

Capturing Value from GPNs: Locally Led Strategic Coupling in Ottawa’s Digital Sector

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1 Introduction

National and regional economic development has become more complex in a globalized and technology-based world. While the opportunities for technology-based economic development are every present and very much of interest to governments, the pace of technological change and corresponding shifts in the global geography of innovation ensure that regions dependent on such economic activity cannot immunize themselves from disruptions.

Policymakers and scholars have questioned if the state is able to direct economies using previous policy approaches and institutional systems (Wong, 2011; Yeung, 2016), and a new emphasis is placed on promoting regional “resilience” in face of rapid economic changes and disruptions (Simmie and Martin, 2010; Boschma, 2015). Using the concept and theory of Global Production Networks (GPN), this paper develops an understanding of how Ottawa’s digital economy has remained both resilient and globally relevant despite being hit by the loss of Canada’s leading high technology firm – Nortel.

This paper explores two interrelated questions. First, it asks how has Ottawa’s digital sector maintained its dynamism and resilience in the aftermath of Nortel’s collapse. Second, it explores the strategies that regional actors are pursuing to grow and maintain the digital sector, and asks what these strategic initiatives teach us about the role of economic development policy in today’s global economy. We explain Ottawa’s experience by way of GPN theory (Coe and Yeung, 2015), and the concept of “strategic coupling” (Yeung, 2015, 2016) in particular. We find that GPN theory helps conceptualize the factors that contributed to Ottawa’s resilience, as well as the vulnerabilities that exist in the region’s position within the global economy. Specifically it helps bring into focus the role of multinational corporations in linking Ottawa’s digital sector back into global production networks following the collapse of its lead firm, Nortel, while also pointing to the inherent vulnerabilities that this brings to the regional economy.

We argue that strategic coupling initiatives have the potential for offsetting these vulnerabilities, by promoting value capture from GPNs. We provide two examples of institutions constructed by regional actors from the private and public sectors and argue they are best described as locally led strategic coupling initiatives that help identify opportunities within global production networks and position regional capabilities to respond to these opportunities and in the process promoting regional firm development. These examples of strategic coupling initiatives have implications for the role of government in the implementation of existing and new policies aimed at regional economic and sectoral development.

This article is outlined as follows. Section 2 provides a brief introduction to global production network theory, the notion of strategic coupling, and the presentation of the paper’s methodological approach. The third section provides a brief history of Ottawa’s digital economy, global technological and market dynamics and how they relate to Ottawa’s regional assets, followed by a discussion of regional policy concerns. The fourth section describes two strategic

coupling initiatives in Ottawa: The Centre for Excellence in Next Generation Networking, and the Wesley Clover incubator and investment management firm and its related organizations. The paper concludes with a discussion on implications for regional economic development and Canadian innovation policy.

2 Global Production Networks and Strategic Coupling

A Global Production Network (GPN) is an interconnected but globally distributed grouping of both private and public actors that carry out production activities such as R&D, manufacturing, assembly, and marketing (Coe et al., 2004; Coe and Yeung, 2015). GPN theory builds on global commodity chain (Gereffi and Korzeniewicz, 1994) and global value chain approaches (Gereffi et al., 2005; Humphrey and Schmitz, 2002) that trace how production has been geographically separated, with increasing specializations within value chain elements. While a “chain” metaphor suggests that production processes follow a linear path, the network concept highlights the many different types of relationships and interactions that occur amongst firms, consumers, and public organizations (Henderson et al., 2002).

GPN theory understands regional economic development as a process of “strategic coupling” between “regional assets” and the “strategic imperatives of global industries” (Yeung, 2015). Sub-national regions develop particular advantages or assets such as forms of knowledge, institutional configurations, R&D capabilities, and cost advantages (Wolfe and Gertler, 2004). These regional assets are historically and geographically specific, which requires firms in the global economy to locate in particular regions to access them. This creates a “coupling” dynamic between regions developing particular capabilities within firms and institutions and lead firms in the global economy accessing these capabilities based on their particular firm strategies. GPN theory is thus multi-scalar, integrating the logics of the global economy to the development of particular regions.

GPN theory recognizes that actors within the production network make strategic decisions. Lead firms seek out different couplings based on corporate strategies that could focus on goals such as decreasing costs and increasing capabilities, innovation, maintaining key customers and markets, managing financial markets, and reducing uncertainty and risk (see Coe and Yeung, 2015). Other firms might seek a more advantageous position within the network, while regional policymakers seek to find ways to plug into GPNs and develop local economies. Actors within the network seek to capture greater value from their network relationships. Thus GPNs are both cooperative in nature and “contested organizational fields where actors struggle over economic relationships” (Levy, 2008, p. 944).

2.1 Strategic Coupling and Regional Economic Development

Strategic coupling to promote regional economic development must consider both how to couple with lead firms in a GPN and how to extract value from these relationships. As Coe and Yeung

(2015) state, “the fact that a region is ‘plugged into’ a global production network does not automatically guarantee a positive developmental outcome, because local actors may be creating value that does not maximize the region’s economic potential”. An undesirable coupling could create a “branch plant” experience where transnational corporations move into a locality, yet foster few linkages with local companies and do little to improve local technological, managerial, and entrepreneurial competencies (see Dawley, 2011).

Value chain conceptions discuss “upgrading” into different points of the chain, where high-skill production or market relations enable value capture (Humphrey and Schmitz, 2002). GPN theory provides a more dynamic conception of value capture, as the type of strategic couplings pursued change over time as technological and market dynamics shift and network relationships are re-arranged. Incorporating technological and economic evolution into GPN theories requires a recognition of decoupling and recoupling that can occur (MacKinnon, 2012). The exit of foreign firms, divestment, or financial risks can produce sudden ruptures and decoupling from GPNs. Regions and firms might also purposefully decouple from GPNs to avoid becoming locked into a disadvantageous position, and then recouple when they can exert sufficient power within the network. Each type of strategic coupling can have negative consequences and create advantages, as well as disadvantages and frictions. For instance, a region might not see equal benefits from its network relationship, human labour can be exploited, or cultures can clash. Regional policymakers need thus not only need to seek out couplings, but also manage the social, economic, and environmental consequences of the couplings (Yeung, 2015).

