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THE BENEFITS OF AN APATHETIC ANCHOR: WHY WATERLOO ADJUSTED FASTER THAN OTTAWA

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Abstract

Why do some communities bounce back from anchor firm collapse more quickly than others? This paper compares Ottawa and Waterloo, two high-technology ecosystems dominated by large, flagship firms, Nortel and Research in Motion (RIM). The Waterloo region adapted rapidly to RIM's decline, buoyed by the proliferation of local, high-technology startups. By contrast, Nortel's failure was deeply disruptive. Although Ottawa's high-technology ecosystem rebounded, recovery was painful, protracted and, in some ways, incomplete. After eliminating several alternative explanations, we conclude that there is a tradeoff in the way communities embed anchor firms. In Ottawa, Nortel was deeply embedded through market-based and associational channels. These ties maximized knowledge spillovers and entrepreneurial recycling as it grew, but simultaneously increased the region's vulnerability to disruptive shocks. By contrast, RIM was an apathetic anchor. It donated generously to community causes, but was otherwise less engaged within its local, high-technology ecosystem. This distance limited positive spillovers as RIM expanded in the aughts. By creating space for independent enterprises and entrepreneurial programming, however, its apathy enabled the region to capitalize on the opportunities presented by the firm's decline.

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Canadian debates over innovation policy, and high-technology industry in particular, consistently emphasize the importance of creating scale-ups or large enterprises (Bergen 2017; Wolfe 2019, 6–7; Harrison, Cooper, and Mason 2004). Anchor firms, such as Ericsson in Sweden (Casper and Whitley 2004), Nokia in Finland (Ali-Yrkkö and Hermans 2004), and Samsung in South Korea (Lim 2008) transformed their respective nations, contributing directly to GDP, attracting international attention, diffusing knowledge, and supporting a variety of public goods. Historically, Canada’s ability to compete in this space has hinged on national champions such as Nortel and Research in Motion (RIM).¹ These enterprises played an even stronger role regionally. Nortel, through its subsidiary, Bell-Northern Research, shaped Ottawa’s technology industry and legitimized its status as Silicon Valley North (Novakowski 2010, 560).² RIM facilitated Waterloo’s unlikely transformation from an agricultural and manufacturing hub into a tech startup incubator (Gillmor 2012).

The danger of relying on flagship firms as regional growth engines is that they fail with discouraging consistency in high-technology sectors. Anchor collapse can represent an existential threat. Communities in mature, manufacturing- or resource-based industries appear the most vulnerable (Dublin and Licht 2005; Safford 2009), but even high-technology clusters such as Rochester, New York and Aalborg, Denmark faced long-term decline following the collapse of regional flagships (Østergaard and Park 2015; Moretti 2019). Canada has been more fortunate as case studies of post-Nortel Ottawa and post-RIM Waterloo emphasize the regions’

¹ Because we focus on developments before the corporation’s 2013 rebranding, we refer to BlackBerry by its original name, Research in Motion (RIM). This includes interviews, where we changed any references from BlackBerry into RIM.

² Northern Electric, a subsidiary of Bell Canada, established a research lab, Northern Electric Research and Development Laboratories, in Ottawa in 1962. This lab merged with Bell Canada’s research arm to form Bell-Northern Research in 1971, even as Northern Electric acquired greater independence from Bell Canada. In 1996, Northern Electric, now Nortel, assumed a majority share in BNR and eventually fully integrated it. For simplicity, the paper refers to both the research lab and its parent company as Nortel, even when discussing developments between 1962 and 1996.

resilience to these disruptive shocks (Haley, Creutzberg, and Julie 2017; Spigel and Vinodrai 2020). Their pathway to and pattern of resilience, however, was very different.

In Ottawa, the failure of Nortel, which employed a fifth of the local technology industry, caused technology employment to contract by roughly 20% between the 2001 and 2006 census. The region took over a decade to recover and, as of the 2016 census, was still operating below 2001 levels in both industrial (-23%) and occupational (-6%) measures of technology employment (Statistics Canada 2001; 2006; 2016). Resilience was based in large measure on foreign direct investment, raising familiar concerns about a “branch plant economy” (Creutzberg, Haley, and Julie 2019). The recent emergence of a dynamic, Canadian software sector represents encouraging movement towards a healthier, more diversified ecosystem, but this pivot took over a decade to execute. In short, Ottawa’s struggles represent a cautionary tale. There is life after anchor collapse, but recovery is a painful and protracted process.

Examining Waterloo,³ one could draw an entirely different conclusion. To an even greater degree than Ottawa, this high-technology hub was overshadowed by a single digital lighthouse, RIM. At its peak in 2011, RIM represented 40% of regional technology employment and over half of the ICT sector. Unlike Ottawa, however, Waterloo rebounded rapidly from RIM’s decline. Employment in high-technology firms fell by just 3% during the most intense round of layoffs between the 2011 and 2016 censuses. An occupational measure of high-technology employment *increased* by 11% (Statistics Canada 2011; 2016). In contrast to Ottawa, high-technology resilience was based principally on local entrepreneurship rather than foreign investment. Between 2011 and 2016, the region averaged over 400 technology startups a year,

³ Unless explicitly discussing “the city of Waterloo,” Waterloo refers to the Regional Municipality of Waterloo, a region of roughly 500,000 which encompasses the cities of Waterloo, Kitchener, Cambridge and their surrounding townships.

ranking second to Silicon Valley startup density according to one survey (Compass 2015). Why did Waterloo adapt more smoothly to the downfall of its anchor firm?

Although popular accounts celebrate the entrepreneurial achievements of former RIM employees, we find that this played a modest role.⁴ Regional resilience was instead based on the capacity of other actors, including incumbent, non-anchor firms and new startups to absorb human capital outflows from declining anchors. This was based less on emergency policy decisions made during the crisis than preexisting, entrepreneurial infrastructure which was easier to construct in the shadow of a detached and distracted flagship firm. As a result, we identify a tradeoff in how communities engage anchor firms. Deeper embedding in Ottawa maximized entrepreneurial and knowledge spillovers as Nortel grew, but increased regional vulnerability to the firm's collapse. By contrast, RIM's indifference to the local, high-technology ecosystem may have limited the degree of positive spillovers in the aughts, but it also preserved a more diversified high-technology ecosystem which was better positioned to capitalize on the firm's decline in the 2010s.

This tale of two anchors has important implications for Canadian policymakers. Though evidence of post-anchor resilience in both communities is encouraging, recovery can be a painful and drawn-out process. Regional leaders seeking to increase resilience and minimize volatility should pursue a loosely coupled strategy, engaging smaller and medium-sized enterprises independently from the local flagship firm and encouraging them to pursue separate strategies. This risk-averse strategy is not free, however, as it reduces knowledge spillovers and local growth in the short to medium term. We conclude by discussing several ways communities might soften these tradeoffs.

⁴ For a detailed study of the career trajectories of former RIM employees, see Spigel and Vinodrai (2020).

Adapting to Anchor Decline

The benefits of an anchor firm are clear, especially in high-technology markets. The most obvious advantages are internal to the firm, as network effects (Haskel and Westlake 2018), the need to develop large intellectual property portfolios (Gallini and Hollis 2019), and the growing importance of data (D. Breznitz 2018) all favor large, superstar firms. But flagship firms also enrich their surrounding community by generating positive externalities which extend beyond the corporation. For example, anchor firms can stimulate local industry through market-based channels. In Sweden, Ericsson helped to create a native, middleware industry by providing a source of stable demand for this risky, radically innovative type of software (Casper and Whitley 2004). These relationships can support knowledge spillovers, as Nokia worked with its formidable network of sub-contractors to upgrade their capabilities (Maliranta 2000: 69; Pajja 2000). These knowledge spillovers can occur even outside of formal supply chains as talented employees launch spinoff enterprises or move to other firms (Maskell and Malmberg 1999; Saxenian 1994; Lucas, Sands, and Wolfe 2009). Anchor firms can also contribute to public goods through non-market channels. For example, Ubisoft in Montreal developed a physical “commons” to support small, video game start-ups (Cohendet et al. 2018). These public goods are often intangible, placing regions “on the map” in a way that makes it easier for smaller enterprises to attract investment and human capital (Gillmor 2012). As a result, it is no surprise that Canadian policymakers seek to attract and develop larger firms (Bergen 2017; Wolfe 2019, 6–7).

The danger of relying on flagship firms is that they fail with distressing frequency in high-technology sectors. Anchor collapse does not need to be a death sentence. In high-

technology industries where firms compete by accumulating deep stocks of human capital, it is often an opportunity (Frederiksen, Wennberg, and Balachandran 2016). Fairchild Semiconductor, which seeded numerous high-technology firms, benefited Silicon Valley even as the firm itself slipped into irrelevance (Saxenian 1994). The closure of Digital Equipment led to a vibrant, locally owned software industry in western Ireland (Green et al. 2001), while Novatel's failure created a dynamic ICT cluster in Calgary (Langford, Li, and Ryan 2016).

Not all regions, however, adapt smoothly to flagship failure (Østergaard and Park 2015). Oulu mitigated the fallout from Nokia's downfall, which employed a third of local technology workers at its height, but employment remains roughly 20% below its 2001 peak (Simonen, Herala, and Svento 2020).⁵ Rochester, New York is still a centre for innovation, but the city has clearly lost ground following the decline of Kodak and Xerox (Moretti 2019). Even success stories vary in the pace at which they reallocate human capital and knowledge. Digital Equipment's closure was deeply disruptive in Galway, Ireland, although the industry eventually recovered (Green et al. 2001). By contrast, IT employment in post-2000 Jena increased as its flagship firm, Intershop, shrank (Buenstorf and Fornahl 2009, 370). Why do some regions adjust more successfully and rapidly to anchor collapse than others?

The Puzzle: Why Did Waterloo Adjust Faster than Ottawa?

To tackle this question, we compare two most similar cases, Nortel in Ottawa and RIM in Waterloo. Both enterprises served as anchor firms in their respective regions, dominating their local ecosystems and propelling them to international fame. Both developed cutting-edge telecommunications technologies, the first digital telephone switch in the case of Nortel and the

⁵ The absolute decline in ICT employment is particularly striking considering that Oulu is one of the fastest-growing cities in Finland.

first commercially successful smartphone in the case of RIM. As a result, both were North American market leaders. Both enterprises were also caught flat-footed by market trends, laying off the vast majority of their staff and posing an existential threat to the local technology sector. Both regions adapted successfully to this shock, reallocating human capital to a mix of foreign multinationals and local, high-technology enterprises.

