The rise of Chinese innovative firms and the changing governance of global value chains

Abstract

This paper proposes an interdisciplinary approach to understanding the rise of emerging economies innovative firms and the implications of their governance and control of global innovation value chains. The paper identifies that the rise of Chinese innovative firms poses a challenge to the traditional geography of innovation and governance of global value chains, where most of the value chain activities were mainly coordinated by developed economies firms. The governance of global value chain in this paper is understood to entail not only the coordination of production, but also the control of innovation. By taking a holistic view of innovation, we show that some Chinese firms have accumulated significant innovation capabilities. We argue, however, that many of the new breed of GVCs exert control of production but not yet innovation. Their governance structure is different from that of existing 'orthodox' GVCs where DMNEs enjoy control of innovation and coordination of GVCs at the same time. As Chinese lead firms continue to strengthen their innovation capabilities, we expect them to exert a stronger control of innovation in many sectors, which will entail a change in power relationships in and the governance structure of GVCs.

Keywords: emerging economies firms, global value chains, governance, China

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1. Introduction

One of the key drivers of globalization has been the changing geography of global production networks (GPNs). This new form of economic organization has resulted in the fragmentation, highly specialized and geographically dispersed value chain functions, prompting new scenarios of governance mode and resultant innovation activities which take place across borders.(Gereffi and Korzeniewicz, 1994). One major element underling this trend has been the shift which has taken place in the spatial distribution of production from the Triad to offshore locations in emerging economies led by China (Dicken, 2011). More recent development seems to suggest that emerging economies led by China and India are now playing an increasingly prominent part in the R&D and technology fields, changing the established geographical patterns of value adding activity and resulting in the creation of a 'new global geography of innovation' (EIU, 2004; Huggins *et al*, 2007).

This changing geography of innovation has grabbed the attention of scholars from different disciplines. The international business (IB) literature, for example, has tried to understand emerging economy multinational enterprises (EMNEs), and their internationalization strategies with intensive debate on their firm-specific competitive advantages and whether existing theories explain their internationalization behavior (for example. Luo and Tung, 2007, Mathews, 2006).). Similarly, the economic geography literature emphasized 'learning through networking and by interacting' (Breschi and Malerba, 2001), particularly at the regional level in explaining the rise of knowledge intensive clusters in emerging economies (for example, Lorenzen and

Mudambi, 2013). More recent years have seen the global value chains (GVCs) and GPNs approaches contributing to an understanding of the importance of international connections and governance structure in the catching- up and upgrading of firms and clusters in emerging economies (Pietrobelli and Rabellotti, 2011). All these have contributed to the recently emerging literature on the changing geography of innovation (Bruche, 2009; Ernst, 2009).

In this paper, we argue, however, that there is a considerable potential for further developments within this domain. In particular, given that EMNEs are increasingly taking the leadership role across industries (BCG, 2014), the extant literature still lacks an understanding of the nature of their leading roles in the global value chains and the associated governance structures these firms deploy. An important reason for this is that scholars still wonder what innovation capabilities EMNEs exactly have (Altenburg et al., 2008; Awate et al., 2012), and whether they have any control on innovation activities within their respective GVCs. Existing studies adopting the GVCs perspectives have mainly focused on the coordination of value chains, while ignoring the control over innovative activities (for example, Gereffi, 2005). In this paper, we focus not only on the coordination of value chains, but also on the control of innovation in value chains.

The remainder of this paper contributes to scholarly knowledge and understanding by engaging in a disciplinary dialogue in order to explore the likely governance structure in the 'new geography of innovation' as the result of the rise of innovation champions from China. We argue that governance in GVCs should be examined along two dimensions – coordination of production and control of innovation. Adopting a more

holistic view of innovation, we demonstrate that some Chinese firms have accumulated significant innovation capabilities. The rise of Chinese innovative firms assuming the 'network flagship' role in in the global value chains may therefore entail different governance structures to those exhibited in global value chains dominated by developed country multinational firms (DMNEs).