GPN theory and strategic coupling have consequences for the role of the state in shaping domestic economic development. Yeung (2016) recently made use of the strategic coupling concept to challenge the relevance of the “developmental state” institutions that propelled East Asian development in the mid 20th century (Johnson, 1982; Wade, 1990; Amsden, 2001). Yeung argues that the “national champion” has disembedded from the states that nurtured them, and has instead evolved to become embedded within global production networks via strategic couplings. Due to the global nature of these economic networks, the state’s ability to shape economic trajectories through policies such as the selection of national champions, the control of finance and subsidies, and trade management has been significantly weakened. Today, the technical and managerial competencies of firms are no longer shaped by state policies, but through inter-firm interactions within GPNs which enables access to technological expertise and market knowledge.

Yeung’s (2016) conception of a “post-developmental” state highlights that policymakers need to be particularly attuned to global dynamics and that they must be strategic in the sense of exploiting the right niches, at the right time, using the right policy instruments. A critical point is that while state support is important, it is no longer sufficient to spur development – other conditions must be in place. In particular, he notes the importance of attracting “transnational technopreneurs” – individuals with international experience and knowledge of markets, technology, and global networks. His insights also have the methodological implication of moving political economic analysis away from its traditional focus on state institutions and

policies. To understand GPNs and strategic couplings, analytical focus must be placed on the firm strategies and the dynamics that shift global production networks. For instance, the modularization of production in ICT and auto industries introduces the potential for firms to capture leadership in niches, and the develop capabilities in design, marketing, as well as manufacture.

As our case studies reveal, this focus on the interplay between GPNs and regional resilience also recognizes the important role that non-state actors such as cooperative R&D organizations, public-private partnerships, and civil society organizations. These non-state organizations create platforms for information sharing and collective action. The associative governance literature (Amin, 1996; Cooke and Morgan, 1998; Morgan, 2007) highlights how these public-private institutions requires the sharing of authority and consensus building.

In summary, GPN theory describes a world where authority is global and diffuse. It is governed by strategic actions, changing network configurations, and new institutions. Such a world creates challenges for economic policymakers, who are unable to control risk and disruptions and must be particularly strategic in their interventions.

2.2 Ottawa Case Study Motivation and Methodology

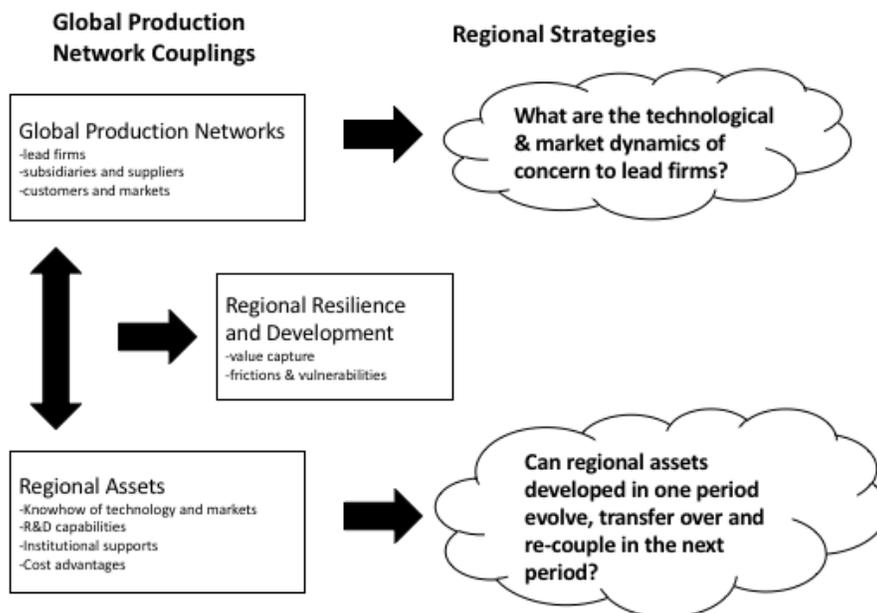
Insights from GPN theory, together with those from the global technology and market dynamics of communications networks and cloud computing, help us understand the recent history of the digital sector in Ottawa, Canada. Ottawa is the capital city of Canada with a population of over 1.25 million. The city-region's local economy is driven by the public sector as well as an information and communication technology (ICT) sector that grew out of federal laboratories beginning in the 1950s and later from the global telecommunications company, Nortel. The region received a shock with the collapse of Nortel beginning with the dot.com crash in 2001 through to its bankruptcy in 2009, yet has since experienced a recovery in ICT employment, witnessed an influx of foreign direct investment, and the growth of indigenous software companies. We seek to understand the factors that explain the region's resilience after the exit of a major anchor firm, and the strategies that Ottawa's digital economy.

Following Yeung's (2016) discussion of the methodological implications of strategic coupling, we do not place primary analytical focus on state institutions or governmental policies. Instead, we have a primary interest in the regional implications of global production network dynamics on the Ottawa region. Our unit of analysis is not the firm or the state, but the meso-level associative organizations comprised of public and private sector actors. This analytical focus uncovers the strategies followed by actors such as technology specialists, angel investors, and regional associations in coupling Ottawa's regional assets to GPNs. It also sheds a different light on how government policy supports are being leveraged by these actors.

Our analytical framework is presented in Figure 1. The left side of the figure demonstrates that the interaction of GPNs with regional assets has implications for regional resilience and

development. This includes a region's ability to capture value from its network relationships and potential frictions that result from a lack of value capture and vulnerabilities due to the potential rupture of network relationships. While MNCs play a critical role in coupling regions to global production networks by way of for example, firm acquisition or establishment of R&D or production centres, we are particularly interested in the strategies that local actors deploy to maintain these couplings, capture value from them, so as to offset vulnerabilities associated with an over reliance on multinationals. Thus, to understand why couplings are "strategic" for firms and regions we need to ask two inter-related questions. First, what are the market and technology dynamics that inform firm strategies and decisions? This question introduces Yeung's (2016) analysis of industrial organization and "technopreneurs" with market and technology knowledge. Second, we recognize that the coupling of regional assets with GPNs is dynamic, and ask whether the regional assets developed in one period can in fact evolve, transfer, and re-couple in future periods to maintain regional resilience. This second question blends GPN theory with evolutionary economics, as discussed by MacKinnon (2012)

Figure 1: Analyzing regional coupling to global production networks



We sought answers to these questions through 55 semi-structured interviews with executive managers of large and small Ottawa based digital firms, government and industry association representatives, mentors, venture capital and angel investors (Table 1).

