this model to a Poisson model-suggests that alpha is non-zero and the negative binomial model is more appropriate than the Poisson model for our data.

As *financial performance* is measured by Tobin's Q, we estimate the models using panel data regression with firm-fixed effects. All our regression models are set this way to maintain a larger number of observations: firm performance Y at year t is regressed on independent variables X at year $t-5$, and control variables at year $t-1$, i.e.,

$$Y_{it} = X_{i(t-5)} + C_{i(t-1)} + e \quad (3)$$

where i = firm, t = year.

5 Results

5.1 Overall patterns

Before discussing the relationships between globalisation/regionalisation and firm performance, we illustrate the overall distribution patterns of three selected MNCs over the 35-year study period. Siemens, Pfizer, and Sony are selected to represent different home countries and industries. To better illustrate the trend across regions, we group the 17 regions from UN M49 codes to seven regions, including North America, Europe, Australia, Eastern Asia, Central and Western Asia, Latin America, and Africa. Figure 1 shows the overall pattern of regional shares of exploration or exploitation for each firm. For the sake of easy reading, we only report the shares in the triad area for sample firms as the rest of the regions contribute only a small portion in their overall exploration and exploitation. The first graph is based on Siemens. Apparently, both exploration and exploitation are concentrated in Europe (home) and North America regions. Interesting, the graph of Pfizer shows that its exploration and exploitation have largely concentrated in Europe, and its home region, i.e., North America, contributes a much smaller share in organisational learning. Sony's exploration and exploitation have concentrated in North America. Similarly, its home region, i.e., East Asia, plays a much less important role. Regardless of the variations across firms, one general observation is that the shares of exploration and exploitation are highly correlated by regions. This differs from what traditionally expected, i.e., regions hosting many developed economies would show a significantly bigger exploration share than exploitation share (and vice versa for regions hosting more developing economies to show a bigger exploitation share than exploration share). This observation also tentatively rejects our Hypothesis 2 in that exploitation shows regionalisation, instead of globalisation patterns. Second, the regional shares of exploration and exploitation for each firm are relatively stable over time.

