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

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Abstract

The diffusion of digital technology is altering dynamics between the global and local scales. This transformation affects the strategic relationships of MNEs with host countries. This article examines how MNEs in leading technology sectors are re-evaluating their relationship to the Toronto region economy. It compares three bodies of literature on global production networks, global innovation networks, and the locational choices 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.

Introduction

The accelerating digitization of the global economy continues to alter the relation between the production of both goods and services and the territory in which it is located (Baldwin 2016). Virtually no economic sector, from financial services to manufacturing and the creative and cultural industries is left untouched by this transformation, as they shift from electro-mechanical forms of production and service provision to cloud-based and data-intensive digital forms (Wolfe 2018). The ensuing digitization of production renders the nature of local and regional economic development more complex, which raises questions about the changing relation between multinational, enterprises (MNEs), and the broader networks in which they are embedded, with local and regional economies.

This article examine how MNEs in leading technology sectors, particularly digital technologies, advanced manufacturing, and automotive production are re-evaluating their strategic relationship to new regional economic conditions in the greater Toronto region. It draws upon insights from 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. Each of these approaches provides a useful perspective to analyze the changing patterns of inward investment into the Toronto Region and conversely, the changing position occupied by the region in the GPNs/GINs and the global R&D strategies of focal MNEs.

As regions and cities contend for inward investment in this globalized environment, their relative success depends on the ability to articulate into the changing investment criteria, or cost/capability ratios of GPNs/GINs, to 'land' part of the economic activity associated with this global odyssey. While spatial variability in economic success is not new, the present era of digital transformation means that key elements of the prospects for local and regional economies are tightly linked to decisions taken 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 GPN/GINS and the complex array of local factors that influence decisions about inward investment into regions is imperative for the successful formulation of local and regional economic development strategies.

The Toronto region economy occupies a unique position within the Canadian urban system, marked by the relative size and diversity of its economy across a wide range of sectors (Bourne, et al. 2011). As its position shifted within the Canadian urban system over the postwar period, Toronto became the headquarters for a growing number of MNEs in both the resource and manufacturing sectors. Toronto emerged as the economic capital and corporate headquarters

of Canada, but one that was strongly dominated by the presence of foreign, mostly US-based, MNEs. Over the past two decades, the status of the Toronto region has changed as it has emerged as a leading centres for the cognitive-cultural economy in North America and an emerging global city, with critical strength in financial services, information and communications technology, advanced manufacturing, and the cultural and creative industries (Scott 2008; Wolfe and Bramwell 2016).

During this transformation, the nature of MNE investment in the region has shifted, with an increasing proportion of inward investment focused on accessing local knowledge assets and integrating them into broader GPNs/GINs. The changing nature of MNE strategies in the Toronto region raises questions about the dynamics of structural coupling between the regional economy and the GPNs/GINs to which it is linked. The paper 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 location in the city was primarily based on a 'competence exploiting' strategy to one whose position in GPN/GINs is increasingly defined in terms of their contribution to a 'competence-creating' strategy (Cantwell and Mudambi 2005). In the process of addressing this question, we examine the implications for the future pattern of economic development in the region: do competence creating business mandates pursued by MNE subsidiaries supporting the region's entrepreneurial high-technology cluster? or do the primary benefits flow to the MNE's home countries and the global network more broadly?

Our examination proceeds through the following steps. The next section of the paper reviews key concepts from three bodies of literature referred to above. We then outline the methodological approach taken in the article and restate the key research questions. The following section summarizes key insights and findings from the empirical material in our case study on Toronto. The article concludes with a summary of the key research insights and their implications for broader questions concerning the "changing geography of relations between production and territory". In the process, the article contributes to a deeper understanding of how the changing investment strategies of MNEs embedded in GPNs/GINs are altering the geographical dynamics of global innovation and production and the implications for regional development strategies.

From Global Production to Global Innovation Networks

We frame our empirical analysis in the context of three distinct bodies of literature — the literature on GPNs and strategic coupling from evolutionary economic geography, the literature on GINs drawn from the innovation systems perspective and the literature on the international investment strategies and locational decisions of MNES, drawn from the international business literature. We compare the effectiveness of each perspective to help interpret the findings from

our case study of the changing role of the Toronto region in global production and innovation networks.