The paper is structured as follows: firstly we set the research context in the rise of China as a rising innovation power which represents a significant change in the geography of innovation. We then discuss the relevant literature particularly regarding governance structures of GVCs in the changing geography of innovation. We go on to examine Chinese champions' innovation capabilities before gauging the governance structure of GVCs with EMNEs as lead firms. We conclude discussing direction for future research.

2. Conceptual Background

2.1 The emergence of China as a rising innovation power

China's leading innovative firms have followed a distinctive technological catch-up process, contrasting with that pursued by earlier latecomer firms based in countries such as South Korea and Taiwan (Amighini et al, 2010). EMNEs based in these latter countries have typically followed a three-stage model for catch up purposes, involving the acquisition of mature technology, followed later by process development and product design capabilities from developed economy multinational enterprises (DMNEs), before they finally invest heavily in R&D, facilitating the development of innovative technologies, products and processes of their own (Kim, 1997). China's

leading innovative firms employ a different approach, relying less on the assimilation of foreign technology and more on in-house innovation (Liu and White, 2001). Access to foreign technologies is normally needed to kick start their catch-up process and this may involve entering into joint venture/alliances agreements with DMNEs, leading to market-orientated product innovation, supported by their low production costs (Liu, 2005). They are likely to complete the process, however by enhancing their own innovation capabilities to world-class standards, helped by participation in GVCs and international technological alliances (Ernst and Kim, 2002; Humphrey and Schmitz, 2002).

Governmental and institutional factors have played a major role in shaping the development of China's national competitiveness and innovation capability over the past thirty years and in the rise of its leading innovative firms (Altenburg et al, 2008; Dobson and Safarian, 2008). The competitiveness of Chinese businesses is improving steadily, helped by the rapid growth in the size of China's domestic market, together with its macroeconomic stability, high standards of basic education and improving business sophistication. On the negative side, however the advance of the catch-up is still being hindered by China's corruption problems and institutional weaknesses, including a lack of judicial independence, property rights protection and sophisticated financial markets (Sala-i-Martin et al, 2010).

Science and technology has occupied a prominent place in China's national economic development strategy over the last thirty years (Lu and Lazonik, 2001), as governments have sought to transform China from a source of low-cost manufactured goods, to a global high-technology player (Xin and Yidong, 2006). A national

innovation strategy has been introduced (Amighini et al, 2010) with attempts being made to encourage market-based funding, improve incentives for innovation by firms, and enhance links between technology suppliers and users (Kennedy et. al, 2008). The effectiveness of this strategy has however been restricted by the persistence of a statist, industrial policy-led approach to innovation (Appelbaum and Parker, 2008), exemplified by the adoption of a government (rather than a science or market) led approach to choosing which major R&D projects the state should fund (Applebaum et al, 2011).

Changes have occurred in China's government thinking regarding the role that should be played by imported technologies in the country's innovative development (Appelbaum et al, 2011). Considerable priority had previously been given to the attraction of inbound FDI from knowhow-intensive DMNEs, since this was seen as helping the country to develop its indigenous innovative capabilities (Bruche, 2009; Jefferson, 2005) and to close its 'innovation deficit' with the Triad countries (Segal, 2010; Walsh, 2007). Government thinking has however now been refocused towards the perceived need to break China's dependence on foreign technology and to create a self-sustaining, innovation orientated economy (Segal, 2010; Walsh, 2007). Government support for international expansion by China's technology-intensive businesses has therefore increased (Luo et al, 2010; Zhang, 2009), helping to stimulate a rapid growth in outward, R&D related OFDI (OECD, 2008). An increasing number of Chinese firms are using participation in GVCs for technology upgrading purposes, whilst some of China's leading firms are now becoming increasingly global players in their own right, enabling them to challenge DMNEs for

the leadership of global production networks and global markets (BCG, 2014; Henderson and Navdi, 2011).

