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**Global Cluster Networks –
Foreign Direct Investment Flows
from Canada to China**

by

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Abstract (ca. 150 words). Using a network perspective of multinational firms, this paper develops conceptions of global cluster networks and global city-region networks that are based on foreign direct investment (FDI) activities. The paper first formulates a global cluster-network hypothesis suggesting that multinational cluster firms are more likely to set up new foreign affiliates in other, similarly specialised clusters to keep up with global industry dynamics. Conversely, it is suggested that non-cluster firms are more likely to avoid cluster destinations in their FDIs. Second, it is hypothesized that cluster networks generate connections between city-regions in different countries that are horizontal and vertical in character and thus shape global city-region networks. To test these hypotheses, the spatial patterns of 299 FDI cases from Canada to China between 2006 and 2010 are investigated, generally supporting the hypotheses developed.

Keywords. Foreign direct investment (FDI), global cities, global cluster networks, global city-region networks

JEL Codes. D83 J61 R12

1. Introduction: Clusters, Foreign Direct Investments (FDIs) and the Globalisation Paradox

Although modern technologies have enabled the exchange of goods and knowledge across regional, national, and cultural boundaries, global economic success still depends on the utilisation of local/regional resources (Bathelt and Taylor, 2002). Research has shown that closely intertwined regional concentrations of firms from a particular sector, together with supporting suppliers and services – so-called industrial clusters (Porter, 1990), continue to attract further firms in the same or related sectors. The local clustering of industries constitutes a globalisation paradox in that, despite powerful globalisation processes, a considerable part of global economic production is performed in such regions (Scott and Storper, 2007). Along with deepening globalisation, further agglomeration of related activities in regional clusters is reinforced by the locational choices of foreign direct investments (FDIs) (Enright, 2000; De Propris and Driffield, 2006). On the one hand, global technological and organizational knowledge can disseminate more easily in local settings when foreign firms set up affiliates in these clusters. On the other hand, multinational firms can appropriate and export local knowledge because they are in a position to standardize the knowledge developed in the original locations through codification in such a way that it can readily be transferred to other locations and countries (Maskell and Malmberg, 1999).

The development of clusters through both localisation activities of multinational firms and internationalisation processes of local firms calls for further exploration of trans-local linkages beyond a separate understanding of the local and the global sphere. In economic geography, trans-local or interregional connections have been formulated from both regional cluster and global network perspectives. In knowledge-based cluster theories, the regional imperative of the global economy is explained using the argument that the adaptation of new technologies results in continuous reproduction and further

development of regional competitive advantages related to the dissemination of tacit knowledge that requires face-to-face communication (Malmberg and Maskell, 2006). Such communication is realised in geographical proximity based on the spatial ‘stickiness’ of local labour markets. However, with the increasing mobility of individuals – especially related to emigrant elites in transnational professional communities – face-to-face communication spans over greater distances and tacit-knowledge sharing occurs regularly across boundaries (Saxenian, 2006).¹ It has gradually been recognized that it is beneficial – and has become common practice – to combine different forms of permanent with temporary and real with virtual face-to-face communication in complex global production settings (Bathelt and Turi, 2011).

In global context, spatial reconfigurations of production activities link multinational corporations in developed economies with manufacturing clusters in developing economies. For developing clusters, trans-local connections may be built either by attracting FDIs from multinational production networks or by receiving contracts from global lead firms within value chains (Dicken et al., 2001).

Although many theoretical discussions and case studies exist about forms of trans-local linkages at the local and global scale, surprisingly little is known about the wider spatial structures of and connections between clusters and city-regions which are formed through these trans-local linkages.² On the one hand, much of the work on clusters, innovation networks, and global cities – although acknowledging the importance of trans-local linkages, power relations, and control functions – is focussed on a specific regional or metropolitan perspective (Cooke and Morgan, 1998; Maskell and Malmberg, 1999). On the other hand, studies of global production networks – while

¹ From an economic perspective, the rise of transnational communities implies that external economies can operate at a larger geographical scale (Simmie, 2003; Phelps, 2004).

² In this paper, we generally define clusters within city-regions. Following from this definition, we expect that city-regions develop economic functions related to those clusters that form inside of them.

being aware of the spatiality of such production configurations – tend to emphasize the flow patterns within technology fields or product chains, while underplaying the complex regional expressions of corresponding linkages (Gereffi et al., 2005). As Storper (2009, 1) forcefully put it: “How should we think of the role of regions in relation to the global economy? Theory has surprising gaps when it comes to building a unified vision of these two scales of development.”

The nature of linkages between different clusters, or different types of city-regions, and other spatial entities at a global level has thus far not been thoroughly analysed in academic studies, and little is known about the wider structure of global linkages between clusters and between city-regions that is generated through FDIs. Taking these observations as a starting point, we designed a study to investigate the nature of FDI-related economic linkages, first, between clusters and non-clusters and, second, between different types of city-regions. As opposed to most other studies on clusters, global production chains, or global cities, we do not investigate trade flows and input-output relations, which are sometimes temporary in nature. In contrast, our focus is on FDIs, which form a basic infrastructure for the development of further material, human capital, and knowledge flows over time and provide more permanent trans-local connections between distant locations. Based on an analysis of 299 FDI cases – across all industries – from Canada to China between 2006 and 2010, this paper aims to investigate the structure of spatial networks generated by these FDIs: (i) between clusters, (ii) between city-regions, and (iii) across different sectors. While the results are limited to this context, our study presents an initial attempt to investigate the wider spatial cluster/city-region linkages generated through FDIs.

Next, section 2 summarises how trans-local connections are conceptualised in different ways in the literature. Based on a critique and a novel understanding of FDIs, section 3 develops hypotheses of global cluster networks and global city-region networks

using a nested framework that combines different conceptualisations of trans-local linkages with respect to FDIs. Section 4 describes our database of 299 FDI cases and the methodology of identifying clusters and city-regions consistently across countries. Section 5 presents the FDI-generated networks of clusters and city-regions between Canada and China and explains their spatial structure. Section 6 concludes and points at future research directions.

2. Framing Trans-Local Connections: Transnational Communities, Clusters, and Production Chains

In the past decade, numerous approaches in economic geography, management, and regional economics have suggested that regional economic success, especially in industrial agglomerations, requires cross-regional and global linkages, which provide access to wider markets, pockets of knowledge, and new technologies. In the literature, trans-local connections are framed in transnational-community, production-network/value-chain, global-pipeline, and global-city conceptions, which focus on (i) individual, (ii) organisational, (iii) cluster, and (iv) city-region levels, respectively (Table 1). However, as Sturgeon et al. (2008, 301) observe regarding these studies, “the focus remains on how these linkages play out within the cluster, not on the larger economic structures that are created when clusters are woven together”. Up to now, these frameworks remain vague with respect to the nature and spatial patterns of durable global linkages, especially related to FDIs.

Table 1 about here

(i) At the individual level, interregional knowledge linkages are established as a consequence of the increasing mobility of emigrant entrepreneurs. Through this, highly educated emigrant professionals become the ‘new Argonauts’ generating novel business opportunities between their first and second home countries related to their unique identity and background (Saxenian, 2006). They operate as boundary-spanners circulating up-to-date market and product information across national borders between distant clusters. These transnational community networks enabled Hsinchu in Taiwan and Bangalore in India to upgrade technologically through functional specialisation and cooperation with Silicon Valley (Saxenian, 2006).

