Innovation and International Business

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Abstract

While classical economic theories of growth emphasized international capital accumulation, and finance-based theories of foreign investment stressed international interest differentials and risk reduction, the technological accumulation approach examines international knowledge building by multinational enterprises (MNEs) and their international business (IB) networks. The two processes of innovation and internationalization have become ever more interconnected as central drivers of development since the first industrial revolution, through to today's information age. The increasing significance of the knowledge-seeking motive for IB networks and of competence-creating subsidiary activities at a local level have linked localized innovation systems to IB and to international knowledge exchange. From a locational perspective, international knowledge connectivity has become critical for sustained innovation and growth. The shift of techno-socio-economic paradigm in the information age is associated with a shift in the character of IB and innovation, with critical implications for IB theory and concepts.

Keywords

Technological accumulation, innovation networks, international knowledge flows, competence-creating subsidiaries, geography of innovation, information age.

Innovation and International Business

The objective of this article is to explain what the international business (IB) perspective has to offer to the subject area of industry and innovation. Research on innovation and international business can be grouped under four headings, which I use to arrange the article into four sections, before concluding in a final section. First, there are increasingly aspects of technological change that are organized across borders, or rely on international knowledge connectivity. This is reflected in the *Industry and Innovation* journal's call for papers on international knowledge flows and international knowledge sourcing in pursuit of the journal's focus theme on innovation and IB. Second, while innovation has come to depend on the structure of IB networks, these networks have been themselves in a process of major change, of a kind that has tended to encourage more open international innovation systems. This is reflected in *Industry and Innovation*'s call for papers on the globalization of technology development within and across the global networks of multinational enterprises (MNEs). Third, while the strategy and innovation literature has tended to focus on the internal or geographically local characteristics of clusters, IB is a primary connector of different innovative locations. This is echoed in the journal's call for new evidence on the localization of innovative activities within firms (such as between the home and host locations of MNEs), taking into account differences in local institutional and political contexts and the rise of innovation in emerging markets. Fourth, and more generally, the change in the IB environment in the information age has reinforced all the other three themes, and so the concluding section of this article considers this underlying driver of the globalization of innovation in its own right.

1. International technological accumulation and cross-border knowledge building

The essential premise of the received theory of foreign direct investment (FDI) is that FDI requires the cross-border transfer of a package of resources (Caves 1982). It is further argued that the most vital part of this package of resources entails the transfer of technology, and (we would add these days) the associated corporate capabilities. This makes FDI unlike foreign portfolio investment (FPI), which is only about the flow of capital or financial resources, so FPI falls into the domain of finance, while FDI and IB lie in the domain of industry and innovation. However, this original starting point for the theory of FDI led IB scholars to conceptualize the MNE simply as a vehicle for technology transfer, without paying much attention to how the technology is created through innovation in the first place. Yet in the more recent IB literature, attention has rightly shifted from the MNE merely as an agent of technology transfer and towards the MNE as a technology creator across national boundaries (Cantwell 1989). While the early question in the IB field was 'why do technologically advantaged firms go abroad to exploit this advantage (and transfer their technology internally to be able to do so)?' (see e.g. Hymer 1960), with the rapid expansion of FDI in now-established MNEs and of FDI from a wider range of home countries the question became 'why do established MNEs source technology creation internationally through an internal network of geographically dispersed affiliates?' (see e.g. Dunning, 1996). This has led to a greater interest in the competence-based or capability-based theory of the firm in the analysis of the MNE (Cantwell and Piscitello 2000; Cantwell and Zhang 2009; Teece 2014), and in the role of inter-company alliances in the capability generation of partner MNEs (Hagedoorn and Narula 1996; Chesnais 1988; Cantwell 2013).

The term 'technological accumulation' encapsulates the view that the development of technology within a firm is a cumulative process, and within IB networks this process may occur across national boundaries (see Ietto-Gillies 2012, chapter 11). The notion of technological accumulation is consistent with the ideas of Rosenberg (1976 and 1982), Usher (1929), and the earlier work of Marx on technological change through continuous processes of systematic adaptation. That is, the creation of new technology is to be understood as a gradual and painstaking process of continual adjustment and refinement, as new productive methods are tested and adapted in the light of experience. In any firm, there is a never ending interaction between the creation of technology and its use in production. When technology is created and used across a diversity of local environments, then firms can learn from that diversity of knowledge and experience. Even where new technology is acquired from outside the firm, and especially when it emanates from sources in unfamiliar settings, it must be gradually adapted and integrated with its existing production methods, thus becoming part of the internally creative process.