This new Chinese démarche in innovation can now be seen to be leading to ground breaking changes in the ownership, control and location of global innovation and R&D activity, creating a new dynamic to the changing geography of innovation. China is now well placed to challenge for leadership in many key technologically-intensive sectors of the global economy (Bruche, 2009; McKinsey, 2015). This startling new development would appear to have major ramifications for the ownership and control of production, innovation and, indeed, for the configuration of future power relationships in the global economy (Peerenboom, 2007).

2.2 Governance Structure of GVCs

The GVCs literature recognizes globalization of economic activities and ties the concept of value-added chain directly to the globalization of industries (Morrison et al., 2008). It emphasizes the key role played by lead firms from developed countries in coordinating globally dispersed and organizationally fragmented production and distribution networks (ibid). Its primary concern is how global production and distribution systems are organized and governed which dictates what, how, when and how much is to be produced (Humphrey and Schmitz, 2002).

Existing studies applying the GVC approach have pointed to the importance of DMNEs' led value chain activities, and how it has benefited the firms in developing countries to continuously improve their products and processes and shift ‘from low-value to relatively high-value activities in global production networks’ (Gereffi, 2005:

171). The argument lies with the learning opportunities for local producers who are inserted into the GVCs via DMNEs which are assumed to possess superior technologies and knowledge (Gereffi, 1999; Marin and Giuliani, 2011). This could therefore give rise to various upgrading opportunities for firms in developing countries (Humphrey and Schmitz, 2002; Giuliani et al., 2005).

The essence of the GVCs literature is based on the idea that upgrading and knowledge transfer are constrained by the structure of governance – 'the functional integration and coordination of internationally dispersed activities' (Gereffi, 1999: 41). The upgrading prospects depend on the governance structure of the value chains. It proposes four different governance structures that represent a continuum from loose to very tight relationships between global lead firms and local suppliers: arm's-length market relations, networks, quasi hierarchy and hierarchy (Humphrey and Schmitz, 2002). It further argues that different governance structures offer different upgrading opportunities: quasi-hierarchical chain offers favorable conditions for fast process and product upgrading, but hinders functional upgrading; market-based relationships do not foster fast product and process upgrading but opens more room for functional upgrading; networks offer ideal upgrading conditions but are the least likely for developing country producers (Humphrey and Schmitz, 2002; Khan et al., 2015).

Extant studies of GVCs are, however, dominated by upgrading in developing countries and the role played by DMNEs as lead firms. Despite the rise of EMNEs, the literature is still yet to study them as global lead firms and the associated GVCs-oriented governance structures and upgrading outcomes. In discussing governance structures of GVCs, the focus was clearly on the coordination of production activities

– the lead firms set and/or enforce parameters along the chain determining what is produced, how it is to be produced and when and how much is to be produced (Humphrey and Schmitz, 2002). This focus on coordination of production with the overlook of control of innovation may seem to be all right in the context of DMNE lead as they control both production and innovation in GVCs (Pavlínek, 2012). It becomes problematic, however, in the context of rising EMNEs, as they may not own significant innovation capabilities and control innovation activities despite their coordination of production (for example, Awate et al., 2012).

Recent contributions indeed suggest the need to distinguish between production and innovation in the context of emerging economies. There has been massive accumulation of production capability in leading emerging economies while innovation capabilities remained heavily concentrated in the developed world (OECD, 2006; Schmitz and Strambach, 2009). With this distinction between production and innovation in mind, Pavlínek (2012) described how strategic functions such as R&D still tend to be highly centralized and controlled by lead firms in the core western European markets despite the dispersal of vehicle production to East-Central Europe. Similarly, Altenburg et al. (2008) and Awate et al. (2012) demonstrated that emerging economies and their firms have perhaps caught up in terms of production capabilities, but still lag in terms of innovation capabilities.