The two regions, however, adapted in different ways. To illustrate how they diverged, we use Canadian census data. Although collected at five-year intervals, the census represents the most reliable measure of local, technology employment.⁶ The 2001 and 2011 census also coincide roughly with the apex of Nortel and RIM's influence.⁷ As Table 1 relates, Nortel's decline in the wake of the dot com crash was deeply disruptive. Employment in technology firms shrank by 20.3% between 2001 and 2006 and reached a new low in 2011 before increasing slightly.⁸ The decrease appears less precipitous when using occupational measures of high-technology employment, but it nonetheless fell by 9.4% between 2001 and 2006. Neither measure recovered 2001 highs, either declining or increasing only modestly after 2006.⁹ Moreover, regional resilience was fueled in large measure by foreign investment into the formerly Canadian-owned telecommunications equipment industry, raising concerns that the

⁶ Labour Force Survey (LFS) data, which comes out monthly, uses a much smaller sample size. We do not use this data in the body of the paper, although its inclusion would not meaningfully change our conclusions. When it deviates from the census figures, it sharpens the contrast between Ottawa and Waterloo.

⁷ LFS data, interviews, and newspaper reports suggest that Ottawa technology employment peaked in the spring of 2000. Layoffs accelerated in the spring of 2001 and employment bottomed in late 2004. In Waterloo, employment peaked at the end of 2010, started declining sharply in mid-2011, and reversed course in January of 2013.

⁸ To capture the creative reallocation of labour in response to a disruptive shock, we deliberately use a broader measure of technology employment drawn from the Brookfield Institute. The contrast remains, however, even if we focus more narrowly on the ICT sector. In Ottawa, ICT employment declined in each census period from 52,370 in 2001 to 36,635 by 2016 for a peak to trough decline of 30%. In Waterloo, ICT employment fell by only 18% between 2011 and 2016. LFS data suggest that Waterloo surpassed its January 2011 peak with 20,000 ICT jobs in April 2020, whereas Ottawa ICT employment remained 34% below its May 2000 peak at 48,000. This LFS data, however, is based on a much smaller sample.

⁹ A proprietary, LFS-derived measure of Ottawa "high-technology employment" rebounded and set a new peak in 2008, but it then declined by 10% and remained below its 2001 level until OCRI discontinued the measure in 2013.

value generated by intellectual property will accrue elsewhere (Creutzberg, Haley, and Julie 2019). It also reflects the proportionately smaller share of human and financial capital allocated to local industry. Ottawa used to attract 16% of Canadian venture capital from its peak in 2000 to the mid-aughts. By 2015-2017, its share had fallen to just 6% (Florida and Hathaway 2018; Florida and King 2015).

Table 1: Technology Employment in Ottawa and Waterloo, 2001-2016

By Industry Code (NAICS) ¹⁰				
	2001	2006	2011	2016
Ottawa	72,835	58,880	55,980	56,335
Waterloo	15,460	18,945	24,490	23,810
By Occupational Code (NOC) ¹¹				
	2001	2006	2011	2016
Ottawa	62,960	57,070	58,230	59,405
Waterloo	10,065	12,345	15,670	17,395

Waterloo’s ability to attract outside investment reflects a significantly shorter and shallower, v-shaped recovery following RIM’s decline. Technology employment shrank by just 2.8% between 2011 and 2016 when RIM imploded. Looking at occupational data, technology employment actually increased by 11%. Furthermore, growth occurred without large-scale external investment. Leading subsidiaries Google and Shopify collectively employed less than a thousand workers in 2016, far fewer than RIM laid off. Resilience was instead based on established, local technology firms and a marked increase in startup activity, from fewer than 100 startups a year before 2010 to more than 400 a year between 2011 and 2016. By this point, Waterloo, a laggard in venture capital markets, had leapfrogged Ottawa and the rest of the

¹⁰ Statistics Canada 2001-2016 census data. Brookfield Institute definition of technology employment combines NAICS codes 3251, 3254, 3333, 3341, 3342, 3343, 3344, 3345, 3346, 3364, 4173, 5112, 5171, 5172, 5174, 5179, 5182, 5413, 5414, 5415, 5417, and 8112 (Vu, Lamb, and Zafar 2019, 63)

¹¹ Statistics Canada 2001-2016 census data. CBRE definition combines NOC codes 0213, 2132, 2133, 2146, 2147, 2148, 2171, 2172, 2173, 2174, 2175, 2232, 2241, 2281, 2282, and 2283 (CBRE 2016)

country in per capita-adjusted measures of venture capital investment.¹² Even though the technology sector exhibits several weaknesses, Waterloo was clearly quicker and more successful in its efforts to foster local entrepreneurship following RIM's decline than Ottawa and it did so in ways that sustained both employment growth and attracted outside risk capital. How did the region pivot so quickly?

The most obvious explanations deepen the puzzle. One would expect regions with a greater share of employment in a single firm to be more vulnerable to anchor collapse, but Nortel had a smaller local footprint. With roughly 15,000 local workers at its peak in 2000, Nortel represented, at most, a fifth of the Ottawa technology sector and a quarter of the ICT industry (Bagnall 2019; Spigel 2011, 15). By contrast, RIM's 10,000 employees constituted 40% of Waterloo's tech sector and well over half of its ICT industry. This single firm controlled 30% of the office inventory in the municipality of Waterloo (McNish and Silcoff 2015, 133). Although precise numbers are elusive, both firms appear to have reduced their headcount by a similar amount. Nortel employed 4,500 in the Ottawa region when the firm was finally unwound, while RIM cut even more deeply, to roughly 2,700 local employees by 2016 (Roose 2015).¹³ Although RIM maintains a presence in Waterloo, it is no longer the region's largest technology firm. Moreover, the firm's centre of gravity, including its R&D operations and its management team, are located outside the region.

If size can't explain the difference between the two regions, perhaps some other, company-specific attribute might. As noted above, both were highly innovative, research-intensive operations, developing new-to-market hardware products in high-technology markets,

¹² This holds even if we exclude a \$168 million USD investment in Thalmic Labs (North) in 2016

¹³ Nortel's various business divisions were acquired by foreign multinationals who often maintained or expanded employment (Haley, Creutzberg, and Julie 2017).

so it seems unlikely that the stock of human capital was superior at RIM. Nortel's Ottawa office was more specialized than RIM, operating as an R&D centre rather than a headquarters. But any dearth of non-technical, senior-level talent did not inhibit start-up and spin-off formation before 2000. On the contrary, Nortel had directly or indirectly nurtured a deep bench of experienced and engaged serial entrepreneurs such as Michael Cowpland, Terrence Matthews, Antoine Paquin, and Jozef Strauss by the time it ran into trouble.

This stable of experienced entrepreneurs deepens the mystery. An influential case study of Rochester described how anchors use their power to exploit smaller enterprises or weaken governance (Christopherson and Clark 2007). This theory might explain the vulnerability of the post-2001 Finnish ICT industry, as Nokia relentlessly pressured its subcontractors and poached labour (Ornston 2014, 467). Nortel, however, was a model corporate citizen, launching spinoffs and supporting startups. In contrast to Rochester, new, growth-oriented enterprises flourished in its shadow. If anything, RIM appeared more exploitative, flexing its muscles in acquisition negotiations with its supplier, Certicom, and an intellectual property rights dispute with a spin-off, Kik. In the short run, RIM's behavior was more damaging to the local ecosystem.

One could argue that Ottawa had bad luck, losing its flagship as credit markets froze in the early aughts, whereas RIM's difficulties coincided with an era of easy credit between 2011 and 2016. Ottawa's 9.4% decline in technology employment between 2001 and 2006 is unique in comparative perspective, however, as NOC-based measures of technology employment increased in Montreal (6.2%), Toronto (5.5%), Vancouver (12.4%), and Waterloo (22.7%) during this time.¹⁴ More importantly, this hypothesis does not explain Ottawa's ongoing failure

¹⁴ Industrial classifications paint a more mixed picture, as only Vancouver (7.6%) and Waterloo (22.5%) grew during this time period. The collapse in employment in high-technology enterprises in Ottawa (-22.3%), however, was an order of magnitude larger than either Montreal (-4.4%) or Toronto (-2.2%).

to recapture its 2001 peak, including its modest performance in the 2011-2016 period.

Technology employment expanded by only 2.0% between 2011 and 2016, the slowest among major Canadian cities. By contrast, occupational growth in Waterloo (11.0%), despite RIM's fall, edged out both Toronto (10.9%) and Montreal (9.8%). NAICS-based measures are less impressive, as Waterloo (-2.8%) trailed Toronto (7.2%) and Vancouver (8.3%), but it performed similarly to Ottawa (0.6%) and Montreal (3.3%) despite the loss of its anchor.

To explain Waterloo's resilience, we might instead turn to regional characteristics. Some communities have attributes which make it easier to retain skilled labour when anchor firms collapse. Again, however, conditions would appear to favour Ottawa. In addition to being a larger city with more amenities, Ottawa's status as the national capital meant that more employees were tied to the region by partners who worked for the federal government (Spigel 2013a). Waterloo, by contrast, was historically overshadowed by Toronto, a deep and dynamic labour market with plenty of large firms who were happy to poach talent exiting RIM. As a result, observers reasonably predicted that Waterloo would be more severely impacted by the decline of its anchor firm as workers fled to Toronto (Spigel 2013b).

One could examine regional governance, specifically the formal and informal ties that bind entrepreneurs and the broader community in Waterloo. Waterloo has famously high levels of social capital and associational density (Nelles, Bramwell, and Wolfe 2005; Bramwell, Nelles, and Wolfe 2008). The entrepreneurial community, organized around the high-technology industry association, Communitech, is no exception (Nelles 2014). Spigel and Vinodrai credit Communitech with connecting laid off RIM employees to growth-oriented, high-technology startups (Spigel and Vinodrai 2020). There is merit to this point, but the Ottawa ICT industry was also highly interconnected when Nortel stumbled Comparative studies find no difference in

the degree of interconnectedness within the two ecosystems (Spigel 2017; 2013a; Lucas, Sands, and Wolfe 2009).¹⁵ Indeed, when Communitech was initially established as the Atlas Group, it was modeled after the Ottawa-Carleton Research Institute (OCRI) (Pender 2017b)! Like Communitech, OCRI launched a raft of similar programs to assist displaced Nortel employees after 2000 (Wong 2007). To the extent that Waterloo was more interconnected than Ottawa, this theory also fails to explain why the region did not suffer from lock-in (Staber 2007; 2001; Safford 2009). In his influential study of the German Ruhr region, Gernot Grabher illustrated how dense ties lead to overspecialization and rigidity by mobilizing suppliers, public policies, and even cognitive processes around a single industry (Grabher 1993). Why, if Waterloo is so tightly interconnected, did it adapt so smoothly to RIM's decline?

We argue that the answer rests neither with the anchor firm in question nor the surrounding region, but the relationship between flagships and the community which hosts them. More specifically, although both the Ottawa and the Waterloo technology industries were interconnected by a robust associational infrastructure and extensive social ties, Nortel and RIM occupied completely different positions within those two ecosystems. Nortel was deeply engaged in the Ottawa tech ecosystem from the community's early days until the turn of the millennium. It launched spinoffs, supported startups, constructed social networks, and shaped investment in public goods. As Nortel grew, this engaged position benefited Ottawa, accelerating entrepreneurial "recycling" (Mason and Harrison 2006) and maximizing knowledge spillovers (Lucas, Sands, and Wolfe 2009). These benefits came with a price, however, anchoring both industry and the institutions which governed it on a single, volatile niche.