The transnational-community literature presents a convincing argument about inter-local or inter-cluster connections, yet it remains unclear whether this concept is applicable to other industries and regions. Generalisations of transnational communities with brain-circulation effects are criticized as relying on few immigrant groups (Whitford and Potter, 2007). Another limitation is the focus of this literature on cultural and network characteristics of emigrant entrepreneurs, while neglecting their organisational embeddedness and the role of transnational enterprises. Without considering the level of the firm, there is a danger of over-interpreting the roles of ethnic networks (Hsu and Saxenian, 2000). As Beaverstock’s (2004) research on global law firms illustrates, many of the ‘new Argonauts’ may be expatriate managers within transnational corporations, whose activities are closely related to FDIs.

(ii) Production and value chain frameworks, in contrast, focus on the organisational dimension of trans-local linkages. The importance of a local cluster’s connection with global lead firms has been emphasized since the debate about new industrial districts in the early 1990s, when Amin and Thrift (1992, 571) suggested that new localised industrial complexes are “set firmly within a context of expanding global corporate networks”. By framing trans-local linkages as value chains, Gereffi (1994)

recognized that changes in fashion markets and in the organisation of the retail sector in the U.S. had a tremendous impact on overseas factories and buyers associated with global sourcing strategies in Asia. Focussing on developing contexts, more recent work investigates how regionally concentrated producers of value chains can benefit from (or are restricted in) their vertical interactions with global lead firms. Humphrey and Schmitz (2002) suggest that trans-local vertical linkages may enable local producers to develop skills, knowledge, and competencies. However, with the adoption of global standards in linking different parts of value chains, trans-local connections with global buyers or turn-key manufacturers may involve more codified, rather than tacit, knowledge circulation (Sturgeon, 2002). As such, the value-chain concept emphasizes different kinds of knowledge and types of linkages, which clusters may access or develop in different industries.

One of the limitations of the value-chain approach, however, is its focus on vertical trans-local connections between cluster firms and global enterprises. Unsatisfied with the linear nature of the value-chain argument, Dicken et al. (2001) propose an actor-network-based understanding of global production networks drawing on the complex interrelationships of economic networks across different scales and emphasizing the tensions between networks and territories, as well as the role of power relations. Overall, these approaches open up possibilities for analysing production networks that span widely across countries by focusing on the role of the key agents in these networks (e.g. lead firms, states), and how they impact production conditions at different levels. At the same time, however, such studies are technology-/value-chain-focused and often do not employ a deeper understanding of the different localised contexts and spatial structures associated with such linkages. They are also primarily focused on input-output relations and do not distinguish between arms-length,

temporary relations and more durable commitments, such as those induced through FDIs.

(iii) At the cluster level, trans-local linkages have been emphasized in recent studies, suggesting that it is of critical importance to look beyond the regional boundaries of clusters to understand why firms are successful in maintaining their competitive strength (e.g. Simmie, 2003; Fitjar and Rodriguez-Pose, 2011). This has been conceptualised in a knowledge-based cluster approach that highlights the external dimension of clusters (Bathelt and Taylor, 2002). In the Boston biotechnology cluster, for instance, firms deliberately establish international strategic partnerships to obtain information about new or different technologies and organisational forms (Owen-Smith and Powell, 2004).

Access to such 'trans-local or global pipelines' entails considerable uncertainties and high investment costs (Bathelt, 2007; Maskell and Malmberg, 2007). Integration into 'global pipelines' heavily depends on the level of trust between the partners, which has to be gradually established. Effective collaboration in innovation processes further depends on a common language, shared basic understanding, and mutually compatible interpretative schemes which are not easy to create among firms in different cultural and institutional contexts (Henn, 2012). Due to the high uncertainties associated with such relationships, trans-local knowledge transfers are concentrated on pre-defined objectives and are established in an explicitly structured way which can be more easily managed through formal collaborations or through hierarchies within multinational corporations, as opposed to the reflexive knowledge flows within clusters.

While knowledge-based theories of clusters emphasize the indispensability of external linkages, they are still based on intra-cluster social relationships and prioritize individual analyses of clusters. Trans-local linkage patterns are vaguely conceptualised, and emerging global networks are not explored. Also, as many cluster approaches focus

on linkage patterns or knowledge flows, it becomes a necessity to distinguish durable FDI-related from temporary relationship-based patterns.

(iv) At the urban and city-region level, trans-local linkages are further explored in the global-cities literature, which argues that global or world cities exercise control and dominance over other cities and regions through a high concentration of global financial and advanced business services, as well as through headquarters of multinational corporations (Sassen, 1994; Taylor, 2004). Based on trans-local financial and service business networks, global cities become first-tier decision-making cores in the global hierarchy of city-regions and extend their leading role both by establishing horizontal linkages with other global cities to reproduce high-order control functions and by developing a hierarchical functional division of labour with regional cities. This produces a centre-periphery dualism.

Aside from emphasizing global city linkages, this literature does not, however, systematically draw conclusions regarding the specific patterns of these linkages and the resulting city-region *networks*. Instead, studies tend to focus on identifying hierarchies of global/world cities generated by FDIs in business services without analysing the nature of interdependencies between global cities and other cities through manufacturing investment linkages.

In sum, these conceptions of trans-local linkages emphasize certain aspects regarding the wider spatial relationships in economic production and control, yet each has clear limitations in terms of what it can explain – and what not. Particularly, none of the approaches conceptualises the foundational role of FDIs in generating durable interregional linkages. As a consequence, we know relatively little about the spatial structure of economic linkages among clusters and city-regions – neither in conceptual nor in empirical terms. In order to develop a framework for such an analysis, we next propose a conceptualisation that utilises elements of the above approaches, and develops

a nested explanation from the individual and firm level to the cluster and city-region level. To explore the spatial configuration of durable trans-local linkages, we formulate a framework of global cluster and city-region networks generated by transnational FDI connections.

3. Global Cluster-Network Hypotheses: Global Linkages of Clusters and City-regions

In this section, we advance global cluster-network and global city-region-network hypotheses by synthesizing the above discussions about trans-local linkages at different scales (Table 1). Synthetic conceptualisations about the architecture of the global economy can also be found in Coe and Bunnell (2003), Depner (2006), Engel and del Palacio (2009), or Henn (2012). The reason for applying such a method of framework building in this study is that the various frameworks of trans-local linkages, although individually limited in their reach, can be fruitfully combined into a wider nested argument as, for instance, demonstrated by Saxenian (2002) who linked transnational-communities with production networks or by Coe et al. (2010) who integrated global-production and global-city networks. What is pivotal in our argument about cluster networks is a network-based understanding of multinational enterprises, which helps us to develop a nested framework connecting the scales of individuals and firms with those of clusters and city-regions.

With respect to the relationship of transnational enterprises or FDIs with local clusters, two generally contradictory arguments have emerged in theoretical discussions, although, in reality, their interactions are contingent, dynamic, and rarely fall neatly into either category (Phelps, 2008). One position views FDIs and industrial clusters as being mutual beneficial to each other, as is expressed in the concepts of the ‘development/entrepreneurial subsidiary’ by Young et al. (1994) and the ‘interdependent

cluster’ by Enright (2000). Not only do FDIs in this view help to create and upgrade cluster firms through local trade and knowledge spill-overs (Birkinshaw, 2000; Thompson, 2002; Depner 2006),³ but subsidiaries of transnational corporations also gain advantages from being in local clusters through reverse spill-overs (Driffield and Love, 2003). Reverse knowledge spill-overs can be realised either by recruiting professionals from sophisticated regional labour markets (Li, 2012), or by in-sourcing technology and market information via local listening posts (Gassmann and Gaso, 2004).⁴ In a geographical perspective, the reinforcement of FDIs and local clusters is partially supported by the evidence that FDIs tend to be directed to places where the same or related industries are located (Head et al., 1995; Hilber and Voicu, 2010). Tentative evidence also suggests that subsidiaries of multinational firms in clusters are more embedded, autonomous, and internationally-oriented (Birkinshaw and Hood, 2000).