The distinction between production and innovation echoes the need to differentiate the tangibles from the intangibles in value chain analysis (Mudambi, 2015) as they may follow different logic. Mudambi and Puck (2016), for example, suggest that production activities are located on the basis of cost whilst innovation activities are

located on the basis of skills and competence and MNEs 'fine-slice' and control different activities by outsourcing and offshoring. This implies that governance structure in GVCs should be examined from two dimensions – the coordination of production and innovation and the control of innovation. For example, the fact that we observe a quasi-hierarchical or 'captive relationship' (Humphrey and Schmitz, 2002) in the production network does not necessarily mean that the same relationship is in place in the innovation network. We believe this is particularly the case in the context of lead firms from emerging economies. This is because, unlike lead firms in developed economies that are in control of both production and innovation (Pavlínek, 2012), it is still questionable whether EMNEs, despite an increasing number of them are now moving into lead firm position exerting both the control and coordination of production within the GVCs (Ernst, 2009; BCG, 2014; Lema et al., 2013). are also in control of global innovation determining what, how and where innovation takes place.

Below, we use Chinese leading firms as examples in order to illustrate their innovation power and their control of innovation networks. We then come back to the governance issue and gauge the implications of the rise of Chinese innovative firms for governance structures of GVCs.

3. Illustrative Cases: Chinese lead firms' relentless push for innovation

No doubt upgrading of Chinese firms have benefited enormously from the opportunities that GVCs offer, complemented by their in-house efforts (Fu and Gong, 2011). Scholars, however, have divergent views regarding their innovation capabilities. Some scholars argue, for example, that 'the Chinese firms are protected,

resource-based, labor-intensive, low-technology and inefficient firms' (Rugman, 2008a),and they tend to 'lack advanced managerial skills in internal knowledge generation and in the systems integration' (Rugman, 2008b). A more benign view sees rapid catch-up in China, but maintains that its firms have not yet produced in cutting-edge innovations (Altenburg et al., 2008).

We believe that the mainstream literature on this issue suffers from a shortcoming in the sense that many scholars equate innovation with ground-breaking technologies. We agree with Bhidé's (2009) view that innovation is a complex process involving advancement in high-level general principles, midlevel technologies, and ground-level, context-specific rules of thumb, all three playing necessary and complementary roles. It is therefore not helpful, when talking about innovation, to purely focus on the high-level ground-breaking technologies as low-level innovations are equally important as Bhidé (2009) argue:

"Technological innovations, especially high-level ones, usually have limited economic or commercial importance unless complemented by lower-level innovations. Breakthroughs in solid-state physics, for example, have value for the semiconductor industry only if accompanied by new microprocessor designs, which themselves may be largely useless without plant-level tweaks that make it possible to produce these components in large quantities. A new microprocessor's value may be impossible to realize without new motherboards and computers, as well.

New know-how and products also require interconnected, non-technological innovations on a number of levels. A new diskless (thin-client) computer, for

instance, generates revenue for its producer and value for its users only if it is marketed effectively and deployed properly." (Bhidé,2009:2)

This more holistic view of innovation has enabled Williamson and colleagues to identify Chinese firms' superior ability in cost innovation, business model innovation and process innovation (Zeng and Williamson, 2007; Williamson and Yin, 2014). Following this approach, we will add onto the list two more innovation capabilities of Chinese firms using examples from our own research.

3.1 Architectural innovation

This refers to the ability to reconfigure an established system to link together existing components in a new way (Henderson and Clark, 1990: p12) in order to manufacture and market products that meet customer needs. This gives late-mover firms the opportunity to gain significant advantage over dominant firms but requires the late-movers to learn how the components are inter-linked into an integral whole and also necessitates unique management and organizational skills (ibid).

We will take one of Huawei' Distributed Base Station (DBS) as an example, where DBS is a solution that Huawei pioneered to help telecommunication operators to build their 3G networks. The major problem that many operators faced was where to find and acquire the necessary space to accommodate the base stations which require huge space. This was particularly the case in densely populated place such as urban areas where space is limited and cost is high. Therefore it appeared extremely difficult for operators to build their 3G networks quickly and economically.