Figure 1 Regional trends of exploration and exploitation – selected MNCs

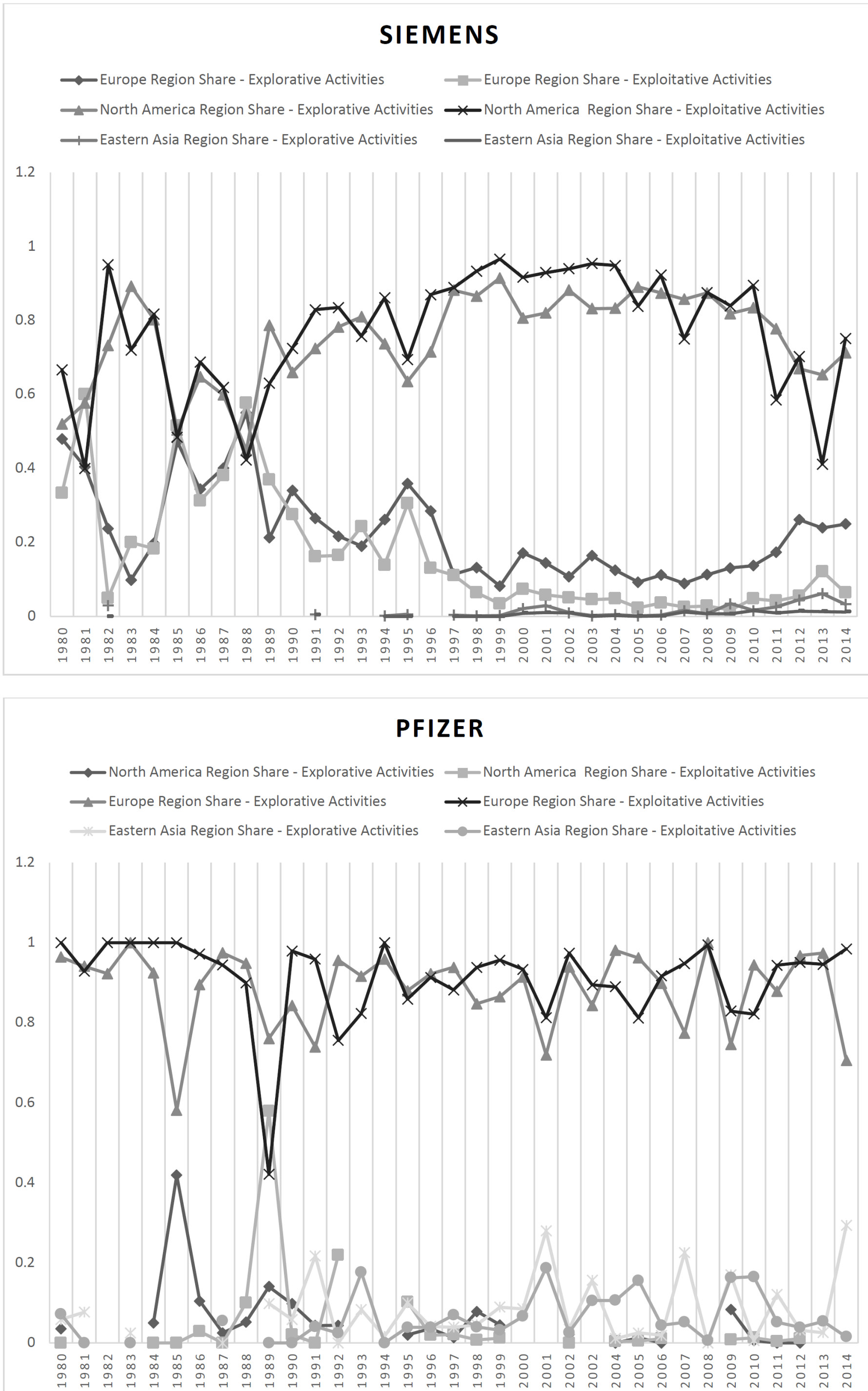
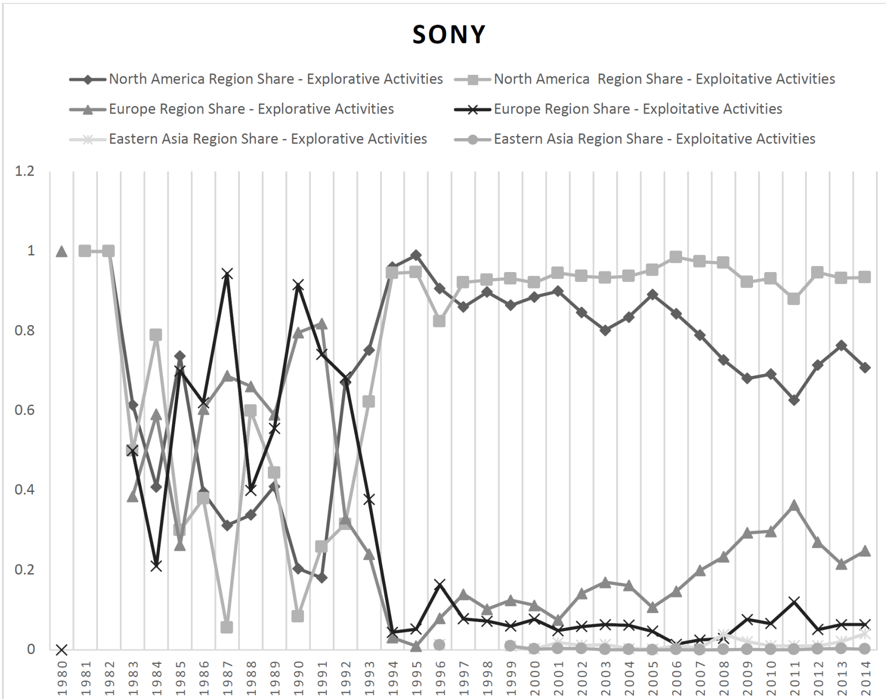


Figure 1 Regional trends of exploration and exploitation – selected MNCs (continued)



This trend suggests that a large scale of geographical dispersion (or globalisation) of competence creating activities, as recommended by many MNC studies, may take a long time to be realised or pick up speed. Lastly, we observe that firm technological knowledge learning activities are concentrated in the triad area, i.e., North America, Europe, and Asia, like the sales distribution found by Rugman and Verbeke (2004). Yet, unlike Rugman and Verbeke (2004)'s observation based on sales data, we find that the home region of selected firms is not necessarily playing the most important role in international organisational learning, e.g., for Pfizer and Sony. This discrepancy may be explained by the MNC restructuring since early 2000s given the different time-frame of our studies. An alternative interpretation is that MNCs may adopt different regional structures for upstream and downstream activities along the value added chain of the firm.