Table 1: Case Study Interviews, by type

Total No. of Interviews	55
Companies	38
Associative Governance Groups	11
Finance	3
Public Research Institutes	2
Government	1

The interviews were conducted between the spring 2015 and summer of 2016. All interview participants were offered anonymity. The interviews were transcribed and analyzed for themes using qualitative software. These interviews were supplemented with reviews of websites, policy documents, and secondary literature. Our initial explorations highlighted the development of two institutions that shed particular light on strategic coupling dynamics. These institutions were explored further through follow-up interviews and questions.

The Ottawa case makes a number of contributions to the GPN literature. First, with a few exceptions (Dörny, 2015; Jacobs and Lagendijk, 2014; MacKinnon, 2013), the concept of strategic coupling has focused on newly industrialized countries rather than western economies (see Chun, 2009; Kleibert, 2016; Liu and Yang, 2013; Yeung, 2009). The exploration of the Ottawa case shed light on the coupling, decoupling, and recoupling dynamics in a region that successfully built, and then lost, a global lead firm. The case is embedded within Canada's national context. Canada is an advanced G7 economy that has struggled to build global lead firms and has a historical dependence on resource exports and foreign technology (see Clement and Williams, 1989). Policy debates have long concerned themselves with the influence of foreign firms on the nation's innovative capabilities (see Watkins, 1968; Britton and Gilmour, 1978; CCA, 2009).

Canada is also not a country that can be described as ever having a "developmental state" (see Laxer, 1989). Its more active industrial policies have traditionally been instigated at provincial (Atkinson and Coleman, 1989) levels rather than the federal level which has, in recent decades, pursued a more indirect approach to industrial development (Creutzberg, 2006,2011). The Ottawa case, could thus help us understand how regional agendas intermingle with sub-national and national policies and the role of industrial policy in Canada's context. Finally, the case explores the digital sector in a high-income country. Canada does not possess the labour cost advantages or domestic economies of scale relevant to coupling dynamics in newly industrializing countries. Thus, this case explores strategic coupling in a unique regional, national, and sectoral context.

3 The Evolution and Vulnerabilities of Ottawa's Digital Sector

The roots of Ottawa's regional strength in the digital economy stems from federal labs operated by the National Research Council, which examined communications technologies during the Second World War (Vardalas, 2001). The key event that established a digital sector was the decision of the Northern Electric Manufacturing Company (later Northern Telecom and Nortel) to create a research and development lab on the outskirts of the city in 1958. Northern Electric was a subsidiary of AT&T/Western Electric, but an anti-trust decision required that AT&T divest from its northern subsidiary. Northern Electric created an R&D lab to develop technologies for Bell Canada rather than importing from the United States. The lab was located in Ottawa because of the pool of talent connected to government R&D facilities. The Ottawa lab became Bell Northern Research (BNR) in 1971, created by Northern Electric and Bell Canada to develop technologies in response to global advances in telecommunications. BNR pioneered the digital switch and the replacement of analog with digital technologies in all segments of telecommunication networks in the 1970s and 1980s. In the 1990s it was a lead developer of fibre-optic networks (Northern Telecom, 1991; MacDonald, 2000).

Mitel, Newbridge Networks and Corel are all prominent spin-offs with roots in BNR and Northern Telecom, or more precisely their failed semiconductor subsidiary, Microsystems International. Two Microsystems employees, Terry Matthews and Michael Cowpland, founded Mitel in 1973, which had initial success in semiconductors and private branch exchange telephone switchboard systems. Mitel was bought by British Telecom in 1986, which led Cowpland to create the Corel software company and Matthews to create the Newbridge Networks telecommunications company (see Voyer and Ryan, 1994). Newbridge played a key role in building the larger technology ecosystem, through its Affiliates program which encouraged spin-off companies not directly associated with Newbridge's core mandate (Mallett, 2004). Newbridge was eventually acquired by Alcatel in 2000.

3.1 Nortel as an Example of a Forced De-Coupling

Ottawa experienced a major boom in the 1990s. Nortel became a global leader in the sale of fibre optic network switches and the region experienced an influx of venture capital (Brouard et al., 2004; Chamberlin and de la Mothe, 2003). By 2000, Nortel was far and away Canada's top R&D spender (RESEARCH Infosource Inc., 2001) and its stock price skyrocketed to become the ninth most valuable company in the world (Calof et al., 2014). Ottawa became home to successful homegrown companies (e.g. Cognos, JDS Uniphase, Mosaid) and it had attracted major multinationals such as IBM, Cisco, Alcatel, and Nokia (Brouard et al., 2004; Mallett, 2004).

The internet bubble burst in 2001 amounted to a major shock to both Nortel and the regional digital sector. Nortel's stock declined rapidly and considerably and the company began to lay off employees. Venture capital investments shrank (Callahan and Charbonneau, 2004). While new start-up firms were created by laid off employees and others within the sector, these firms

struggled to grow (Brouard et al., 2004), and many did not follow growth oriented business strategies (Spigel, 2011). After 2001, Nortel focused on internal cost cutting and organizational restructuring but without success. In January 2009, Nortel, despite remaining on the cutting edge of technology development (in areas such as 4G/LTE wireless, long-haul optical, and fibre-optic transmission). filed for bankruptcy protection and in June of that year it announced that it would sell its business units (Calof et al., 2014).