¹⁵ The Waterloo region does possess stronger mentoring networks (Spigel 2017). We argue that this is not a coincidence, but rather reflects Nortel's privileged position within Ottawa's technology industry and, by contrast, RIM's limited influence over Communitech.

By contrast, RIM was an apathetic anchor. To be clear, the firm was a good corporate citizen, contributing generously public goods, including Communitech, and engaging its employees in various charitable causes. When it came to business, however, the firm was more focused on international markets than its local ecosystem. RIM was never active in shaping Communitech's mandate and rarely partnered with local firms. In the short to medium run, RIM's growth made life more difficult for the region's high-technology enterprises by vacuuming up real estate and human capital. In the long run, however, it placed the region in an advantageous position by encouraging firms to develop different business models and nurturing an independent associational landscape focused on smaller enterprises. When RIM failed, this ecosystem of independent firms was in a position to hire displaced labour and aspiring entrepreneurs could draw on a mature and relevant portfolio of supporting resources.

The following two sections develop this argument in more detail by reviewing developments in Ottawa and Waterloo. Each section begins by characterizing the relationship between each anchor and its surrounding community. Drawing on Grabher's (1993) framework, we describe how Nortel was more economically, politically, and cognitively embedded within its local, technology ecosystem than RIM. Each section continues with process tracing, illustrating how Nortel's central position defined adjustment in both pre- and post-bust Ottawa and how RIM's apathy created space for a very different ecosystem in Waterloo. In addition to the census data above, analysis draws on secondary literature and 55 interviews with industry representatives, academics, journalists, investors, and policymakers in Ottawa, Waterloo, and Toronto conducted between 2015 and 2019.¹⁶

¹⁶ To preserve anonymity, we have eliminated any information which could be used to identify our interview subjects. Because we interviewed 11 former RIM employees, we sometimes disclose their organizational affiliation, but not their position.

Ottawa: A Long Recovery from Anchor Collapse

The history of Ottawa's high-technology ecosystem stretches back to the early postwar years and the activities of federal research bodies such as the Defense Research Board (DRB) and the National Research Council (NRC) (Spigel 2011). Although they had a national mandate, these organizations played an outsized role in the capital region by co-funding private research, allowing companies access to their labs, and launching spin-out firms. For example, Computing Devices Canada used DRB support to develop their R&D capabilities, Leigh Instruments' location technology was based on NRC research, and Lumonics spun off from the DRB to commercialize laser technology (McDougall 2015).

This collaborative ecosystem and its strength in telecommunications attracted Northern Electric, precursor to Nortel, to the region in 1962. Until the 1950s, Northern Electric had functioned as a branch plant within the Bell system, manufacturing products developed in the US to avoid import duties. When an anti-trust suit cut off access to its American partners, Northern Electric established its own research facility on the outskirts of Ottawa (Spigel 2011). By the 1970s, this private sector laboratory, renamed Bell-Northern Research (BNR) after a merger with Bell Canada's research facilities and henceforth referred to as Nortel in this paper, had become a regional anchor. By developing a series of technological breakthroughs, including the first digital telecommunications switch and, later, advances in fiber optic communications, this "magnet organization" would attract thousands of researchers to Ottawa and served as a hub for regional cooperation (Harrison, Cooper, and Mason 2004, 1062).

Nortel was deeply integrated into the region through economic, political, and cognitive channels. In many ways, it represented the ideal anchor firm. First, the organization was

enmeshed within market relationships. Nortel, independently and through its ties to Bell Canada, partnered with local sub-contractors, beginning with the establishment of a semiconductor manufacturing subsidiary, Microsystems International Ltd (MIL), in 1969. MIL would prove short-lived, but its employees would go on to launch more than twenty startups including Calian, Mitel, and MOSAID Technologies (Harrison, Cooper, and Mason 2004; Chamberlin and de la Mothe 2003). Mitel, which specialized in business telephony systems, was exceptionally prolific. Co-founder Terry Matthews would eventually found numerous companies, most notably Newbridge Networks, which actively supported ninety startups through its nine affiliates (McDougall 2015; Spigel 2011).¹⁷ Altogether, industry veteran Denzil Doyle traced 450 technology companies back to Nortel in a 2008 mapping exercise (Wahl 2009).

Nortel supported the ecosystem in other ways. An industry observer characterized the firm as an “acquisition machine,” purchasing numerous local firms over the course of the 1980s and 1990s (interview with industry representative, 25 July 2018, Ottawa). Nortel was also willing to cooperate with its alumni and other local enterprises, constructing a dense network of local partners (Bagnall 2019). JDS, a 1981 spinoff of Nortel, supplied fiber-optic equipment to Nortel and grew alongside the telecommunications giant, developing its own network of clients and merging with the US-based firm, Uniphase in 1999. At its peak, JDS-Uniphase employed 10,000 local workers, almost as many as Nortel (Ebner 2003). This pattern of cooperation extended to other areas such as research. For example, Nortel and Mitel were the two largest private sector founders of the Canadian Microelectronics Corporation (CMC) in 1984, which conducted research on integrated chip design (Niosi and Bergeron 1995, 54–55) before becoming a federally funded university research support organization in the 1990s. As part of the

¹⁷ His partner, Michael Cowpland, established the software firm Corel.

partnership, Nortel provided foundry and design capabilities to train Canadian engineering students in semi-conductor design, diffusing knowledge embedded within its laboratories to the broader industry (McDougall 2015).

Research collaboration was institutionalized in 1983 within the Ottawa-Carleton Research Institute (OCRI), which connected the Regional Municipality of Ottawa-Carleton, three institutes of higher education, the federal National Research Centre and the Communications Research Centre, two real estate companies, and seven tech firms, with a mandate to increase inter-firm, private-public, and industry-university cooperation in “microelectronics, communications, and computer technologies” (Julie 2016, 4). Of those seven firms, five, most notably Bell Canada and Nortel, operated in the telecommunications industry (Wilson 1999, 1). Their influence in the following decades was clear. OCRI was co-located with Photonics Research Ontario, the Canadian Photonics Consortium, and the Ottawa Photonics Cluster and developed close ties with the Telecommunications Research Institute of Ontario, the Optical Processing and Computer Consortium of Canada, and the National Capital Institute of Telecommunications (Julie 2016). Through these partnerships, OCRI developed physical infrastructure, including a focused ion beam facility and also secured provincial support to expand university engineering programs and research. For example, the CMC consortium received a \$24.6 million federal grant to fund its research into semiconductors in the early 1990s (Niosi and Bergeron 1995, 55).

Nortel played a central role in this process. Nortel contributed financially to OCRI’s operations. Municipal support, which kickstarted OCRI in the early 1980s, represented just 5% of its \$7 million budget by 1998 (Wilson 1999, 7). As Canada’s largest telecommunications equipment supplier and partner to one of its principal telecommunications operators, Nortel also

added heft to OCRI's lobbying efforts. As the firm swelled to represent over 90,000 global employees and one third of the value of Canada's principal stock exchange, its influence extended to education, procurement, taxation, trade, and immigration. Nortel could influence public policy with a "snap" of its fingers (Julie 2016, 15). A veteran confirmed, "When you're the 800-pound gorilla and you want something changed, it changes. When they want to change tax policy or trade policy, they had people on the staff that could make that happen" (interview with industry representative, 25 July 2018).

By this point, Nortel was deeply embedded within the collective identity of the region. Ottawa was rebranded "Silicon Valley North" (Shavinina 2004) as technology employment surpassed federal employment for the first time in the city's history (Harrison, Cooper, and Mason 2004, 1048). As the largest and one of the oldest technology companies in the region, Nortel received the lion's share of the attention (Spigel 2017, 299). Together with Mitel and JDS-Uniphase, it defined the region as a "telecom town" (interview with industry representative, 25 July 2018, Ottawa). Five of the region's largest six firms by employment and six of the top ten by revenue were in the telecommunications sector (PriceWaterhouseCoopers 1998).

In the short to medium run, Nortel's involvement benefited high-technology enterprises across the region. The market opportunities, human capital investment, and pre-competitive research described above benefited mature and new enterprises alike. Ottawa developed the largest ICT venture capital market in the country during the 1990s (Lucas, Sands, and Wolfe 2009, 204) and ranked first on per capita-adjusted measures of venture capital investment more generally (Florida and King 2015, 13). To this pool of risk capital, one could add over one hundred angel investors (PriceWaterhouseCoopers 1998). Their ranks included Nortel employees, who organized the "Purple Angels" group in 2001 (Spigel 2011). Even though the

pace at which Nortel vacuumed up human capital challenged startups in the 1990s (interview with industry representative, 25 July 2018, Ottawa), it did not suppress entrepreneurial activity in the same way as RIM's growth in Waterloo did (see below). Venture capitalists reported no trouble in attracting talent from Nortel (Spigel 2013a, 99; Harrison, Cooper, and Mason 2004, 1064) and the number of high-technology firms in Ottawa doubled between 1990 and 2000 (Spigel 2013a, 98). With this track record, one might expect that the region would adjust relatively rapidly and smoothly to the fall of its anchor firm.

Instead, Ottawa was hard hit by Nortel's failure. Nortel was punished by the collapse of fixed line and optical equipment markets in 2001 and its disadvantageous position was compounded by a bad bet on the CDMA mobile telephone standard, its failure to commercialize LTE technology, and financial mismanagement after the dot com crash (Calof et al. 2014). Global employment shrank from 94,000 to 37,000 between 2000 and 2002, including a two-thirds reduction in Nortel's 15,000 strong Ottawa offices (Spigel 2011, 15). The "black cloud" (Calof et al. 2014) over the organization prompted world-class researchers and talented managers to leave the firm even before it declared bankruptcy in 2009 (Kogler, Spencer, and Kedron 2017). Local, high-technology job opportunities were limited, however, because the entire Ottawa tech sector was reeling at the same time.

Nortel's fall directly affected suppliers such as JDS-Uniphase. Facing a collapsing market for fiber optical equipment, the firm was in no position to capitalize on the outflow of human capital from Nortel. With its narrower product portfolio, JDS-Uniphase was even more vulnerable to the dot com crash. By 2003, employment had shrunk from a peak of 10,000 to just 580 (Ebner 2003) and the firm had moved its headquarters to California. Even firms existing outside of Nortel's supply chain, such as Newbridge Networks and Mitel, were impacted by

virtue of their position in telecommunications markets. Newbridge Networks, which had been sold to Alcatel in 2000, laid off 800 employees, while Mitel only survived by transitioning from network switches to Internet telephony. Because the 1990s startup scene was so heavily focused on photonics, optical networking, and wireless technologies (Harrison, Cooper, and Mason 2004, 1050), the disruption extended across the ecosystem to small- and medium-sized firms as well (McCann 2003). A former Ottawa-based employee reflected, “When the bubble burst it didn’t knock out just Nortel, it knocked out thousands of companies in Canada. We lost so much. It wasn’t just a company. We lost an entire industry” (interview with industry representative, 13 August 2018, Waterloo). Even the most optimistic figures, like OCRI’s custom measure of high-technology employment, contracted by 20% between 2001 and 2004 (Novakowski 2010, 557).