A contrary view of the relationship between FDIs and industrial clusters is that they are detrimental to each other. On the one hand, it is argued that the involvement of FDIs in local communities may jeopardize the sustainability of clusters, since FDIs may be footloose and not committed to a specific local economy (Phelps, 2008). They may act as free-riders and direct crucial knowledge out of the cluster. In negotiations with ‘nomadic’ transnational enterprises, local governments are usually in a disadvantaged position. They may have to use public resources and preferential policies to attract and retain such firms which could, in turn, negatively affect the territorial innovation environment and long-term regional development (Rodríguez-Clare, 1996; Yamin and

³ It is argued here that under certain conditions (such as the presence of local firms with high absorptive capability), FDIs can stimulate the development of new clusters – especially in less developed regions.

⁴ Without a well-functioning legal system to protect intellectual property, both FDI-based spill-overs and reverse spill-overs may also negatively impact the local firms or transnational enterprises.

Sinkovics, 2009; Dicken, 2011). On the other hand, FDIs may avoid clusters, if geographical proximity to competitors could lead to knowledge leakage and imitation in a less-established legal context (Kugler, 2006).

These two perspectives appear incompatible in terms of the relationships between FDIs and clusters implying conflicting FDI—cluster geographies: co-location versus exclusion. However, we argue that these seemingly contradictory arguments are an expression of different contextual and strategic conditions, reflecting different behaviours of FDIs with different objectives, capabilities, and locations. Subsidiaries are set up by transnational corporations for different reasons: resource seeking, low-cost labour exploitation, market penetration, or knowledge acquisition (Dunning, 1993). Different types of FDIs thus interact differently with industrial clusters. For FDI subsidiaries that are part of knowledge-creation organisations and that pursue innovation strategies, cluster locations may be localities with knowledge flows that are ‘in the air’. In empirical studies, it has been shown that FDI affiliates and cluster firms learn from one another and create knowledge in co-localised settings (Almeida, 1996; Nachum and Keeble, 2003; De Propris and Driffield, 2006). Conversely, for FDI cases with weak knowledge-creation capabilities and with natural-resource or low-cost labour competitive strategies, clusters can become places of fierce competition from which they escape.

From a practical perspective, the question arises as to how to differentiate knowledge-based FDIs from other kinds of FDIs? Studies, such as those of Enright (2000), Birkinshaw and Hood (2000), and Andersson et al. (2002), suggest that the characteristics of FDIs, at least partially, depend on the territorial environment, in which they are embedded, suggesting that there is a difference between cluster and non-cluster locations. Simmie’s (2003) study in England shows that innovative firms based in the most innovative metropolitan regions (and their respective clusters) have the strongest

linkages to international markets in order to acquire innovation-related knowledge, while firms from less innovative regions have fewer such linkages. Since leading-edge knowledge and related skills are highly concentrated in few regions, this may lead to the creation of linkages that cut across the most highly developed clusters in different countries. Taking this at least as a starting point, the origin of FDIs could be used as a good proxy to differentiate various kinds of FDIs.

On the one hand, FDIs originating from clusters, especially those located in developed contexts, are more likely driven by innovation rather than by low-cost competition. As timely access to specific and unique knowledge is increasingly critical for innovation, external knowledge acquisition becomes a key issue for cluster firms (Gassmann and Gaso, 2004). They employ their absorptive capabilities to acquire tacit knowledge through FDIs from learning networks in foreign clusters. On the other hand, FDIs from non-cluster regions on average have weaker knowledge creation and management capabilities, and are less likely to adapt to the cluster settings in a host country. They might instead be directed to non-clusters to seek resource- or low cost-based advantages.

In a geographical perspective, the FDI-based connections between clusters thus generate unique cross-cluster patterns that we refer to as ‘global cluster networks’.⁵ Some anecdotal evidence supports our proposition of the development of global cluster networks. In Oliver et al.’s (2008) analysis of two clusters, leading glazing firms in the Castellon ceramic tile cluster in Spain establish affiliates in an Italian ceramic cluster in Emilia with advantages in the ceramic equipment segment, while ceramic equipment

⁵ A related term, ‘global networks of clusters of innovation’, is used by Engel and del Palacio (2009) to show how globally connected clusters of innovation become established in high-technology industries, although they do not refer to an explicit regional perspective. In a similar way, other literature has also recognized the importance of global networks that link different clusters (e.g. Andersen and Lorenzen, 2007). Much of this work, however, seems to *assume* the existence of such networks, and does not test this proposition empirically or present a comprehensive explanation.

firms from Emilia vice versa set up affiliates in Castellon. Through such FDI linkages, up-to-date industrial knowledge can be quickly transferred between the clusters. Similar matching investments have also been found in other industries – e.g. between Silicon Valley and Hsinchu in the information technology sector (Saxenian, 2006) and between Hollywood and Vancouver in the motion-picture industry (Scott and Pope, 2007).

The proposition of global cluster networks calls for a novel interpretation of transnational organisations. Instead of a transaction-cost-based view of the firm, Ghoshal and Bartlett's (1990) view of the firm as an inter-organisational network appears more appropriate in this context. Such a network view goes beyond headquarter-subsidary linkages that imply unidirectional hierarchical flows of knowledge within multinational corporations. Embedded in cluster contexts that stretch across both the source and the target regions of FDIs, multinational corporations rather operate as *networks within networks* (Dicken and Malmberg, 2001). In order to adjust to changing local demand conditions and specific needs, FDI affiliates require more autonomy and innovative capability, through which conventional, hierarchical headquarter-subsidary relationships become less likely.

This is especially the case in a dynamic cluster context where cutting-edge industrial knowledge is localised as if it was 'in the air'. By 'being there', FDI affiliates can learn through local horizontal monitoring and vertical interaction (Malmberg and Maskell, 2006; Bathelt, 2007; Li, 2012). Labour flows within the local labour market, often unintentionally, further contribute to knowledge circulation between FDI affiliates and local firms (Glückler, 2007; Belussi, 2010). Consistent with a knowledge-based view of transnational enterprises (Kogut and Zander, 1993), FDI affiliates do not only integrate their operations into the 'local buzz' in various ways, but also get access to external knowledge from other units of the same organisation across distance, thus establishing 'natural pipelines' for the local cluster. Within transnational FDI networks,

knowledge can be transferred back and forth, for instance, through assignments and reassignments of expatriate managers across different contexts (Beaverstock, 2004; Riusala and Suutari, 2004; Hocking et al., 2007). The combination of spatial proximity within local clusters and organisational proximity to other corporate units in distant clusters gives FDI affiliates a unique opportunity to transfer both codified and tacit knowledge across clusters (Boschma, 2005; Bathelt and Turi, 2011). Through organisational proximity, FDI affiliates embedded in global cluster networks challenge the traditional dichotomy of tacit knowledge as being local versus codified knowledge as being ubiquitous (Amin and Cohendet, 1999). Through geographical proximity in the cluster context, FDI affiliates operate as durable ‘pipelines’ of trans-local knowledge flows and, as such, complement temporary learning of cluster firms in trade fairs and professional conferences (Bathelt and Schuldt, 2010) in more permanent ways. These considerations lead to a first set of hypotheses about global cluster networks that can be formulated as follows:

(H1a): *FDIs that originate from clusters in a home economy are more likely to be directed to clusters (as opposed to non-clusters) in the host economy.*

(H1b): *FDIs that originate from non-cluster contexts in a home economy are more likely to be directed to non-cluster areas (as opposed to clusters) in the host economy.*

(H1c): *FDIs from clusters are more likely to be directed to clusters in similar or related (rather than different) industries/technologies, thus generating global cluster networks.*