Figure 2 reports the concentration of organisational learning across regions over time for the three firms. Siemens experienced a period of more regionalisation between mid-1980s and mid-2000s. It seems the company is moving toward more globalisation lately. Pfizer maintains a relatively high level of regionalisation, which has been stable over time. Sony with a similarly high level of regionalisation over time, on the other hand, seems to be moving toward the globalisation of exploration and further regionalisation of exploitation since late 1990s. In sum, the concentration of organisational learning across regions over time has been largely stable for firms, but variations do exist across firms and industries.

Figure 2 Trends of globalisation vs. regionalisation – selected MNCs

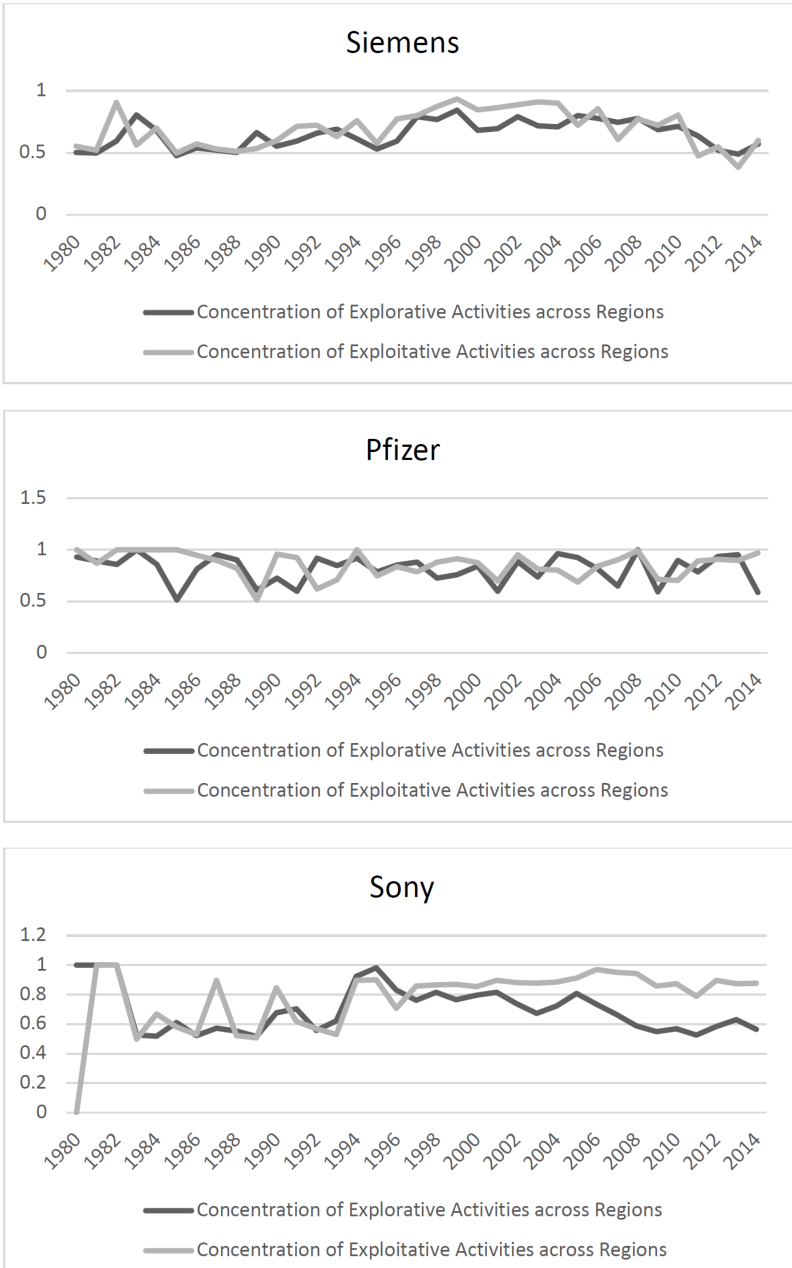


Table 1 Pearson correlation matrix

	Variables	*N*	*Mean*	*Std dev*	*Min*	*Max*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1	Geographical concentration of exploration	328	0.62	0.21	0.16	1.00	1											
2	Geographical concentration of exploitation	328	0.63	0.25	0.00	1.00	0.4583	1										
							<.0001											
3	Exploration	338	0.50	0.20	0.02	1.00	0.4488	0.0682	1									
							<.0001	0.2183										
4	Exploitation	338	0.82	0.58	0.00	3.46	–0.3931	–0.0526	–0.7275	1								
							<.0001	0.3422	<.0001									
5	Patent stock	260	11,466	11,527	1	55,196	0.2129	0.3044	–0.0807	0.2450	1							
							0.0007	<.0001	0.1954	<.0001								
6	R&D intensity	264	0.12	0.06	0.01	0.50	–0.4276	–0.3751	–0.3571	0.1816	–0.5296	1						
							<.0001	<.0001	<.0001	0.0051	<.0001							
7	ROA	264	0.06	0.06	–0.20	0.21	–0.5168	–0.4705	–0.4509	0.2913	–0.4515	0.3418	1					
							<.0001	<.0001	<.0001	<.0001	<.0001	<.0001						
8	Earnings per share	264	3.10	10.49	–23.89	117.82	–0.0203	–0.0330	0.0883	–0.0845	–0.0653	–0.0472	0.0914	1				
							0.7591	0.619	0.1766	0.1959	0.3285	0.4447	0.1385					
9	Debt	264	0.11	0.08	0.00	0.48	0.2710	0.1735	0.0187	0.0388	0.0976	0.0215	–0.2388	–0.0989	1			
							<.0001	0.0084	0.7756	0.5529	0.1435	0.7285	<.0001	0.1088				
10	Firm size	264	4.70	1.12	0.00	6.18	0.4305	0.3330	0.1953	–0.0527	0.5836	–0.6273	–0.2808	0.1177	0.1463	1		
							<.0001	<.0001	0.0026	0.4202	<.0001	<.0001	<.0001	0.0562	0.0174			
11	Firm age	371	4.30	0.84	0.00	5.14	0.0491	0.0462	–0.0843	0.1265	0.1749	–0.2433	0.1868	0.1422	0.1306	0.6736	1	
							0.3751	0.4042	0.1218	0.02	0.0047	<.0001	0.0023	0.0208	0.034	<.0001		
12	Pharma industry	338	0.51	0.50	0.00	1.00	–0.2713	–0.2913	–0.3213	0.2008	–0.4707	0.5219	0.6141	–0.0300	0.0055	–0.2121	0.1917	1
							<.0001	<.0001	<.0001	0.0002	<.0001	<.0001	<.0001	0.6465	0.9334	0.001	0.0004	