While the product cycle theory (Vernon 1966, Hirsch 1967) supposed that a particular act of technology creation was then diffused abroad, in the technological accumulation approach the use of technology in new environments feeds back into fresh adaptation and (depending upon the state of local scientific and technical capability) new innovation. When production is located in an area that is itself a center for innovation in the industry concerned, the firm may gain access to local capabilities which allow it to extend technology creation in what are for it previously untried directions. In recent years technological accumulation has frequently been organized in international networks, or in other words internationally integrated MNEs or flagship MNEs that

orchestrate global value chains (GVCs). At one time MNEs may have been simply the providers of technology and finance for scattered international production, driven mainly by natural resource-seeking and market-seeking motives; today they have become global organizers of economic systems, including systems for allied technological development in different parts of the world, now incorporating knowledge-seeking motives. This international knowledge search and discovery of new combinations relies on the role of IB in establishing and facilitating greater connectivity between spatially dispersed knowledge sources (Cano-Kollmann et al 2016).

The technological accumulation approach therefore addresses the question of why it is that technology is often developed in international networks orchestrated and connected by an MNE or a flagship firm, rather than in a series of independently controlled plants coordinated only through arms length markets. Yet the need to exercise administrative coordination and control may be not so much a feature of the market for technological knowledge which is the focus of internalization theory (Buckley and Casson 1976), as a feature of the social or collaborative nature of technological development itself (Kogut and Zander 1993, 1995). In the alternative evolutionary view, technological knowledge is not an immediately usable intermediate product in its own right, but is rather an input into the collective corporate learning processes by which tacit capabilities and hence technology in the broader sense is generated. As such, it is an input that normally has its greatest relevance to the learning process of the firm (or network of firms) that created it and set the problem-solving agenda to which it represents a response, and thus it is likely to be of the greatest value to the originating entities (Cantwell 1991, 1994).

The generally greater ease of transfer of technology within the MNE or the IB network that it orchestrates may be attributed to the establishment of common social communities with shared values across the differentiated units that are part of the international MNE network (Kogut and Zander 1993; Nohria and Ghoshal 1997), but this is far from the only means by which intra-network learning and exchange is enhanced. The deliberate efforts of the MNE to integrate sub-unit activity and to direct some division of labor in tasks that require inter-unit coordination ensures that the technological activities of the different parts of an MNE network tend to be related. Inter-unit knowledge flows in the MNE follow a complex networked pattern (Chini 2004), generating strong reciprocity between prominent sub-units although leaving some other sub-units in an isolated position (Monteiro, Arvidsson and Birkinshaw 2008). The consequent relatedness of associated learning processes of the constituents of an MNE organizational system tends to raise their mutual absorptive capacity as potential recipients of the knowledge created by other members of their group. Also, as just argued, it ensures that the value placed upon knowledge is most often highest within the international network of an MNE. Indeed, in addition to any shared community-based values, the role of internal (and external) organizational politics, power and conflict in the MNE (Mudambi and Navarra 2004; Forsgren, Holm and Johanson 2005) can also be readily incorporated into the technological accumulation or evolutionary approach to the MNE. Sub-unit diversity and differentiation within the MNE network tends to increase the capacity for exploration in learning across the group, relative to exploitation, while the divergent capacity of sub-units to evolve successfully towards competence-creating mandates may be due to (and reinforce) substantial differences in the power and influence they are able to exercise within their respective MNE groups owing to their origins (Cantwell and Mudambi 2005).

Due to the potential for IB connections to reinforce the learning processes associated with learning and continued technological accumulation, once they have achieved a sufficient level of technological capabilities, firms are generally keen to produce in locations which offer them access to further sources of complementary innovation. However, such knowledge-seeking investments tend not to be directed to the locations from which their major international rivals within the same industry have emanated (Cantwell and Santangelo 2002). Some recent studies have stressed that local competitive interaction may offset the potential attractions of knowledge spillovers in a cluster (Shaver and Flyer 2000; Chung and Kalnins 2001; Alcácer 2006; Alcácer and Chung 2007; Aharonson, Baum and Feldman 2007). It has been argued that the co-location of firms in local networks may sometimes suffer from the problem of adverse selection, since laggards have more to gain from knowledge spillovers, but leaders have more to lose from knowledge leakages. However, at least in the absence of dominant local firms, leading foreign-owned firms may be better equipped to become established over time as insiders in a local system, and so to cultivate mutually beneficial two-way knowledge exchange with indigenous actors (Cantwell and Mudambi 2011). Yet with respect to the home bases of leading MNEs in the same industry, their mutual deterrence helps to explain why these leaders in an industry do not tend site technological development in the heartlands of their major international competitors. This continuing element of locational separation of the core innovative efforts of leading MNEs (and the locational boundedness of knowledge that derives from interaction in local networks) reinforces the differentiation of their respective foci of expertise, if it were not for which one might have expected a greater degree of convergence in global corporate technological paths as an outcome of international knowledge-seeking strategies.