(H1d): *Global cluster networks are likely to develop in similar ways in different industry groups (rather than in specific industries only).*

Global cluster networks result from a nested framework that connects the firm level and the individual level with the cluster level (Figure 1). These networks provide a

mechanism for trans-local knowledge linkages and, at an aggregate scale, reflect structural features of the global economy in a novel way. Drawing from a similar spirit as in Coe et al.'s (2010) analysis of production chains and geographical networks, we next explore how global city-region-network patterns can be derived from FDI-connected clusters and non-clusters.⁶

Figure 1 about here

By viewing clusters and FDI linkages as networks, following Dicken et al.'s (2001) argument of the territorial embeddedness of networks, we can expect that global cluster networks develop that are characterised by specific spatial patterns. Although clusters are defined as geographical phenomena, it is not easy to delineate their spatial boundaries precisely (Porter, 1990; Martin and Sunley, 2003). To be consistent with the method of cluster identification, we restrict the scale of clusters in our exploration to the level of cities or city-regions.⁷ At an aggregate level, city-regions can include one or more clusters.⁸ In the global system of city-regions – from global cities at the top of the hierarchy to manufacturing cities in the middle range and highly-specialised or rural cities at the bottom – the dominant (not necessarily most innovative) economic

⁶ It has long been recognised that FDIs often seek urban areas to have access to basic urbanisation economies. In our analysis, we are interested in exploring which types of urban areas are chosen by FDIs and what kinds of spatial patterns are generated. Cluster-based linkages between city-regions may, for instance, provide simultaneous access to different forms of agglomeration economies (Phelps, 2004; Parr, 2004).

⁷ We are fully aware that some clusters stretch across cities or even national borders, but from the large body of literature of individual cluster cases, we feel confident that this limited definition applies to most clusters.

⁸ This is consistent with the role of urban economies of diversity which may generate a metropolitan form with multiple centres (Phelps, 2004; Parr, 2004).

functions of cities are often reflected by a group of clustered firms in manufacturing or service sectors.⁹

Due to the large concentration of corporate control functions and access to capital, global cities are in a favourable position to become FDI decision-making centres. As global cities are also core locations of multiple clusters, a large proportion of the investments originating from global cities are likely grounded in these clusters, rather than in non-cluster activities. Some of the FDIs originating from global cities create horizontal linkages with other global cities to access complementary knowledge and labour pools. Other FDIs from global cities are more vertical in character and, in a downwards-direction, link up with cities in the medium-range of the city-region hierarchy, thus extending the global cities' power/control capacities as part of global city-region networks.

From the existence of global cluster networks, within which clusters in similar industries/technologies are connected through FDI linkages, we expect that city-regions of similar kind and scale become linked with each other. As illustrated below, it can be assumed that global networks of city-regions generated by cluster-based FDIs involve more horizontal connections between city-regions than networks formed by non-cluster FDI cases.

First, manufacturing city-regions that are embedded in manufacturing cluster networks are more likely to be connected with each other through cluster-based FDI affiliates. According to the global cluster-network hypothesis, these FDI affiliates across clusters put specific emphasis on local knowledge and labour pools, as clusters even in the same sector become specialised in different subfields. Thus, global networks of manufacturing city-regions generated by cluster-based FDIs are less likely to be

⁹ Here, we do not intend to equate clusters with innovative local industries, as warned by Martin and Sunley (2003). Locally successful industries may also consist of vertically-integrated firms. Conversely, clusters in developing contexts may be trapped in low-cost competition.

primarily composed of vertical FDI linkages spanning from developed regions to export processing areas in developing countries. Compared to non-cluster FDIs, they are more likely to develop horizontally between city-regions with similar or related industrial structures. Examples of such global manufacturing city-region networks can be found, for instance, between Silicon Valley, Hsinchu, and Bangalore (Saxenian, 2006) in high-technology industries, between Castellon and Emilia in the ceramic industry (Oliver et al., 2008), or between Prato and Wenzhou in the textile and garment industry (Hooper, 2010).

Second, in professional services such as finance, which represent central control functions located in global city-regions, cluster-based FDIs likely generate linkages across global cities. The resulting network of global cities thus combines the views of Sassen's (2001) global-city model and network analyses of world cities (Alderson and Beckfield, 2004; Taylor, 2004). In the latter studies, networks of world cities that are drawn from relational data of multinational producer services demonstrate intensive connections between high-order cities through bilateral headquarter–affiliation linkages. Since Sassen's (2001) global-city framework emphasizes the clustering of advanced producer services in global cities, one can assume that cluster-based networks of global cities are formed by corporate FDI affiliates, which are nested in the professional services clusters of these cities. But such functional reasoning might be reductionist. It is also possible that cities in the upper-middle range of the city-region system would be connected by FDI linkages of cluster firms in professional services. However, since financial resources in regional control centres are limited, such FDI networks can be expected to remain moderate. Similarly, upwards-directed cross-order connections of city-regions may be moderate at the global scale.

These arguments suggest that various connections among clusters in manufacturing and service sectors can be articulated within the context of city-regions,

not necessarily reflecting a strictly hierarchical, but a diversified, multilateral spatial pattern. This leads to a second set of global city-region-network hypotheses that are derived in relation to the global cluster-network hypotheses:

(H2a): *FDIs are more likely to originate from global cities, as opposed to other city-region types.*

(H2b): *Cluster-based FDIs are more likely to originate from global cities than non-cluster FDIs.*

(H2c): *FDI linkages that originate from global cities are both horizontal and vertical in character, and not primarily downwards-directed.*

(H2d): *Horizontal city-region networks that connect city-regions of similar function and status are more likely to be established by cluster-based FDIs, as opposed to non-cluster FDIs.*

(H2e): *The linkage patterns of global city-region networks are likely to differ between different sectors/industry groups.*

Altogether, the above reasoning leads us to suggest the existence of a nested framework of cluster and city-region networks at the global scale (Figure 1). While spanning across different levels from individuals to city-regions, we argue that FDI-based linkages form the core of this global architecture. Whereas the above conceptualisations of global cluster and global city-region networks require comprehensive testing, FDI linkages from Canada to China are used in this paper as an initial substantiation of the theoretical claims made.

4. Data and Methods: FDIs, Cluster Identification and City-region Classification

Testing the global cluster-network and global city-region-network hypotheses requires both case-specific FDI data connecting cross-border regions and detailed local

industry data to identify clusters and classify city-regions. In the initial analysis presented in this paper, we establish a database of 299 FDI cases from Canada to China over a five-year period from 2006 to 2010. This is based on data from the Asia Pacific Foundation of Canada, an independent think-tank sponsored by the Canadian Government (Asia Pacific Foundation of Canada, 2006-2010). According to the investment values of these 299 FDI cases, our database accounts for an estimated 74 per cent of the overall Canadian direct investments in China in this period (Statistics Canada, 2011). As such, the FDI sample represents the bulk of FDI flows from Canada to China. For each FDI case, our database includes the firm name, the geographical origin and destination of the investment, and a brief description based on which industry and investment specifics can be identified. Although widely spread across different industries, FDI from Canada to China concentrate in the areas of manufacturing (79 cases), mining (72), finance and insurance (31), and telecommunications and software (29).

