Localization of Global Networks: New Mandates for MNEs in Toronto's Innovation Economy

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Abstract

The current wave of technological transformation is altering dynamics between the global and local scales. This transformation affects the dynamic linkages between multinational enterprises MNEs and the host economies in which they invest. This article examines how MNEs in leading technology sectors are re-evaluating their relationship to Toronto's innovation economy. It employs elements of three conceptual approaches on global production networks, global innovation networks, and the locational strategies of MNEs. Firms engage with the host region in new ways by tapping into knowledge sources to diversify the locational base of their R&D activities, as well as with local entrepreneurial ecosystems in emerging technologies and industry niches.

Keywords: global innovation networks, global production networks, competence creating, strategic coupling, regional innovation systems, Toronto.

JEL Codes: 019, 051, R11, R58.

Introduction

The revolution in transportation and communications technologies during the 1970s and 1980s altered the calculus of firms' decisions with respect to the spatial allocation of investment (Dicken 2011), leading to what Baldwin has labelled 'the great convergence' (2016) The ensuing relocation of production, part of the second unbundling,[i]. exerts a strong influence on local and regional economies in which they invest through the linkages formed between global networks and regional economies. However, the 'third unbundling' currently underway, extends to "the new international movement of knowledge" (Baldwin 2016, 139; OECD 1996), which is increasingly the focus of efforts by leading multinational enterprises MNEs to coordinate their knowledge exploration and production activities across a range of global sites. This article explores how MNEs in leading technology sectors, particularly digital technologies, advanced manufacturing and automotive, are re-evaluating their strategic relationship to the economy of the Greater Toronto Area (GTA). It reviews perspectives afforded by three bodies of literature: that on Global Production Networks (GPNs) and strategic coupling, the literature on Global Innovation Networks (GINs), and the International Business (IB) literature on the global strategies and locational choices of MNEs. The article draws on insights from each approach to analyze the changing strategies of inward investment by MNEs into the Toronto area and conversely, the changing position occupied by Toronto's innovation economy in the global networks and global research and development (R&D) strategies of leading MNEs.

As regions and urban agglomerations contend for inward investment in this globalized environment, their relative success depends on the ability to articulate into the changing investment criteria employed by MNEs and the global networks in which they are embedded. While spatial variability in economic success is not new, the present era of technological transformation accentuates the degree to which prospects for local and regional economic development are linked to decisions by actors beyond the region's borders, reinforcing the point that processes of innovation and economic development are intersected by 'nested scales' that are mutually constitutive and encompass the global, national and local levels (Swyngedouw 1997; Coe and Bunnell 2003). Understanding the interplay between the supra-national dynamics within the global networks of MNEs and the complex array of local factors that influence investment decisions into regions is critical for understanding the prospects for local and regional economic development.

The Greater Toronto Area occupies a unique position within the Canadian urban system, marked by the relative size and diversity of its economy across a wide range of economic sectors (Bourne, et al. 2011). As its preeminent status within the Canadian urban system shifted over the postwar period, Toronto became the headquarters for a growing number of MNEs in

both the resource and traditional manufacturing sectors. Over the past two decades, however, the Toronto economy experienced a subsequent transformation, emerging as a leading centre for the cognitive-cultural economy in North America, with critical strength in financial services, information and communications technology, advanced manufacturing, and the cultural and creative industries (Scott 2008; Wolfe and Bramwell 2016).

The nature of MNE investment in the region has shifted over the past two decades as well, with an increasing proportion of inward investment focused on accessing local knowledge assets and integrating them into global research and development activities. The changing nature of MNE strategies in the GTA raises questions about the dynamics of strategic coupling between Toronto's economy and the global networks to which it is linked. The article thus addresses research questions at the heart of the theme for this special issue—which factors influenced Toronto's transition from an enclave for MNE's whose investment was primarily based on a 'competence-exploiting' strategies to one whose position in global networks is increasingly defined in terms of their contribution to 'competence-creating' strategies (Cantwell and Mudambi 2005). To address this question, we examine the critical factors that underlay this transition and how it reinforces and alters the pattern of development in the urban economy. Closely related is the question of how inward investment by MNEs increases pressure on scarce resources in the regional economy, particularly for highly qualified talent, and reduces the supply available to sustain the growth of the region's indigenous technology sector (Denney, Southin, and Wolfe 2021).

The examination proceeds through the following steps. The next section of the paper reviews key concepts from three bodies of literature referred to above and assesses the relative contribution of each approach to understanding the transition. It then outlines the methodological approach taken in the article and restates the key research question. The following section summarizes insights and findings from the qualitative material in the case study on Toronto. It concludes with a summary of the key research insights and their implications for other urban and regional economies about the broader questions concerning the "changing geography of relations between production and territory".

From Global Production to Global Innovation Networks

The empirical analysis is framed in the context of three related bodies of literature—the literature on global production networks (GPNs) and strategic coupling, the literature on global innovation networks (GINs) and the literature on the international investment strategies and locational decisions of MNEs, drawn from the IB literature. We link this discussion to the

literature on regional innovation systems (RIS) to examine the nature of the coupling between the local and regional economy and global networks. While the GPN approach has been the dominant perspective for understanding the structural linkages between global networks and regional economies (Henderson, et al. 2002; Coe, et al. 2004; Coe, Dicken, and Hess 2008), recent contributions to the literature draw attention to the conceptual progression from a focus on global value chains to global production networks and global innovation networks (Parilli, Nadvi, and Yeung 2013). They attribute the emergence of the GIN concept to a recognition of the trend for high value-added activities, such as engineering, product development and R&D, to be dispersed across an array of geographic locations. In acknowledging this shift, they suggest that "[a]dditional thinking is needed to understand the competitive position and prospects of regions within this globalized scenario by identifying the relevance of these key activities and processes (i.e. R&D, innovation, production, and market) for regional development" (Parilli, et al. 2013, 971). Our analysis addresses this question by drawing on insights from both the GPN and GIN perspectives.