The notion that the geographical dispersion of technological development enhances innovation in the network of the MNE as a whole is founded on the belief that innovation is location-specific as well as firm-specific (Cantwell 1989). These location-specific and firm-specific characteristics of technological development both depend upon social networks (Singh 2005), and so they are largely attributable to the social or human element of technology. The scientific and technological traditions of each country, the shared experience of its researchers and production engineers and the communication between them across companies, the nature of its educational system, and its common business practices all contribute to the distinctiveness of the path of technology development undertaken in each location (Nelson 1993, 1995). By drawing on innovations of various kinds depending upon the conditions prevailing in each relevant center MNEs develop a more distributed and complex technological system. The attractiveness of locations for subsequent complementary investments by other actors may well be strengthened in the process. The involvement of foreign-owned MNEs in centers of innovation has a direct effect on broadening the scope of local technological capability, and an indirect effect through its competitive stimulus encouraging other firms to extend their local innovation efforts. The process helps to strengthen locational poles of attraction for technological activity.

The increased role of locationally dispersed sourcing of technology from the major centers of excellence through the international networks of more globally integrated MNEs (Cantwell 1995) has led to a growing interest in the asset-acquiring or knowledge-seeking motive for FDI (Cantwell 1989; Kogut and Chang 1991; Dunning 1992, 1995, 1996; Pugel, Kragas, and Kimura 1996; Cantwell and Janne 1999; Cantwell and Piscitello 2000; Chung and Alcácer 2002; Berry

2006), and in the greater decentralization in the management of international research and development (R&D) to capture 'home-base augmenting' or locally 'competence-creating' benefits (Pearce and Singh 1992; Papanastassiou and Pearce 1997; Pearce 1997, 1999; Kuemmerle 1999a, 1999b; Cantwell and Mudambi 2005). The potential for global knowledge search has been further highlighted by the finding of Singh (2007) that even in technologically less advanced countries, knowledge outflows to foreign MNEs tend to exceed knowledge inflows from foreign MNEs to host country organizations.

The relationship between knowledge exchange between the sub-units of an IB network and other organizations in a local area on the one hand, and knowledge exchange between the sub-units of an MNE group internationally on the other, requires a delicate balance. If there are isolating mechanisms that are associated with the greater local embeddedness of subsidiaries, and with a greater degree of subsidiary autonomy, then the international diffusion of knowledge within the MNE may remain limited while subsidiaries become separated islands of specialized expertise (Sölvell and Zander 1998; Zander and Sölvell 2002). Alternatively, if more decentralized and autonomous subsidiary networks are themselves not geographically bounded but associated with some distinct cross-border business networks of their own, then the parent companies of MNEs may react to the trend towards increasing sub-unit authority by seeking to reduce the emergent federative nature of multinationality, through constraining the geographical span of MNE operations (Yamin and Forsgren 2006). Yet it may also be that more competence-creating sub-units themselves become engaged in greater knowledge-based interactions with their MNE parent, since the development of new combinations around the core business expertise of their group require their more active collaboration (Berry 2014; Cantwell and Piscitello 2015).

International MNE networks for innovation have been evolving over time, and they are not the outcome of the introduction of some readily made and planned structure. As noted already, this evolutionary perspective incorporates issues of learning to accommodate continuing and enhanced inter-unit differentiation within the MNE, and differences in the ability of sub-units to exercise power and influence within their respective MNE groups.

The most typical pattern of international specialization in innovative activity within the MNE is for the development of technologies that are core to the firm's industry to be concentrated at home, while other fields of technological activity may be located abroad, and in this sense the internationalization of research tends to be diversified and complementary to the home base (Cantwell and Kosmopoulou 2002). Thus, when advanced technology creation is internationally dispersed it is most often attributable to foreign technology acquisition by the firms of 'other' industries - for example, chemical industry MNEs developing electrical technologies abroad, or electrical equipment MNEs developing specialized chemical processes outside their home countries (Cantwell and Santangelo 2000). From the other side of host countries as opposed to investing MNEs, a local center of excellence for some specialized field of innovation (say in chemicals) will tend to attract investments in local chemical research not so much by foreign-owned MNEs in the chemical industry, by to a greater extent by MNEs from other industries, whose objective is to tap into the resources of the center in order to diversify their own technological base (Cantwell and Kosmopoulou 2002).

The choice of foreign location for technological development in support of what is done in the home base of the MNE depends upon whether host regions within countries are either major

centers for innovation or not (termed 'higher order' regions by Cantwell and Iammarino 2000, and Cantwell and Janne 1999). Whereas most regions are not major centers and tend to be highly specialized in their profile of technological development, and hence attract foreign-owned activity in the same narrow range of fields; in the major centers much of the locally-sited innovation of foreign-owned MNEs does not match very well the specific fields of local specialization, but is rather geared towards the development of technologies that are core to the current techno-economic paradigm (notably information and communication technology [ICT]) or earlier paradigms (notably mechanical technologies) (Cantwell, Iammarino and Noonan 2000). The need to develop these general purpose technologies is shared by the firms of all industries, and the knowledge spillovers between MNEs and local firms in this case may be inter-industry in character. Thus, ICT development in centers of excellence is not the prerequisite of firms of the ICT industries, but instead involves the efforts of the MNEs of other industries in these common locations.