To identify clusters, we consult detailed industry data in the two countries. In Canada, we follow Holmes and Stevens' (2003) study and use the 2006 Canadian business patterns data (Statistics Canada, 2006), which cover all registered business establishments. From detailed industrial data at the level of Census Metropolitan Areas (CMAs) and Census Agglomerations (CAs),¹⁰ we calculate location quotients (LQs) for both the number of establishments and employees in all local industries with FDI activity. To exclude extreme cases with only very small firms or with one single giant firm, both LQs are used in combination with each other when identifying clusters. Local industries with both LQs larger than 1 exhibit agglomeration tendencies and are

¹⁰ CMAs and CAs represent all urban economic areas in Canada. According to Statistics Canada (2006), these areas are defined by a larger urban core with at least 10,000 people combined with one or more closely-related adjacent municipalities that are connected to the urban core through commuter flows. There are 33 CMAs and 111 CAs in Canada in 2006.

regarded as potential cluster candidates.¹¹ For most local industries, the two LQs are consistent, resulting in the same groups of CMAs/CAs with LQs larger than 1.

Since standard industrial classification systems usually cannot capture the full scope of clusters (Porter 1990) and in order to insure that the identified potential clusters have coherent internal structures, we next add local technologically related industries to each potential cluster, using the most detailed industry classification available. As such, we view the identified agglomerated industries as core activities and combine them with those technologically related 4-6-digit industries according to the North American Industry Classification System (NAICS) that exist in the same city-region. These are industries exhibiting strong potential for producer-user linkages with the potential clusters' core industries. For example, Toronto has an agglomeration in the area of motor vehicle parts manufacturing (3363). This 4-digit industry does not, however, encompass the full breadth of an auto parts cluster as other relevant industries are scattered across other sections of the industry classification system. For the auto parts cluster, we therefore add the branches industrial mould manufacturing (333511), battery manufacturing (335910), and other related sectors. Having constructed clusters with coherent structures, we recalculate the revised number of establishments and employees, as well as the respective LQs, to be used as final criteria for cluster identification. If these industrial ensembles have a sufficient scale in meeting distinct

¹¹ There is no commonly accepted LQ criterion for identifying clusters (O'Donoghue and Gleave, 2004). However, industries with LQs larger than 1 can be regarded to be agglomerated, compared to average concentration patterns of industries. Although different LQ cut-off values larger than 1 are often used in practice to define clusters (Braunerhjelm and Carlsson, 1999), they may not be easily comparable since LQs are sensitive to industry and geographical scales. In this analysis, we use an LQ of larger than 1 as one criterion for identifying clusters, similar to Porter (2003) and Freedman (2008). As indicated in Appendix A and B, however, our final classification is quite robust to increases in the LQ cut-off value.

lower size limits for the number of establishments and employees,¹² and if both LQs are near or larger than 1, we identify them as ‘clusters’.¹³ In our analysis, the four numerical criteria prove to be coherent since they are in most cases either simultaneously met or fail altogether.

The same steps are undertaken at the city level in China based on economic census data from 2004 (National Bureau of Statistics of China, 2004) and the China City Statistical Yearbook for 2005 (National Bureau of Statistics of China, 2005).¹⁴ Through this stepwise procedure, we finally identify 32 clusters in Canada and 31 in China (Appendix A and B), out of originally 198 and 118 local industries with FDI cases in Canada and China, respectively. Most of the identified clusters are quite prominent, and the results are consistent with the findings of cluster identifications using different methods (e.g. Spencer et al., 2010).

In the next stage of the analysis, we develop a typology of city-regions in both countries. In accordance with the theoretical discussion of global city-region networks and in taking competitive economic advantages of the cities in both countries into consideration, we distinguish five types of city-regions based on two criteria: economic function and power/influence within the city-region system. The respective city-region types are: global city, regional control centre, manufacturing city, resource centre, and

¹² To ensure that clusters have a sufficient size to potentially generate self-sustaining growth triggers, we define a lower limit in the number of establishments of 100 and an employment minimum of 5,000 people. These lower limits are chosen based on case studies of clusters to insure the identified clusters reach a critical mass for local interaction, knowledge exchange, and learning. The cut-off points chosen may seem somewhat arbitrary, but our final results are robust to variation in the minimum number of establishments and employees. Of the identified clusters in Canada, only 4 (of a total of 32) clusters have less than 10,000 employees and 5 have less than 200 establishments. In China, only 1 (of 31 identified) cluster has an overall employment of less than 10,000 and 12 have less than 200 establishments.

¹³ Strictly speaking, these are still only potential clusters as we do not use data about input-output linkages or knowledge flows between the local industry branches. For the sake of simplification, however, we refer to them as clusters throughout this paper.

¹⁴ This data is structured according to the China Industry Classification System (CICS) from 2003. The CICS is a classification system similar to the NAISC, with the 4-digit level as the most detailed one that is compatible with the 6-digit NAICS level.

rural and other city (Table 2). Global cities are identified according to their worldwide economic, political, and cultural influences, especially their dominant role as financial and producer-service centres in the global economy (Sassen, 2001). We define Toronto, Beijing, and Shanghai as global cities, since they are widely acknowledged as such in related studies.¹⁵ Compared to global cities, regional control centres in our typology are defined as national capitals (i.e. Ottawa), capitals of provinces, as well as China's city-level provinces (e.g. Chongqing). These city-regions are assumed to have political and economic power primarily at the national or sub-national level. Of the 38 FDI-related CMAs/CAs in Canada and 91 city-regions in China, 7 (18 per cent) and 22 (24 per cent) are classified as regional control centres, respectively.

Table 2 about here

Manufacturing cities are characterised by a large share of employment in manufacturing, but lack regional/national political powers. Since China, as an industrialising country, generally has a much higher percentage of manufacturing employment than Canada, we need to apply differentiated but comparable criteria to separate manufacturing cities from other city-regions. Using the national employment share in manufacturing as a benchmark (28 per cent in China and 12 per cent in Canada), we define manufacturing cities as those city-regions, not assigned as control centres, where the manufacturing employment is 2 per cent points above the national average. Of

¹⁵ The three cities are all in the top 20 global cities ranked by Foreign Policy, A.T.Kearney and the Chicago Council on Global Affairs (available from: <http://www.foreignpolicy.com/node/373401> [18 August 2011]) and Citi Private Bank and Knight Frank (available from: https://www.privatebank.citibank.com/ann_2010.03.23.htm [18 August 2011]), and are classified as world alpha cities (available from: <http://www.lboro.ac.uk/gawc/world2010t.html> [18 August 2011]).

the 38 FDI-related CMAs/CAs in Canada, 14 (37 per cent) are accordingly classified as manufacturing cities, and 32 of the 91 city-regions (35 per cent) in China.

Resource centres are another unique and interesting group related to Sino-Canadian investment flows. The identification of resource centres is straightforward since these city-regions have a disproportionately large share of employment in mining. We identify Calgary as the only Canadian city-region in this category with an employment share in mining of 6 per cent and 6 Chinese city-regions which have a share of more than 10 per cent of employment in mining. In comparison, other FDI-related city-regions in both countries show substantially lower employment in mining (mostly less than 2 per cent). The remaining city-regions in both countries and several rural areas are regarded as rural and other cities.¹⁶ The results of the city-region classification in both countries are summarised in Table 2.

5. Results: Spatial Patterns of FDI Linkages from Canada to China

Having justified our methodology, this section presents the results of the analysis regarding the formation of Canadian–Chinese cluster and city-region networks due to FDI linkages. Table 3 summarises FDI linkage patterns depending on whether (or not) they originate from clusters in Canada and whether they are directed to clusters (or non-clusters) in China across different industry groups. Since we identify clusters according to 2004 census data in China and 2006 business patterns data in Canada,

¹⁶ In Canada, Vancouver joins this group of city-regions as a specific case in the Canadian city-region system. Arguments can be found to classify Vancouver alternatively as a resource or manufacturing centre (e.g. Rees, 2004) – or if combined with Victoria as a regional control centre – although it does not meet any of the criteria discussed above. This situation is a reflection of the highly unequal structure and size distribution of the Canadian city system, which makes it extremely difficult to identify a homogenous set of regularities that describe the growth patterns of cities (Simmons et al., 2004). To avoid an arbitrary element in our typology, we choose to assign Vancouver to the group of rural and other cities. The consequence is that it is not possible to identify typical investment patterns for this group as it is a rather heterogeneous group of city-regions, with Vancouver being dominant in terms of the number of FDIs.

spatial patterns of FDI linkages from Canada to China since 2006 should be interpreted as the outcome of locational decisions of multinational firms based on pre-existing regional clusters. In Table 3, for all investment cases across all industries, 44 of 66 Canadian cluster firms (66.7 per cent) decided to set up a foreign affiliate in a Chinese cluster, whereas 22 firms (33.3 per cent) decided to direct their FDIs to a non-cluster. This different behaviour is highly significant, supporting hypothesis (H1a).