GPNs: Characteristics, Determinants and Change

Since the 1970s, the locus of global production has been transformed by a series of innovations that made the coordination and transportation of goods, and subsequently services, easier to manage. Commencing with the container revolution that reduced the cost and ease of transporting finished goods to destination markets (Dicken 2011), subsequent advances in information and communications technologies (ICTs) altered the calculus of coordinating diverse production activities at a global level. This was realized through the ease of transmitting information across those locations (Archibugi and Michie 1997). However, as Baldwin notes, this wave of globalization has been primarily marked by the outsourcing and distribution of production in a relatively small number of manufacturing sectors, particularly electronics and electrical machinery. Knowledge and understanding of how this trend has affected the service sector is less apparent (Baldwin 2016, 98).

The deeper integration of the global economy stimulated the literature on global production networks, which argued that the economic development trajectories of specific regions are influenced by the dynamic processes through which regional firms are strategically coupled with lead firms in GPNs. GPNs consist of the nexus of a set of operations through which a product or service is produced and distributed across national and territorial boundaries (Coe, et al. 2008, 274). They constitute a means of economic organization through which firms mobilize a combination of regional assets, such as specialized inputs or a concentration of skilled labour, by searching for, creating, maintaining and detaching from, relationships with

regions that fit their network needs (Henderson, et al. 2002). GPNs are characterized by the complex intertwining of both economic and non-economic actors producing a range of goods and services across multiple locations for global markets. They are comprised of 'actors'(including firms), extra-firm actors (e.g, unions, interest groups, governments) and intermediaries (e.g., financial intermediaries, logistics providers, standards setting bodies). The activities contained within GPNs can range from resource extraction and materials processing to conceptual design and high-end fabrication and services (Yeung 2009; Mackinnon 2012; Coe and Yeung 2015).

The GPN perspective recognizes that the interests and priorities of the actors that comprise a network are not always aligned with respect to the goals of network firms versus those of local or regional economic development. The key dynamic in the spatial configuration of production is the 'cost-capability ratio' (CCR). From the perspective of a lead firm, the GPN perspective maintains that the combination of high capability and low cost is indicative of a potential supplier that is ideally positioned to allow the lead firm to extract maximum value from its productive activities. Through a process of continually optimizing CCRs, lead firms and suppliers find newer and better configurations of their networks. This recursive process has the potential to continually redistribute different aspects of production to different locations globally (Coe and Yeung 2015).

The approach recognizes that local actors embedded in GPNs enjoy a certain degree of autonomy to craft strategies to promote their own goals and objectives. It thus underscores the 'territoriality' of production networks with respect to how they are constituted by the economic, social, and political arrangements prevailing across the spatial scales in which they operate (Henderson, et al. 2002, 446). Equally important is the dimension of power relations within the network; intra-firm relationships involve internal power dynamics that are contested among the component members of the network, including the relations between head offices and various subsidiaries of the MNEs that comprise the network (Coe, et al. 2008), a point explored in greater depth by the IB literature discussed below on changing MNE strategies (Cantwell and Mudambi 2005).

The potential synergies between host regions and the needs and capabilities of GPN firms has been elaborated through the concept of strategic coupling (Yeung 2016). Strategic coupling involves the dynamic processes by which relational assets are matched to the strategic needs of the lead firms; regional institutions play a critical role in aligning these relational assets to the needs of the firms and associated partners and suppliers in the GPN (Mackinnon 2012, 241). Strategic coupling refers to the process wherein regional actors converge with actors in the GPN to form a mutually beneficial arrangement based on the degree to which

regional 'bundles' of assets align with the strategic needs of the lead firm and/or the GPN more broadly (Henderson, et al. 2002; Coe and Yeung 2015; Yeung 2016). More specifically, strategic coupling is the dynamic process through which actors, be they translocal members of GPNs or regional actors, negotiate and coordinate local assets and translocal requirements via some configuration of relational connections (Yeung 2009, 213; Mackinnon 2012, 230).

While several critiques and extensions of the GPN approach have recently been advanced (Coe and Yeung 2019), the most striking lacuna is the primacy of attention paid to manufacturing sectors and firms, at the expense of attention to investments in R&D and software development. To a significant degree, the GPN perspective is concerned with the tangible economy of the global production of manufactured goods, at the expense of the growing role and importance of the intangible economy, which according to recent estimates represents 40% of total investment in the US and leading European economies (Hazan, Haskel, and Westlake 2021). As Baldwin notes, this focus overlooks the growing "servicification" of the manufacturing sector, as the competitiveness of manufacturing activity increasingly depends on the value of service activities related to design, operating systems, cloud-based applications to enhance the value of the product and data-based platforms that extend the hardware capabilities (Baldwin 2016, 160), as well as investments in intangible assets, such as intellectual property, software, databases, social media platforms, branding and marketing (Haskel and Westlake 2018; Corrado, et al. 2021).

The shift from tangible forms of production, driven by the increasing adoption and diffusion of digital technologies, extends across virtually every sector from resources and manufacturing to financial services and the creative and cultural industries, as they shift from electro-mechanical forms of production to software-enabled and data-intensive digital forms (Shih 2015; Breznitz and Zysman 2013; Andreesen 2011). As enhanced software functionality has been incorporated into less tangible and visible software-based technologies, the leading edge of the digital economy is now platform-based business models, software-defined digital networks, cloud computing, artificial intelligence, massive data sets, social media algorithms and smart phone apps (Kenney, et al. 2019; Grabher and van Tuijl 2020; Cusumano, Yoffie, and Gawer 2020; Jacobides and Lianos 2021).[ii] This transformation is fundamentally changing the basis for investment decisions by a growing number of MNEs. Increased investments in intangible, knowledge-based assets lie behind the changing calculus of MNE investments, which, in turn, has stimulated theorizing about the growing relevance of global innovation networks.

The Emerging Role of GINs

Growing investments in intangible assets in the global economy has generated interest in the way in which innovation processes and systems operate across territorial boundaries. The global dispersion of research and development activities by MNEs, linking international research activities with territorial and regional innovation systems (RIS), has contributed to the shift in focus from GPNs to global innovation networks (GINs). A GIN is defined as "a globally organized web of collaborative interactions between different organizations (firms and/or non-firm organizations) engaged in knowledge production that is related to and resulting in innovation (Chaminade, et al. 2016, 372). At issue is how complex innovation processes are embedded in territorial or regional contexts and the different forms that embeddedness takes for different technologies and industries. As such, the analysis focuses on systematic differences in innovation dynamics across those industries (Binz and Truffer 2017; Cooke 2013).