2. International business networks for innovation

The increasing appreciation of the role of technological accumulation and learning within the MNE has been facilitated by the recent trend for MNEs to establish, extend and deepen their international networks to support this process. These networks have traditionally been divided into two kinds. First are the networks of international production and international R&D facilities organized within and owned by MNEs. The increasingly networked structure of dispersed corporate facilities is the logical outcome of the shift by MNEs away from local market-oriented investments and multi-domestic organizational structures towards internationally integrated

strategies that began in the late 1960s (Hedlund 1986; Bartlett and Ghoshal 1989; Dunning 1992), and which led to the emergence of knowledge-seeking strategies. An interactive international network of MNE affiliates replaces a system of satellites or miniature replicas. Second are the inter-organizational networks in which MNEs increasingly participate. These include the growing number of strategic alliances between MNEs themselves generally in selected industry segments in which they each see some development opportunity, and a greater variety of local networks that link MNE affiliates with their suppliers and customers or regular project partners, and with other (sometimes non-firm) actors. Although each of these networks may have various purposes, perhaps the most prominent motive prompting MNEs to enter into them has been that joint learning processes are believed to be a means of raising the rate of innovation of the MNE, and hence its technological competitiveness.

With the shift towards international networks for technology creation, US MNEs have been following in the footsteps of many European MNEs (Cantwell 1995), and they have been steadily increasing the internationalization of their R&D facilities (Berry 2014). This has not been nearly so true of Japanese MNEs, in which the very rapid growth of R&D in Japan has tended to outstrip the extension of their operations abroad (Cantwell 1992). However, the R&D of Japanese MNEs located in the US and Europe has also been growing quite fast, and it seems that such Japanese-owned R&D has been especially aimed at tapping into the strongest areas of local expertise and skills (Kogut and Chang 1991; Mowery and Teece 1992; Graham 1992; Ozawa 1991, 1992). In other words, in the international R&D that Japanese MNEs have undertaken, technology acquisition has been a prominent and perhaps the most important motive, especially in the case of horizontal (cross-field) knowledge acquisition, as opposed to vertical

(supply chain) knowledge exchange (Cantwell and Zhang 2011). Nevertheless, the strength of their historical inter-firm ties at home, and relatedly the high degree of organizational centralization exercised over their international operations, has severely constrained the capacity of Japanese MNEs to establish open international networks for innovation (Westney 1993; Lam 2003; Cantwell and Zhang 2006).

Even where MNEs establish networks in which technological activity is locationally specialized across selected major centers, this does not usually destroy the distinctiveness of their national origins. As stressed earlier, firms follow differentiated paths to learning even when their fields of search are similar. Hence the nature of their tacit capability is path-dependent, and reflects their starting point in nationally differentiated types of expertise (see, for example, Kogut 1987, 1990). Moreover, the home center of the MNE normally continues to be the single most important individual source of knowledge and capability, a theme that is emphasized by Patel and Pavitt (1991). Thus, the technological paths of firms from some common nationality of origin often display some distinctive characteristics that reflect the pattern of specialization of their home country (Cantwell 2000). While the international technological efforts of MNEs are certainly significant, by reinforcing locational specialization among the major host country centers they may sustain rather than erode national systems of innovation (Archibugi and Michie 1995). Hence, while MNEs have tended to become more technologically diversified (Cantwell and Piscitello 2000), the impact of their geographically redistributing innovative activity in line with location advantages has been to make countries more narrowly technologically focused in their patterns of specialization (Cantwell and Vertova 2004).

Nonetheless, as MNEs have moved towards the construction of international networks so the number of overlaps in their areas of knowledge creation in a given industry have increased. Nationally specific but overlapping patterns of technological development have helped to promote international joint ventures (Mowery and Rosenberg 1989). In addition, technological relatedness has been rising such that formerly separate branches of technology have been increasingly brought together in recent innovations. An important element in this process has been described as a trend towards technology fusion (Kodama 1991, 1992). While it is true that, as argued previously, the knowledge created by a firm is usually of greatest value to itself given its own particular experience in production, it may still be of some value to other companies after allowing for the costs of converting it for use in a somewhat different setting. R&D projects also tend to create potential spinoffs that the firm itself decides not to pursue, but which are increasingly likely to be of interest to some other firms as the extent of technological overlaps rises.

The shift towards more open innovation networks has relied upon and been accompanied by a trend towards more organizationally decentralized MNE networks for knowledge development and exchange. The emergence of more decentralized international MNE networks for innovation, and an increasing fragmentation of production systems, have opened up new opportunities for at least some developing countries to catch up technologically (Ernst 2002, 2005; Ernst and Kim 2002; Athreye and Cantwell 2007). MNEs have begun to allocate rather more R&D and technological development activities to selected developing countries, and knowledge-creating nodes are increasingly being dispersed through global production networks that include some developing (or formerly developing) countries (Hobday 1995; Ernst 2001; Zhao 2006).