3.2 The Recoupling of Ottawa's Assets by way of Inward Foreign Direct Investment

It was global companies, however, that were quick to recognize the value of Nortel's business units and R&D talent. In the wake of Nortel's closure in 2009, a number of leading multinational companies established operations in Ottawa and/or significantly expanded their R&D operations (Table 1). Several companies such as Nokia, Ciena, and Eriksson took over former Nortel R&D and business units. Others, such as Huawei, hired Nortel's star staff. Many of these firms were encouraged to invest in Ottawa by way of grants from the provincial government. Ottawa has also experienced the creation and growth of a notable number of new software oriented companies, including the flagship e-commerce company, Shopify, and others such as Klipfolio, You.i.tv, the Better Software Company, and PageCloud which have attracted significant investment funds (Feibel, 2016).

Table 1: Major multinationals establishing new or expanding existing R&D facilities in Ottawa

Nokia Siemens Networks	2009	Acquired Nortel's CDMA division and its LTE (Long Term Evolution) Access division for \$650 million US. Provision for Nokia to maintain at least 2,500 employees (CBC News, 2009)
Eriksson	2009/2013	Acquired Nortel Networks Corp.'s carrier wireless assets for US\$1.13 billion; hired 800 Ottawa based former Nortel employees. (Meckback, 2013). Opened new R&D lab in 2013 as centre of excellence for new wireless technologies and testing. Received a \$3 million grant from the Ontario government to expand R&D operations and create jobs for recent grads.
CIENA	2010	Acquired Nortel Network's Ethernet networks division; \$25 million in funding from Ontario in exchange for hiring 353 new staff, and to invest \$900 million into R&D in Ontario (Markey, 2011). CIENA now carries out a vast majority of its R&D in Ottawa (Pilienci, 2015)
Huawei	2010	Invested \$80 million into its Canadian Research Centre in Ottawa; supported by a \$6.5-million Strategic Jobs and Infrastructure Grant from Ontario. The company committed to create 157 new jobs in the facility by 2015. (Pilienci, 2014). Employs former Nortel employees. In 2016 Huawei announced that it is expanding its workforce at a faster rate than planned. The company will receive an extra \$16 M from the provincial government to support 5G-wireless related R&D.
CISCO Systems	2013	Expanded Ottawa R&D centre as part of a \$4 billion investment in Ontario for which it received a grant of up to \$220 million in support from provincial government conditional on

		expanding its workforce.
ZTE	2014	The Chinese telecommunications equipment company announces plans to invest \$17 M over three years in an Ottawa R&D center focused on innovation, certification, mobile security, and hardware and integrated circuit design. Will add 40 jobs. (Computer Dealer News, 2014; Queen's Park Briefing, 2014)
Apple	2016	Announcement of an R&D facility, research area yet to be formally revealed (Sali, 2016). Speculation that it will focus on self-driving cars (Ottawa Business Journal, 2016).

Much of this inward investment is linked to Ottawa's regional assets and capabilities associated with the technological development of communication networks. Since the early 1970s with the work of Bell Northern Research, the Ottawa region has been engaged in several major technological advancements in networks beginning with the development of early analog telecommunication systems to digital and optical communication switches that allowed for the development and expansion of the Internet and wireless communication systems through to today's next generation networks known as software defined networks (SDN).

In tracking the evolution of telecommunications networks over two decades El-Sayed & Jaffe() have shown that new network architecture has emerged approximately once a decade, driven by a new to accommodate network traffic growth, new services, and advances in technology. Currently, we are experiencing the development and diffusion of a new architectural - that of SDN - which is driven by the demands of very large data centres and cloud computing applications (Oltsik, 2012). SDN is allowing for scalable and resilient networks that provide high degree of control over data flows; network users with significant datacenter infrastructure and internet traffic, such as Amazon and Google, can therefore increase functionality and reduce the costs of network equipment (see Metz, 2012). The new network architecture is also allowing for custom networks to be built by software alone (i.e. network virtualization), and for the virtualization of functions that formerly were delivered through hardware components (i.e. Network Function Virtualization (NFV)) (Hayano & Katsuura, 2015).

Both SDN and NFV are proving to be disruptive to established GPNs that have been at the forefront of developing network technology. Large vendors that provide what was only recently proprietary hardware – the server infrastructure that underpins networks – are experiencing a significant disruption to their business models. This is due to the fact that with SDN, this server hardware is being commodified, and in the process, the value - the intelligence and control – is shifting from being embedded in hardware to the software that comprises the SDN controller (Darbha & Shevenell, 2013). It is also driving innovation in interface software, network control and traffic management, and enabling new services and cloud based applications. By one account, the global market for SDN is estimated to reach US\$35 billion by 2018 and US\$100 billion by 2020 (SDxCentral, 2015).

Ottawa's digital sector for its part, is very much engaged in these developments largely because of its regionally embedded expertise. These include several of Ottawa's largest firms including

Alcatel-Lucent, Cisco Systems Canada, Huawei Technologies Canada, CIENA Corporation and Mitel Networks as well as a number of newcomers including Corsa Technologies and CENX.

Our interviews with leading multinational firms, as well as technology and sectoral experts, confirmed that technical talent remains Ottawa's primary regional asset and that specialized skills developed in earlier periods, continue to be highly valued and transferable to new sub-sectors and technological configurations. Access to hardware skills and experience is allowing companies to develop networking technologies at the interface between hardware and software. Expertise in software development under time constraints (i.e. real-time computing) is allowing companies to ensure quality of network services. And expertise in the area of system reliability is sought after for "internet of things" companies developing digital applications in sectors such as automotive, aerospace, and medical.¹ One major company with an R&D lab in Ottawa, noted that the R&D teams were able to surmount technical challenges much faster than expected - highlighting both technical talent and ability to form cooperative R&D teams, as existed in BNR.

Interviews also signalled that technical experts were fairly immobile due to Ottawa's affordability and family oriented lifestyle. This requires multinational companies to locate in Ottawa to access talent, and also provides new companies with a stable employee base. New companies also noted access to experienced technology advisors, as well as formal and informal entrepreneurial networks as regional assets. An advisor and angel investor community stems from business leaders with backgrounds in anchor firms such as Nortel, Newbridge, Cognos, as well as new firms such as Shopify.

3.3 Vulnerabilities of a Regional 'R&D Branch Plant' Economy

Despite benefiting from having regional capabilities that are relevant to current global technological shifts in communication networking, Ottawa's digital sector, with its prominence of MNCs, is not without vulnerabilities. A major concern among some of the sector's leaders is that Ottawa's sector is overly focused on R&D rather than commercial ventures and the successful development of companies.