This shift parallels Baldwin's differentiation between the stages of globalization and is consistent with the distinction made by Phil Cooke between Globalisation 1 and Globalisation 2, with the latter driven by MNE's expanding search for new sources of exploitable knowledge in different knowledge-intensive regions, often drawing upon public sources of research funding in those regions (Cooke 2005). Building on the distinction between Globalisation 1 and 2, Cooke was among the first to argue that leading East Asian economies were shifting their priority from being part of GPNs to GINs. He argued the GPN approach suffered from a failure to appreciate the relative rise of innovation as a competitive weapon in comparison to the earlier emphasis on 'productivist' norms (Cooke 2013). The GIN perspective highlights relationships established to support the higher-level capabilities used to create new technologies, products and formats used to establish new market segments.

The growing dispersal of innovation activities stimulated the gradual emergence of GINs as a "globally coordinated interactive innovation process" (Chen and Vang 2008, 13). Early studies of GINs suggested they were driven in part by the need to monitor and learn from new technology trends, partly by the rising costs of R&D, and growing shortages of R&D personnel In industrial countries (Chen 2004). GINs were established to engage with local sources of specialized knowledge and capabilities that could provide complementary inputs for the development of new technologies. By coordinating the best minds, laboratories, research, and ideas on a global basis, leading MNEs promoted the emergence of GINs grounded in a series of 'islands of innovation' dispersed across a range of geographic locales with strong concentrations of research and knowledge capabilities in both industrial and industrializing countries. The 'islands of innovation' identified by Cooke are grounded in territorial innovation systems that subsume both national and regional innovation systems (RIS), the latter of which

incorporate subsystems for knowledge exploration by public and private research organizations, as well as knowledge exploitation by firms (Chen and Vang 2008; Cooke 2013).

GINs can be established for a variety of purposes, including creating new products or services to bring to markets, acquiring existing technologies from start-up or scale-up firms, or undertaking advanced research in leading edge regions through new collaborations. In contrast to the logic of GPNs that are motivated by efficiency-seeking or market-expanding strategies, GINs are impelled by knowledge or asset-seeking strategies that involve gaining access to new capabilities need to innovate (Chaminade and Plechero 2015). They are formed through the spatial reallocation of knowledge-creating processes to regions beyond the core locations of leading MNEs. The mechanisms for coordinating GINs are not restricted to interactions within a hierarchical structure but are based on external collaborations governed on a horizontal basis. A critical aspect in this perspective is that GINs are "highly embedded in territories and are pinned down to certain locations, and that, conversely, regional characteristics have a strong influence on the geography of a firm's innovation networks" (Chaminade, et al. 2016, 371).

The Changing Calculus of Firm Strategies

The focus in the GIN approach from a concern with efficiency seeking strategies to knowledge exploiting ones bears an affinity to recent theorizing in the IB literature on the changing calculus of inward investment strategies by MNEs. Integrating the IB approach with the literature on GPNs and GINs reflects the need for a more holistic perspective on the ways global knowledge flows intersect with the regional and local level (Bathelt, Cantwell and Mudambi 2018). Linking these perspectives also affords valuable insights into the role of agency on the part of critical actors at the regional and local level and its implications for regional economic development (Grillitsch and Sotarauta 2020). The IB research suggests that relations between subsidiaries in host locations and parent MNEs have shifted as subsidiaries assume expanded mandates to pursue "competence creating" ("asset augmenting") strategies in place of more conventional "competence exploiting" ("asset seeking") strategies (Cantwell and Mudambi 2005; Cantwell 2009; Cantwell 2013; Cantwell 2015; Cantwell 2017). For the MNE, the goal is to disperse a range of high-value-creating activity across different regional nodes, or centres of excellence, that constitute the MNEs global innovation network, generating an integrated portfolio of locational assets. MNEs increasingly are seen as "evolutionary learning organizations, which create (and draw upon) a regular and cumulative flow of knowledge and capabilities from locationally differentiated sources" (Cantwell 2009, 38).

In this approach, competence-creating subsidiaries are more engaged in knowledge exchange and development with local actors, while competence-exploiting ones focus on the exploitation of lower input costs. Subsidiaries are assigned broader scope to pursue competence-creating investment strategies with the expectation that the host location is not just a market for the home country's products, but a potential source of competitive advantage for the MNE as well. Competence-creating subsidiaries are more likely to locate in regional contexts where strong potential exists to establish productive network relations (through strategic coupling to a GIN). "[W]hen considered as a whole, the diversified structure of location-specific assets becomes a source of competitive advantages where the particular combination that has been found is synergistic […] (Cantwell 2009, 37). In terms similar to that found in the GIN literature, MNEs invest in what are termed 'higher order' centres, i.e. those with specialized centres of excellence or research competence to tap into available sources of knowledge. In this approach, the MNE is depicted "as an international network for geographically dispersed innovation" which stresses "the dynamic connectedness between local knowledge creation and exchange in each node of the network (Cantwell 2009, 36; Cantwell 2017, 48)."

The modularization of digital technologies across the economy is intensifying this trend. This is especially true for non-ICT firms in related industries, who need to tap into specialized research competences associated with the ICTs to remain competitive with cutting edge firms (Cantwell 2017, 46). It is reinforced by the global shortage of R&D human capital, especially in software/IT related areas, which is driving US MNEs to open new research 'hubs' with strong concentrations of workers with the needed level of STEM degrees and requisite IT skills. It is facilitated by the greater modularization of software and IT, which facilitates the dispersal of MNEs R&D activities across a broader range of networks and locations (Branstetter, Glennon, and Jensen 2019). Cantwell, as well as Fuller and Phelps, emphasize that power relations within GINs are far from unidirectional. Subsidiaries enjoy a degree of offsetting power to influence HQ decisions through their specialized knowledge of specific capabilities located in their territory. This endows managers of subsidiaries with scope to engage in complex negotiation strategies with their respective headquarters to expand the mandate and scope of the subsidiary's activities and capture benefits available from unique regional assets (Fuller and Phelps 2018). For this strategy to succeed, subsidiaries must be embedded in their local networks of research activity and competence creation to serve as a node of knowledge creation and innovation within the broader GIN.