GPNs: Characteristics, Determinants and Change

Since the 1970s, the process of globalization, defined as "the increasing extension, interpenetration, and interdependence of production systems, corporations, markets and networks of flows across national boundaries" has increased apace (Martin, et al. 2018, 4). The locus of global production has been radically transformed by a series technological innovations that have made the coordination and transportation of goods, and subsequently services, easier to manage. Commencing with the container revolution that drastically reduced the cost and ease of transporting finished goods to destination markets (Dicken 2011), advances in information and communications technology (ICT) from the 1980s onwards radically altered the calculus of coordinating diverse production activities at multiple locations around the globe (Baldwin 2016). The rapid diffusion of ICTs further altered the calculus of transportation and communications economics by facilitating more effective coordination across dispersed geographic locations and by substituting the transmission of information for the physical transportation of goods, capital, and labour (Archibugi and Michie 1997).

The current age of globalization has been characterized as trade in value-added goods, where production is best viewed as an "elaborately choreographed transnational odyssey" characterized by the global outsourcing of production, national and regional specialization in specific ranges of production, and an evolving spatial division of labour (Kenney 2004). However, as Baldwin observes, the new wave of globalization has been primarily marked by the outsourcing and distribution of production in a relatively small number of economic sectors, particularly electronics and electrical machinery. Knowledge and understanding of how this trend has affected the service sector is less clear (Baldwin 2016, 98)

The enhanced integration of the global economy has given rise to the literature on global production networks, which posits that the economic development trajectories of specific regions stem from the dynamic processes by 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, Dicken, and Hess 2008, 274). They serve as 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 production needs (Henderson, et al. 2002). GPNs thus constitute a new form of economic organization characterized by the complex intertwining of both economic and non-economic

actors producing a range of goods and services across multiple geographic locations for global markets. They are comprised of 'actors' – firms, extra-firm actors (e.g., unions, interest groups, governments etc.), and intermediaries (e.g., financial intermediaries, logistics providers, standards setting bodies etc.) — all of whom are involved in the processes of value creation, value enhancement and value capture. Controlled by 'lead' or 'focal' firms, 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 various actors that comprise a network are not always aligned with respect to the goals of value capture for the firms in the network versus local economic development. Value capture becomes the most important strategic imperative in a GPN and the ability of any individual node (i.e., region or location) in the network to capture value depends on the nature of the activities which land at that node. The key dynamic in the spatial configuration of production is the 'cost-capability ratio' (CCR). From the perspective of a lead firm, GPN theory 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 are constantly finding newer and better configurations of their networks that allow them to attain greater value. This recursive process has the potential to continually redistribute different aspects of production to different locations globally (Coe and Yeung 2015).

However, the approach also recognizes that local actors embedded in GPNs enjoy a certain degree of autonomy to craft strategies to promote their own goals and objectives. Thus, the perspective underlines 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 itself — 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).

The potential synergies between host regions and the needs and capabilities of GPN lead firms has been elaborated more formally in 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 actors in cities and regions 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 generally (Henderson, et al. 2002; Mackinnon 2012; Coe and Yeung 2015; Yeung 2016). The harnessing of regional assets (such as skills, expertise, knowledge etc.) must be accomplished by regional institutions and positioned to complement the strategic needs of trans-local actors situated within the GPN (Coe, et al. 2004, 470). From this perspective, regional development occurs as the product of strategic coupling between GPN elements and region-specific assets. More specifically, in an urban/regional development context, strategic coupling is a dynamic process through which actors, be they trans-local members of GPNs or regional actors, negotiate and coordinate local assets and trans-local requirements via some configuration of relational connections (Yeung 2009, 213; Mackinnon 2012, 230).

While several critiques and extensions of the GPN approach have been advanced (Coe and Yeung 2019), the lacuna that is most striking for our present analysis is the primacy of attention focused on manufacturing sectors and firms, at the expense of software and services. 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). The degree of transformation is so extensive that the question has been posed, "does hardware even matter anymore?" (Shih 2015). 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. This transformation is altering the calculus of CCR's across a range of sectors and fundamentally changing the basis for investment decisions by a growing range of firms. The increased focus on intangible and knowledge-based assets as key drivers of the digital economy has created greater interest in the role of global innovation networks.

The Emerging Role of GIS/GINs

The growing importance of knowledge-based and intangible assets in the production of goods and services (Haskel and Westlake 2018) has stimulated interest in the way in which innovation processes and systems operate across regional and national boundaries. From this perspective, the global dispersion of research and development activities by MNEs, linking their international research activities with national and regional innovation systems, has led to the analyses of

global innovation systems (GIS) and global innovation networks (GIN). At issue is how complex, innovation processes are embedded in national or regional territorial 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).