It wasn’t all bad news. Steep job losses were partially offset by entrepreneurial activity. According to a mapping exercise by local entrepreneur Denzil Doyle, the number of new firms increased from 1,350 in 2000 to 1,600 by 2005 (Wong 2007, 13). There were weaknesses, though. First, many new companies adopted a conservative and risk averse stance (Spigel 2011; 2013a, 105–11). For example, small consultancy operations expanded (Andrew and Doloreux 2016, 144), benefitting from the growth of federal contracts which were concentrated in the Ottawa region (Huggins 2008, 283). Second, those new enterprises enjoyed limited support. In the late 1990s, OCRI prioritized pre-competitive research and staffing for large multinationals. This model was not well-adapted for capital-scarce startups looking to hire just one or two employees and unable to independently to commercialize university research (Julie 2016, 17). Third, OCRI’s sectoral focus compounded the problem, because its entrepreneurial content was not appropriate for less capital-intensive niches such as software. For example, OCRI prioritized large venture capital funding rounds, which are important in the capital-intensive hardware

industry. This failed to accommodate the changing financial climate of the early 2000s or the nature of the software industry where a few million dollars could kickstart a profitable business (Spigel 2011). Fourth, OCRI failed to deliver the peer-to-peer and veteran mentoring services which were a central part of Communitech's mandate and highly regarded by Waterloo startups (see below). OCRI's mentoring service answered queries, but it did not construct the dense, interpersonal networks which were valued in Waterloo (Spigel 2017, 301). To the extent that OCRI did deliver services tailored to smaller startups, programming was often geared toward conventional service firms such as restaurants rather than growth-oriented enterprises (Spigel 2011).

OCRI's struggles to develop new programming reflected a more fundamental problem, as Nortel's decline threw the association into disarray (Andrew and Doloreux 2016, 148). First, the organization faced a gradual but relentless decrease in revenue, from \$9 million to \$2 million (Julie 2016, 17). This was compounded by the retreat of the "800-pound gorilla" which gave the local tech industry a powerful voice and focus. Even though political interference would likely have increased following a pair of mergers and a broader mandate in 1998 and 2000, Nortel's declining cachet compounded the problem. Mayoral candidate Jim Watson campaigned against the association, remarking "How many of you know what OCRI stands for, let alone what it does?" (Kovessy 2010), while the up-and-coming Shopify CEO Tobi Lutke dismissed it as running "golf tournaments for lawyers" (Silicoff 2015). By 2013, OCRI, reconstituted as Invest Ottawa, stopped tracking high-technology employment altogether. When Invest Ottawa proposed a new innovation hub, it did not receive municipal support and its design was instead copied and launched by its protégé, Communitech, in Waterloo (interview with industry representative, 25 July 2018, Ottawa).

In this environment, the initial renewal of the Ottawa technology ecosystem hinged on established strengths in telecommunications. Of the six Ottawa technology firms which went public between 2005 and 2010, five (March Networks, RAM Telecom, Bridgewater Systems, DragonWave, and Mitel) operated in the telecommunications space. Foreign direct investment played an even more important role in stabilizing employment in the region. Nortel's competitors, which represented just 10% of employment in telecommunications employment in 2000, constituted 30% of the sector by 2005 (Kogler, Spencer, and Kedron 2017). Acquisition activity and foreign employment increased further following Nortel's bankruptcy in 2009 (Haley, Creutzberg, and Julie 2017). Invest Ottawa played a constructive role in this process (Julie 2016, 10), brokering discussions which led to the Centre of Excellence for Next Generation Networks (CENGN). Like the collaborative research and physical infrastructure of decades past, this testbed created opportunities for smaller, local telecommunications firms (BTI, Corsa, CENX) to enter the supply chain, in addition to anchoring large foreign subsidiaries such as Nokia and Ericsson (Haley, Creutzberg, and Julie 2017, 13–15).

By the 2010s, the region was clearly diversifying from telecommunications equipment. For example, of the four technology enterprises which went public between 2013 and 2015, none focused on telecommunications. Diversification was based, in part, on the ability to parlay the region's historic strengths in telecommunications equipment into expertise in "the Internet of Things." Canadian firms such as Better Software, Cloudlink Technologies, Klipfolio, Rarelogic, and Wind River to used CENGN to test and market new software applications layered on top of 5G networks (Haley, Creutzberg, and Julie 2017). For similar reasons, Ottawa was an attractive location for RIM (renamed Blackberry) when it chose to pivot to automotive software and autonomous vehicles. Wesley Clover, the holding company and investment management firm for

Terry Matthews, now supports in a wider array of sectors than its relatively focused predecessor (Haley, Creutzberg, and Julie 2017).

The most dramatic steps toward diversification, however, came from outside Nortel and its immediate orbit. Shopify, now the largest firm in Canada by market valuation, anchors a cluster of dedicated software firms spinning off new software enterprises, inspiring entrepreneurial activity, and, through its employees, investing in new ventures (Silicoff 2015). Significantly, Shopify and its peers do not trace their roots back to Nortel (Kogler, Spencer, and Kedron 2017) or even OCRI (Spigel 2011). These new software firms are based in downtown Ottawa, physically removed from the Kanata suburbs which housed Nortel and its successors (Spigel 2017, 118). Since OCRI's programming did not meet their needs, they constructed a more supportive associational landscape from scratch, founding independent organizations such as The Ottawa Network (software-oriented venture capitalists), Third Tuesday (for social media firms), and Fresh Founders (cross-sectoral) (Spigel 2013a, 117; Silicoff 2015).¹⁸

Their association-building efforts succeeded, but it was a slow process. It took Shopify, founded in 2004, over a decade to supplant Nortel as a regional anchor. During this time, employment in software publishing and computer systems, which expanded in post-RIM Waterloo, contracted. Even in the most recent period between 2011 and 2016, software publishing and computer systems employment increased by only 10%, less than Waterloo and not enough to recapture 2001 highs. Occupational measures of software employment are even more modest. Post-Nortel Ottawa thus presents a mixed picture. On the one hand, a diverse

¹⁸ This reinvention and resurgence of the technology sector has drawn Invest Ottawa into the startup scene with a variety of programs for younger, smaller, software firms. This sector's influence within Invest Ottawa, however, has also contributed to the fragmentation of its associational landscape. The Kanata North Business Association was established, in part, to recapture the narrower sectoral and geographic focus of OCRI's heyday (interview with industry representative, 24 July 2018, Ottawa).

collection of foreign multinationals, from Ericsson to Huawei, have created opportunities for small- and medium-sized Canadian firms in telecommunications and downstream markets. These enterprises are now flanked by domestic anchors, namely Shopify, operating in a completely separate market. The region is thus better positioned to withstand disruptive, technological shocks. On the other hand, this transition was gradual and remains incomplete whether measured by technology employment, patenting (Dachis and Kim 2018), or venture capital investment (Florida and Hathaway 2018; Florida and King 2015). Ottawa's struggles are even more striking when compared to Waterloo, a region which, at first glance, should have suffered an even steeper decline.

Waterloo: The Benefits of an Apathetic Anchor

One could attribute the fragility of the Ottawa tech sector to the “weakness of strong ties” (Grabher 1993), but the Waterloo region is also highly connected. The region's oft-repeated, Mennonite tradition “barn-raising” may be overstated (Bathelt and Spigel 2019), but the metaphor accurately captures unusually high levels of social capital and associational density in the region (Nelles 2014; Bramwell, Nelles, and Wolfe 2008). Individuals have been connected by an overlapping patchwork of churches, clubs, musical societies, and other civic organizations since the late 19th century (Nelles, Bramwell, and Wolfe 2005, 233). This characterization extends to industry, which worked together to attract the University of Waterloo in 1959 and collaborated with it to construct an extensive co-operative educational program (Bramwell and Wolfe 2008). The high-technology, university spinoff, WATCOM, and the faculty-led startups which followed in its wake, developed a strong, informal mentoring network which was

institutionalized as the “Atlas Group” in the early 1990s and then the technology industry association, Communitech, in 1997 (Pender 2017a; Nelles 2014; Ornston 2016).

By this point, all of these enterprises were overshadowed by Research in Motion (RIM). Founded in 1984 by former University of Waterloo students, the firm was a technological pioneer, developing the first commercially successful smart phone, snagging a 20% global market share, and dominating the lucrative North American market (McNish and Silcoff 2015). To an even greater degree than Nortel, RIM dominated the tech landscape in Waterloo from its rise at the turn of the millennium until early 2010s. Pegged at 10,000 employees at its peak (Pender 2015), this represented 40% of regional technology employment and well over half of the ICT sector. If Nortel anchored an ecosystem, 2011 Waterloo was effectively a company town. Local representatives certainly described it in such terms. In the words of a community representative, “[RIM] was the only game in town For ten years the policy was to give [RIM] whatever they wanted and get out of the way They swallowed the suburbs” (interview with community organizer, 10 July 2018, Waterloo).

For a firm of this size, however, RIM’s influence was surprisingly muted. Unlike Nortel, RIM spun off few firms before its decline. There were exceptions such as IGLOO (interview with policymaker, 16 July 2018, Waterloo), but a more typical response to this question was, “Spinoffs? Not out of RIM. The answer is no, I’d be hard pressed to come up with one Ted Livingston and Kik? But when he founded Kik, RIM sued him” (interview with industry observer, 15 March 2017, Waterloo).¹⁹ Speaking about the 2004-2010 period, another commented, “During that period of time, people would say things like ‘[RIM] is sucking the oxygen out of the room’ and ‘Anyone who would dare to leave [RIM] would be threatened that

¹⁹ Quantum Valley Investments, the venture capital firm sponsored by Mike Lazaridis and Doug Fregin, is another candidate, but it was established in 2013, when RIM was declining and after they left the firm.

they'll never work in town” (interview with industry representative 13 August 2018, Waterloo). RIM executives denied malicious intent, but a former employee confirmed that local partnerships were simply not a priority, “We were acquiring companies up until 2010, but not spinning anything off at all. The goal was to build a talent pool ... but it wasn't knit into the community (interview with industry representative, 17 July 2018, Waterloo).

Although RIM was busy acquiring companies, it was not very active locally. Of the thirty firms RIM integrated between 2001 and 2015 only three, Certicom, tinyHippos, and Slipstream, had strong ties to the Waterloo region. Even this was not friction-free as Certicom rejected and litigated RIM's initial overtures. No interviewees, including representatives from two of the firms above, built their business model around RIM or its supply chain. In the words of another co-founder, “It was never a strategy [to be acquired by RIM] and I can say within the entrepreneur group that I cut my teeth with, it was never a strategy to work with RIM or to be acquired by RIM” (interview with industry representative, 29 August 2018, Waterloo). This is not surprising as some interpreted the Kik lawsuit as a “clear message” not to venture too close to RIM's technology (interview with industry representative, 13 August 2018, Waterloo). One entrepreneur, citing this case and the rumors above, made a conscious decision to stay out of RIM's way (interview with industry representative, 19 July 2018, Waterloo).