Embedding GINs in Regional Innovation Systems

The three perspectives reviewed above highlight the importance of dynamic linkages in the form of strategic coupling between GINs, competence creating strategies, and regional development. From the GPN perspective we retain the concept of strategic coupling as the critical mechanism that specifies the way activities of global networks are embedded in regional and local economies; from the GIN perspective, we adopt the insight that the global coordination of MNE activities is shifting from a focus on production activities to a broader range of innovation-related activities, critical for rising investments in intangible assets; and from the IB perspective we draw the insight on the shift in MNE strategies from competence exploiting to competence creating strategies that drive the growth of GINs. Regional innovation networks are linked to elements of global innovation networks in which MNEs play a key role (Parilli, et al. 2013). The region is thus conceived as a porous territory whose boundaries intersect with a broad range of socially embedded relations between firm and non-firm actors operating across multiple geographic scales (Mackinnon 2012).

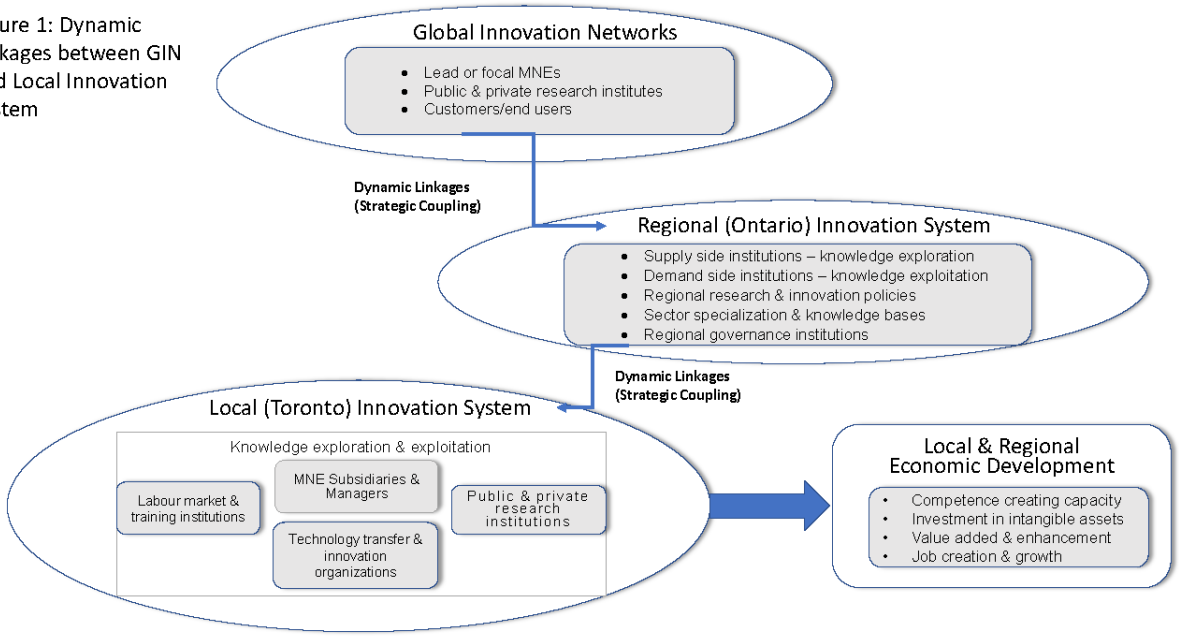
The way in which a GIN is embedded in a regional innovation system (RIS) is conditioned by the specific economic sector in which the GIN is grounded, and the local knowledge base tapped into for knowledge exploration and knowledge exploitation in the network (Liu, Chaminade, and Asheim 2013). The RIS, in turn, is comprised of the constellation of institutions, at the regional level, both public and private, that contribute to the innovation process. RIS emerge and evolve over time by incremental processes of institutional change through market interactions and changes in the innovation support system. The RIS is defined as "the set of economic, political and institutional relationships occurring in a given geographical area which generates a collective learning process leading to the rapid diffusion of knowledge and best practice" (Nauwelaers and Reid 1995; Cooke, Uranga, and Etxebarria 1997; Cooke 2004; Asheim and Gertler 2005).

A critical element of the RIS is the infrastructure of institutions that contribute to, and support, the innovation process, as well as the network of internal and external relations between public agencies and private actors. The RIS is conceived in terms of both the demand and supply side for innovation. On the supply side are the organizational sources of knowledge exploration in the regional economy. Closely linked to these are the institutions that contribute to the training and preparation of highly qualified labour. The demand side of the system includes the productive sector of the regional economy concerned with knowledge exploitation: firms that adopt the scientific and technological output of the supply side to create products and processes for broader markets. Between the two, lies a range of intermediary organizations that contribute to the acquisition and diffusion of technological

capabilities, including technology transfer centres, technology brokers, business incubators, commercialization offices in the higher education sector that diffuse ideas to the private sector and institutions for financing innovation, such as private equity and venture capital firms (Braczyk, Cooke, and Heidenreich 1998).

The degree to which the RIS becomes linked to GINs depends on the quality of local institutions that stimulate innovation at the local level and support the form of local/global networks and pattern of interaction necessary for innovation (Asheim, Isaksen, and Trippl 2019). A strong RIS is one that effectively links internal sources of knowledge and ideas with the internal and external potential to convert those ideas into exploitable knowledge. Relevant factors that sustain this interaction include a high degree of interaction among local actors, the presence of collective civic organizations that provide effective representation for key firms and institutions, and a set of shared norms and values that underpin a strong local identity. The linkages between the GIN and RIS are governed by a form of strategic coupling, linked to the knowledge exploring institutions in the region as well as the knowledge exploiting activities undertaken by members of the GIN in the regional and local context (Cooke et al. 2007; Chaminade and Plechero 2015, 218; Asheim, et al. 2019). These relationships are depicted in Figure 1.