Early analyses of the topic observed that the dispersal of innovation activities generated the emergence of a "globally coordinated interactive innovation process" which took the form of global innovation networks. MNE efforts were seen to have followed an evolutionary process through which the companies shifted from a focus on sales and manufacturing operations to a greater focus on expanding R&D activities in foreign locations. By coordinating the best minds, laboratories, research and ideas on a global basis, leading multinational companies have facilitated the transition to a global innovation system grounded in a series of 'islands of innovation' dispersed across a variety of geographic locales with strong concentrations of research and knowledge capabilities in both industrial and industrializing countries (Chen and Vang 2008, 13; Cooke 2013).

GIS/GINs represent a fundamentally different phenomenon than GPNs in that they involve networks formed with the objective of enhancing the exchange of knowledge needed for innovation-related activities across different geographic locales. They are not restricted to interactions within a hierarchical structure but are based on external collaborations that occur on a horizontal basis. Thus, they are governed primarily by network relations, rather than market or hierarchical ones. The critical factor 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). In contrast to the focus on strategic coupling in the GPN framework, the overall performance of the GIS depends on the effectiveness of structural coupling between specific actors, actor networks and institutions that span innovation subsystems based in individual regions or countries (Binz and Truffer 2017).

The form of attachment of a GIS/GIN to a regional economy is conditioned by the nature of the local knowledge base (Liu, Chaminade, and Asheim 2013). The degree to which regional innovation systems become linked to GIS/GINs depends on the quality of local institutions that stimulate innovation at the local level, but that also support the form of local/global networks and pattern of interaction necessary for innovation. 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 of key firms and institutions, and a set of

shared norms and values that underpin a strong local identity (Chaminade and Plechero 2015, 218).

The Changing Calculus of Firm Strategies

Layering the perspective of the GIS/GIN literature on that of the GPN perspective ties in with recent attention in the IB literature to the changing calculus of MNE investment strategies. A significant body of research suggests that the relations between subsidiaries in host locations and their parent MNEs have shifted as subsidiaries have been given increasing 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 nodes or centres of excellence that collectively form the MNEs international network, resulting in an integrated portfolio of locational assets across a range of host countries or regions. 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 are typically associated with the exploitation of lower input costs. Subsidiaries are being awarded broader scope to pursue competence-creating investment strategies in the view 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. Competence-creating subsidiaries are more likely to locate in those contexts where strong potential exists to establish productive business network relations (through structural coupling to a GIS/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). Cantwell emphasizes that MNEs invest in what are termed 'higher order' centres, i.e., those with specialized centres of excellence or research competence to tap into available local sources of knowledge. This stream of research depicts "the MNE 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 development and diffusion of digital technologies across the globe are intensifying the above trends. This is especially true with respect to ICTs, particularly for non-ICT firms in related industries, who want to tap into specialized research competence associated with the ICTs

(Cantwell 2017, 46). This trend is intensified by the global shortage of R&D human capital, especially in software/IT related areas of expertise, which is driving US MNEs to open new research 'hubs' with strong concentrations of workers with needed level of STEM degrees who possess the required skills. Recent research confirms that the knowledge assets of host countries (or regions) are critical for the decisions being made to relocate part of MNE R&D activities offshore. This trend is facilitated by the modularization of software and IT, which allows the MNEs to disperse their R&D activities across a broader range of networks (Branstetter, Glennon, and Jensen 2019).

Both Cantwell and Fuller and Phelps reinforce the point that power relations are not unidirectional within GINs. Subsidiaries enjoy a degree of offsetting power to influence HQ decisions through specialized knowledge that derives from access to spatially relational knowledge located in their territory. This endows managers of subsidiaries with the scope and resources to engage in complex negotiation strategies with their respective headquarters both to offset or minimize decisions with potentially negative implications for the territory, as well as to expand the mandate and scope of the subsidiary's activities to capture the benefits available from uniquely regional assets (Fuller and Phelps 2018). For this strategy to succeed, local subsidiaries must become embedded in their local networks of research activity and competence creation and become a node of knowledge creation and innovation synergistic with the overall GIS/GIN.