Table 3 about here

In comparison, of the 233 investment cases originating from non-clusters in Canada, only 30 firms (12.9 per cent) opened branches in Chinese clusters. The bulk of the 203 Canadian non-cluster firms (87.1 per cent) opened their Chinese facilities outside a cluster. The Chi square test ($\chi^2_{df=1} = 79.91$, $p < 0.0000$) is highly significant, indicating that, for FDIs from Canada to China, locational choices of multinational firms are not independent from their localised industry settings. Cluster firms in Canada are five times more likely to form cross-cluster linkages through FDIs in China, compared to non-cluster firms.¹⁷ Conversely, non-cluster firms in Canada are 2.6 times more likely to avoid clusters than are cluster firms. These findings support hypothesis (H1b), together with hypothesis (H1a) suggesting that cluster-based firms direct their FDIs to locations

¹⁷ Since we define clusters within city-regions, another interpretation of Table 3 could be that diversified urban economies, rather than specialized cluster effects, generate these FDI spatial patterns. We do not find strong support for this interpretation though, as the correlation coefficient between urban diversity, as measured by the inverse of Herfindahl-Hirschman Index of employment, and the number of FDIs is only 0.202 (albeit significant at the 5 per cent level). When the cluster effect, as measured by the number of identified clusters per city-region, is included as an independent variable into a linear regression analysis, urban diversity is no longer significant. From this statistical evidence, we believe Table 3 can be appropriately interpreted as evidence for the existence of global cluster networks. This implies that the FDI-based global networks of city-regions observed in this research are generated by cluster effects, rather than by urban economies.

from which they can draw crucial knowledge inputs and agglomeration economies, while non-cluster-based FDIs seem to seek for natural resource locations, low-cost labour and other advantages in their industry context.¹⁸

The fact that cluster firms are more likely to establish subsidiaries in clusters can be observed across different industries. Contingency tables of manufacturing, telecommunications, and finance and insurance industries show similar patterns of cluster connections (Table 3): 63.6 per cent (14 out of 22), 100 per cent (23 of 23), and 53.8 per cent (7 of 13) of the FDI cases from Canadian manufacturing, telecommunications, and finance and insurance clusters choose to establish foreign affiliates in Chinese clusters, respectively. The Chi square tests in these industries ($\chi^2_{df=1} = 13.04$, $p < 0.0003$ for manufacturing; $\chi^2_{df=1} = 3.97$, $p < 0.0463$ for telecommunications; $\chi^2_{df=1} = 3.3$, $p < 0.0692$ for finance and insurance) support hypothesis (H1d). Altogether, these observations strongly suggest that FDIs from within clusters lead to spatial patterns of internationally connected clusters, or global cluster networks, formed by multinational firms.

What remains unexplored is whether the identified global cluster networks are constituted through connections between clusters in similar or closely related technologies/industries, or whether cluster-based FDI cases direct their investments to different, only partially related technological contexts. To answer this question, Table 4 specifies for the 66 FDI cases originating from Canadian clusters what kinds of linkages are formed between which cluster industries. Of the 23 FDI linkages from telecommunications and software clusters in Canada, 19 (82.6 per cent) provide connections to information, communication, and software clusters in China, while 2 of the remaining 4 firms are directed to specialised, technologically related telecommunication equipment and computer manufacturing clusters. For finance

¹⁸ This is supported by most of the 72 FDI cases in mining and the 24 cases in agriculture.

clusters, 7 of 13 FDI linkages (53.8 per cent) are directed to other finance clusters in China. Similarly, 6 of 7 firms (85.7 per cent) in computer equipment clusters, 4 of 6 firms (66.7 per cent) in auto parts clusters, and 4 of 9 firms (44.4 per cent) in pharmaceutical clusters choose to establish FDI linkages in Chinese cluster locations of the same industry. Table 4 confirms the trend that clusters in similar or closely related technologies/industries are connected through FDI linkages, supporting hypothesis (H1c).¹⁹

Table 4 about here

As suggested in our conceptualisation, spatial patterns of FDI linkages accumulate at the city-region level and establish global city-region networks. Figure 2 summarises the identified structures of city-region networks between Canada and China by cluster and non-cluster FDIs, for five categories of Canadian city-regions with outgoing FDIs (FDI origins) and five types of Chinese city-regions with incoming FDIs (FDI destinations). It clearly indicates the importance of global cities as origins of FDI decisions. Overall 123 FDI cases originate from the Canadian global city Toronto, yet the number of FDI cases originating from Canadian rural and other cities is almost equally high with 116 cases (primarily due to the role of Vancouver). This result lends moderate support to hypothesis (H2a), as other city-regions are also important origins of FDIs.

At closer analysis, a clear difference can be found between cluster-based FDIs and non-cluster FDIs. In particular, 33 of 66 cluster-based FDIs (50.0 per cent) originate from a global city (Toronto), while this is only true for 90 of 233 non-cluster-based FDIs (38.6 per cent). This difference is significant, supporting hypothesis (H2b), which

¹⁹ These and the following results are stable and generally do not change with alterations in the cluster criteria used or classification procedures applied.

suggests that cluster-based FDIs are more likely to originate from global cities than non-cluster FDI.

Figure 2 about here

Further analysis of the direction of FDIs originating from global cities shows that these are associated with both horizontal and vertical linkages (Figure 2). A total of 33 of 123 FDIs (26.8 per cent) from Toronto are directed to the Chinese global cities Shanghai and Beijing, creating horizontal global-city connections that support both types of cities by connecting each other's knowledge pools. The majority of FDI connections originating from the global city Toronto are, however, downwards-directed toward medium-range cities, particularly establishing linkages with regional control centres (42 FDIs) or manufacturing cities (25 FDIs). This supports hypothesis (H2c), suggesting that global cities deepen their power/influence across the global hierarchy of city-regions by the means of horizontal and vertical FDI linkages.

Comparing the upper left corner in Figure 2 of cluster-to-cluster FDI linkages with the lower right corner of non-cluster-to-non-cluster FDIs provides some indication about the likelihood of horizontal FDI linkages differentiated by cluster status. In terms of horizontal linkages, 9 of 19 cluster-based FDIs (47.4 per cent) from global cities connect with other global cities, and 1 of 2 cluster-based FDIs (50.0 per cent) from manufacturing cities provide linkages with other manufacturing cities. In comparison, only 14 of 82 non-cluster FDIs (17.1 per cent) from global cities and 5 of 18 non-cluster FDIs (27.8 per cent) from manufacturing cities generate horizontal connections. This finding indicates moderate support for hypothesis (H2d), which suggests that horizontal linkages are more likely created by cluster-based FDIs than by non-cluster-FDIs – although this does not hold for all city-region types.