This concern is not without merit. As Fuller (2014) has shown, the prominence of MNCs in regional ICT sectors can shape regional development pathways in a way that can be unsatisfactory in the long term. In comparing the integrated circuit (IC) design sectors of Bangalore, India, to that of East China, Fuller finds Bangalore's sector is driven by MNC-owned design establishments and Indian design service firms. This is in contrast to that of East China which is dominated not by MNCs but by local fabless design firms that focus on creating their own ICs. Whereas Bangalore has benefited comparatively from the development of a more

¹ Nortel was developing "five nines" reliability meaning, that equipment would run 99.999% of the time (Calof et al., 2014, p. 3). Ottawa companies noted their ability to offer virtualization services with "six nines" reliability.

technically capable workforce due to MNC investment in training and capabilities, China has captured more value from its IC sector in terms of revenue and in control of the technology via patents despite having “fewer designers with less sophisticated skills”. Fuller finds that the different development pathways also have implications for the local ecosystem of firms such that Bangalore’s trajectory has resulted in more local design service firms many of which can be self-financed, without venture capital support. Again, this is in contrast to East China whose focus on providing chips required for electronics assembly has benefited from an abundance of venture capital.

From interviews, it is clear that Ottawa’s technical talent is highly valued by companies following innovation-based, rather than cost reduction based, strategies. However regional value capture, as with Bangalore, may be limited to the direct economic impacts associated with salaries of high-tech workers, albeit well payed, rather than the development of capabilities in management and market knowledge that are created with the build-up of indigenous firms. Growing a company within Canada, or “scale up”, was frequently mentioned as a primary challenge for domestic companies. Policy reports note a pattern of premature buy-outs and acquisitions of Canadian companies before they can reach sufficient scale. Both a lack of managerial talent, large domestic markets, and domestic capital are noted as scale up barriers. Companies that are seen to be undervalued with significant technical assets make enticing targets for acquisition (references needed here).

Local actors acknowledged Ottawa’s vulnerability to shifts in multinational strategy, in particular, interfirm decisions on where to locate R&D activities. This concern is not unlike that which arose in Canada in the 1970s when “branch plants”, low in the company value chain, became a dominant presence in the Canadian economy. Indeed, previous criticism of foreign owned companies found that these operations contributed minimally the economy due to the practice of importing the majority of their technology and restricting domestic activities to domestic market sales (Britton and Gilmour, 1978). While the high skill equivalent, the “R&D Branch plants”, is different in so far as a significant amount of technical development occurs within the region, vulnerabilities remain because of intense global competition for technical capabilities. The focus on R&D creates a regional struggle to embed the commercialization of technical know-how within the home region.

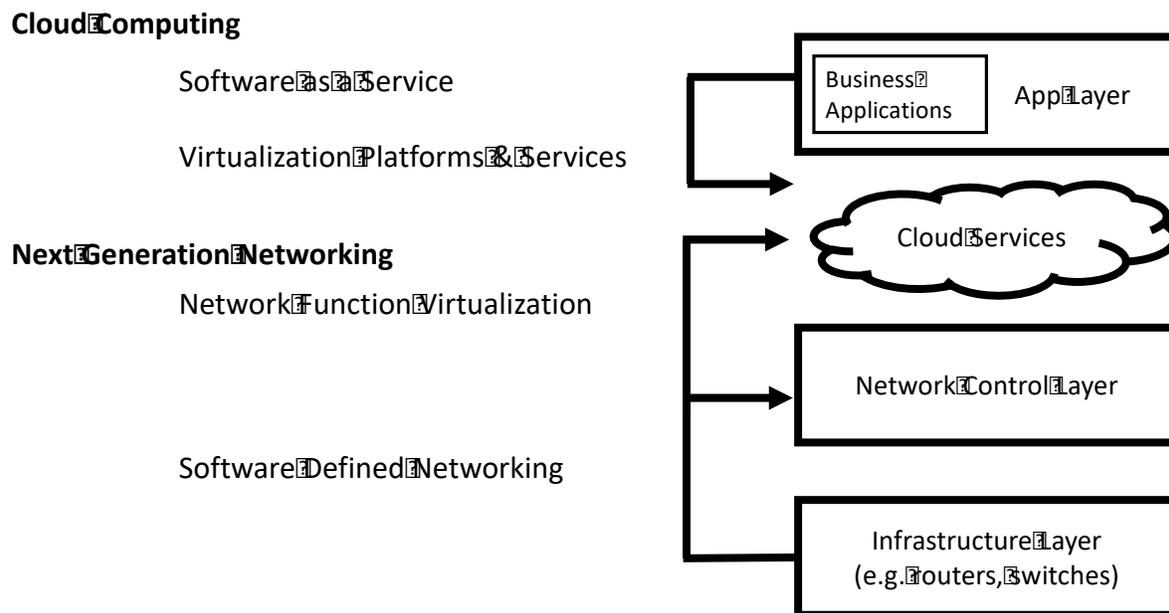
4 Locally Led Strategic Coupling for Regional Economic Development

In this section, we show how strategic coupling can be fostered at the regional level and in a manner that can potentially help mitigate the downsides of an MNC dominated regional industrial structure. As an approach for regional economic development, strategic coupling is unlike traditional approaches for promoting firm attraction, expansion and creation, in that it requires a more sophisticated understanding of the technology and market dynamics and how a region’s assets can contribute to this. Our stylized conception of the technological and market dynamics relevant to Ottawa is presented in Figure 3. This model, which is adapted from the

layer model of an ICT ecosystem developed by Fransman (2010), is based on engineering conceptions of the different functional layers of ICT systems, from the networks that transport data packets, to the applications used by consumers. Next generation networks and cloud computing are two technological dynamics influencing and re-arranging multiple functional layers. Both have their unique dynamics, yet fall under the general trend of software decoupling from computing hardware.

In Ottawa's digital sector, multinationals and local start-ups are playing key roles in related technological development and cloud applications, developing software and applications at the interface of hardware and SDN control layers and in the cloud related applications.