GPN/GINs and Patterns of Regional Economic Development

As regions contend for inward investment in this globalized environment, their success is determined by the ability to articulate into existing GPNs, and emerging GIS/GINs by "landing" part of the economic activity associated with the global odyssey of modern goods and service production. The perspectives outlined above conceive of the region as a porous territory whose boundaries are intersected by a broad range of socially embedded relations between firm and non-firm actors operating across multiple geographic scales (Mackinnon 2012). From reshaping power structures and reallocating resources to prompting the construction of industrial districts and production platforms, GPNs, as well as GIS/GINs, exert an important influence on regional developmental trajectories (Coe, et al. 2004; Yeung 2009; Mackinnon 2012; Chaminade and Plechero 2015; Yeung 2021).

This view of economic development in a globalizing context offers a conceptual link between GPN/GINs, competence creating strategies, and regional development. From a GIS/GIN perspective, economic activity is embedded in complex networks of global, national, regional, and local innovation systems. Key elements of these systems include spatially clustered firms, national, regional, and local governments, educational and research institutions, and an array of

support institutions. Consequently, elements of national and regional innovation networks are linked to elements of other networks to form global production networks (GPNs) in which multinational corporations play a key role as system integrators (Parilli, Nadvi, and Yeung 2013).

Thus, regional development can be viewed as the dynamically produced outcome of the interaction between region-specific relational networks (e.g., social networks, networks of company CEOs, etc.) and global networks and innovation systems within the context of changing regional governance structures. For a region to succeed in attracting a higher value mix of activities within the global network or innovation system, the region must have the potential to become an economically efficient node for a specific state of production (from the GPN perspective); or a critical source of research and innovation (from the GIS/GIN perspective. Critical to the outcome of this process is the mix of region-specific assets. These region-specific assets, such as quality of the labour force, education and training institutions, or research institutions, combined with government agencies, civic and business associations, and innovation intermediaries to influence the manner and extent to which the region-specific assets attract inward investment from global production and innovation networks. According to Henderson et al. GPNs become territorially embedded in the sense that they are influenced and constrained by a range of local economic, social and governance arrangements found in the territories in which they locate (2002, 452).

The key economic development challenge facing regional authorities involves their ability to discern the dynamic trajectory of GIS/GINs, and to constantly compare their assets and capabilities with the likely future needs of those innovation networks to ensure that local assets are relevant to future investment strategies. Similarly, a particular region's status as the source (i.e., the home region) or the host (i.e., the receiving region) also matters. It is often the case that MNEs are more deeply embedded, and hence more likely to engage in high-value-added activities, in their home country (Gertler, Wolfe, and Garkut 2000). The type of structural coupling also matters; organic coupling, that forms in a co-evolutionary manner between the lead MNE and the regional assets is also more likely to yield a high degree of embeddedness than are the more superficial forms coupling based on political-economic relations between regions and GINs. In addition, those relations between a lead firm and a particular set of regional assets that are asymmetrical (typically in favour of the lead firm heading the GPN) are likely to yield less than desirable forms of strategic coupling from the region's perspective.

Key Research Questions and Methodology

Since the global financial crisis in 2008/9, several research-intensive technology MNEs (both foreign and domestic) operating in the Toronto region have altered their inward investment

strategy through increases in the level and complexity of research and development activities. Long home to competence exploiting MNE activity, the key research question in this paper is what factors have influenced the investment strategies of these MNEs and the GPNs/GINs that they are part of. In parallel, to what extent are these 'lead' firms in GPNs/GINs using their expanded mandates for increased R,D &I to engage more directly with the burgeoning technology ecosystem and the strong research infrastructure in the Toronto region. Conversely, to what extent, do their enhanced operations draw resources and talent away from the region's indigenous technology ecosystem. Stated in other terms, are MNE subsidiaries embedding themselves within the regional technology ecosystem, or are they maintaining an enclave and rigidly bounded relationship of partners and providers of ideas, information, and services (Christopherson and Clark 2007)? Equally important is the question of whether the IP developed through interaction with local research institutions and the operations of their research centres is integrated into broader production activities in their home countries, rather than the host countries, thus limiting the form of structural coupling for firms in the local innovation ecosystem. The core argument of the paper is that MNEs are engaging with the Toronto region in new and different ways by creating new knowledge and information sources to diversify the locational base of their R&D activities, as well as by engaging with emerging entrepreneurial ecosystems in the region to spur firm growth in emerging technologies and new industry niches. However, the extent to which their investments are working to the benefit of the local tech ecosystem remains open to question, and their expanded presence increases the competition for talent in the technology sector, either bidding up the price that local firms must pay for key hires or denying them access to the talent they need to grow.