Huawei's idea was to break the traditional base station into two separate functional modules – the Base Band Unit (BBU) and the Remote Radio Unit (RRU) which are connected by optical fiber. Because the BBU is small in size, it can be installed almost anywhere indoor such as on a wall, on the staircase or in a store room, or alternatively, in an outdoor cabinet of the existing network equipment room if operators have one. Similarly, the RRU is also small and light weighted (below 20kg) so that it can be easily installed on the mast or walls near antennas. This basically means that, compared to the bulky and heavy traditional base stations, the DBS became portable which not only minimized the requirement for space, but also give operators enormous flexibility in terms of site location. In addition, the large number of bulky cables between traditional base stations and the antenna is replaced by one single optical fibre connecting the BBU and RRU. This brings the advantage of high-bandwidth, low loss, and sufficient mechanical flexibility to allow deployment of the remote radio unit at large distances from the indoor BBU. Moreover, the DBS can be quickly reconfigured to support different mobile-network technologies (2G or 3G) or even several such technologies at the same time - therefore allowing for future evolution to 4G.

Because of the multiple benefits in terms of space saving, site flexibility, higher capacity and low installation and operational costs, the DBS was considered a major breakthrough in 3G network construction and soon became an industry standard, allowing Huawei to reap enormous commercial benefits in both China and overseas. There was no major technological breakthrough in this innovation. Almost all major technologies existed already. What is changed is the architecture of the existing

components and Huawei's architectural innovation has made it revolutionary. Its commercial DBS was first deployed in Singapore and then at a large scale in Netherland and then many other countries including China.

3.2 Grafting innovation

China's innovative firms have also shown a highly pronounced ability to find new uses and applications for existing technologies, leading to the development of new products and solutions, based on the application of their core technologies in additional industries (Williamson and Yin, 2014). BYD, for example, initially established itself as a strong player in the rechargeable battery industry (Kang and Ke, 2008). However, the launch of its F3DM in 2008, the first commercialized plug-in hybrid electric vehicle in the world that does not need a professional charging station, was clearly an application of the firm's existing battery technology in the vehicle manufacturing field. BYD later repeated the same story by producing a range of electric vehicles using its newly developed ferrous-based battery offering favorable cost, capacity, and safety performance to the traditional Lithium-ion battery. Further application of its battery technologies have also seen the company penetrating into the electricity grid energy storage sector.

China South Locomotive is a state-controlled enterprise that designs, engineers and produces electric locomotives for China's high-speed railway network. China South Locomotive possesses an extensive research capability, enabling it in 2002 to develop a high-speed Electric Multiple Unit (EMU) that could run at 200 km/hour. In 2004, the company collaborated with Bombardier and Kawasaki Heavy Industries to jointly design and manufacture high-speed electric multi units (EMUs) that would run at

250km/hour for China's railway system. Within a short time, the company was able itself to design, engineer and produce EMUs that ran at a speed of 350 km/ hour with better performance in terms of comfort, security and speed (Xinhuanet, 2011). In December 2010, its CRH380A EMU set a world record of 486.1 km/hour in trial operation (Chuang and Johnson, 2011), powered by an EMU convertor with the highest powered single unit in the world. Over recent years China South Locomotive has also endeavored to extend the application of its core technologies (in propulsion and controls) to develop products in new areas, such as urban metro transit, electric vehicles, and wind power generation. Its grafting innovation has seen the launch of its A-type metro vehicles in 2008 ending the monopoly of foreign companies in this growing Chinese market, enabling the company to win nearly 68.5% of the contracts awarded for such products in 2011. In 2008 the company bought a 75% stake in Dynex, a specialist high power semiconductor company in the UK, in order to use the latter's advanced technologies in areas such as IGBTs1 to improve the performance of high-speed trains. However, the company has also begun to develop IGBT modules to be used in industries such as wind power generation, electric vehicles and smart electricity grids.