The general structure of city-region networks formed by different FDI cases according to industries is summarized in Figure 3. The upper left corner of Figure 3 displays city-region connections across all industries. It shows that the general city-region network of FDIs from Canada to China is quite complex, with both horizontal and vertical connections between different types of cities. Different spatial linkages patterns can be found when analysing this data by industry group. In mining, for instance, there are clear linkages from rural and other cities in Canada (mostly from Vancouver) to rural areas in China (lower left corner in Figure 3). As a global centre of mining exploration (Russell et al., 2009), Vancouver takes the lion's share of mining-related FDIs from Canada – and most of the mining FDIs are directed to rural areas in western China, where important natural mineral deposits can be found. This suggests that resource-seeking might be prominent in these cases.

Figure 3 about here

The upper right corner of Figure 3 shows cross-border spatial networks of manufacturing investments. Most of the manufacturing FDIs originate from Toronto where 5 of a total of 19 manufacturing clusters in Canada are located. The global city Toronto (with a large manufacturing base) is linked with manufacturing centres and regional control centres in China that have manufacturing clusters. In the area of advanced producer services, as argued in the global city-region hypothesis and Sassen's (2001) global-city model, global cities are well connected with other global cities by means of inter-cluster linkages. This is indicated for FDIs in finance and insurance in the lower right corner of Figure 3. A total of 11 of 29 FDIs in finance and insurance (37.9 per cent) originating from Toronto are directed to global cities in China. In sum, Figure 3

supports hypothesis (H2e), according to which linkage patterns of city-regions differ by industry group.

6. Conclusion: Towards Global Cluster Networks

In line with other theorisations of trans-local economic linkages at various scales, this paper develops and substantiates a global cluster-network framework for exploring dynamic spatial patterns and connections in the global economy. According to this framework, global cluster networks are generated through cluster firms setting up FDI affiliates in clusters with similar or related industries. FDI linkages across clusters provide an important mechanism for the global dissemination of knowledge generated in specific localities and the localised learning processes related to this global knowledge. This is because FDI connections are able to exploit both spatial proximity within local clusters, as well as organisational proximity within corporate networks at a distance. In a cluster context, FDI linkages with other cluster nodes develop into durable global pipelines for the transfer of codified and tacit knowledge, complementing the role of commercial conferences and trade fairs in temporarily co-located settings. In a corporate context, FDI cases of cluster firms challenge the previous atomistic interpretation of multinational corporations in terms of their locational decision-making processes for new FDI affiliates. In the global cluster network, multinational corporations are less adequately viewed as strictly hierarchical organisations, but as multilateral corporate networks that are embedded in and linked with various cluster networks. In the context of city-regions, in turn, FDI linkages of cluster firms in manufacturing and/or producer services generate global city-region networks, within which city-regions are connected through horizontal and vertical linkages.

To substantiate the global cluster-network and global city-region-network hypotheses, this paper presents an analysis of the spatial patterns of 299 FDI cases from

Canada to China between 2006 and 2010. After identifying clusters and classifying city-regions in a way comparable between the two countries, we find that the results of FDI linkages from Canada to China are generally consistent with the hypotheses developed. First, in both manufacturing and producer services, cluster firms from Canada are more likely to set up FDI affiliates inside existing Chinese clusters, while non-cluster FDI from Canada are more likely to avoid clusters in China ([H1a] and [H1b]). Second, in these global cluster networks, FDI cases from telecommunications, finance, computer equipment, and auto parts in Canada generate connections to similar or closely related industrial clusters in China ([H1c] and [H1d]). In combination, these findings support the complex global cluster-network hypothesis, implying that global cluster networks are formed through FDI linkages between clusters in closely related technologies. Third, our data shows that FDI linkages originating from global cities are especially important and establish both horizontal and vertical connections across the global city-region network ([H2a] to [H2c]), thus strengthening the power/influence of global cities. Fourth, the patterns of city-region networks generated by FDIs from Canada to China differ according to industry group and cluster characteristics (i.e. cluster-based versus non-cluster-based FDIs) ([H2d] and [H2e]).

Due to a lack of large numbers of disaggregated FDI cases and other complementary data, the sub-sets of global cluster-network hypotheses and global city-region-network hypotheses have only been partially tested in this paper for FDIs from Canada to China. In this analysis, empirical support is generally stronger for the former hypotheses than for the latter. Overall, encouraged by recent case studies on cluster connections and interactions, and supported by the findings about FDI linkage patterns from Canada to China, we expect that global cluster networks will become more manifest and visible over time as the internationalisation of cluster firms proceeds. Because of the specific knowledge available in clusters that shapes their labour market, we expect that

more cluster firms will establish linkages with other clusters in similar technologies to 'be there' in order to keep up with – and benefit from – industry dynamics at the global scale. Through this, clusters in similar fields can be expected to connect with one another, forming global networks that strengthen each other and eventually generate global city-region networks.

The analysis of FDI patterns from Canada to China calls for further quantitative research about global patterns of cluster dynamics in order to extend our knowledge of FDI-induced broader economic linkages and to produce generalisations. The global cluster-network hypothesis also requires more qualitative investigations to explore how codified and tacit knowledge is transferred across clusters through expatriate managers, immigrant entrepreneurs, and other transnational professionals, and to investigate why (or why not) cluster or non-cluster linkages are formed. All of these conclusions emphasize the need for a wider future research agenda on cluster networks and spatial FDI dynamics in the global economy.

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Table 1 Frameworks of Trans-Local Economic Connectivity

Scale	Conceptual frameworks	Key drivers of trans-local connectivity	Main arguments	Limitations
Individuals	Transnational communities	Emigrant engineers/entrepreneurs	- They trigger external knowledge transfer/learning	- Focus on few immigrant groups - Lack of corporate and FDI dimension
Firms	Global value chains/production networks	Multinational headquarters/global buyers/global producers	- Local clusters as nodes of multinational corporations - External learning of cluster firms depends on value chain governance	- Focus on vertical interactions - Focus on input-output relations, not FDI - Spatial relations only secondary
Clusters	Global pipelines	Trade fair attendees/business travellers	- Trans-local pipelines provide crucial growth resources - Temporary clusters lead to pipeline generation/extension	- Focus on intra-cluster relations - Global linkages vaguely conceptualised - Durable FDI-related networks unexplored
City-regions	Global cities	Global producer servicers/multinational headquarters	- They are concentrated in global cities - They exercise control/power along the urban hierarchy	- Focus on input-output relations, not FDI - Focus on the top group of global cities

Table 2 Types of City-regions with FDI Activities by Country, 2006-2010

Type of city-region	Number (percentage) of Canadian city-regions with outgoing FDIs	Number (percentage) of Chinese city-regions with incoming FDIs
Global city (GC)	1 (3 %)	2 (2 %)
Regional control centre (RCC)	7 (18 %)	22 (24 %)
Manufacturing city (MC)	14 (37 %)	32 (35 %)
Resource centre (RC)	1 (3 %)	6 (7 %)
Rural and other city (RO)	15 (40 %)	29 (32 %)
Total	38 (100 %)	91 (100 %)

Table 3 Origins and Destinations of FDI-based Cluster Networks from Canada to China by Cluster Status and Industry Group, 2006-2010

	TO \ FROM	All industries		Manufacturing		Telecommunications and software		Finance and insurance	
		Cluster	Non-cluster	Cluster	Non-cluster	Cluster	Non-cluster	Cluster	Non-cluster
Cluster		44	22	14	8	23	0	7	6
Non-cluster		30	203	12	45	5	1	4	14
Chi square		79.91		13.04		3.97		3.3	
(P value)		(.0000)		(.0003)		(.0463)		(.0692)	
Degrees of freedom (df)		1		1		1		1	
N		299		79		29		31	

Table 4 FDI-based Cluster Networks from Canada to China by Cluster Industry, 2006-2010