Table 2 Negative binomial regressions on innovative performance

Variables	*All*			*Electronics*		*Pharmaceutical*	
	1	*2*	*3*	*4*	*5*	*6*	*7*
Geographical concentration of exploration (H1)		0.25⁺ (0.14)		–0.05 (0.09)		0.73* (0.32)	
Geographical concentration of exploitation (H2)			0.23* (0.11)		–0.01 (0.07)		0.67* (0.28)
Exploration	–0.64*	–0.43	–0.34	–0.00	–0.04	1.04	1.10⁺
	(0.32)	(0.35)	(0.35)	(0.41)	(0.40)	(0.65)	(0.65)
Exploitation	–0.25*	–0.47***	–0.47***	0.08	0.06	–0.06	–0.15
	(0.12)	(0.13)	(0.13)	(0.16)	(0.16)	(0.24)	(0.24)
Balance (exploration × exploitation)	–0.55⁺ (0.33)	0.16 (0.34)	0.08 (0.35)	–0.56 (0.40)	–0.50 (0.38)	–1.33⁺ (0.70)	–1.23⁺ (0.70)
Patent stock	0.00***	0.00	0.00	–0.00	–0.00	–0.00**	–0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
R&D intensity	1.27*	1.13*	1.17*	1.72	1.72	2.20**	2.11**
	(0.53)	(0.53)	(0.52)	(1.15)	(1.15)	(0.78)	(0.78)
ROA	2.37***	1.39**	1.49**	–1.02*	–1.04*	1.86⁺	2.14*
	(0.45)	(0.49)	(0.49)	(0.46)	(0.47)	(1.04)	(1.03)
Earnings per share	–0.00	–0.00	–0.00	–0.00	–0.00	0.05⁺	0.04
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.03)
Debt	–0.50	–0.92*	–0.72*	–0.20	–0.24	–0.96	–0.80
	(0.35)	(0.38)	(0.36)	(0.38)	(0.38)	(0.59)	(0.58)
Firm size	–0.08	–0.28**	–0.31**	0.41***	0.41***	–0.06	–0.12
	(0.10)	(0.10)	(0.10)	(0.12)	(0.12)	(0.17)	(0.18)
Firm age	2.69***	2.53***	2.54***	1.84***	1.88***	–1.61	–1.63
	(0.26)	(0.32)	(0.31)	(0.37)	(0.37)	(1.46)	(1.45)
Pharma industry	2.38***	1.63**	1.63**	.	.	.	.
	(0.37)	(0.53)	(0.52)	.	.	.	.
Firm dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	–6.07***	–4.20**	–4.19**	–4.88**	–5.04**	13.22*	13.59*
	(1.06)	(1.51)	(1.49)	(1.65)	(1.65)	(6.49)	(6.46)
N	206	180	180	94	94	86	86
Log lik.	–1,277.05	–1,133.03	–1,132.33	–580.56	–580.67	–479.62	–479.46
Chi-squared	647.16	559.25	560.65	364.84	364.61	140.09	140.41
df_m	41.00	40.00	40.00	35.00	35.00	35.00	35.00

Notes: Standard errors in parentheses; $^{+}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table 3 Panel data regressions with firm-fixed effects on financial performance

Variables	*All*			*Electronics*		*Pharmaceutical*	
	1	*2*	*3*	*4*	*5*	*6*	*7*
Geographical concentration of exploration (H1)		1.32***		0.19		1.38^{+}	
		(0.39)		(0.17)		(0.79)	
Geographical concentration of exploitation (H2)			0.99**		0.27*		0.41
			(0.31)		(0.13)		(0.76)
Exploration	–0.11	1.58^{+}	1.68^{+}	–0.09	0.01	4.75**	4.66**
	(0.91)	(0.86)	(0.87)	(0.46)	(0.45)	(1.55)	(1.57)
Exploitation	–0.70*	–0.28	–0.30	–0.10	–0.06	0.70	0.75
	(0.28)	(0.26)	(0.26)	(0.20)	(0.20)	(0.48)	(0.50)
Balance (exploration × exploitation)	1.42^{+}	–0.28	–0.48	0.21	0.08	–3.68*	–4.12*
	(0.85)	(0.80)	(0.81)	(0.48)	(0.47)	(1.73)	(1.78)
Patent stock	–0.00	0.00^{+}	0.00^{+}	0.00**	0.00**	–0.00**	–0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
R&D intensity	–1.48	–0.23	–0.21	–7.37***	–7.23***	5.58*	5.58*
	(1.81)	(1.65)	(1.65)	(2.14)	(2.10)	(2.45)	(2.49)
ROA	6.26***	1.58	1.84	–2.73***	–2.53***	7.41**	7.07**
	(1.55)	(1.39)	(1.41)	(0.69)	(0.68)	(2.52)	(2.55)
Earnings per share	–0.01	0.00	0.00	–0.00	0.00	–0.00	–0.01
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.08)	(0.08)
Debt	0.59	1.70	2.41*	–0.87	–0.49	2.18	2.84^{+}
	(1.15)	(1.05)	(1.04)	(0.67)	(0.68)	(1.70)	(1.70)
Firm size	–1.07**	–1.79***	–1.80***	0.10	0.06	–2.32***	–2.37***
	(0.33)	(0.30)	(0.31)	(0.18)	(0.18)	(0.53)	(0.54)
Firm age	0.42	0.50	0.36	–3.47***	–3.34***	10.63***	10.82***
	(0.90)	(0.93)	(0.92)	(0.50)	(0.49)	(2.79)	(2.83)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	4.86^{+}	6.32^{+}	7.05*	15.44***	14.96***	–38.78**	–38.72**
	(2.84)	(3.46)	(3.41)	(1.73)	(1.67)	(11.72)	(11.89)
N	226	218	218	112	112	106	106
R-sq	0.30	0.43	0.43	0.85	0.85	0.53	0.52
adj. R-sq	0.23	0.37	0.37	0.82	0.83	0.46	0.44
F	8.66	13.47	13.27	48.06	49.89	9.41	8.89