The illustrative cases above lead us to believe that it would be wrong to dismiss all Chinese firms as mere copycats, as an increasing number of firms from China have demonstrated significant innovation capabilities. In an effort of further upgrading and catching-up, many of these firms have started to invest in developed countries and regions in a search for strategic assets (Buckley et al., 2007), notably by setting up R&D centres overseas (in addition to their domestic R&D networks). This is

[1] Insulated gate bipolar transistors.

buttressed by the government's policies towards 'going global' and 'indigenous innovation'- the former to encourage Chinese firms' overseas investment and the latter a drive to put China and its firms in control of innovation. Huawei, for example, is now managing an enormous global innovation network consisting of 22 overseas R&D centres including 10 in Europe, 9 in North America, 2 in Asia Pacific and 1 in South Africa as well as 28 joint innovation centres with leading telecom operators across the world. Sany has also established R&D centres in America, Germany, India and Brazil, whilst China South Locomotive opened dedicated overseas R&D centres in the UK in 2009, America in 2013 and Germany in 2014 respectively. Other Chinese firms are now following suit. According to a recent survey of a few hundreds of leading Chinese innovative firms conducted by the Chinese government, 70 of them have already set up 137 overseas R&D centres, the majority of which are in developed countries (Ministry of Science and Technology, 2012).

4. Emergence of GVCs dominated and controlled by the new cadré of Chinese innovative firms

If the surge in overseas R&D investment by Chinese companies identified above continues, it will establish the Chinese 'giants' as a significant force in causing a dramatic shift in the ownership and control, as well as in the geography of global innovation (Von Zedtwitz, 2005). Lema et al. (2013), for example, in their study of the global wind power industry argue that the most significant force behind the recent global redistribution of technological innovation capacities towards China was not driven by Western lead firms but mainly by Chinese lead firms' own decomposition strategies and particularly their overseas R&D investment. Below we gauge what

GVCs' governance structures could look like if Chinese firms continue to rise into lead firm position and strengthen their innovation capabilities. We examine Chinese lead firms' role in two dimensions as suggested earlier – coordination of production and control of innovation.

Traditionally DMNEs have been coordinating and orchestrating the GVCs and organizing production and the creation and diffusion of knowledge in most sectors, based on their superior, knowhow-related capabilities (Ernst and Kim, 2002; Ernst, 2009; Schmitz and Strambach, 2009). This is still the case in the extant studies of the 'new geography of innovation' (for example, Mudambi, 2008),despite that increasing fragmentation and geographical dispersion of global innovation has created immense opportunities for latecomer firms from emerging economies to upgrade their knowhow-related capabilities and gain access to new technologies (Humphrey and Schmitz, 2002; Awate *et al*., 2012).

The rise of the new global innovative firms in China (and in other emerging economies) indicates that this state of affairs is now changing. Gereffi (2014) argues that power relationships in GVCs have been recently shifting towards strategic contract suppliers in emerging economies. We believe that a more profound change is taking place in the global economy as a result of the ongoing reconfiguration of global industrial leadership. Some Chinese firms have already become global flagship firms in their respective industries. Huawei, for example is now the world's largest telecom-equipment maker whilst Lenovo the largest PC maker and Haier the largest household appliances manufacturer. Similarly in the rail equipment industry, China South Locomotive and China North Locomotive have both surpassed Siemens to become

the world's No. 3 and 4 manufacturers by sales (BCG, 2014). One of the most dramatic changes happened in the wind turbine sector, in which no Chinese firm made its way into the top 10 in 2005, but then four did so in the 2010 rankings, occupying the 2nd, 4th, 7th and 10th places respectively (Lema et al., 2013).

The fact that increasing number of Chinese firms are becoming global 'flagship firms' indicate a change in the power relationship in GVCs and therefore resulting in a new breed of GVCs. Some of them are now taking the control and coordination of production within GVCs. Lema et al. (2013), in their detailed study of the wind turbine sector in China, described how the Chinese lead firms such as Goldwind have gradually developed the coordination capabilities that allow them to make effective use of the modular domestic supply chain and at the same time cultivate a long-term relationship with global supply chain. The new coordination capabilities across domestic and international supply base, combined with a strong cost-quality combination suggest Chinese lead firms in the wind turbine sector are quickly developing competitive advantages that are attractive to not only customers in China buy also outside. Evidence presented by Lema et al. (2013) clearly demonstrated the role of Chinese lead firms in setting the terms under which others firms in the chains operate and exercising varying degrees of coordinating power over them. This is a significant change from the earlier GVCs where it has always been the DMNEs in control and coordination of value chain activities.