Figure 1: Dynamic Linkages between GIN and Local Innovation System



Regional development is thus construed as the dynamically produced outcome of the interaction between region-specific networks for knowledge exploration and knowledge exploitation and GINs within the context of evolving regional governance structures. Critical to this process is the mix of region-specific assets, such as the quality of the education and training institutions, or research institutions, combined with government agencies, civic and business associations, and innovation intermediaries, that shape the way in which those assets interact with inward investment from lead firms in GINs. GINs become territorially embedded in a range of local economic, social and governance arrangements in the territories in which they locate (Henderson, et al. 2002, 452; Cooke 2013).

Key Research Questions and Methodology

Since the global financial crisis in 2008/9, a host of research-intensive technology MNEs (both foreign and domestic) have altered their investment strategy in the Toronto area towards increased investment in the level and complexity of their R&D activities. The key research question addressed is what factors have influenced the shift to a competence creating strategy on the part of these MNEs and their GINs. In parallel, to what extent are 'lead' firms in GINs using their expanded mandates for R and D activities to engage with the burgeoning network of start-up and scale-up firms in the region (Denney, et al. 2021). The core argument is that MNEs are diversifying the locational base of their R&D activities by engaging with new sources for knowledge exploration in Toronto, by tapping into Toronto's dense labour market, as well as by engaging with emerging entrepreneurial firms to spur their own capabilities in emerging technologies and new industry niches. However, the extent to which their investments work to the benefit of domestic firms in the local innovation system remains an open question, and their expanded presence may intensify the competition for talent in the technology sector, potentially bidding up the price that local firms pay for key hires or denying them access to the talent they need to grow.

Method/Empirical Strategy

The case study draws from four interrelated research projects conducted on the financial services, ICT, automotive and advanced manufacturing sectors in Toronto between 2011 and 2020. Interview insights are supported by a review of primary sources and secondary documents related to the theme of the study. In the course of that research more than 200 firms were interviewed across the four sectors from start-ups and scale-ups to established

domestic and foreign MNEs. Firms were identified from industry association lists, existing industry connections, and introductions from interviewees. Interviews lasted between 45 minutes and one hour. The analysis of 30 interviews with executives at both foreign and domestic MNEs in the Toronto region forms the basis for the analysis. The semi-structured interview guide was organized into five sections with questions that covered: the firm's innovation strategy, Toronto's position within their global innovation networks, the relative contribution of local activities to their global strategy, the nature of R&D activities undertaken in the Toronto area, and the relative importance of the local talent base and educational institutions for their investment strategy. Interviews were transcribed and subjected to a thematic analysis to identify common themes. In several cases, interviews were supplemented with on-site visits to the firms' new or expanded research and innovation centres for first-hand observation of the activity being undertaken in Toronto.

Changing Status of Toronto in GINs

Toronto's economy is Canada's largest and most economically diverse. It differs from other leading cities in the country in terms of the breadth of its industrial structure and preeminent position in the Canadian urban system (Bourne, Britton, and Leslie 2011). The Toronto region constitutes the metropolitan core of Ontario's regional innovation system (Gertler and Wolfe 2004),[iii] situated at the centre of the dense urban network extending through much of southwestern Ontario. Its current status as a centre for higher order business and financial services, as well as research-intensive activities, marks a structural shift from its traditional role as a major manufacturing hub for southwestern Ontario through the postwar period. The regional economy draws on a dense pool of talented and highly skilled labour to drive its continued growth, a labour market fed, in turn, by a steady flow of migration, with Toronto absorbing almost 40% of all immigrants to Canada (Wolfe and Bramwell 2016). Over the postwar period, Toronto relied on high levels of foreign investment, especially in key manufacturing and technology-intensive sectors of the economy. It was home to the national offices of leading companies in the automotive and ICT sectors, such as GM, Ford, Stellantis, Fairchild Semiconductor, Canadian Marconi, Canadian General Electric, Canadian Westinghouse and Control Data. With few notable exceptions, these headquarters were primarily sales operations with competence exploiting mandates, focused on distributing their company's products for the Canadian economy (Britton 2003; Britton 2004; Creutzberg 2005).

Transformation of GINs in Toronto's Innovation Economy

Over the past decade, as the economy recovered from the global financial crisis of 2008-09, announcements by leading MNEs signalled a shift in their approach. Both the extent and nature of recent investments signify a change in status for Toronto, based on the opening of a new 'window of locational opportunity' (Scott and Storper 1987; Boschma, et al. 2017). Toronto's economy, especially in the automotive and ICT sectors, has followed a developmental path corresponding to the shift in its strategic coupling from GPNs to GINs, based on new competence creating MNE strategies. The region, referred to as the Toronto-Waterloo Innovation Corridor, also experienced an expansion in the number of start-up and scale-up firms in the technology sector, especially software, as well as high growth service firms that have attracted record inward flows of venture capital, reaching a new peak in 2021 (McKinsey and Company 2016; Toronto Financial Services Alliance 2017; Avison Young 2019; Denney, et al. 2021; Kirkwood 2022). Concurrently, the divisional offices of leading global MNEs, headquartered in the region, have expanded their R&D mandates to tap into recognized strengths in digital technology, especially machine learning and deep learning. This shift reflects the structural break around 2008, based on radical innovations in cloud computing, software platforms, mobile applications and the growing shift in ICT functionality from hardware to software (Shih 2015; Baldwin 2016; Kenney and Zysman 2019).

The decision by leading MNEs, including IBM, Cisco, GM, Thomson Reuters, Google, Cisco, Nvidia, LG, Samsung, and Huawei, to locate or expand advanced research and development activities in Toronto reflects a focus on expanding their competence creating capabilities in new and emerging technologies. The vibrancy of the local innovation system and rising levels of VC and private equity investment constitutes a further signal to GINs of the potential attractiveness of the region (Silcoff 2021). While Silicon Valley and the wider San Francisco Bay area clearly stand out as the preeminent innovation centre in North America (Kenney and Zysman 2020), the Toronto-Waterloo Innovation Corridor now ranks as one of the largest technology centres in North America, after the Bay Area and New York (Toronto Global 2018).