Figure 3: Technology and Market Dynamics



An understanding of these technological and market dynamics have been an important backdrop to efforts to link regional capabilities to the global production networks. Figure 3 maps out the elements that are contributing to a major technological shift that is creating a more competitive and fast-moving innovation environment, as the shorter development times associated with software encroach on the traditional domains of hardware. In turn it is also creating new power dynamics within digital GPNs as the provision of solutions becomes more disaggregated and potentially removes barriers that have preventing new actors from participating in digital economies, and as large data users drive technological goals.

All of this change is also opening up opportunities for new entrants which, as we argue, can be realized through locally led strategic coupling. In this section, we explore two such initiatives

that local actors are pursuing to maintain and grow the digital sector, to reduce the vulnerabilities mentioned above, and position Ottawa strategically within global production networks. These initiatives – Centre of Excellence for Next Generation Networks and Wesley Clover, L-Spark and Alacrity – are best understood as strategic coupling initiatives because of the way they combine knowledge of technical opportunities and market dynamics with regional assets.

4.1 Centre of Excellence for Next Generation Networks (CENGN)

CENGN is a not-for-profit organization headquartered in Ottawa started in August 2014. It is partially funded by a federal government Centres of Excellence for Commercialization and Research program (\$11.7 M for 2014-2019), under the Networks of Centres of Excellence program. Other revenue comes from its private sector members, which include lead firms such as Cisco, Fujitsu, Juniper, Nokia, and Telus. In April 2017, the provincial government of Ontario provided CENGN with \$63 M over five years to build an internet cloud linking the province's regional innovation centers. As a federal government Center of Excellence, CENGN fits within federal policy objectives associated with the commercialization of research and building networks between universities and business. However, a deeper look at CENGN demonstrates that it can also be described as a strategic coupling initiative, aiming to grapple with some of Ottawa's key potential vulnerabilities and frictions.

Major firms and organizations act as Tier 1 or Tier 2 partners, and small and medium sized businesses have affiliate memberships. CENGN also lists firms, associations, and numerous universities as partners. This includes the major industry associations that work to develop common standards and platforms for next generation networks, such as the Open Networking Foundation, Open Platform for Network Function Virtualization (OPNFV), the OpenDaylight project, and the OpenStack Foundation, and the European Telecommunications Standard Institute.

As a federal government sponsored entity CENGN involves partners from across the country, yet Ottawa is well represented. All Tier 1 and Tier 2 network members, except one, have office locations in Ottawa.² The Board of Directors is chaired by a senior executive from Nortel, and has individuals who work for a local venture capital firm (Mistral Venture Partners), a local University (Carleton), and a representative from Ottawa's regional development organization named Invest Ottawa.

The idea for the organization stems from a meeting convened by Invest Ottawa to discuss the needs of large multi-national companies. Multinational networking companies such as Cisco, Nokia, and Juniper compete internationally, but local employees also recognized the importance of maintaining regional R&D capabilities as local offices also competed for the award of R&D

² As of June 2017.

mandates within their firms. In subsequent discussions software defined networks, network function virtualization, and the internet of things were chosen as key technological trends shaping the future of internet networks. The consortium of partners submitted a successful application to the Centres of Excellence for Commercialization and Research awards. Invest Ottawa staff played a leadership role in writing the proposal, and the director of product management and R&D for Cisco Canada became CENGN's full-time President and CEO. CENGN is involved in three principal activities aimed at strengthening Canada, and Ottawa's, R&D capabilities and its talent base: development of a testing platform, commercialization projects, and training.

CENGN created a multi-vendor physical and virtualized network lab by installing physical hardware at CENGN, negotiating access to network hardware elements from private vendors, and partnering with the wide area network for education and research bodies in Canada called CANARIE (the Canadian Network for the Advancement of Research, Industry and Education) which enables connectivity speeds of more than 100 gigabytes per second. The platform demonstrates interoperability between vendors and multiple software and hardware products, as envisioned by the new network architectures. This unique testing centre, incorporates the region's knowledge of both hardware and software, and seeks to showcase Ottawa and Canada as a unique environment for the development of next generation networks.

CENGN is also involved in commercialization activities. By offering "commercialization acceleration" grants of between \$50,000 to \$100,000. Companies engaged in these projects have access to CENGN's network infrastructure, which enables them to demonstrate, test, and validate their products across multiple different hardware elements. These commercialization activities can also be viewed as strategic coupling initiatives. CENGN asked the lead firms who are members to identify their top three "pain points" with an aim towards finding an SME that could help solve the problem. This has created an opportunity for Ottawa based companies to partner with large firms on technology demonstrations. For instance, Corsa is an Ottawa-based start-up company producing switches with high-end capabilities for the scale-up of SDN. Corsa partnered with BTI Systems (an Ottawa based company offering cloud networking solutions acquired by Juniper in 2016) to demonstrate how their networking technologies could handle large unexpected data flows. CENX is an Ottawa company that provides network analytics and service assurance solutions. It partnered with Telus, Fujitsu, and Juniper on a project that demonstrated the ability to automatically diagnose and resolve network problems.

CENGN is also involved in training employees and students. The organization offers beginner to expert courses in SDN, NFV, and new datacenter architectures, new software environments (OpenStack, OpenDaylight), and solutions for vendors. Internship programs train students and recent graduates. Courses are offered by CENGN staff, member companies, and an Ottawa regional company specialized in promoting new standards and training (Inocybe).

CENGN's history and activities highlight it as a strategic coupling initiative relevant to the Ottawa region. This new institution is strongly informed by an analysis of SDN and NFV

technology and market dynamics of concern to leading internet networking companies, combined with a local strategy to leverage and grow Ottawa's primary regional asset in internet network related technical competencies. The strategies deployed also go beyond the commercialization of research, towards strategic coupling. The multi-vendor testing platform creates regional R&D infrastructure, where new companies can collaborate with lead firms. CENGN's training programs and development of its R&D infrastructure is also seeking to improve technical capabilities so local R&D offices can win interfirm competitions. The organization is building stronger linkages with international lead firms as well as standards organizations relevant to new networking technologies. A primary benefit of CENGN is that it was created to grapple with the strategic imperatives of lead firms embedded in the Ottawa region, and that it actively seeks to create connections between these lead firms and the new companies that embody Ottawa's regional assets.