Unlike Nortel, therefore, RIM did not possess a significant local supply chain. Its five largest partners in 2009, Elcoteq, Jabil Circuit, Marvell Technology Group, Multifineline Electronix, and Qualcomm were not even Canadian, much less local. There were a few exceptions. MKS worked closely with RIM, as did Certicom, prior to its acquisition.²⁰ But interviewees (industry observer, 15 March 2016 and representative, 17 July 2018, Waterloo) and

²⁰ Although, by this point, Certicom was based in Mississauga.

secondary sources (Gillmor 2012; Howitt 2019) were more likely to cite hotels, restaurants, or real estate brokers when discussing RIM's local "supply chain." In the words of one veteran, "All of RIM's suppliers were elsewhere, JBIL, Flextronics ... There was no real supplier infrastructure locally. You'd see the odd box from a company that wanted a few people on the ground here, but that was pretty rare" (interview with industry representative, 19 July 2018, Waterloo).

This aloof relationship extended to policymaking. Like Nortel, RIM would become the most important member and the largest contributor to Communtech. RIM, however, was one of the youngest and smallest firms when local executives established the Atlas Group. It was never particularly active in shaping the organization's agenda, even following its reorganization into Communtech in 1997. A former employee remarked, "When I joined RIM, they weren't joiners. They weren't even members of the Chamber of Commerce!" (interview with industry representative, 17 July 2018, Waterloo). That would change with the establishment of a government relations team at the turn of the millennium, but civic engagement was based on building goodwill in the community at large rather than reshaping the local business ecosystem. Another former employee summarized their efforts thusly, "We were a good corporate citizen ... and set up a bunch of ways for our staff to give back, calling it a 'Give to Get' scheme But in terms of sticking our nose in the business of government, we didn't do that" (interview with industry representative, 20 July 2018, Waterloo). Both identified a doctor recruitment initiative as their most notable local campaign, a broad, cross-sectoral effort which benefited firms across the community rather than RIM or its closest partners (interviews with industry representatives, 17 and 20 July 2018, Waterloo).

Local representatives echoed these remarks (interview with community organizer, 23 November 2017). On the one hand, they applauded RIM's financial commitment to the local community. A former politician, referring to charitable donations by Jim Balsillie and Mike Lazaridis, said, "I don't think there would be another company that was so loyal to the community, whose owners invested so much in the community, they were always such a strong supporter of the community" (interview with politician, 28 November 2017, Waterloo).²¹ At the same time, they likened RIM to "the Vatican in Rome." When it came to policymaking, "They lived their own life The only time we'd be involved was when they wanted to build a building. They never had an impact on our policy decisions" (interview with former politician, 28 November 2017, Waterloo). RIM's influence was even more circumscribed in Kitchener, where an old dispute between the company and the city prompted policymakers to woo the University of Waterloo and Communitech instead of RIM in their development plans (interview with former politician, 17 August 2018, Waterloo).²²

Individuals familiar with the subject (interviews with industry representatives, 1 December 2017 and 12, 17, 19, and 20 July 2018, Waterloo) suggested that RIM played a similar role at the associational level. All agreed that RIM played a valuable, supporting part by providing real estate in Communitech's early days and pitching in to sponsor speakers and other events. None, however, described RIM as actively shaping Communitech's agenda. One identified elements of tension, remarking "[RIM was] oblivious to the ecosystem in town and they didn't want any part of it. They would do things like hackathons and run them in Georgia or

²¹ These donations include the Perimeter Institute for Theoretical Physics, the Centre for International Governance Innovation, the Balsillie School of International Affairs, and the Institute for Quantum Computing. Significantly, these gifts were made by individuals rather than the company itself. With the possible exception of the Institute for Quantum Computing, they were weakly connected to the firm's corporate strategy.

²² The firm also maintained a rocky relationship the local paper, *The Record*, blacklisting a reporter in response to critical coverage in 2007 (Howitt 2019, 165–68).

New York City and so there was this huge disconnect between RIM and this town” (interview with industry representative, 13 August 2018, Waterloo). Whether based on a friendly understanding or tension, the effect was the same. Communitech’s independence enabled it to devote 30% of its budget to startups. Unlike OCRI, it prioritized mentoring rather than basic R&D or specialized engineering programs. As an organization, Communitech maintained a broad sectoral scope encompassing both hardware and software instead of focusing on mobile communications, encryption, or related niches (interview with industry representative, 29 November 2017, Waterloo).²³

Even the University of Waterloo, where RIM’s influence was the most tangible, presents a mixed picture. On the one hand, RIM clearly influenced the curriculum, not least through an apprentice-style system of co-op education, which diffused new ideas from RIM into the classroom (Munro and Bathelt 2014).²⁴ The expansion of this program was, in turn, based on RIM’s ability to secure reforms in both Queen’s Park and Ottawa (interview with industry representative, 20 July 2018, Waterloo).²⁵ In contrast to initiatives such as the CMC above, however, research collaboration between RIM and the University of Waterloo was less institutionalized (Sweeny 2009, 35). Some departments, such as electrical engineering, worked closely with RIM, but others, even in relevant disciplines, did not (interviews with academics 22

²³ In comments which highlight the contrast with OCRI, Gary Will, a Communitech veteran and longtime industry observer, concluded “Just about the best thing we did at Communitech was move the focus away from [commercialization] toward expertise, EIRs [entrepreneurs in residence], mentors, and things like that” (Will 2017)

²⁴ Kik’s controversial spin-off followed a co-op placement.

²⁵ Like Nortel, RIM was actively involved in provincial and federal politics, but the company’s impact on public policy was undercut by the fact that its dual executives advanced completely different strategic visions. Mike Lazaridis prioritized basic research, whereas Jim Balsillie vigorously lobbied for more attention to commercialization. This tension extends to their charitable donations, with the Perimeter Institute prioritizing basic and open research in theoretical physics whereas the Centre for International Governance Innovation, oriented toward the social sciences, has focused increasingly on the commercialization and application of technology.

and 24 November 2017, Waterloo). Explicitly contrasting RIM with Nortel, one faculty member concluded,

Everyone had partnerships with Nortel and did things with Nortel. It was hard to have a policy review where a Nortel representative was not present. Not only here, but in Ottawa, government things, you wouldn't assemble something on university-government relations and not have Nortel on it. But I don't remember people from RIM. RIM never had that status. It seemed that you didn't need a RIM person. (interview with academic, 22 November 2017, Waterloo).

Much like its relationship with Communitel, RIM's cultural imprint on the University of Waterloo was subtle and indirect. Faculty at the University of Waterloo celebrated the firm, but they were just as likely to encourage students to start their own companies as they were to recommend working for RIM (interview with academic, 24 November 2017, Waterloo).

President David Johnston, in contrast to peers in Ottawa, relentlessly promoted student entrepreneurship at the height of RIM's influence. Under his tenure, the University of Waterloo launched the Conrad Centre for Business, Entrepreneurship, and Technology in 2002, the Accelerator Centre in 2006, and the Velocity residence, a student business incubator, in 2008 (Sa and Kretz 2015, 110), none of which were connected to RIM or its short-term strategic interests.

In the short run, one could argue that RIM's indifference to the local ecosystem compromised these initiatives. Even though RIM served as a powerful role model and contributed generously to new programming, it did little to assist new enterprises with acquisitions, spin-offs, or strategic partnerships. RIM's most tangible impact on a startup in the aughts took the form of rising rents and wages. The firm vacuumed up human capital from the University of Waterloo and the rest of the ecosystem (interview with industry representative 13 August 2018, Waterloo). In contrast to depictions of 1990s Ottawa (see above), investors remarked, "[RIM] was sucking up every employee and driving wages higher. There was huge

wage inflation. It was not a cheap place to find labour. So, the startup culture was suffering because everyone was going to [RIM]” (interview with industry representative, 22 November 2017, Waterloo). Partly as a result of these dynamics, entrepreneurship in the Waterloo region dipped precisely when it spiked in Ottawa. The faculty startups which had defined the region in the 1980s started to decrease in the 1990s (Bramwell and Wolfe 2008; Bathelt, Kogler, and Munro 2011). Excepting Pixstream, which seeded a cluster of two dozen firms after it was acquired by Cisco in 2000-2001, the mid-2000s marked a lull in entrepreneurship. In 2004, there were only 250 high-technology firms in the area and Communitech supported just eight startups (Howitt 2019, 110).

In the long run, however, RIM’s aloofness benefited Waterloo in two ways, by preserving an ecosystem of mature, independent firms and creating a supportive environment for new enterprises. The number of established, technology firms in Waterloo might have represented a smaller share of the labour force, but because they predated RIM’s rise, they were largely unconnected from it and mobile communications more generally. OpenText (4,000 employees) in enterprise information management and Desire2Learn (1,000 employees) in education were not disrupted by the iPhone or the Android operating system and, instead, could exploit the outpouring of human capital from RIM. At the height of the crisis, firms affiliated with Communitech had 2,000 open job listings (interview with former politician, 28 November 2017, Waterloo). That reflected a coordinated effort, which leveraged the region’s dense networks and deep reservoir of social capital (Spigel and Vinodrai 2020). As a participant observed, this was only possible because RIM was so marginal to the ecosystem,

You’ll find that the people in that room, that so-called room, talking about how we would deal with the aftermath, how we would reconstitute the ecosystem, actually had nothing to do with RIM at all. As I look back, I think it’s a very

interesting observation, because [other firms] could act because they were not suffering from the same adjustments ... I don't have empirical evidence, but anecdotally I'm thinking, "Look around that room. We had adjacencies, but no direct involvement. It might have been pennies. The rest of the ecosystem was not tightly coupled" (interview with industry representative, 29 November 2017, Waterloo).

In addition to hiring by established firms, Waterloo benefited from a surge in entrepreneurial activity during the 2011-2016 period. Few of those startups were established by former RIM employees (Spigel and Vinodrai 2020). The impetus instead came from University of Waterloo students, socialized and trained by the suite of entrepreneurial programs which had been developed in RIM's shadow (Sa and Kretz 2015, 110–11). As RIM's technological lead shrank, those students opted to launch their own firms. An industry representative identified the 2007-2008 period as a turning point, even though financial markets were effectively frozen at this time,

If I think back ten years, [in] 2007 or 2008, a bunch of the smart kids coming out of universities started saying, "You know I really don't want to work for [RIM] and they started their own companies ... So, I think more people started doing startups because the technology started to fail. When that failed, that's when the startup scene started (interview with industry representative, 13 August 2018, Waterloo).

The number of startups increased exponentially as RIM shrank, from 8 in 2004 to 155 by 2010 and a peak of 513 in 2014. Between 2011 and 2016, Communitech averaged 419 startups a year. In the 2015-2017 period, Startup Genome identified 500 startups in Waterloo versus 629 in the significantly more populous Ottawa region (Startup Genome 2018). Those startups benefited from the flight of human capital from RIM (Spigel and Vinodrai 2020), but they could also draw on a robust infrastructure which was already in place before RIM declined. In addition to being socialized to become entrepreneurs at the University of Waterloo (Ornston 2016), University of Waterloo's Velocity business

incubator ran half a dozen supporting schemes. The Accelerator Centre partnered with university- and non-university startups, while Communitech continued to prioritize peer-to-peer mentoring in addition to other entrepreneurial programming (Spigel 2017).