Notes: Standard errors in parentheses; $^{+}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

5.2 Statistical results

Table 1 reports the correlation matrix of independent and non-categorical control variables. *geographical concentration of exploration* and *geographical concentration of exploitation* are correlated, which is consistent with observations in Figures 1 and 2. We therefore include independent variables individually in regression models. Some high correlations between controls are logical, such as *patent stock* and *R&D intensity*, *firm size* and *R&D intensity*, *firm size* and *firm age*. To control for their impacts, we remove one variable from each highly correlated pair of variables in our regressions and our results are consistent.

We report hypothesis tests on firm innovative and financial performance separately. Table 2 reports the Negative Binomial regression results on firm *innovative performance*. Model 1 is the baseline model with only controls. Model 2 adds independent variable *geographical concentration of exploration*, and model 3 adds *geographical concentration of exploitation* to the baseline model. Both independent variables are positively significant with *geographical concentration of exploration* being marginal significant. We further run the regressions for the sample MNCs by industries. Models 4 and 5 report the results for the electronics firms, and models 6 and 7 are for the pharmaceutical firms. The pharmaceutical firms drive the main results observed in models 2 and 3, with positively significant coefficients for both *geographical concentration of exploration* and *geographical concentration of exploration* in models 6 and 7. Meanwhile, the two independent variables are not significant for electronics firms in Models 4 and 5.

Table 3 reports the panel data regression results on firm *financial performance*. Both *geographical concentration of exploration* and *geographical concentration of exploitation* in models 2 and 3 are positive and strongly significant. Industrial models show that *geographical concentration of exploration* is important for pharmaceutical firms whereas *geographical concentration of exploitation* has a significant impact on electronics firms' financial performance.

With one continuous variable measuring geographical concentration, a positive coefficient indicates regionalisation, and a negative coefficient implies globalisation. Hence, the positively significant coefficients on the concentration variables across models and industries suggest that regionalisation, through the concentration of exploration and exploitation in one or a few regions, has a positive impact on firm innovative and financial performance. Hypothesis 1a argues for a positive association between regionalisation of exploration and firm performance, which is supported by the results. Hypothesis 2 expects that globalisation of exploitation would have a positive impact on firm performance. Yet, the empirical results on Hypothesis 2 suggest the opposite.

The differences across industries entail a contingency view of organisational learning. The negative coefficients of independent variables in models 4 and 5 in Table 2 hint the importance of globalisation for electronics firms' innovative performance, although they do not reach a statistically significant level. It may be explained by the limited number of sample firms in the current study. In contrast, regionalisation plays a more critical role in improving pharmaceutical firms' innovative performance. This finding is largely consistent with industrial trends. For instance, the electronics industry is experiencing a relatively faster globalisation process with strong competitors from geographically dispersed emerging economies. The industry accounted for 10 percent of China's GDP growth and about 35 percent of China's foreign trade by 2010 (Bhaumik et al., 2016). This trend urges leading firms in the industry to globalise their competence creating efforts for both proactive and defence reasons, such as tapping into local knowledge, deploying listening posts, and monitoring major competitors etc. Pharmaceutical industry, on the other hand, has been relatively stable and concentrated in the triad area, even though overseas subsidiaries of pharmaceutical firms tend to patent significantly more than those of electronics firms as shown by our data summary. Industrial differences are also manifested by the coefficients of control variables, such as *exploration*, *exploitation*, *balance*, *patent stock*, *R&D intensity*, *ROA*, etc. Lastly, in the baseline models, i.e., model 1, *exploration*, *exploitation* and *balance* are largely significant. Yet, with the addition of distribution variables, these control variables are no longer significant. While the extant literature focuses on the type (exploration vs. exploitation) and magnitude (the balance between exploration and exploitation) of technological knowledge learning activities, our results offer strong evidence of the importance of distribution of activities as such.