Several reasons account for the changed approach to inward investment by MNEs in Toronto. A key attractor is Toronto's standing as a leading source of cutting-edge research and knowledge exploration. The Toronto-Waterloo Innovation Corridor is home to 18 post-secondary institutions, including 10 Universities and 8 Colleges of Applied Arts and Technology. The region is noted for its world-leading research and technology centres, housed both at these post-secondary institutions and in partnership with some of the companies located in the region (McKinsey and Company 2016; Toronto Global 2018; Avison Young 2019). Particularly

notable has been the rising standing of its research capabilities in core technologies associated with the emerging technology paradigm, including cloud computing, big data and data analytics, and artificial intelligence and machine learning. Its global standing in the field of machine learning is attributed to the pathbreaking research of University of Toronto computer scientist, Geoffrey Hinton, the pioneer of deep learning, and several of his Ph.D. students, who co-founded a machine vision start-up bought by Google in 2013.[iv] This acquisition, and the subsequent success of Alphabet subsidiary, AlphaGo, brought international attention to the region, a fact frequently cited in interviews with companies expanding local competence creating mandates. The recently announced opening or expansion of major research labs by these MNEs confirms the way the regional strength in digital technology is drawing firms to the region to tap into its knowledge base. The federal and provincial governments have reinforced this position with the creation of the pan-Canadian AI strategy administered by the Canadian Institute for Advance Research (CIFAR) and by providing support to the Vector Institute, housed in the MaRS Discovery District (Hepburn and Wolfe 2015; McKinsey and Company 2016; Toronto Global 2018; Trippl, et al. 2021; Hemmadi 2022).

Equally important for companies interviewed was the deep talent pool available in the region and the steady stream of graduates from post-secondary institutions. The talent pool is fed by the more than 400,000 students enrolled across 18 post-secondary institutions. Particularly attractive has been the growth in STEM programs from 83,000 to more than 110,000 students in 2018, including Computer Science, Mathematics and Faculties of Applied Sciences and Engineering (Toronto Global 2018, 24–26). Some companies mentioned the area's strong entrepreneurial start-up culture among post-secondary students, which provides a potential source of start-up companies to be acquired (confidential interview). Toronto ranks first in Canada on Tech Talent by a wide margin, with 250,000 tech workers employed in the Corridor, representing 8.8% of all employment, accounting for more that a quarter of all tech workers in Canada. The tech employment pool, including the categories of software developers, computer support, database and system analysts, and computer and information system managers, grew by 66,900 workers from 2014 to 2019, for a 5-year growth rate of 36.5% (CBRE Research 2021).

Toronto's diverse economic structure also generates potential for numerous synergies across different industry sectors or verticals. Its standing as one of the top twenty financial services centres globally and high ranking in North America was cited as a key factor by many firms. It is a major market for the purchase of IT products and services and a good location to develop and test new products, as well as tap into the burgeoning ecosystem of software and Fintech firms developing their own products and services. Interviews with ICT firms emphasized

the advantage of selling to Canadian banks who then deploy their products and technology to a national branch banking network (Wolfe, et al. 2011; Toronto Financial Services Alliance 2017). They observed that the Canadian financial services brand carries great credibility in international markets, considering the way the banks weathered the global financial crisis in 2008/09 (confidential interview).

For automotive companies, the combination of a strong automotive sector with internationally recognized strengths in ICT-based technologies makes Toronto an attractive location for the development of software for next generation infotainment systems and the control system for connected and automated vehicles (C/AVs) (Council of Canadian Academies 2021). Automotive companies view Toronto is a great source of software developers, especially when compared to their home base in Detroit (confidential interview). Several are working in partnership with leading ICT companies in the region, as well as researchers at the region's post-secondary institutions. Interviewees in both the automotive and ICT sectors identified an additional advantage for the region: it is easier to assemble a diverse research team and function effectively from the start in Toronto than in other locations, such as Silicon Valley. They attributed this to the diverse, multi-cultural population of the Toronto area (with more than 50% of current residents born outside Canada), than was the case with other tech centres where they operate (confidential interview). Additional reasons cited for locating or expanding in Toronto included the fact that while they had research facilities in China and India, language barriers and the time difference create significant obstacles to surmount. Toronto enjoys the advantage of being just a four-hour flight from Silicon Valley. In addition to accessing a well-educated labour force, employees in Toronto have very low attrition rates (confidential interview and site visit).

The rationale for embedding GINs in Toronto through new and expanded corporate mandates present a consistent account. They build on existing or new linkages with the research infrastructure in the region and draw upon the deep talent pool to establish their own corporate research facilities, from new software development products to more exploratory research. IBM Canada represents an intriguing case.[v] The US company has long standing roots in Canada and has functioned for the past five decades as a competence creating, rather than competence exploiting, subsidiary. It is the largest software company and one of the top five R&D performers in Canada. Established in 1967, IBM Canada's Software Solutions Lab, located in Markham in the northeast corner of the region, is part of IBM's largest team of software engineers outside the US. IBM had long sponsored research collaborations with university and other researchers in the form of one-off collaborations on individual projects. In the late 1990s, it adopted a new approach with the creation of the Centre for Advanced Studies (CAS) , which

became the platform for managing research collaborations. CAS has long-standing reciprocal relations with the University of Toronto's world-leading Computer Science department (Lucas 2004). The success of CAS prompted IBM to establish Smart Computing for Innovation (SOSCIP), a high-performance computing network in partnership with several regional universities and the Ontario government. This in turn led to the launch of the IBM Incubator Initiative (i3) in 2015 to build on the foundation laid by the previous two undertakings (DiFrancesco and Wolfe 2018).

A similar pattern is observed in the case of GM. While the origins of the auto industry in the Toronto region date to the early 20th century, historically, the 'Big Three' assemblers had little domestic engineering or R&D capacity, despite the substantial proportion of North American vehicle production in the province. In the words of the former President of GM Canada, the sector was completely reliant on technology developed elsewhere for the cars assembled; not a recipe for success in a knowledge-based and innovation-intensive economy. Beginning in 2016 and driven by internal lobbying by the executive team at the Canadian subsidiary, GM announced a series of expansions for its corporate R&D activities in the Toronto region, including the expansion of its Canadian Technical Centre (CTC) from its headquarters in Oshawa to Markham, the location of major research centres of IBM and other ICT companies. It intends to employ 1000 research engineers in the Centre. In December 2019 it announced that part of the Oshawa site would be converted to an Advanced Technology Track to "assist with the development and integration of software and hardware for advanced vehicle systems, including vehicle motion embedded controls, advanced driver assistance systems, autonomous vehicle systems, infotainment and advanced technology work". It also has plans for a new mobility research centre in downtown Toronto where it will host up to 300 research engineers working on urban mobility solutions (DiFrancesco and Wolfe 2018). When asked why GM was expanding its R&D capabilities in C/AVs in Ontario, rather than California, one interviewee replied they were drawn by the unique capabilities of Ontario's research institutions, the quality of talent graduating from its universities and the fact that Ontario combined relative proximity to corporate research facilities in Michigan with the advantage of not being tightly integrated into the HQ's R&D efforts (confidential interview).