Critics are quick to comment on the dearth of initial public offerings and high-profile acquisitions since 2002, with remarks such as “There hasn’t been an exit in [Waterloo] in over decade, so is something gone from that secret sauce?” (interview with industry representative 19 August 2019, Toronto). But the region’s startups have succeeded in attracting external investment. Waterloo’s startups raised more early-stage venture capital investment (\$92.6 million) than their Ottawa-based counterparts (\$90.6 million) in 2015-2017 (Startup Genome 2018), despite the region’s smaller population. In fact, the region has supplanted Ottawa, from a position of near-irrelevance a decade ago, as the national leader in per capita venture capital investment (Florida and Hathaway 2018). External investment has, in turn, fueled employment gains. Whereas software publishing and computer system design employment increased by 10% in Ottawa between 2011 and 2016, it grew by 85% in Waterloo. This was not merely a result of RIM’s reclassification as a software firm. Occupational measures of software employment, which shrank in Ottawa, increased by 32% in Waterloo. Foreign direct investment helped, but Google and Shopify branches collectively represented less than a thousand employees in 2016 and cannot explain the region’s resilience.

The long-term sustainability of this ecosystem remains unclear. Waterloo continues to exceed Ottawa in the latest data on per capita adjusted measures of patenting, but activity has declined more sharply following the collapse of its anchor (Dachis and Kim 2018). As noted above, the region’s post-RIM track record of scaling

firms is also modest. Without the deep-pocketed multinational corporations and the new anchor, Shopify, which underpin Ottawa's tech sector (Bagnall 2020), the region could prove more vulnerable to any post-pandemic induced tightening of credit. Google's recent plans to expand their footprint by several thousand employees could represent an even greater danger, threatening to suppress entrepreneurship in much the same way which RIM did in the aughts. Waterloo's policymakers thus face a familiar set of tradeoffs in thinking about how to engage this emerging anchor.

Conclusion: The Art of Anchor Engagement

At one level, the post-anchor experiences of Ottawa and Waterloo are encouraging. Neither suffered the marked, long-term decline which characterized high-technology clusters in Aalborg, Denmark (Østergaard and Park 2015) or Rochester, New York (Moretti 2019). Both regions successfully reinvented themselves by attracting external capital and developing local startups in new industries. The two cases thus reinforce a growing body of literature which suggests that anchor collapse is not a death sentence for high-technology ecosystems, as the human capital in an immature, rapidly evolving industry can be redeployed to other ends (Spigel and Vinodrai 2020; Green et al. 2001; Haley, Creutzberg, and Julie 2017; Langford, Li, and Ryan 2016; Buenstorf and Fornahl 2009).

In contrast to popular narratives, however, regional reinvention did not originate with failing anchors. This may occur in younger firms (Buenstorf and Fornahl 2009), but studies indicate that surprisingly few Nortel and RIM employees went on to launch successful, growth-oriented startups (Spigel and Vinodrai 2020; Kogler, Spencer, and Kedron 2017). Instead, both Ottawa and Waterloo relied on external actors, including local incumbents and new startups, to

exploit the human capital exiting large anchor firms and spearhead regional renewal. As a result, the pace and nature of adjustment varied widely. In Waterloo, a combination of established domestic firms and local startups absorbed this talent with relative ease, sustaining high-technology employment in the wake of RIM's decline. In Ottawa, however, adjustment was painful and protracted.

After eliminating several alternative explanations, we attribute these differences to the relationship between the anchor firms and their respective ecosystems. In Waterloo, although RIM donated to various local causes, it was largely indifferent to the industry which surrounded it. RIM's apathy led local technology firms and associations to forge their own path, positioning them to absorb displaced labour and deliver relevant programming when the anchor imploded. By contrast, Nortel was deeply embedded in the Ottawa technology ecosystem, partnering with local firms, spinning off enterprises, and anchoring associational governance. This arrangement benefited local industry as Nortel grew, but its failure impacted a much wider array of firms and disrupted associational governance when it was most urgently needed.

These dynamics extend to other cases of anchor decline, such as Nokia in Finland. Nokia more closely resembles RIM both in the timing of its decline and its status as a mobile handset producer. The Finnish technology community, however, was more heavily affected by its fall than Waterloo was. Even though Nokia employed only 20% of Finnish ICT sector at its peak (Pajarinen and Rouvinen 2013), ICT employment fell by a similar amount, 17.5% between 2008 and 2016. In contrast to Waterloo, where technology employment shrank by just 2.7%, an analogous measure of technology employment in Finland fell by 10.3% (OECD 2020).²⁶ Why was Nokia's decline so disruptive in Finland?

²⁶ This measure of the ICT industry includes D26ICT, D46ICT, D582, D61, D62, and D951. The broader measure adds D20T21, D266, D26X, D27, D28, D303, D71, and D72.

As a companion working paper relates, Nokia was deeply embedded within the Finnish high-technology ecosystem (Ornston 2021). In addition to constructing a large, supplier network (Ali-Yrkkö and Hermans 2004, 113), the firm underpinned associational governance (Ornston 2018, 87) and lobbied for supportive policies, including ambitious public investments in R&D and human capital (Moen and Lilja 2005, 372). In the short to medium run, these developments were positive, enabling sewing machine and toothpaste cap producers to enter mobile communications and upgrading R&D capabilities across the Finnish innovation system (Ornston 2012b, 81–85). In the long run, however, Nokia’s influence was a mixed blessing. In addition to mobilizing public policies and private firms around mobile devices and network equipment, Nokia narrowed Finnish innovation policy around the maximization of technological R&D (Ornston 2012a). This was fine for larger firms such as Nokia with robust translation and commercialization capabilities. Much like Ottawa, however, it did not meet the needs of startups, particularly those operating in different sectors (Ornston 2018, 93–94). As a result, Nokia’s collapse was deeply disruptive. In addition to taking down partners across the ecosystem, it threw Finnish innovation policies into a “state of confusion” (Laasonen, Kolehmainen, and Sotarauta 2020, 15).

Like Ottawa, the Finnish technology sector would recover, supported by a more diverse and, arguably, more sustainable constellation of new, growth-oriented startups in a wider variety of niches (Ornston 2018, 98–100). Few of these startups, however, came from Nokia (Pajarinen and Rouvinen 2013). Instead, the reinvention of the Finnish high-tech scene was spearheaded by a new generation of university students. Like their Ottawa-based counterparts, these entrepreneurs had to construct their own infrastructure from scratch, launching new associations (the Aalto Entrepreneurship Society) and events (the Slush conference) which delivered the types

of support they needed. Much like in previous crises in Finland, these initiatives were soon scaled by national policymakers through the Vigo Accelerator and other initiatives (Ornston 2018, 98–100), but the restructuring was smoother and faster in Waterloo where this infrastructure was already in place (Ornston 2021).

To the extent that there is a tradeoff between maximizing spillovers on the one hand and improving resilience to disruptive shocks on the other, future scholarship should focus on ways to soften this dilemma. The cases above point to several possibilities. First, dynamics in Waterloo illustrate how the type of embedding matters (Heidenreich 2012; Boschma 2005). RIM's focus on broad-based quality of life improvements and civic engagement over narrower, task-specific involvement benefited the Waterloo region, but did not narrow the region's comparative advantage around a particular sector or business model. This type of community development is often championed on the grounds of sustainability and equity (Zheng and Warner 2010), but it also appears less vulnerable to the lock-in that occurred in Ottawa.

Second, the type of anchor may matter. This study has focused on corporate actors, but universities can also anchor high-technology clusters (Feldman and Desrochers 2003; Walshok and Shragge 2014) and the University of Waterloo's status as a regional leader predated and rivalled RIM's (Bramwell and Wolfe 2008). Under president David Johnston, the university was certainly more involved in shaping the local, technology ecosystem than RIM, partnering with Communitech, Kitchener, and other actors in the promotion of high-technology entrepreneurship (Ornston 2019). An "engaged" university presents its own set of challenges (S. M. Breznitz and Feldman 2012), but its intrinsically interdisciplinary and cross-sectoral scope may mitigate the risk of regional lock-in (Armstrong 2019).

Finally, policymakers can beyond look regional anchors to encourage alternative industrial orders (Crouch 2005; Staber 2007; Herrigel 1996). The Finnish gaming association, the constellation of informal organizations in downtown Ottawa, and even the Atlas Group in Waterloo each seeded regional reinvention and development. Recent work on “Schumpeterian developmental agencies” suggests that even small investments in these types of initiatives can facilitate diversification and are more likely to develop radically new alternatives (D. Breznitz and Ornston 2013; 2014; D. Breznitz, Ornston, and Samford 2018). Having nurtured successful responses to disruptive shocks at the national level, these small-scale, modestly endowed agencies could serve as a model for regional policymakers as well.

References

- Ali-Yrkkö, Jyrki, and Raine Hermans. 2004. “Nokia: A Giant in the Finnish Innovation System.” In *Embracing the Knowledge Economy: The Dynamic Transformation of the Finnish Innovation System*, edited by Gerd Schienstock, 106–27. Cheltenham, UK: Edward Elgar.
- Andrew, Caroline, and David Doloreux. 2016. “Moving from Complaisance Revisited: Ottawa Trying Again to Define Its Regional Advantage.” In *Growing Urban Economies: Innovation, Creativity, and Governance in Canadian City Regions*, edited by David A. Wolfe and Meric S. Gertler, 139–56. Toronto: University of Toronto Press.
- Armstrong, Ben. 2019. “Brass Cities: Innovation Policy and Local Transformation.” PhD Dissertation, Cambridge, MA: Massachusetts Institute of Technology.
- Bagnall, James. 2019. “Bagnall: Nortel’s Bankruptcy 10 Years on: What Was Lost.” *Ottawa Citizen*, January 14, 2019. <https://ottawacitizen.com/business/local-business/bagnall-nortels-bankruptcy-10-years-on-what-was-lost/>.
- . 2020. “High-Tech Giants Should Have Enough Cash to Withstand the COVID-19 Storm.” *Ottawa Citizen*, March 17, 2020. <https://ottawacitizen.com/business/local-business/high-techs-giants-have-enough-cash-to-withstand-the-covid-19-storm>.
- Bathelt, Harald, Dieter F. Kogler, and Andrew K. Munro. 2011. “Social Foundations of Regional Innovation and the Role of University Spin-Offs: The Case of Canada’s Technology Triangle.” *Industry and Innovation* 18 (5): 461–86. <https://doi.org/10.1080/13662716.2011.583462>.
- Bathelt, Harald, and Ben Spigel. 2019. “Questioning Cultural Narratives of Economic Development: An Investigation of Kitchener-Waterloo.” *The Canadian Geographer* 63 (2): 267–83. <https://doi.org/doi.org/10.1111/cag.12512>.
- Bergen, Benjamin. 2017. “Canada Has a Scale-up Problem, Not a Start-up Problem.” *CIGI Online*, 2017. <https://www.cigionline.org/articles/canada-has-scale-problem-not-start-problem>.