Method/Empirical Strategy:

The ensuing case study draws from four interrelated research projects conducted on the financial services, ICT, and automotive and advanced manufacturing sectors in the greater Toronto region between 2011 and 2020. During that research more than 200 firms were interviewed across the four sectors from start-ups and scale-ups to established domestic and foreign MNEs. The analysis of 30 interviews with executives at (both foreign and domestic) MNEs in the Toronto Region provides the basis for the analysis. In several cases, the interviews were supplemented with on-site visits to the firms' new or expanded research and innovation centres for first-hand observation of the activity located to Toronto. Insights and findings from that analysis are situated in terms of the themes in the broader literature outlined above.

Changing Status of the Toronto Region in GPNs/GINs

Toronto's economy is the largest in Canada and the most economically diverse. It differs significantly from the other leading cities in the country in terms of the breadth and diversity of its industrial structure and its preeminent position in the Canadian urban system (Bourne, Britton, and Leslie 2011). Toronto's status marks a shift from its role as a major manufacturing hub for Southern Ontario to its current position as a centre for higher order business and financial services, the cultural and creative industries, core manufacturing in the automotive and aerospace sectors, as well as research-intensive innovative activity. The regional economy draws on a dense pool of talented and highly skilled labour to drive its continued growth, a labour market that is fed, in turn, by a steady flow of migration, with Toronto absorbing almost 40 per cent of all immigrants to Canada. (Wolfe and Bramwell 2016). Over the postwar period, Toronto was reliant 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, FCA, Fairchild Semiconductor, Canadian Marconi, Canadian General Electric, Canadian Westinghouse, and Control Data. With few notable exceptions, these headquarters were primarily sales operations focused on distributing the companies' products for the Canadian economy (Britton 2003; Britton 2004; Creutzberg 2005).

Transformation of the role of GPNs/GINs in the Toronto Region

Over the past decade as the economy recovered from the financial crisis of 2008-09, announcements by leading MNEs signalled a shift in their approach to the regional economy. Both the extent and nature of recent investments signify a change in status for the region, based on the opening of a new 'window of locational opportunity' (Scott and Storper 1987; Boschma, et al. 2017). Over the past decade, Toronto's economy, especially in the automotive and ICT sectors, has followed a developmental path corresponding to the competence creating MNE strategy. At the same time, the region witnessed an expansion of the number of start-up and scale-up firms in the technology sector, especially software, as well as high growth service firms that have been attracting greater inward flows of venture capital (McKinsey and Company 2016; Toronto Financial Services Alliance 2017; Avison Young 2019; Denney, et al. 2021). Concurrently, the divisional offices of leading global MNEs, to which the region is home, have expanded the R&D mandates of their local offices to tap into recognized strengths in ICTs, especially machine learning and deep learning. This strategic shift reflects the structural break around 2008, based on the 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 2016). The decision by leading MNEs, including IBM,

Cisco, GM, Thomson Reuters, and Uber to locate or expand advanced research and development activities in the Toronto region reflects their focus on enhancing competence creating capabilities in these new and emerging technologies. The vibrancy of the local tech ecosystem and rising levels of VC and private equity investment provides a further signal to GINs on the potential attractiveness of the region (Silcoff 2021). As confirmation of its newly acquired status, since the mid-2000s Toronto has ranked as one of the largest technology clusters in North America, after the San Francisco Bay Area and New York (Toronto Global 2018a), a status confirmed in the latest ranking of tech talent centres by CBRE Research (2019). At the same time, it is generating the potential for intensified competition for the available talent and for control over locally generated intellectual property (IP).

The are numerous reasons for the change in approach to inward investment by MNEs in the Toronto economy. A major attractor is Toronto's standing as a leading source of cutting-edge research and innovation. 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 top companies located in the region (McKinsey and Company 2016; Toronto Global 2018a; Avison Young 2019). Particularly notable has been the rising standing of its research capabilities in the core technologies associated with the emerging post-2008 IT paradigm, including cloud computing, big data and data analytics, and artificial intelligence and machine learning.