5.3 Robustness tests

To test the robustness of our findings, we run regressions with alternative measures and different empirical settings. For dependent variables, we collect the annual number of new product releases from *Nexis Uni* database as an alternative measure of firm innovative performance (Chou et al., 2018; Mudambi and Swift, 2014). Due to the number of missing data points, the model fit is not acceptable. We further employ Altman Z-score and revenue growth rate as alternative measures of financial performance. Altman Z score is a formula for determining whether a company, notably in the manufacturing space, is headed for bankruptcy. The formula considers profitability, leverage, liquidity, solvency, and activity ratios. An Altman Z-score close to 1.8 suggests a company might be headed for bankruptcy, while a score closer to 3 suggests a company is in solid financial positioning. Revenue growth rates are calculated based on annual revenue changes. The results with alternative dependent variables are largely consistent with our main findings.

For the geographical concentration of technological knowledge learning activities, we employ two alternative measures. First, we pull the parent patents and overseas subsidiary patents together and re-calculate the independent variables. In this case, the headquarters in the home region is also taken into consideration when calculating the concentration index. The results are consistent for financial performance models but lose significant in innovative performance models. Second, some regions may devote more resources on exploration or exploitation, which could potentially impact the results. We re-calculate the exploration and exploitation shares, as well as concentration variables, to capture the simple participation of each region in exploration or exploitation by leaving the extent of participation out. For this alternative measure, an exploratory or exploitative citation only appears in a region's annual exploration or exploitation share once regardless how many times it was cited in a year. For example, if region X's exploratory citations in year t are A, A, B, C, C, and C, our independent variable measures in Tables 2 and 3 include all 6 citations in the index calculation. The alternative measure only includes three citations, i.e., A, B, and C, in the calculation. The results with alternative measures are consistent with those in Tables 2 and 3. While Zander and Solvell (2002) caution the importance of considering the magnitude of change in MNC geographically dispersed organisational learning, our results show that the magnitude and the distribution of activities as such are independent. It again points to the importance of distribution in future organisational learning studies.

We further employ some alternative measures of control variables and obtain largely consistent results. R&D intensity is replaced by available slack resources (that is calculated by subtracting net profit from gross profit and then divided by total sales) and absorbed slack resources (that is calculated as general and administrative expenses divided by total sales). Firm size is alternatively measured by revenue, and ROA is replaced by ROE. Lastly, given the continuously shortened product life cycles in high-tech industries (Bauer and Fisher, 2000; Teramae et al., 2020), we re-run all our models with l-year and 3-year lags. The results are largely consistent but less significant, suggesting the dynamic nature between technological knowledge learning activities and firm performance over time (as well as across industries as shown above), which worth further exploring in future studies.

6 Discussion and conclusions

This study connects the organisational learning and the MNC literature and seeks the answer to the question of how the geographic distribution of technological knowledge learning activities impacts large MNCs' performance. The distribution of activities has largely been neglected by the organisational learning literature. While the geographical location is a critical topic in the MNC literature, regionalisation vs. globalisation has been an ongoing puzzle that deserves further attention. We define regionalisation as a concentrated distribution of technological knowledge learning activities in one or a few geographical regions, and globalisation as an even distribution. By analysing over 35-year patent and firm data of the world's largest MNCs in electronics and pharmaceutical industries, we find that regionalisation of exploration and exploitation is positively associated with firm innovative and financial performance.