A third case is Thomson Reuters (TR), which announced the relocation of its corporate head office from New York to Toronto in 2016. Although founded in Toronto in 2008 through Thomson Corporation's purchase of Reuters Group, and registered in Ontario, the company had been headquartered in New York City. The success of its initial research investments in Ontario and a growing interest in the research capabilities of the Toronto-Waterloo Corridor stimulated its desire to embed its corporate research initiatives in the region. TR announced that it would

expand its Canadian operations through the creation of a new Toronto Technology Centre (TTC), located on the Toronto waterfront, that would host 400 jobs by the end of 2018. However, the company's long-term goal is to expand to a total of 1,500 software engineering and data science jobs. According to TR's CEO, this decision is "all about talent", citing Ontario's stock of 200,000 high-skilled tech workers (at the time), and the high number of tech workers graduated by Ontario universities per year. The company noted that many of its informational products were geared to financial services firms and the combination of the strong research base in the region, access to a plentiful supply of talent, and proximity to some of its leading customers made the region an attractive location (DiFrancesco and Wolfe, 2018). The company regards the Toronto Waterloo Innovation Corridor as containing one of the densest concentrations of technology skills in the world.

> *So if you have any ambitions of building a new Tech Centre and hiring on the scale that we wanted to, there are very few places in the world where you could conceivably pull that off. . . . the Toronto- Waterloo corridor is one of the places where you can actually do that* (confidential interview).

In all three cases considered above, the company is integrating Toronto-based activities more tightly into its GIN. In IBM's case, i3 is intended to accelerate the commercialization of the research sponsored both by its university collaborations, as well as promote the growth of up to 500 start-up firms in Toronto's innovation system. It is designed to integrate the products of start-up firms into the suite of IBM products and allow them access to the capabilities of Watson to further develop and enhance their own products, so they can sell into the IBM customer base.

> *So if we can take a platform of small start-up companies like 6 or 7 for a solution, bundle it together and put it on our production enterprise level system, we can take them to the Holy Land, which is production and revenue. And it helps us as well, because we are able to . . .grow our markets, we make markets in this case* (confidential interview).

i3 will take space in five of the existing incubators and accelerators in Toronto. IBM's contribution to the Innovation Hubs includes physical space in some instances, access to the cloud and cognitive platforms and other computing technologies, design thinking support in the development of products, as well as the strategy for bringing them to market, embedded executives and marketing, sales, and export support (DiFrancesco and Wolfe 2018).

In GM's case, the transformation of the company's R&D strategy is driven by the increased reliance of automotive R&D on "combinatorial knowledge", which integrates

formerly discrete knowledge bases, rather than "cumulative knowledge" that builds on existing knowledge stocks (Liu, et al. 2013). The creation of combinatorial knowledge requires more integrated networks and partnerships. GM Canada is building new partnerships with start-up firms through its expanded engineering and R&D capabilities in Oshawa and Markham. It is also building connections with start-up companies through the region's network of incubators and accelerators, such as the University of Toronto's Creative Destruction Lab (confidential interview). In words that echo John Cantwell, the former President of GM Canada said that "our industry will be drawn to those jurisdictions with leading talent and capabilities in these areas of needs and opportunities, such as lightweight materials, mobile connectivity, data analytics, advanced battery technology, cybersecurity, software development, sensors and artificial intelligence" (Carlisle 2016).

TR's research at the TTC will expand capabilities in cognitive computing, visualization, user experience and cloud development. The TTC has a corporate mandate to adapt the latest research insights in big data/data analytics, artificial intelligence, and cognitive computing into its range of corporate products across the company's lines of business. The major Canadian banks are all customers of TR and potential synergies with the financial services sector was a key motivation for the expansion. Another area of research is predictive analytics. They specifically highlighted the importance of the Vector Institute and the exploratory research it supports as an attractor for the firm. The TTC is also developing an open platform to allow third party developers and vendors to access the company's data and content to create specialized products that add value to TRs' own products. Outside developers in the broader innovation system need access to the company's products and data to develop the application, authenticate its effectiveness in working with the TR product, and finalize it. To this end, they are working with the network of firms located in MaRS, as well as other incubators and accelerators (DiFrancesco and Wolfe 2018).

Other cases investigated afford additional insights into the dynamic interaction between local leadership of a subsidiary or domestic MNE and the changing mandates for the Toronto area. In the first instance, the Toronto based research lab of a global MNE is the product of a long history of a Toronto software company formed through the merger with one in Montreal in the 1990s. The company recruited a top University of Toronto computer scientist as head of research, and he built a unique research department by hiring graduates from computer science and establishing a tradition of regular interaction between the company and the university. When the Toronto company was absorbed into a US-based software company, they retained the research department and expanded it to the point where 75% of the company's researchers are in Toronto. They maintain a strong relationship with the university, with both

students and faculty regularly moving between the two. The research lab operates more on the exploration side of R&D than the exploitation side, but where the research has commercial potential, it takes the lead on product development. The company attributes the success of the research lab to the core of talented students recruited from the university, as well as Toronto's scale as the 4th largest urban area in North America with a large, diverse pool of talented people.

> *. . . [the] hugely diverse population here accords with the values of [the company] . . . . both in terms of they want to have a diverse and inclusive workforce and also the diversity seems to change the . . . breadth and the creativity of the work. . . . its' more creative if there's a diverse set of individuals* (confidential interview).