Its international standing in the field of machine learning is attributable to the pathbreaking contribution 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.[1] While Toronto's research capabilities in the field of AI had been widely recognized by academic experts, this acquisition, and the subsequent success of Google subsidiary, AlphaGo, brought international attention to the region, a fact frequently cited in our interviews by companies expanding their local competence creating mandates. The number of leading MNEs who recently announced the opening of major research labs, including GM, Thomson Reuters, Google, Nvidia, LG Samsung, Uber and Huawei, provides a further indication of the way the revolution in digital technology is drawing firms to Toronto to tap into its knowledge base in machine learning and deep learning. The federal and provincial

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

governments have strengthened this position with the creation of the pan-Canadian AI strategy administered by the Canadian Institute for Advance Research (CIFAR) and by providing support for the Vector Institute, based in the MaRS Discovery District (Hepburn and Wolfe 2015; McKinsey and Company 2016; Toronto Global 2018b; Trippl, et al. 2021).

Equally important for the companies interviewed was the deep talent pool available in the region and the steady stream of graduates from its post-secondary institutions. This talent pool is fed by the more than 400,000 students enrolled across these 18 post-secondary institutions. Particularly relevant for inward MNE investment 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 2018b, 24–26). Some companies also mentioned the region's strong entrepreneurial start-up culture among post-secondary students, which provides a source of start-up companies that can be bought the company (confidential interview). Toronto ranks first in Canada on Tech Talent by a wide margin, with 250,000 tech workers employed in the region, representing 8.8 per cent 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 per cent (CBRE Research 2021).

The region's diverse economic structure also generates potential for numerous synergies across different industry sectors or verticals. Toronto's standing as one of the top twenty financial services centres globally and its rank as third 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 also noted that the Canadian financial services brand carries great credibility in international markets, especially considering the way the banks weathered the 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 a strong candidate for the development of software for next generation infotainment systems and the control system for connected and automated vehicles (C/AVs). 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 the ICT sectors identified an additional advantage for the region; it is easier to get a diverse research team to function effectively right from the start in Toronto than in other locations, such as Silicon Valley. They attributed this to the diverse, multi-cultural population of the region (with more than 50 per cent of current residents born outside of Canada), than was the case with other tech centres where they operate (confidential interview).

Additional advantages to locating in Toronto was summarized during a site visit to the Innovation Centre for a leading ICT company. While many companies were expanding to China and India, this often creates language barriers and the time difference which are significant barriers to overcome. Toronto enjoys the advantage of being just a 4-hour flight away from Silicon Valley. In addition to accessing a well-educated labour force, employees in Toronto have very low attrition rates. Finally, Canada has a relatively stable political system and sound governments (confidential interview and site visit).

The range of activities that the new and expanded corporate mandates are undertaking in the Toronto region provide a consistent account. Overwhelming, they are building on existing or new linkages with the research infrastructure in the region to establish their own corporate research facilities from new software development products to more fundamental research. IBM Canada represents an intriguing case.[2] The US company has long standing roots in Canada and has functioned for the past five decades as 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, 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 that took 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 SOSCIP, a high-performance computing network in partnership with several regional universities and the Ontario government. This in turn led to the

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[2]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 (reference to be added after peer review).

launch of the IBM Incubator Initiative (i3) in 2015 to build on the foundation laid by the previous two undertakings.

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 within the next few years. 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. 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 the 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 capabilities of the Toronto region created a desire to embed its corporate research initiatives more solidly 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 indicated 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 (full reference provided after peer review). The company regards the southern Toronto's technology 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 the three cases considered above, the company is integrating the region 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 tech ecosystem. 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 (full reference provided after peer review).

> 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 the Toronto Region. 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 (full reference provided after peer review).

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. 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 & R&D capabilities in Oshawa and Markham. It is also building connections with start-up companies through the region's extensive 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. All the major Canadian banks are customers of TR and potential synergies with the financial services sector was a key motivation for the move. Another of research they are developing is predictive analytics. They specifically highlighted the importance of the Vector Institute and the research it is supporting 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 for their customers to TRs' own products. Outside developers in the broader ecosystem 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 tapping into the tech ecosystem located in MaRS, as well as other incubators and accelerators (full reference provided after peer review).