Although the new Chinese flagship firms, or other EMNEs, may have started to exert the role of coordination of production in the GVCs, things can also work against them and constrain their power. This would particularly be the case when Chinese firms

still lack the ability to create and control strategic innovation and technology and rely on foreign knowledge. A recent case study of Suzlon, an Indian firm and one of the top five players in the world in terms of global market share, for example, shows that its subsidiaries in developed countries, because of their control of knowledge, enjoy significant bargaining power vis-à-vis the headquarter (Awate et al., 2015): Despite Suzlon owned 100% of stake in its German subsidiary REpower, it did not participate in determining the latter's R&D strategy and was not involved in decisions regarding REpower's R&D activities.

Given the late-comer status of EMNEs, including those coming from India and China, it is not unreasonable to extend the argument also to Chinese MNEs. Indeed, a recent patent landscape mapping confirmed that the number of patents in the field of wind turbine is disproportionately dominated by firms in developed countries such as Vestas, GE and Siemens (Relecura, 2013). None of the Chinese firms is among the top 10 patent asset holders despite that four of them are now among the world's top 10 in terms of market share. It is not surprisingly therefore to see that many Chinese wind turbine firms have been relying on licensing arrangements with European design houses (Lema et al., 2013).

Our conjecture is, therefore, in the near future, many of the new breed of GVCs coordinated by Chinese firms may involve a hitherto unprecedented separation of control of innovation and technology from coordination of production – they may have started to exert control of production but not yet innovation. These new governance structures are therefore likely to be very different from those of existing

'orthodox' GVCs where DMNEs enjoy control of innovation and coordination of GVCs at the same time (Schmitz and Strambach, 2009).

Given Chinese lead firms' relentless push into innovation, however, we expect more Chinese firms to be gradually in control of innovation in addition to production. As a result, the governance structures of the new GVCs may converge to those of the 'orthodox' GVCs in the future. This is because it is power relationships between actors within GVCs that define their governance structures. Power, however, is 'relational, i.e., the exercise of power by one party depends on the powerlessness of other parties in the chain' (Schmitz and Strambach, 2009: 241). As Chinese lead firms continue to strengthen their innovation capabilities, this would change power relationships in GVCs and as a result we would expect them to exert a stronger control of innovation.

Our own research on China South Locomotive may help to illustrate this. As mentioned before, the company has already established a strong competence in propulsion and control and therefore is proud of the fact that it is able to engineer and produce the 'heart' of the locomotives – the electric traction drive system. It was not able to, however, design and manufacture its own IGBT modules and silicon chips – the 'heart' of Electric Traction Drives – and had to rely on import. This constrained not only China South Locomotive's further expansion in the railway industry, but also their more recent penetration into the urban transit, wind power and electric vehicle industries as IGBT and its modules are also widely used in these industries. In October 2008, China South Locomotive undertook its first overseas acquisition and purchased 75% of stake in Dynex, a small semiconductor manufacturer in the UK,

precisely for its IGBT technologies and know-how. To an extent this is a classic knowledge-seeking investment as China South Locomotive's primary motive is to acquire and learn the IGBT technology. However, this case is also different from many others in the extant literature including the case of Suzlon in Awate et al. (2015) as China South Locomotive does help to set the direction of its subsidiary's R&D activities and maintain a control of the latter's innovation by rolling over an R&D agreement between the parent and subsidiary every three years. This is partly because China South Locomotive had already had a strong competence in propulsion and control and Dynex needs its parent firm's knowledge of the railway system in order to design and engineer suitable IGBT modules for Chinese railway. The combination of knowledge and technologies have also seen the parent and subsidiary now work together to develop electric vehicles.