4.2 Wesley Clover, L-Spark & Alacrity

Wesley Clover, and its affiliated organizations, is a second institutional structure that demonstrates strategic coupling initiatives in Ottawa's digital ecosystem. Wesley Clover was created by Terry Matthews as an investment management firm in 2000. Matthews is the Ottawa region entrepreneur who founded Mitel and Newbridge Networks. The Newbridge affiliate program was responsible for the development of new Ottawa-based companies in the 1990s. Matthews has regional loyalties to both Ottawa and Wales. He holds British and Canadian citizenship, was knighted in 2001, and has received honorary degrees from both the University of Wales and Ottawa's Carleton University. Wesley Clover is closely connected to L-Spark, an Ottawa based incubator and accelerator program, and Alacrity, an organization that internationalizes the Wesley Clover model.

Wesley Clover acts as an incubator and angel investor for companies principally involved in digital business enterprise solutions. It provides office space, administrative support, and mentorship to new companies. However, it does not operate as an incubator where the entrepreneur acts as the primary source of potentially commercially relevant ideas. Rather, new companies are principally built from market demands discovered through interaction with lead business enterprises that act as strategic partners. Lead firms provide information on the products and services that are requested by their customers or that are linked their own internal strategies that they do not wish to develop in house. Wesley Clover will offer to create a solution for the lead firm (or their customer) and shoulder the development cost. The lead firm is also under no obligation to buy the solution once it is developed. The new company created to deliver the product retains all intellectual property rights, and benefits from feedback from the consumers that initially identified the market need. These arrangements between lead firms, Wesley Clover, and its start-up companies occurs without a high degree of formal business arrangements. The flow of information about problems to solve and potential market demands occurs through network relationships.

Wesley Clover has developed strategic partnerships with lead firms such as Mitel, British Telecom, and Fujitsu. These relationships are closely linked to the social networks Matthews' developed from his business experience. Companies are built by recruiting new university graduates who have equity stakes in their new companies. Matthews acts as a mentor, and when companies demonstrate growth potential Wesley Clover will often recruit experienced business managers (many from the Ottawa technology community) to help run the company.

Wesley Clover partnered with Invest Ottawa to apply for funding from the "Canada Accelerator and Incubator Program", resulting in the creation of L-Spark in 2014. This organization focuses on business enterprise software solutions related to cloud computing, software as a service, and virtualization platforms and services. The organization aims to connect new business entrepreneurs with mentors from the Ottawa area with experience in growing companies and marketing to business enterprise consumers. Leo Lax, L-Spark's Executive Managing Director formerly established and managed the Newbridge Networks Affiliates program. Mentors include individuals with backgrounds in telecommunications and executives from new software oriented firms, such as Shopify.

The Alacrity Initiative diffuses the Wesley Clover model within Canada and internationally. Owen Matthews (Terry Matthews' son) founded the Alacrity incubator and accelerator in Victoria, British Columbia in 2009 and another office opened in South Wales in 2012. Alacrity has since established offices in Istanbul, Turkey; Lille, France; Shanghai China; Pune, India; Mexico City; Singapore; and Jakarta Indonesia. Each office has different institutional set-ups dependent on local conditions and ability to leverage local funding sources. As with the Wesley Clover model, industrial investors are welcomed to create a funding pool for new companies and to bring proposals for products or services where they see market demands from their own operations or relationships with customers. The internalization of the Wesley Clover model promises to help Ottawa companies access information on international markets and to partner with other companies by offering low cost licensing or sharing of intellectual property (e.g. source code, software platforms).

While Wesley Clover, L-Spark, and Alacrity are called incubation and acceleration initiatives, and have taken advantage of government funding sources to promote start-ups, they are perhaps best understood as strategic coupling initiatives connecting Ottawa's regional assets to the market and technological dynamics in GPNs. Each initiative leverages Ottawa's unique regional asset of advanced knowledge of the business enterprise market stemming from the region's telecommunications history. It connects these regional advantages with potential advanced demands of the business enterprise market with respect to cloud based software solutions by seeking couplings with lead firms. Of the lead firms that act as strategic partners for Wesley Clover, Mitel has the strongest physical presence in Ottawa while other companies have linkages to Matthews' business history. Matthews is thus an example of the "transnational technopreneurs", which Yeung (2016) sees as indispensable for successful strategic coupling.

5 Discussion

This paper briefly reviewed the history that made Ottawa a node in the global digital economy, the major shock after the loss of the city's major firm (Nortel), and the relatively quick reintegration of Ottawa into digital global production networks as a key site for R&D. In recent years, lead firms located in Ottawa because of the region's technical talent, built from the legacy of Nortel and other telecommunications companies. Ottawa's technical capabilities were able to develop, carry over and recouple into global production networks that are responsible for major technological shifts in digital networks, demonstrating that the resilience of Ottawa's digital sector can be partially explained by how regional assets couple with global lead firms. While leading Ottawa companies such as Nortel, Mitel, and Newbridge played a key role in and in establishing regional capabilities in the development of early internet network hardware (e.g. switches, fibre-optical cables), it does not imply that these regional capabilities would remain relevant in the evolution away from hardware to software based networking technology. The region has, however, retained its vitality as a node in the global development of next generation networks and cloud software, despite the external shock of Nortel's demise.

GPN theory provides a convincing explanation for Ottawa's digital sector's recovery and resilience after the collapse of Nortel. Lead firms quickly expanded operations in Ottawa to take advantage of the technical talent – the region's core innovation asset. However, this new network relationship produces vulnerabilities that the region might have previously expected to have surmounted with the creation of a Canadian owned lead firm. The region is now exposed to the vulnerabilities associated with dependence on potentially footloose multinational companies, and with the challenges of building new indigenous companies.

Regionally led strategic coupling efforts have been working towards addressing these vulnerabilities by seeking to capture additional value from GPNs coupled to Ottawa by fostering regional company development and expansion that leverage opportunities identified within GPNs. What follows are three central observations that arise from locally led strategic coupling for the purpose of regional economic development.