This study contributes to the discussion of regionalisation and globalisation in MNC literature. Rugman and Verbeke (2004) demonstrate the regionalisation of the world's largest MNCs in terms of international sales, which represent downstream activities along a supply chain. We focus on an upstream activity, i.e., knowledge learning activities associated with technological innovation, over a more than three decades period. Geographical dispersed competence creation that involves both exploratory and exploitative learning has been a critical development of contemporary MNCs and component of multinationality advantages (Bartlett and Ghosbal, 1987; Bartlett and Ghoshal, 1986; Kogut and Zander, 1992; Leiponen and Helfat, 2011; Zander, 1998; Zander and Solvell, 2002). This study advances our understanding on whether an upstream supply chain activity of the MNC exerts a similar regionalised pattern, and whether regionalisation has involved towards globalisation over the last two decades since the early work on the issue. This study empirically shows that the regionalisation of exploration and exploitation has been a stable phenonium for large MNCs in the last couple of decades. The regionalisation as such is also positively associated with firm innovative and financial performance. Moreover, we find that the MNC's home region does not necessarily play the most important role in the regionalisation of organisational learning, although the home region was critical for international sales (Rugman and Verbeke, 2004). This could be interpreted as the evidence of the MNC's stride toward globalisation given the time elapsed between these studies, as well as firm adopting different regional strategies across supply chain activities. We further demonstrate that regional composition has been stable by concentrating in the triad area, but the regional pattern of concentration may vary across industries. These results endorse a finer-grained examination on the evolution and implication of globalisation in future research, e.g., the relationship between regionalisation and globalisation, the predecessors of the positive effects of regionalisation on performance, the contingencies of multinationality advantages, and optimal alignments across global supply chain activities, to name a few.

Another key contribution of the current study is the identification of a critical dimension of organisational learning, i.e., the distribution of activities, in determining firm performance.

Distribution of firm resources and activities, by enabling organisation's strategic and operational possibilities (Miller and Martignoni, 2016), have only started to attract research attention recently, for instance in studies of alliances and business groups (Bos et al., 2017; Chen and Chu, 2012; Gama and Bandeira-de-Mello, 2021; Misangyi et al., 2006). Whereas extant organisational learning literature focuses on the quality/type and the quantity/magnitude of learning, we initiate the investigation of the distribution of technological knowledge learning activities. The significant results on the distribution of exploration and exploitation, after controlling the individual effects of exploration, exploitation, and ambidexterity, suggest that distribution must not be neglected when evaluating the relationship between organisational learning and firm performance. While the fundamental question for research on ambidexterity may reside more in how to build synergy through ambidexterity so to optimise exploitation and exploration fully for sustained competitive advantage [Raisch and Birkinshaw, 2008; Simsek, (2009), p.867; Piao and Zajac, 2016], the distribution as a critical determinant of synergies deserves future research attention.

Our findings on the regionalisation of organisational learning offer practical implications for MNC managers. Instead of targeting at a globally dispersed competence creating network, large MNCs should consider concentrating resources and competence creating efforts in one or a few regions, including both home and international regions. The findings are also applicable to the global supply chain issues caused by the current COVID-19 pandemic. While researchers are actively exploring strategies improving the resilience of global supply chains, our findings offer supporting evidence of a regionalisation strategy that may be deployed by MNC managers in re-shaping global supply chains.

This study, as one of first attempts to understand the geographical distribution of MNC technological knowledge learning activities and its performance implications, suffers from some limitations. We relate an even distribution of organisational learning across regions within the contemporary MNC's global network to a clustering network structure. We compare the regionalisation as a partial clustering structure, which is operationalised by patent statistics in our empirical analyses. This cross-disciplinary approach connecting social networks, MNCs, and organisational learning literature could be a prosperous tool in advancing our understanding across fields. Yet, the current study focuses only on one dimension of the network structure, i.e., the concentration of nodes. Future research may further build upon this approach and empirically operationalise other features of MNC competence creation networks. As one of the first attempts to study intra-firm distribution of MNC technological knowledge learning activities, we focus on the world's largest firms in the pharmaceutical and electronics industries to secure the observation of geographic dispersion of activities. This setting, however, limits the number of sample firms available for the analyses and the generalisability of the results. Future studies should extend empirical analyses to MNCs with different sizes, which would also allow more firm-level and environmental controls. We measure exploration and exploitation by employing organisational and temporal boundaries, e.g., exploration as the new knowledge to a firm within the last five years. With other meaningful boundaries, such as geographical, technological, and industrial, future studies could use different measures to incorporate the multidimensional nature of exploration and exploration.

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