Cluster industry in Canada with outgoing FDIs	Cluster industry in China with incoming FDIs	FDI linkages, number
Telecommunications and software clusters		23
	Information, communication and software clusters	19
	Telecommunication equipment clusters	1
	Computer manufacturing clusters	1
	Non-clusters	2
Finance clusters		13
	Finance clusters	7
	Non-clusters	6
Pharmaceutical clusters		9
	Pharmaceutical clusters	4
	Non-clusters	5
Computer equipment clusters		7
	Telecommunication equipment clusters	4
	Computer manufacturing clusters	1
	Software clusters	1
	Medical equipment clusters	1
Auto parts clusters		6
	Auto parts clusters	4
	Non-clusters	2
Motion picture clusters		3
	Non-clusters	3
Producer services clusters		2
	Lease and business service clusters	1
	Non-clusters	1
Paper publishing clusters		1
	Non-clusters	1
Petro-engineering clusters		1
	Non-clusters	1
Metal manufacturing clusters		1
	Non-clusters	1
Total		66

Figure 1 Nested Model of Global Cluster Networks

Figure 2 FDI-based City-Region Networks from Canada to China by Cluster and Non-cluster Status, 2006-2010

Note: GC = Global city; MC = Manufacturing city; RCC = Regional control centre; RC = Resource centre; RO = Rural and other city

Figure 3 FDI-based City-Region Networks from Canada to China by Industry Group, 2006-2010

Note: GC = Global city; MC = Manufacturing city; RCC = Regional control centre; RC = Resource centre; RO = Rural and other city

Appendix A

Identified Canadian Clusters with FDIs in China by City-region and Industry, 2006-2010

(Source: Based on data from Asia Pacific Foundation of Canada, 2006-2010; Statistics Canada, 2006)

Identified cluster by city-region and industry	NAICS industries included	Establishments, number	Employees, number	LQ of establishments	LQ of employment
Calgary finance	522112; 522130; 522220; 522310; 523	5,091	18,827	1.1	1.0
Calgary oil and gas	2111; 541330; 541360; 541620; 5629	8,846	80,800	4.5	5.8
Edmonton petro-engineering	3241; 541330; 541360; 2111	1,773	13,470	1.4	1.3
Hamilton auto parts	3361; 3362; 3363; 3365; 3369; 333511; 3336; 335312; 335315; 335910	98	6,624	1.5	1.8
Kitchener auto parts	3361; 3362; 3363; 3365; 3369; 333511; 3336; 335312; 335315; 335910	112	11,472	2.4	3.8
London auto parts	3361; 3362; 3363; 3365; 3369; 333511; 3336; 335312; 335315; 335910	86	13,530	1.9	5.1
Montreal clothing	315	1,318	19,995	3.6	3.4
Montreal computer equipment	334; 335910	496	15,376	1.5	1.4
Montreal finance	522112; 522130; 522220; 522310; 523	11,152	47,831	1.2	1.1
Montreal furniture	337	1,059	13,959	1.5	1.1
Montreal metal products	331; 332	1,417	36,062	1.1	1.0
Montreal motion pictures	512	3,015	19,768	1.9	2.5
Montreal performing arts	711	3,609	14,085	1.8	1.3
Montreal pharmaceuticals	325410; 339110; 621510; 541710	1,280	32,506	1.4	1.9
Montreal software	5112	230	7,699	1.2	1.6

Montreal telecommunications	517	391	20,087	1.1	1.8
Ottawa computer equipment	334; 335910	188	12,444	1.9	3.9
Ottawa software	5112	155	5,327	2.6	3.9
Toronto auto parts	3361; 3362; 3363; 3365; 3369; 333511; 3336; 335312; 335315; 335910	796	47,554	1.1	1.2
Toronto computer equipment	334; 335910	907	24,837	1.5	1.3
Toronto finance	522112; 522130; 522220; 522310; 523	23,256	127,859	1.2	1.7
Toronto motion pictures	512	6,077	21,072	1.9	1.7
Toronto pharmaceuticals	325410; 339110; 621510; 541710	1,754	38,880	1.0	1.4
Toronto plastic	326	801	40,025	1.4	1.5
Toronto producer servicers and corporate control functions	541110; 541190; 541212; 541611; 541612; 541619; 541810; 541820; 551113; 551114; 561110	58,226	345,486	1.4	1.7
Toronto software	5112	646	12,108	1.7	1.5
Toronto telecommunications	517	769	22,029	1.2	1.2
Vancouver computer equipment	334; 335910	247	8,512	0.9	1.1
Vancouver pharmaceuticals	325410; 339110; 621510; 541710	897	14,202	1.2	1.2
Vancouver producer services and corporate control functions	541110; 541190; 541212; 5416; 541810; 541820; 5511; 5611	23,516	103,542	1.3	1.2
Vancouver software	5112	297	8,066	1.8	2.5
Vancouver telecommunications	517	294	12,311	1.0	1.7

Notes: NAICS = North American Industry Classification System; LQ = Location quotient

Appendix B

Identified Chinese Clusters with FDIs from Canada by City-region and Industry, 2006-2010

(Source: Based on data from Asia Pacific Foundation of Canada, 2006-2010; National Bureau of Statistics of China, 2004, 2005)

Identified cluster by city-region and industry	CICS industries included	Establishments, number	Employees, number	LQ of establishments	LQ of employment
Beijing information, communication and software	G	3,500	334,102	n.a.	4.9
Beijing lease and producer services	L	38,383	628,099	n.a.	5.7
Beijing pharmaceuticals	368; 27	268	41,612	3.9	0.9
Beijing scientific research and geophysical research	M	15,716	400,982	n.a.	2.9
Beijing telecommunication equipment	401	134	28,840	4.3	0.8
Changzhou auto parts	372; 2911; 3940	148	16,873	1.0	1.0
Chengdu finance	J	2,625	77,000	n.a.	1.2
Chongqing auto parts	372; 2911; 3940	230	105,790	2.8	1.5
Daqing oil	3612; 710; 790; 2511	83	120,376	29.6	17.6
Guangzhou auto parts	372; 2911; 3940	161	44,612	1.0	0.8
Guangzhou finance	J	2,951	107,900	n.a.	1.3
Jinan information, communication and software	G	335	8,513	n.a.	1.0
Nanjing information, communication and software	G	801	120,000	n.a.	1.3
Shanghai automation equipment	4111	81	11,321	3.7	4.6
Shanghai auto parts	372; 2911; 3940	563	139,469	1.1	1.4
Shanghai finance	J	787	182,400	n.a.	1.6
Shanghai information, communication and software	G	1,500	94,800	n.a.	1.3
Shanghai lease and producer services	L	31,148	458,700	n.a.	3.1
Shanghai medical equipment	368	117	17,654	2.8	3.4
Shanghai metal products	34	1,388	159,053	1.7	1.9

Shanghai plastic and rubber	2651; 2652; 291; 30	1,335	180,086	1.4	1.7
Shenzhen information, communication and software	G	1,444	140,000	n.a.	2.1
Shenzhen telecommunication equipment	401	179	146,168	6.9	15.2
Shijiazhuang pharmaceuticals	368; 27	41	46,795	2.3	8.7
Suzhou computer manufacturing	404; 405; 406	663	385,224	2.7	13.0
Suzhou information, communication and software	G	550	38,300	n.a.	1.1
Tianjin finance	J	3,179	50,400	n.a.	1.0
Weifang auto parts	372; 2911; 3940	141	28,678	1.3	1.8
Wuhan auto parts	372; 2911; 3940	106	41,483	2.4	0.9
Wuxi bicycles	374; 3940; 2912	68	17,675	1.4	4.5
Yantai gold mining	921; 3321	70	57,404	11.6	34.6

Notes: CISC = China Industry Classification System; LQ = Location quotient; n.a. = not available