- Boschma, Ron. 2005. "Proximity and Innovation: A Critical Assessment." *Regional Studies* 39 (1): 61–74. <https://doi.org/10.1080/0034340052000320887>.
- Bramwell, Allison, Jen Nelles, and David A. Wolfe. 2008. "Knowledge, Innovation and Institutions: Global and Local Dimensions of the ICT Cluster in Waterloo, Canada." *Regional Studies* 42 (1): 100–116. <https://doi.org/10.1080/00343400701543231>.
- Bramwell, Allison, and David A. Wolfe. 2008. "Universities and Regional Economic Development: The Entrepreneurial University of Waterloo." *Research Policy* 37: 1175–87. <https://doi.org/10.1016/j.respol.2008.04.016>.
- Breznitz, Dan. 2018. "Data and the Future of Growth: The Need for Strategic Data Policy." In *Data Governance in the Digital Age*, 66–73. Waterloo: Center for International Governance Innovation.
- Breznitz, Dan, and Darius Ornston. 2013. "The Revolutionary Power of Peripheral Agencies: Explaining Radical Policy Innovation in Finland and Israel." *Comparative Political Studies* 46 (10): 1219–45. <https://doi.org/10.1177/0010414012472466>.
- . 2014. "Scaling Up and Sustaining Experimental Innovation Policies with Limited Resources: Peripheral Schumpeterian Developmental Agencies." In *Making Innovation Policy Work: Learning From Experimentation*, edited by Yevgeny Kuznetsov in Mark Dutz. Washington DC: OECD/World Bank.
- Breznitz, Dan, Darius Ornston, and Steven Samford. 2018. "Mission Critical: The Ends, Means, and Design of Innovation Agencies." *Industrial and Corporate Change* 27 (5): 883–96. <https://doi.org/10.1093/icc/dty027>.
- Breznitz, Shiri M., and Maryann P. Feldman. 2012. "The Engaged University." *The Journal of Technology Transfer* 37 (2): 139–57. <https://doi.org/10.1007/s10961-010-9183-6>.
- Buenstorf, Guido, and Dirk Fornahl. 2009. "B2C—Bubble to Cluster: The Dot-Com Boom, Spin-off Entrepreneurship, and Regional Agglomeration." *Journal of Evolutionary Economics* 19 (3): 349–78. <https://doi.org/10.1007/s00191-008-0119-3>.
- Calof, Jonathan, Gregory Richards, Laurent Mirabeau, Hussein Mouftah, Peter MacKinnon, Peter Chapman, and P.M. Vasudev. 2014. "An Overview of the Demise of Nortel Networks and Key Lessons Learned." Ottawa: Telfer School of Management, University of Ottawa.
- Casper, Steven, and Richard Whitley. 2004. "Managing Competences in Entrepreneurial Technology Firms: A Comparative Institutional Analysis of Germany, Sweden and the UK." *Research Policy* 33 (1): 89–106. [https://doi.org/10.1016/S0048-7333\(03\)00100-8](https://doi.org/10.1016/S0048-7333(03)00100-8).
- CBRE. 2016. "2016 Scoring Canadian Tech Talent." Los Angeles: CBRE.
- Chamberlin, Tyler, and John de la Mothe. 2003. "Northern Light: Ottawa's Technology Cluster." In *Clusters Old and New: The Transition to a Knowledge Economy in Canada's Regions*, edited by David A. Wolfe, 213–34. Kingston and Montreal: McGill-Queen's University Press.
- Christopherson, Susan, and Jennifer Clark. 2007. *Remaking Regional Economies: Power, Labor, and Firm Strategies in the Knowledge Economy*. Routledge.
- Cohendet, Patrick, David Grandadam, Chahira Mehouchi, and Laurent Simon. 2018. "The Local, the Global and the Industry Common: The Case of the Video Game Industry." *Journal of Economic Geography* 18 (5): 1045–68. <https://doi.org/10.1093/jeg/lby040>.
- Compass. 2015. "Waterloo, the David vs. Goliath of Startup Ecosystems." 2015. <https://startupgenome.com/blog/waterloo-the-david-vs-goliath-of-startup-ecosystems>.

- Creutzberg, Tijs, Brendan Haley, and Todd Julie. 2019. "Luck, Legacy and Local Leadership: Transitioning to New Digital Opportunities in Ottawa." Presented at the Creating Digital Opportunity Conference, Toronto, April 30.
- Crouch, Colin. 2005. *Capitalist Diversity and Change: Recombinant Governance and Institutional Entrepreneurs*. Oxford: Oxford University Press.
- Dachis, Benjamin, and Jacob Kim. 2018. "Move Over, Waterloo and Ottawa: Calgary Is Now Out-Innovating You." *C.D. Howe Institute* (blog). May 31, 2018. <https://www.cdhowe.org/expert-op-eds/move-over-waterloo-and-ottawa-calgary-now-out-innovating-you-cbcs-road-ahead>.
- Dublin, Thomas, and Walter Licht. 2005. *The Face of Decline: The Pennsylvania Anthracite Region in the Twentieth Century*. Cornell University Press.
- Ebner, Dave. 2003. "JDS Presence Fades from Ottawa." *The Global and Mail*, August 12, 2003. <https://www.theglobeandmail.com/report-on-business/jds-presence-fades-from-ottawa/article1165505/>.
- Feldman, M. P., and P. Desrochers. 2003. "Research Universities and Local Economic Development: Lessons from the History of Johns Hopkins University." *Industry and Innovation* 10 (1): 5–24.
- Florida, Richard L., and Ian Hathaway. 2018. "Startup North: Canada's Startup Ecosystems Are Growing But Still Lag the Global Leaders." Toronto: Martin Prosperity Institute.
- Florida, Richard L., and Karen M. King. 2015. "Startup City Canada: The Geography of Venture Capital and Startup Activity in Canada." Toronto: Martin Prosperity Institute.
- Frederiksen, Lars, Karl Wennberg, and Chanchal Balachandran. 2016. "Mobility and Entrepreneurship: Evaluating the Scope of Knowledge-Based Theories of Entrepreneurship." *Entrepreneurship Theory and Practice* 40 (2): 359–80. <https://doi.org/10.1111/etap.12223>.
- Gallini, Nancy, and Aiden Hollis. 2019. "To Sell or Scale Up: Canada's Patent Strategy in a Knowledge Economy." 72. IRPP Study. Montreal: Institute for Research on Public Policy.
- Gillmor, Don. 2012. "The Invention of Waterloo." *The Walrus*, September 12, 2012. <https://thewalrus.ca/the-invention-of-waterloo/>.
- Grabher, Gernot. 1993. "The Weakness of Strong Ties: The Lock-in of Regional Development in the Ruhr Area." In *The Embedded Firm*, edited by Gernot Grabher, 255–77. London: Routledge.
- Green, Roy, James Cunningham, Imelda Duggan, Majella Giblin, Mike Moroney, and Leo Smyth. 2001. "The Boundaryless Cluster: Information and Communications Technology in Ireland." In *Innovative Clusters: Drivers of National Innovation Systems*, 47–64. Paris: OECD.
- Haley, Brendan, Tijs Creutzberg, and Todd Julie. 2017. "Capturing Value from GPNs: Locally Led Strategic Coupling in Ottawa's Digital Sector." Presented at the Creating Digital Opportunity Conference, Montreal, May 3. https://munkschool.utoronto.ca/ipl/files/2015/03/Capturing-Value-from-GPNs_Strategic-Coupling_Ottawa_July-2017-1.pdf.
- Harrison, Richard T., Sarah Y. Cooper, and Colin M. Mason. 2004. "Entrepreneurial Activity and the Dynamics of Technology-Based Cluster Development: The Case of Ottawa." *Urban Studies* 41 (5–6): 1045–70. <https://doi.org/10.1080/00420980410001675841>.

- Haskel, Jonathan, and Stian Westlake. 2018. *Capitalism without Capital: The Rise of the Intangible Economy*. Princeton University Press.
- Heidenreich, Martin. 2012. "The Social Embeddedness of Multinational Companies: A Literature Review." *Socio-Economic Review* 10 (3): 549–79. <https://doi.org/10.1093/ser/mws010>.
- Herrigel, Gary. 1996. *Industrial Constructions: The Sources of German Industrial Power*. Cambridge, UK: Cambridge University Press.
- Howitt, Chuck. 2019. *BlackBerry Town: How High Tech Success Has Played Out for Canada's Kitchener-Waterloo*. Toronto: Lorimer.
- Huggins, Robert. 2008. "The Evolution of Knowledge Clusters: Progress and Policy." *Economic Development Quarterly* 22 (4): 277–89. <https://doi.org/10.1177/0891242408323196>.
- Julie, Todd. 2016. "The Evolution of Ottawa's Local High-Technology Governance Institutions: A Case Study of OCRI and Invest Ottawa." Presented at the Creating Digital Opportunity Conference, Saskatoon, April 25.
- Kogler, Dieter, Gregory M. Spencer, and Peter Kedron. 2017. "Anchors Away! The Evolution of an ICT Cluster After the Sinking of Its Flagship Company." Presented at the Globalization in Crisis? The Urban and Regional Challenges of the Great Instability, Cambridge, July 13.
- Kovessy, Peter. 2010. "Mayor Watson: Who Stands to Benefit?" *Ottawa Business Journal*, October 25, 2010. <https://obj.ca/article/opinion-mayor-watson-who-stands-benefit>.
- Laasonen, Valtteri, Jari Kolehmainen, and Markku Sotarauta. 2020. "The Complexity of Contemporary Innovation Policy and Its Governance in Finland." *Innovation: The European Journal of Social Science Research* 0 (0): 1–22. <https://doi.org/10.1080/13511610.2020.1842176>.
- Langford, Cooper H., Ben Li, and Camille D. Ryan. 2016. "Innovation from an Oil and Gas Platform: Calgary." In *Growing Urban Economies: Innovation, Creativity, and Governance in Canadian City Regions*, edited by David A. Wolfe and Meric S. Gertler, 157–77. Toronto: University of Toronto Press.
- Lim, Chaisung. 2008. "Towards Knowledge Generation with Bipolarized NSI: Korea." In *Small Country Innovation Systems: Globalization, Change and Policy in Asia and Europe*, edited by Charles Edquist and Leif Hommen, 113–55. London: Edward Elgar.
- Lucas, Matthew, Anita Sands, and David A. Wolfe. 2009. "Regional Clusters in a Global Industry: ICT Clusters in Canada." *European Planning Studies* 17 (2): 189–29. <https://doi.org/10.1080/09654310802553415>.
- Maskell, Peter, and Anders Malmberg. 1999. "Localised Learning and Industrial Competitiveness." *Cambridge Journal of Economics* 23 (2): 167–85. <https://doi.org/10.1093/cje/23.2.167>.
- Mason, Colin M., and Richard T. Harrison. 2006. "After the Exit: Acquisitions, Entrepreneurial Recycling and Regional Economic Development." *Regional Studies* 40 (1): 55–73. <https://doi.org/10.1080/00343400500450059>.
- McCann, Luke. 2003. "Ottawa Feels the Pain of Losing Tech Firms." *The Global and Mail*, September 16, 2003. <https://www.theglobeandmail.com/report-on-business/ottawa-feels-the-pain-of-losing-tech-firms/article1045677/>.
- McDougall, Glenn. 2015. "The Ottawa Technology Cluster." *Doyletech Corporation* (blog). January 29, 2015. <http://doyletechcorp.com/exela-commodi-consequa/>.