The cases discussed in this paper suggest that a 'new geography' of innovation is emerging where EMNEs not only coordinating but to some extent controlling the innovation activities within their respective GVCs.

5. Conclusions and Future Research

This paper investigated the implications for the changing geography of innovation as a result of rising Chinese innovative firms. Drawing from our primary research, but also incorporating insights from secondary, we argue that the rise of Chinese innovative firms will result in a change in not only the location of innovation activities, but also the governance structures of the global value chains. In particular, we argue the governance structure of some of the new breed of GVCs would feature EMNEs controlling production activities of the value chain but not yet the innovation

activities. This will be very different from the governance structure of orthodox GVCs with DMNEs controlling both production and innovation activities. However, as Chinese lead firms continue to strengthen their innovation capabilities, we expect them to exert a stronger control of innovation which will entail a change in the power relationships and the governance structure of GVCs orchestrated by these EMNEs.

The separation of control of innovation from coordination of production in GVCs in some of the new 'breed' of GVCs has significant implications and poses a number of theoretical and policy challenges. To understand better the nature and impact of the changing geography of innovation, we surely need a good understanding of lead EMNEs' strategies and behaviors. Most of the dominant theories were, however, developed with DMNEs in mind and there is only limited dialogue between disciplines such as international business, economic geography and innovation (Mudambi, 2015; Yeung, 2009). We believe that further interdisciplinary dialogue with EMNEs as lead firms in the research context would help to generate new insights, as we have illustrated through our analysis of some of the Chinese firms.

An interesting area for study is the geography of value creation and value capture. In his analysis of knowledge-intensive industries, Mudambi (2008) argue that EMNEs' push into activities at both ends of the '*smile' curve is changing the geographic reality in which 'the activities at the ends of the overall value constellation are largely located in advanced market economies, while those in the middle of the value chain are moving (or have moved) to emerging market economies'* (p. 706). The rise of EMNEs as lead firms in GVCs is already changing the power relationships of the global business. Their control of innovation will bring a paradigm shift in the

governance of GVCs. How this is going to change value creation and value capture in the value chain necessitates a detailed study of the power relations that articulate the new lead firms and the various tiers of subordinate firms within them (Henderson and Nadvi, 2011).

We also feel that there is an urgent need to understand the nature and impact of the changing geography of innovation as the result of the rise of innovation champions from emerging economies. For example, the dispersion of innovation activities by DMNEs has resulted in a 'global hierarchy of innovation hubs' (Ernst, 2009) with 'leading clusters of the Triad region at the apex and a very limited set of Chinese and Indian 'innovation nodes' at lower levels' (Bruche, 2009: 280). The question is whether this Triad hegemony is going to be shaken by the rise of innovation champions from emerging economies, involving the rise of global centers of excellence in leading developing countries?

Similarly, the current changing geography of innovation has contributed to the emergence of new knowledge clusters in some emerging economies such as India and China (for example, Huggins et al., 2007; Lorenzen and Mudambi, 2013). But would the rise of innovation champions from emerging economies bring in learning and upgrading opportunities for firms and regions in developed countries where they invest heavily for innovation related activities? Unfortunately, to date there have been very few studies addressing this issue (Giuliani et al., 2005), with the exception of He and Khan (2015). Our view is that the EMNEs' potential impact on industrial clusters and regional development in the West is made possible by at least three factors:

Firstly, many emerging economy innovation giants have become knowledge generators in their own right (as argued above). Secondly, associated with their surging overseas investment is the international mobility of highly skilled technical and managerial labor from China and other leading emerging economies to the West who, if arriving in sufficient volume, could facilitate the development of industrial clusters in the West. Thirdly, recent research on Chinese investment in Italy finds that Chinese firms provide their Italian and European partners with entry to geographically wide sales networks, and direct access to the huge and rapidly expanding Asian market (Pietrobelli et al., 2011). This indicates that emerging economy lead firms may also have an important role to play in improving local clusters' external connectivity within developed economies.

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