Other cases investigated afford valuable insights into the dynamic interaction between local leadership of a subsidiary or domestic MNE and the changing mandates for the Toronto operation. 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 a Montreal one in the late 1990s. The company recruited one of UofT's top computer scientists 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 large San Francisco based company, they retained the research department and expanded it to the point where 75 per cent of the researchers employed globally by the company are in Toronto. They maintain their strong relationship with the university, with both students and faculty moving between the two on a regular basis. Most of the key people in the research department hold a PhD from UofT. It operates more on the discover side of R&D than the development side, but where the research has commercial potential, they assume the lead on developing the product. The company attributes the success of their research lab to the presence of a core of talented students they recruit 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 find examples of reverse takeovers of Canadian firms that result in the corporate control remaining in Toronto, such as the firm founded by a serial entrepreneur in Toronto 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 providing data 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 to the usual takeover story, the CEO of the Toronto start-up took control of the larger company, while much of the executive and product development functions retained in Toronto. The company has grown at a compound annual growth rate of 60 per cent since the merger and has established itself as one of the most successful Canadian scale-up firms of the past decade. Another twist on this alternative is provided by the example of Uber, which recruited a top UofT 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, she took the experience gained to found her own start-up, Waabi, in Toronto to continue the product development locally.[3]

Another example is a Canadian computer services company founded in the 1980s that has grown to become one of the largest ICT firms in Canada and a leading global ICT services firm. Most of its head office functions and the higher order of its product development roles are anchored in Toronto and Montreal. They develop their IP and product mix through their Canadian R&D capability and then export outwards, using their Canadian base to build markets and their customer base overseas. For software development projects, they will use cheaper labour overseas, such as in India, to develop parts of the product, but the overall project is managed from Toronto and Montreal, given the origins of the company there (confidential interview). The company provides a clear example of a Canadian-owned GIN based in Toronto with operations in a wide range of global locations.

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[3] https://waabi.ai/

The cases examined above confirm the way in which 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 are also enhancing firm capabilities by attempting to establish links between the offerings of local start-up and scale-up firms and the company's own products. Left unresolved is the issue of the way that the GINs and competence creating mandates are supporting cluster development in the Toronto tech ecosystem. The extent to which firms integrate a range of start-ups into their GINs holds important implications for the evolution of the local tech ecosystem. For their part, the companies maintain they are focused on enhancing linkages with local companies and supporting the growth of the tech ecosystem. However, at least one interviewee revealed that they had encountered difficulties in integrating local firms into the company's global product mix. This reinforces the critique that the exercise of power remains unequal within both GPNs and GINs with a substantial potential for them to operate as an enclave, rather than an embedded, cluster, with the primary benefits transferred to the company's home base (Christopherson and Clark 2007; Breznitz and Taylor 2014). Conversely, the case of Waabi, suggests that local contextual factors, which attract GINs to a local economy, can work to the benefit of the local tech ecosystem in unexpected ways.

Conclusion

The research findings from this study reveals 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 entrepreneurial ecosystems to spur firm growth in emerging technologies and new industry niches. In so doing, MNES are creating new connections and new forms of structural coupling between the regional economy and their GINs. For the most part, the cases reinforce the theoretical and conceptual insights afforded by the literature on GINs, as well as the IB literature. While much of the GIN literature has focused on the emergence of new and dynamic research centres and 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 has altered the logic of technology development between traditional industrial economies and newly industrializing ones. The continuing transformation of Toronto's economy both in terms of inward investment by MNEs in GINs, as well as the burgeoning domestic tech ecosystems attests to the potential geographic and spatial impact of these developments.

On balance, the case study suggests that the GIN/GIS perspective and the IB literature on competence creating mandates afford a better insight into the changing relations between global MNEs and the regional economy in North America's fourth largest urban agglomeration. Through competence-creating mandates, MNE subsidiaries are engaging the regional economy in new ways, focusing on expanded research and talent recruitment. Unresolved is the extent to which the GINs will become embedded in the local economy, ensuring that both the IP generated and growth that occurs benefit the Toronto region, rather than the MNEs home location. One key conclusion that cannot be confirmed is the extent to which the new MNE competence creating mandates are contributing to supporting the growth of the high-tech ecosystem in contrast to the extent to which they are competing with domestic start-up and scale-up firms for scare talent, bidding up wages in the process, and capitalizing on the IP generated in local research institutions to channel it back to their home base. Subject for future research is the critical issue of whether the GINs are engaging with the regional economy as embedded versus enclave clusters, as well as the extent to which local scale-up firms can access the talent, capital, and IP they need to grow to global scale on their own. The spatial organization of innovation and production remains an evolving topic but hopefully the insights provided in this article shed some light on the evolutionary paths open to major metropolitan regions in established industrial economies.

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