We also found examples of reverse takeovers of Canadian firms that resulted in corporate control remaining in Toronto. One case is the firm founded by a serial entrepreneur in 2009 based on his observation that the adoption of cloud computing was becoming the norm for enterprise applications and the increased availability of data had altered expectations on the part of employers and employees. The company developed software to disrupt the human capital management (HCM) market by making data available to employees on a timely basis. However, they recognized the need to merge with a more established firm to accelerate their growth and in 2012 were acquired by a large US firm with a substantial service reputation and distribution capabilities. In a novel twist, the CEO of the Toronto start-up assumed control of the larger company, with most of the executive and product development functions retained in Toronto. The company has grown at a compound annual growth rate of 60% since the merger and has established itself as one of the most successful Canadian scale-up firms of the past decade (confidential interview).

A different version of this narrative is provided by the case of Uber, which recruited a top University of Toronto computer scientist to run its Toronto-based research lab, raising the prospect that the IP would flow back to Silicon Valley. When Uber shut its research lab shortly after, the researcher took the experience gained to found her own start-up, Waabi, in Toronto to continue product development locally.[vi] A final example is the Canadian computer services company, founded in the 1980s, that has grown to be a leading global ICT services provider. Most of its head office functions and the higher order of product development are anchored in Toronto and Montreal. Their IP and product mix are developed through their Canadian R&D capability and then exported globally, using the Canadian base to build markets and customers overseas. For software development projects, they employ cheaper labour overseas to develop

parts of the product but manage the overall project from Toronto and Montreal (confidential interview).

The above cases confirm the way both foreign and domestic MNE strategies in the Toronto region are shifting to the development of competence creating mandates within their respective GINs. These strategies access the region's knowledge base through the recruitment of top-quality graduates and research collaborations with the post-secondary education sector. They enhance firm capabilities by establishing links between the offerings of local start-up and scale-up firms and the company's own products. The extent to which firms integrate a range of start-ups into their GINs holds important implications for the evolution of the local innovation system. Conversely, however, the extent to which their enhanced operations draw resources and talent away from domestic start-ups and scale-ups in the local innovation system may present challenges. While companies interviewed maintain they are focused on strengthening linkages with local firms, at least one revealed they had encountered difficulties in integrating local firms into the company's global product mix. This provides some support for the critique that the exercise of power with GINs remains unequal, with the potential for them to operate as an enclave, rather than an embedded cluster (Christopherson and Clark 2007; Breznitz and Taylor 2014). Equally important is the question of whether IP developed through the interaction with local research institutions and the expanded operations of their research centres is integrated into broader production activities in their home countries, rather than Toronto, thus limiting the degree of strategic coupling with firms and institutions in the local economy. However, the case of Waabi suggests that local contextual factors, which attract GINs to the region, can redound to the benefit of the local innovation system in unexpected ways.

Conclusion

This article employs conceptual insights from three bodies of literature to analyze the changing nature and form of dynamic linkages in the form of strategic coupling between Toronto's innovation economy and the global networks in which it is embedded. The key contribution is to illustrate how the progression from a GPN perspective to a GIN perspective reflects the shift in patterns of investment in the economy from tangible assets to a growing range of investments in intangible assets, underscoring the increased emphasis placed on R&D in software development and AI. The article adopts insights from the IB and regional innovation systems literature to highlight the critical role of agency on the part of both MNEs and their subsidiaries in the host economy in shifting inward Investment strategies from competence exploiting to competence creating mandates. Research findings from the study confirm that

firms are engaging with host regions in new and different ways by accessing local knowledge and information sources to diversify the regional and locational base of their R&D activities, as well as by engaging with local innovation systems to support firm growth in emerging technologies and new industry niches. In so doing, they are creating new linkages and forms of strategic coupling between the regional economy and their GINs. While much of the GIN literature has focused on the emergence of dynamic research centres of innovation in developing countries, especially East Asia, this overlooks the extent to which post-2008 developments in software and the increasing transfer of hardware functionality to software, as well as increased demand for critical skills, is providing enhanced opportunities for local and regional economies in industrial countries to shift the locus of their innovation activities within GINs. Unresolved is the extent to which the GINs are engaging with the local economy as embedded versus enclave networks, ensuring that both the IP generated and growth that occurs benefit the Toronto region, rather than accrue to the home base of lead firms in the GIN. An additional question for future research concerns the degree to which the Toronto case is *sui generis* or whether it reflects a broader trend in the role of regional economies in other countries in GINs.

A key economic development challenge has long concerned the ability of regions and localities to alter their trajectory of path development and the structural shifts that will move their economy to new paths (Hassink, Isaksen, and Trippl 2019). While much of the literature focuses on internal regional structures and agency, this analysis suggests that a critical issue for economic development policy is to discern the dynamic trajectory of relevant GINs and compare regional assets and capabilities to the needs of those innovation networks. This is a long-term policy challenge to which governance institutions in the RIS need to respond by both studying technology trends and assessing regional assets and capabilities on a recurring basis. The key policy implication that flows from this case study is the critical importance of analyzing the role played by supply side institutions in the RIS that support knowledge exploration and the training of highly qualified personnel with requisite technical skills, as well as the contribution of intermediary organizations for knowledge transfer and dissemination and regional innovation policies that expand the regional research base and the education and training for critical skills. The spatial organization of innovation and production remains an evolving issue, but the insights provided in this article shed some light on the development paths open to major metropolitan areas in established industrial economies.

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Endnotes

[ii] The first unbundling occurred with the dramatic fall in shipping costs fostered by the original Industrial Revolution in the 18th and 19th centuries, part of Baldwin's Great Divergence (2016).

[ii]Research for this article was undertaken in the context of a broader national study of the growing importance of the digital economy in Canada. Results of the extensive series of projects conducted as part of that study can be found on the project website: https://munkschool.utoronto.ca/ipl/creating-digital-opportunity/

[iii]Following Cooke et al. 1997, the RIS is defined by the political-jurisdictional boundaries of the appropriate territorial unit, in this case the Province of Ontario.

[iv]https://www.utoronto.ca/news/u-t-deep-learning-pioneer-geoffrey-hinton-receives-honorary-degree

[v]Many of the interviews were confidential, but in the following three cases the companies gave permission to report on their investments in a publicly available document. Where those results are in the public domain, individual companies are identified by name (DiFrancesco and Wolfe 2018).

[vi]https://waabi.ai/