Especially where technologies are part of an integrated system but have become modularized, and component knowledge is developed at more than one location, then the MNE itself can provide an alternative institutional device for intellectual property right (IPR) protection (Zhao 2006) in weaker IPR environments. Even if the component knowledge developed locally in a developing country leaks out, or is intentionally co-developed with local partners as part of a more open system, it is in itself of limited value to others without understanding how it fits into a broader system of complementary knowledge, held by the MNE mainly in other locations.

The trend towards more complex knowledge systems and technology fusion across formerly separate fields of development has generated increasing interconnectedness between intra-firm and inter-firm networks, thus blurring the boundaries of the firm (Cantwell 2013). A rising technological distance of knowledge combinations and greater local subunit creativity tends to lead to search being conducted across organizational boundaries, especially when such search is geographically localized. But in the traditional fields of strength of their own MNE group, creative subunits draw even more heavily on their parent company's knowledge base (Cantwell and Piscitello 2015). This complementary combination of external and internal knowledge sources is especially relevant in the context of more open innovation systems. Competence-creating subsidiary activities rely upon the development of combinative capabilities with local knowledge sourcing (and hence spillovers). The emergence of new fields of competencies (for the MNE group) represent a search for new domains of application for established lines of business, or the fresh application of local knowledge within the MNC's own industry or line(s) of business. So, new capability generation in sub-units does not usually move them out of their initial base, but rather tends to broaden that base, and extend its applications and its connections.

Hence, IB scholarship is moving from a focus on the MNE as such towards an analysis of more open IB network structures, combining internal and external elements in open innovation systems. Thus, Dunning and Lundan (2008) redefined the MNE as the orchestrator of IB networks, akin to the earlier notion of Nohria and Ghoshal (1997). Today, firms often exercise control over much wider IB networks in forms that are commonly known as global production networks or GVCs, in which substantial parts of the network or chain are not owned, but are effectively controlled or orchestrated by the flagship firm. This sphere of control and coordination approach in place of the conventional ownership and employment perspective is not a new view of the (expanded) scope of the firm, but it is one that has now become central to the conceptualization of IB in the current era, despite raising some obvious empirical challenges as it departs from the customary legal definition of the corporation.

While a conventionally hierarchical firm as described by Chandler (1977) or Hymer (1972) relied for its capacity to coordinate activity on the formal legal authority associated with the ownership of production facilities or the use of employment contracts, within a system of stable organizational structures and relationships; instead, the orchestration of networks whose composition may fluctuate as projects come and go relies on more informal agreements that mutually bind the contributors together due to the reciprocity required as knowledge becomes more complex and interdependent across actors and across space (Cantwell 2013). This interesting potential frontier for future research into more open IB network formations may well require evidence at the project level rather than at the firm level, since the informal ties that bind actors rely on knowledge connectivity and reciprocity rather than on formal contracts.

3. The international location of innovative activities

In recent times research has been revived on the local knowledge spillovers generated by foreign-owned firms in host locations (see e.g. Perez 1997; Liu, Siler, Wang and Wei 2000; Blomström, Kokko and Globerman 2001; Cantwell and Piscitello 2005; Wei and Liu 2006; Driffield and Love 2006, 2007). Yet allied to this now revitalized stream of research, there has been an increasing awareness of the importance of absorptive capacity on the part of recipient firms (Cohen and Levinthal 1989) as a necessary condition for beneficial spillovers to occur. At the same time the current perception of the MNE as an international network for geographically dispersed innovation has stressed the dynamic connectedness between local knowledge creation and mutual exchanges in each node of the network (Cantwell 1989). Thus, there is a growing awareness that spillovers cannot be treated as following a unidirectional pipeline of knowledge transfers simply trickling down from the parent company through subsidiaries and on to other actors (Marin 2006). Instead, spillovers must now be analyzed in a two-way setting since the local evolution of subsidiaries towards competence-creating capabilities matters to the capacity of subsidiaries and indigenous firms to interact in knowledge creating activities, and hence for the presence or absence of local knowledge spillovers in either direction (Feinberg and Gupta 2004; Marin 2006; Cantwell and Piscitello 2007).

Thus, concern has increasingly come to be focused on the localization of the knowledge sources of foreign-owned subsidiaries themselves (Almeida 1996; Frost 2001; Almeida and Phene 2004; Phene and Almeida 2008). It has become clear that for an MNE to realize local knowledge

spillovers it must rely on the building of suitable business relationships, and not just on siting activities in a munificent location. In other words, a locally competence-creating type of MNE subsidiary strategy depends upon the embeddedness of the subsidiary within its own local network (Birkinshaw, Hood and Jonsson 1998; Nobel and Birkinshaw 1998; Andersson and Forsgren 2000; Forsgren, Holm and Johanson 2005), and on its ability to establish an insider status in the relevant local industry (Cantwell and Mudambi 2011).