5.1 The Importance of Local Actors

A key characteristic of CENGN and Wesley Clover as strategic coupling initiatives is that they are not led by state actors. "Technopreneurs" with specific knowledge of technology and market dynamics and loyalties to the Ottawa region play leadership roles. Ottawa's access to "transnational technopreneurs" comes from individuals with knowledge of multinational firm R&D and regional business leaders. These individuals can create networks that gather information about market demands across the globe, whether the relevant lead firms are in Ottawa or not. Wesley Clover is supported by Terry Matthews' business linkage and knowledge of international markets, while CENGN's agenda was informed by R&D specialists in the regional offices of global firms. These were also "associational" initiatives, where private sector

knowledge was combined with local governmental organizations (Invest Ottawa) to create new institutions (CENGN and L-Spark).

Through the leadership of these technopreneurs, both organizations accessed information from lead firms about problems that need to be solved and potentially profitable opportunities. These initiatives do not follow a linear model where a researcher or entrepreneur starts with an idea and then commercializes it. Rather these initiatives considered how Ottawa's regional assets could plug into global production networks, and how relationships with lead firms can be maintained and new companies could be built from global linkages.

5.2 The Importance of Understanding Technology Dynamics

From a policy standpoint, the examples given of locally led strategic coupling, together with the notion of a technopreneur, highlight the importance of having a more detailed understanding of the digital opportunities that arise from technological change than is typical of traditional economic development strategies. This is especially important in digital and telecommunications related sectors. Hess and Coe's (2006) study of the mobile-telecommunications industry, for example, finds that technological change and deregulation converted the sector's relatively simple value chains towards more complex production networks. Furthermore, telecommunications is a "technology driven" sector (Ó Riain, 2004), where technology designs, standards, and technological trajectories determine power relations and opportunities within the network.

The strategic coupling initiatives explored in this paper created physical, virtual, and organizational platforms to give Ottawa an advantage in this fast-paced global environment. Wesley Clover's organizational platform provides access to advanced market demands and a social network with potential for new companies to combine their expertise. CENGN created a physical and virtual internet network to enable the testing and validation of new products, potentially reducing their time to market and creating relationships with lead firms based on direct experience with their products. It is noteworthy that these couplings are not characteristic of formal supplier relationships. Many of the couplings involve little to no formal business relationship. Rather the interaction occurs via the exchange of information and collaboration to solve particular problems in global production networks. This is a type of GPN industrial organization that is particularly relevant to digital software innovation.

5.3 The Importance of the Role of Government

Though technopreneurs have been shown to be necessary to achieve successful strategic coupling outcomes, the cases also demonstrate that they are insufficient. Both strategic coupling initiatives accessed governmental programs, revealing the way in which governments have indirectly supported this strategic coupling approach to economic development. CENGN was

enabled by the federal government Network of Centres of Excellence program, and Wesley Clover partnered with Invest Ottawa to create L-Spark through the Canada Accelerator and Incubator Program. Neither of these government initiatives however were designed to support strategic coupling. That they were used in this manner was the result of leadership from regional non-state actors who understood the technological and market dynamics in the digital sector, and the opportunities that come with building relationships with global lead firms and local capabilities. The importance of local actors shaping how federal policies are implemented highlights the methodological importance of examining local actor perspectives rather than the perspectives of the national state in studies of the political economy of regional development.

In addition to providing programmatic support for strategic coupling initiatives, governments can also help address the broader regional innovation support system especially that which can assist in scale up of promising firms. The critical gap frequently noted in Ottawa that these initiatives cannot fully address involves growing firms to reach sufficient scale within Canada. While the two strategic coupling do alleviate some scale-up barriers by opening the door to access global markets and accessing managerial competencies, it is often not enough. Limits of start-up funding levels often drive firms to relocate outside of Canada to access capital. One example is a recent announcement by the federal government of a later stage venture capital fund (Venture Capital Catalyst), which goes against the traditional reluctance to offer support beyond the start-up stage. In these ways, governments can play, as Yeung's (2016) notes, a catalytic role for domestic firms integrating seeking to integrate into GPNs. The strategic coupling initiatives help support R&D infrastructure, talent development, and start-up firms.

What are the prospects for this "scale up" funding to develop successful Canadian firms? Strategic coupling could be used as a concept to identify the most promising scale-up opportunities. The concept of strategic coupling warns that the state's ability to fully nurture national champions is limited, but that government policy can help firms tap into niche development opportunities specific to particular sectors (Coe and Yeung, 2015). Finding these sector specific development opportunities requires a strong understanding of technical and sector dynamics and how they relate to specific regional assets. Thus, the identification of strategic coupling opportunities could be required for the state to most effectively play a catalytic role that could capture value from the build-up of domestic firms and avoid undesirable trajectories, such as the "R&D branch plant" scenario in Ottawa discussed in the next section.

6 Conclusion

This article relates GPN theory and strategic coupling to the case of Ottawa, a region in an advanced G7 country that recovered from the loss of a global telecommunication firm. We find that GPN theory is helpful in explaining Ottawa's resilience by bringing into focus the way in which technical talent within the region reconnected via MNCs to global production networks that are leading a transformation in network communication infrastructure. Yet, Ottawa's new

coupling also introduces vulnerabilities particularly in the form of potentially undesirable path dependencies that see Ottawa being limited to an “R&D branch plant” for major multinationals.

We argue that two regionally led strategic coupling initiatives are helping strengthen the coupling to GPNs while at the same time helping offset the vulnerabilities associated with MNC R&D dependence. While it is too early to assess to what extent these regionally led strategic coupling initiatives will contribute to the region's success, these initiatives have had in the way they connect technology and market dynamics of concern to lead firms with the regional assets built over Ottawa's history. The recognition that these institutions are engaging in strategic coupling has implications for government policy. Local state and non-state actors can leverage government programs and transform them into sector and region-specific initiatives based on deep technical and market knowledge. Yet, policy gaps remain, suggesting that governments might benefit from developing policies that more explicitly identify and leverage local strategic coupling initiatives.

7 References

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