- McNish, Jacquie, and Sean Silcoff. 2015. *Losing the Signal: The Untold Story Behind the Extraordinary Rise and Spectacular Fall of BlackBerry*. London: Random House.
- Moen, Eli, and Kari Lilja. 2005. "Change in Coordinated Market Economies: The Case of Nokia and Finland." In *Changing Capitalisms: Internationalization, Institutional Change and Systems of Economic Organization*, edited by Glenn Morgan, Richard Whitley, and Eli Moen, 352–79. Oxford: Oxford University Press.
- Moretti, Enrico. 2019. "The Effect of High-Tech Clusters on the Productivity of Top Inventors." w26270. National Bureau of Economic Research. <https://doi.org/10.3386/w26270>.
- Munro, Andrew, and Harald Bathelt. 2014. "Innovation Linkages in New- and Old-Economy Sectors in Cambridge-Guelph-Kitchener-Waterloo (Ontario)." In *Innovating in Urban Economies: Economic Transformation in Canadian City-Regions*, edited by David A. Wolfe, 219–44. Toronto: University of Toronto Press.
- Nelles, Jen. 2014. "Myth Making and the 'Waterloo Way': Exploring Associative Governance in Kitchener-Waterloo." In *Governing Urban Economies: Innovation and Inclusion in Canadian City-Regions*, edited by Neil Bradford and Allison Bramwell, 88–109. Toronto: University of Toronto Press.
- Nelles, Jen, Allison Bramwell, and David A. Wolfe. 2005. "History, Culture and Path Dependency: Origins of the Waterloo ICT Cluster." In *Global Networks and Local Linkages: The Paradox of Cluster Development in an Open Economy*, edited by David A. Wolfe and Matthew Lucas, 227–52. Montreal: McGill-Queen's University Press.
- Niosi, Jorge, and Maryse Bergeron. 1995. "Electronics." In *Flexible Innovation: Technological Alliances in Canadian Industry*, edited by Nathalie Hade, Michèle Sawchuck, Jorge Niosi, and Maryse Bergeron, 38–58. Montreal: McGill-Queen's University Press.
- Novakowski, Nick. 2010. "Ottawa: The Knowledge City and a Labyrinth of Obstacles." *GeoJournal* 75 (6): 553–65. <https://doi.org/10.1007/s10708-009-9273-x>.
- OECD. 2020. "STAN STructural ANalysis Databse." Paris: OECD. stats.oecd.org/Index.aspx?DataSetCode=STANI4_2020#.
- Ornston, Darius. 2012a. "Old Ideas and New Investments: Divergent Pathways to a Knowledge Economy in Denmark and Finland." *Governance* 25 (4): 687–710.
- . 2012b. *When Small States Make Big Leaps: Institutional Innovation and High-Tech Competition in Western Europe*. Ithaca: Cornell University Press.
- . 2014. "When the High Road Becomes the Low Road: The Limits of High Tech Competition in Finland." *Review of Policy Research* 31 (5): 454–77. <https://doi.org/10.1111/ropr.12091>.
- . 2016. "Small States and Small Cities: Using Interpersonal Networks to Accelerate Economic Restructuring in Waterloo." Innovation Policy Lab Working Paper Series 2016–03. Innovation Policy Lab Working Paper. Toronto.
- . 2018. *Good Governance Gone Bad: How Nordic Adaptability Leads to Excess*. Ithaca: Cornell University Press.
- . 2019. "Ideas as an Innovation Policy Instrument." In . Washington D.C.
- . 2021. "When Flagships Falter: How Finland and Waterloo Adapted to Anchor Collapse." SSRN Working Paper.
- Østergaard, Christian Richter, and Eunkyung Park. 2015. "What Makes Clusters Decline? A Study on Disruption and Evolution of a High-Tech Cluster in Denmark." *Regional Studies* 49 (5): 834–49. <https://doi.org/10.1080/00343404.2015.1015975>.

- Pajarinen, Mika, and Petri Rouvinen. 2013. "Nokia's Labor Inflows and Outflows in Finland: Observations from 1989 to 2010." ETLA Reports. Helsinki: The Research Institute of the Finnish Economy.
- Pender, Terry. 2015. "BlackBerry Cuts More Jobs." *The Record*, July 20, 2015.
- . 2017a. "Six UW Grads Have Founded Firms Worth More than \$1 Billion." *The Record*, February 8, 2017.
- . 2017b. "Communitech's Tech Savvy Is Admired Around the World." *The Record*, June 3, 2017. <https://www.therecord.com/business/2017/06/03/communitech-s-tech-savvy-is-admired-around-the-world.html>.
- PriceWaterhouseCoopers. 1998. "The Ottawa Techmap." Ottawa: PriceWaterhouseCoopers.
- Roose, Kevin. 2015. "The Life, Death and Rebirth of BlackBerry's Hometown." *Fusion*, February 8, 2015. <https://splinternews.com/the-life-death-and-rebirth-of-blackberrys-hometown-1793845127>.
- Sa, Creso M., and Andrew J. Kretz. 2015. *The Entrepreneurship Moment and the University*. New York: Palgrave MacMillan.
- Safford, Sean. 2009. *Why the Garden Club Couldn't Save Youngstown: The Transformation of the Rust Belt*. Cambridge, Mass: Harvard University Press.
- Saxenian, Annalee. 1994. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press.
- Shavinina, Larisa V., ed. 2004. *Silicon Valley North: A High-Tech Cluster of Innovation and Entrepreneurship*. Bingley, UK: Emerald Group Publishing.
- Silicoff, Sean. 2015. "From Hardware to Software: Ottawa's Push for a Tech Revival." *The Global and Mail*, September 18, 2015. <https://www.theglobeandmail.com/technology/ottawas-resurgent-tech-scene/article26430302/>.
- Simonen, Jaakko, Johannes Herala, and Rauli Svento. 2020. "Creative Destruction and Creative Resilience: Restructuring of the Nokia Dominated High-Tech Sector in the Oulu Region." *Regional Science Policy & Practice*. <https://doi.org/10.1111/rsp3.12267>.
- Spigel, Ben. 2011. "A Series of Unfortunate Events: The Growth, Decline, and Rebirth of Ottawa's Entrepreneurial Institutions." In *Entrepreneurship and Global Competitiveness in Regional Economies: Determinants and Policy Implications*, edited by Gary Libecap and Sherry Hoskinson, 47–72. Bingley, UK: Emerald Group Publishing.
- . 2013a. "The Emergence of Regional Cultures and Practices: A Comparative Study of Canadian Software Entrepreneurship." PhD Dissertation, Toronto: University of Toronto.
- . 2013b. "World Weary Waterloo Waits and Wonders: When Will RIM's Worries Wane?" September 22, 2013. <http://www.benspigel.com/blog/tag/RIM>.
- . 2017. "Bourdieu, Culture, and the Economic Geography of Practice: Entrepreneurial Mentorship in Ottawa and Waterloo, Canada." *Journal of Economic Geography* 17 (2): 287–310. <https://doi.org/10.1093/jeg/lbw019>.
- Spigel, Ben, and Tara Vinodrai. 2020. "Meeting Its Waterloo? Recycling in Entrepreneurial Ecosystems after Anchor Firm Collapse." *Entrepreneurship & Regional Development*, March, 1–22. <https://doi.org/10.1080/08985626.2020.1734262>.
- Staber, Udo. 2001. "The Structure of Networks in Industrial Districts." *International Journal of Urban and Regional Research* 25 (3): 537–52. <https://doi.org/10.1111/1468-2427.00328>.

- . 2007. “The Competitive Advantage of Regional Clusters: An Organizational—Evolutionary Perspective.” *Competition & Change* 11 (1): 3–18.
<https://doi.org/10.1179/102452907X166836>.
- Statistics Canada. 2001. “2001 Census: Data Tables.” Ottawa: Statistics Canada.
<https://www12.statcan.gc.ca/english/census01/Products/standard/themes/DataProducts.cfm?S=1>.
- . 2006. “2006 Census: Data Tables.” Ottawa: Statistics Canada.
<https://www12.statcan.gc.ca/census-recensement/2006/rt-td/index-eng.cfm#tab5>.
- . 2011. “2011 National Household Survey: Data Tables.” Ottawa: Statistics Canada.
<https://www12.statcan.gc.ca/nhs-enm/2011/dp-pd/dt-td/Index-eng.cfm>.
- . 2016. “2016 Census Data Tables.” Ottawa: Statistics Canada.
<https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/dt-td/index-eng.cfm>.
- Sweeney, Alastair. 2009. *BlackBerry Planet: The Story of Research in Motion and the Little Device That Took the World by Storm*. Mississauga: John Wiley & Sons Canada, Ltd.
- Vu, Viet, Creig Lamb, and Asher Zafar. 2019. “Who Are Canada’s Tech Workers?” Toronto: Brookfield Institute.
- Wahl, Andrew. 2009. “The Good, the Bad and the Ugly: Nortel Networks -.” *Canadian Business*, March 30, 2009. <https://www.canadianbusiness.com/business-strategy/the-good-the-bad-and-the-ugly-nortel-networks/>.
- Walshok, Mary Lindenstein, and Abraham J. Shragge. 2014. *Invention and Reinvention: The Evolution of San Diego’s Innovation Economy*. Palo Alto: Stanford University Press.
- Will, Gary. 2017. “The Evolution of Ottawa’s Startup Community with Ian Graham of TheCodeFactory.” *Cultivating Startups*. Accessed November 2, 2020.
<https://cultivatingstartups.com/ep-17-evolution-ottawas-startup-community-ian-graham-thecodefactory/>.
- Wilson, Christopher. 1999. “Civic Entrepreneurship and the Ottawa Centre for Research and Innovation.” Centre on Governance Case Study. University of Ottawa.
http://www.christopherwilson.ca/papers/OCRI_Case.pdf.
- Wolfe, David A. 2019. “A Digital Strategy for Canada: The Current Challenge.” 25. IRPP Insight. Montreal: Institute for Research on Public Policy.
- Wong, Ging. 2007. “From Unemployment to Sustainable Livelihoods in Ottawa’s Technology Sector.” 44. Queen’s University School of Policy Studies Working Paper. Kingston: Queen’s University.
https://qspace.library.queensu.ca/bitstream/handle/1974/14852/Wong_2007_Unemployment_to_Sustainable_Livelihoods.pdf;sequence=1.
- Zheng, Lingwen, and Mildred Warner. 2010. “Business Incentive Use Among U.S. Local Governments: A Story of Accountability and Policy Learning.” *Economic Development Quarterly* 24 (4): 325–36.