Once they have achieved a sufficient level of technological strength in their own right, MNEs may gradually develop international networks for innovation. Firms that are more technologically diversified have the capacity to benefit most from the geographic dispersion of their R&D, which dispersion gives them access to more diverse technological resources, and a greater ability to make relevant connections between diverse pools of knowledge (Lahiri 2010). However, as mentioned earlier, such knowledge-seeking investments tend not to be directed to the home countries from which their major international rivals within the same industry have emanated (Cantwell and Santangelo 2002). Indeed, a number of recent studies have recognized the role of firm heterogeneity in locational strategies and impacts - in the sense that individual firms interact differently with specific local networks, as well as experiencing different degrees of knowledge inflows and outflows with these networks - and they have stressed that local competitive interaction may offset the potential attractions of knowledge spillovers. The continuing element of locational separation of the core innovative efforts of leading MNEs in most industries in their respective home bases (and the locational boundedness of knowledge that derives from interaction with local networks in host sites) reinforces the differentiation of the respective foci of expertise of each MNE, and hence the locational profile of an IB network plays

into corporate competitiveness. In turn, the most successful clusters now tend to be also those with the strongest international knowledge connectivity. This has led to a growing interest in global cities (Goerzen et al 2013).

Viewed from the perspective of MNE strategy, technological leaders derive their strength in part from their greater capacity to embed themselves in local networks (as opposed to building their knowledge in isolation from others). Hence, leaders tend to be able to crowd out laggards in effective local networks rather than the other way round. Thus, when speaking of firm heterogeneity in innovative IB contexts it may be more critical to establish whether firms can be regarded as insiders or as outsiders within local networks, and to develop a better understanding of the determinants of insidership or outsidership in the knowledge networks of different places (Cantwell 2009). While the concerns over the appropriability of knowledge suggest that leading firms will want to build closer and more interdependent relationships before working with partners, their differential ability to establish strong social connections is likely to be locally specific, and to vary a great deal between clusters. So which firms emerge as the local leaders in this respect, or in other words establish themselves as the key insiders in a region, is likely to vary from one local network to another. This is an important topic at the intersection of IB and economic geography, about which we need to know much more.

The contours of the overall change in the international distribution of innovative efforts have been mapped more broadly in a study across many countries at different levels of development (Athreye and Cantwell 2007). This demonstrates that with reference to the most advanced kinds of technological innovation (as measured by patenting in the US) there was actually further

consolidation, not reduction, in the degree of geographic concentration across countries from around 1970 through to the early 1990s. However, lower level kinds of innovation of the sort that rely on simpler and more basic capability development were already dispersing during this period, as measured by the total international licensing receipts earned by the firms of countries for their intellectual property creation, and this was accounted for in part by new entrant countries. Then, in a further transition since the early 1990s, the more sophisticated kinds of innovative effort have become more geographically dispersed across countries too. In particular, two emerging market entrants have been especially important contributors to this latest phase of cross-country technological catch up - China and India.

With respect to the general impact of the growth of the MNE on host country innovative environments, when considered on average across countries, it seems that inward FDI since 1950 has not preceded the emergence of the earlier stages of innovation in countries catching up (Athreye and Cantwell 2007). Instead, the initial acquisition of basic capabilities in new locations has often depended upon trade, subcontracting and licensing relationships with foreign-owned and foreign-located MNEs, short of inward FDI into the host economy. The strengthening of basic capabilities especially in smaller entrepreneurial firms in catching up locations such as India has been further strongly encouraged especially since the early 1980s by the rapid growth of arms length markets for intellectual property trade, which has created an opportunity for the emergence of new players, connected to new international inter-firm business networks for knowledge exchange (Arora, Fosfuri and Gambardella 2001). However, the extension of more traditional FDI networks to new locations that had already built up sufficient absorptive capacity

in the form of basic capabilities, has on average facilitated the catch-up of countries such as China in more sophisticated kinds of innovation since the early 1990s.

Unlike the economic and technological catch up of countries that achieved it during the 20th century, such as Japan and South Korea, which relied on building relatively closed national industrial systems in the era of science-based mass production, countries catching up in the 21st century, such as China and India, rely on global connectivity. While competence-creating MNE sub-units located in mature industrialized countries depend on their local knowledge embeddedness, the newer competence-creating MNE sub-units located in China have drawn to a greater extent on global knowledge sources (Cantwell and Zhang 2013). Likewise, indigenous actors in emerging markets have been presented with opportunities through greater global knowledge connectivity. In the information age, as production has become fragmented and modularized, and hence geographically dispersed in GVCs, locations catching up may use the attraction of assembly-type activities at low value points in the value chain as a point of entry from which to learn and so gradually migrate up the value chain to higher value activities (Mudambi 2008). However, the capability-enhancing potential of participation in GVCs has also been questioned. The significance of knowledge flows from advanced country firms to support technological upgrading in developing country suppliers seems to be contingent on several issues, and most notably on the governance of the value chain (Schmitz 2004). In particular, knowledge flows to facilitate upgrading of the functions of supplier firms towards, for instance, design, marketing and R&D functions involved in deeper innovation activities often seem limited, so contributing little to firms' improvement of their positions in GVCs (Schmitz 2004; Giuliani et al. 2005). Indeed, rather than GVCs acting as key conduits of knowledge and

capabilities for developing country firms, it may be that local investment in creating and cumulatively deepening knowledge resources provides the necessary basis for participating in such chains and networks in the first place (Ernst and Kim 2002).

Alcácer and Oxley (2014) have demonstrated that when suppliers acquire knowledge from outsourcing contracts with MNEs, technological learning is merely one step towards building capabilities to move up the value chain - in the way that (say) some Korean firms managed successfully in the past. To put it in terms familiar from the Korean or Taiwanese experiences, a capability for original equipment manufacture (OEM) need not necessarily translate into a capability for original design manufacture (ODM), or original brand manufacture (OBM). Alcácer and Oxley (2014) discuss some of the more micro strategic processes within firms that make connections between different parts of a value chain, and which may create some quite formidable barriers to continued capability building in partner companies. This is another potentially fruitful area for further research, especially in emerging market contexts.

4. Innovation in international business in the information age

A critical importance of ICT to the now more complex management of innovation in MNEs is that it enables firms to better exploit their corporate technological diversification across national boundaries, as well as across business areas. This owes to the dual role of ICT as being both a means of combining fields of knowledge creation that were previously kept largely apart, and a managerial process technology that lowers internal coordination costs, and thus extends the potential boundaries of firms. The first facet of ICT entails the greater facility to develop related

combinations of formerly separate lines of technological development (Santangelo 2002). With respect to the second facet, the methods of managing more complex combinations and greater diversity have also improved. Thus, the social technology of management practice has itself developed to facilitate technological diversification (Granstrand 2004). This implies the feasibility of the kind of organizational structure that is needed to sustain a more diverse firm, and one that is more flexible and potentially adaptable.

However, while this use of ICT has led many smaller firms to extend the breadth of their technological diversification to create new combinations, in some of the very largest MNEs the extent of technological diversification has been reduced, so as to better focus on the most promising possible combinations from amongst the broader initial dispersion of innovative activity that such companies have inherited from the past (Cantwell and Bachmann 1998; Cantwell and Fai 1999; Cantwell and Santangelo 2000). The particularly pronounced trend towards a wider dispersion of innovative effort in ICT is one facet of the paradigm shift in the general conditions for innovation and growth, according to the neo-Schumpeterian perspective upon long-run techno-socio-economic change (Freeman 1987; Freeman and Perez 1988; Freeman and Louça 2001; Perez 2002). However, empirical investigations also show that industries differ in the propensity of their firms to diversify into technologies that lie in complementary or non-primary fields for the industry (Cantwell and Qiu 2013, 2015).

While the expanded contribution of ICT is a widely acknowledged feature of the so-called knowledge-driven economy or the paradigm of the information age, with its associated need for more general and multiple skills on the part of the workforce; the greater significance of business

process re-engineering and the more frequent changing and reconstitution of firm boundaries may not have been so widely appreciated. The new paradigm is one of continual experimentation over the right mix at the firm level, seeking out the most productive combinations of business areas and technologies. Since individual locations are inevitably specialized in their activity, and indeed increasingly specialized owing in part to greater subsidiary-level specialization within MNEs (Cantwell and Vertova 2004), the most suitable and potentially innovative combinations of activity now commonly require international connections. For this purpose the MNE is the principal institutional vehicle or orchestrator.

Using the more traditional narrower lens upon firm boundaries according to the legal definition of the firm by its ownership of assets and its employment contracts, and the associated sharp dichotomous distinction between the firm and the market (in which pure market coordination applies to any transaction outside the firm and those that it employs), Rangan and Sengul (2009) have shown how the growth of ICT tends to facilitate de-internalization. This is because ICT reduces the transaction costs of using market-based or contractual mechanisms. However, where there are coherent GVCs or global production networks these market connections frequently continue to be orchestrated and monitored by a flagship firm in a GVC network. In an IB network such as a GVC the role of the MNE is to become an integrator of locationally and organizationally differentiated streams of new knowledge creation, across the key nodes in a system of connected internal and external networks.

This suggests that the IB concept of 'internalization' may need to be recast to reflect the changes that have occurred in the information age. If the firm or MNE is defined instead as a center of

administrative control of IB networks (and notably GVCs) rather than in legal or purely ownership terms, then at least a weaker form of internalization would entail the displacement of the arms length market coordination of genuinely independent agents by the orchestration of networked IB actors by flagship MNEs (Alcácer, Cantwell and Piscitello 2015). A critical implication of this alternative perspective on internalization advantages is that rather than seeing an increasing externalization of business relationships as a simple reversal of internalization in a hierarchical firm, a kind of symmetrical switch in direction along a linear scale, it can be appreciated instead that internal and external networks become increasingly complementary and hence coordinated to a greater extent in common, in the systems that are characteristic of the information age (Cantwell 2013).

5. Conclusions

As explained earlier, competence-creating initiatives require a greater degree of sub-unit autonomy, and an embeddedness in host country or locally grounded international networks. At the same time, a knowledge-seeking MNE strategy requires core corporate group knowledge to be combined with the expertise that lies behind the new lines of application being opened up by the competence-creating sub-unit, which therefore also requires a closer and more reciprocal relationship with its parent company (Cantwell and Piscitello, 2014). This may in turn depend upon whether a subsidiary's knowledge comes to the attention of its parent (Monteiro 2015), and on the motivation associated with existing headquarter capabilities (Song and Shin 2008). So MNE structures have been transformed in the knowledge-driven and globally interconnected information age to facilitate a more intense interaction between the capabilities of firms and

those of places, as well as with the changing governance structures of IB networks (Cantwell 2015).

In the information age with its knowledge-driven form of capitalism, and the accompanying trend in IB towards knowledge-seeking FDI and more locationally dispersed competence-creating activities, the implication is a change in the nature of the competitive advantages of firms and places, and in the greater extent of their mutual interaction (Alcácer, Cantwell and Piscitello 2015). What are termed ownership advantages in the eclectic paradigm (the advantages of the nationality of origin of firms), which are the capabilities that firms develop or access through their home country and IB networks, evolve increasingly through a capacity to make knowledge-based international connections between locations that represent key competence-creating nodes in what have become GVCs. What is more, while in Hymer's original formulation the advantages of MNEs were assessed relative to domestic firms in each host country one market at a time, which suited the period of early MNE growth and market-seeking FDI he was describing, these advantages must now be understood as the key competencies of a focal MNE relative to the other major MNEs present in the same industry. This recognizes that competition has now become international (see Cantwell, 2000). What is more, accessing external capabilities through their IB networks, increasingly used in combination with their own internal capabilities, has become a vital part of the explanation of the innovation and growth of MNEs. We need to know more about this phenomenon of technological knowledge building and innovation that simultaneously crosses both organizational and national boundaries in and around IB networks.

So, to summarize, I have identified five areas for further research, which offer potentially fruitful avenues for contributions to the literature on innovation and IB. First, there are opportunities to enhance our understanding of various aspects of international technological knowledge connectivity (Cano-Kollmann et al 2016), beyond a typology of the principal channels for knowledge transmission and their relative significance in the information age (Bathelt and Henn 2014). The possible levels of analysis of international knowledge connectivity range from the study of locations such as global cities, through international inter-organizational alliances or collaborative global projects, to knowledge exchange between individuals across geographic, cultural and linguistic boundaries. Second, it would be helpful for us to know more about the complex interactions between locationally dispersed MNEs and the places in which they are active. From a strategy or industry perspective, given the widespread finding that the intensity and effectiveness of knowledge spillovers depends critically on the strength (or lack) of local embeddedness by firms, future research might improve our comprehension of the factors that enable foreign-owned firms to become insiders (or to avoid being treated as outsiders) in a local innovation system. From a public policy or a host regional perspective, what is the relationship between local and international knowledge networks, and how does this relationship promote or retard local technological development efforts?

Third, what are the implications of rising knowledge complexity and the emergence of the multi-technology corporation for cross-border knowledge combinations between locations with different patterns of technological specialization? While more complex knowledge structures that draw on multiple fields of expertise, when taken together with geographic specialization requires more distant knowledge combinations, we would like to better understand the scope and

limitations of this process, and the conditions under which organizations and places have been able to facilitate knowledge linkages at a distance. Fourth, ideally research should be able to move beyond the level of firms as legal entities or locations as administrative units (as traditionally defined), to undertake project-based analyses of international knowledge networks or the work of international inventor teams. In particular, how do internal and external networks that span different territories intersect with and complement each other, and what kinds of projects are most likely to create stable network relationships that endure over time and across multiple projects? What is the relationship between open innovation systems for locations (greater mutual inflows and outlows of knowledge), within organizations (greater decentralization of knowledge creation and authority over it), and between organizations (greater outsourcing of knowledge-based tasks, and technology-driven partnerships)?

Fifth and finally, it would be welcome to see more research investigating the scope for and the determinants of the capacity for learning and capability building that enables firms or places to move from lower value adding to higher value adding segments of GVCs. For firms this should include a comparative study of the multiplicity of actors or sub-units that may be involved in an IB network or to whom selected activities are subcontracted, and for sub-national regions or cities this should allow us to compare sites that have become or have thrived as knowledge-creating international network nodes with those that have not, especially in emerging market contexts. In the information age innovation and IB networks are ever more closely bound together, not least in countries that are currently catching up technologically. Hence, greater scholarly attention to the relationship between innovation and the internationalization of the processes of knowledge creation and exchange is badly needed.

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