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How innovation systems in Finland and Alberta work: Lessons for policy and practice

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Abstract: *Innovation enhances human prosperity and well-being and is considered a major driver of economic growth. Yet, the innovation process varies in different countries and regions. Understanding the 'how' can help both policy makers and practitioners to facilitate innovation. We contribute to such understanding by comparing the development of two small, contrasting innovation systems in Finland and Alberta, Canada in their historical, economic, and social contexts – a type of research that has been called for but is rare in the systemic innovation research. Instead of describing components and outcomes only but change over time in innovation systems, we capture how they work. This and the comparison of systems with different rates of innovation and change offer a more grounded basis for policy and practice recommendations than comparisons to an abstract ideal, and also reveal some implications for the notion of path dependence in innovation systems.*

Keywords: innovation systems, Finland, Alberta, comparative case study, historical, social, economic context of innovation, change and path dependence in innovation systems, innovation policy

Innovation – the introduction of new products and processes – facilitates human prosperity and well-being and is considered a significant driver of economic growth (Martin, 2012). Yet, the innovation process varies markedly in different countries and regions (Nelson, 1993), and scholars and policy makers want to understand why. Those studying innovation systems (e.g., Edquist, 1997, 2011; Freeman, 1987; Lundvall, Johnson, Andersen, & Dalum, 2002; Niosi, 2011) have identified organizations (such as firms, universities, research institutes, funding bodies) and institutions (e.g., routines, rules, laws, cultural norms and values) as important pieces of the puzzle and elements of innovation systems. Competency building and inter-organizational learning (Lundvall et al., 2002) and activities such as R&D, financing of innovations, and incubation (Edquist, 2011) have been added to the innovation systems approach to introduce dynamism to better explain and facilitate the innovation process.

Despite recognizing innovation systems as dynamic, researchers view them as path dependent. Once organizations and institutions involved in innovation are established, they are assumed to 'lock in' and follow a trajectory that is difficult to change in the absence of external shocks (Carlsson, 2006; Edquist, 2011, p. 1732; Freeman, 1987), primarily due to a country's or a region's unique political and economic history (Nelson, 1993). Based on a historical comparative case study of two small innovation systems, Finland and Alberta, Canada, we argue that innovation systems do change and can be changed (Garud, Kumaraswamy, & Karnøe, 2010; Hart, 2009; Klochikhin, 2012). Understanding such change can be helpful to innovation practitioners and policy makers, particularly in avoiding piecemeal attempts at change, such as copying a single element from a different innovation system with the hope of facilitating innovation in another (Mowery, 2011; Stanley, 2007). Despite calls for research on change in and comparisons of innovation systems (Niosi, 2011), very few comparative studies exist (e.g., Akpolat & Chang, 2008), especially those examining change over time (Edquist, 2011; Hart, 2009).

We chose Finland and Alberta for our comparison for several reasons. First, Finland and Canada, and Alberta in particular, provide a good contrast. Finland, known as an innovation 'hot spot' (Kao, 2009), regularly places well in international comparisons for innovation, whereas Canada tends not to do so well. For example, Finland placed third in the World Economic Forum Innovation

Index in 2010–2011, while Canada was 11th of 15 countries (Tekes, 2012). Canada's rate of productivity growth – considered an indicator of innovation – trails the OECD average (OECD, 2012) and is commonly attributed to low business investment in R&D and lack of innovation (Council of Canadian Academies, 2009; OECD, 2012). Alberta, the most prosperous Canadian province, scores worst in productivity growth at a 0.8% annual increase 1996–2012 compared to 2.0% in Finland (Alberta Government, 2012).

Second, despite differences in innovation and productivity growth, Finland and Alberta have many similarities. They are similar in size – size of an innovation system has been found a relevant factor in the rate of innovation, and its inclusion in analysis has been encouraged (Hart, 2009, p. 653). In 2011, Finland had a population of 5.3 million and GDP of US$ 270 billion, whereas Alberta's population was 3.8 million and GDP US$ 295 billion.[1] Both are sparsely populated northern regions with abundant natural resources, although as its higher GDP suggests, Alberta's oil and gas have been more valuable than Finland's forests. Both innovation systems are also affected by the policies of the larger jurisdictions of which they are a part: The European Union and the Canadian federation.

Third, despite these similarities in regional or national characteristics, the two innovation systems differ in the way they work. For example, the Finnish system has gone through both significant and incremental changes (Kaitila & Kotilainen, 2008; Niinikoski, 2011), whereas despite the public efforts in Alberta, any changes in the system have been minor (Simpson & Murgatroyd, 2012). These differences provide a window for examining how innovation systems work and a basis for lessons for innovation policy and practice.

[1] The population and GDP statistics are from Statistics Finland (2012a) and Statistics Canada (2012). Since Finland reports GDP in euros (€ 194 billion in 2011), it was converted to US dollars by using the average exchange rate for 2011 (1.39), provided by Bank of Canada. The average exchange rate for 2011 for the Canadian dollar to US dollars was virtually at par, so the original figure for Alberta GDP ($295 billion) provided by Statistics Canada was used.

Fourth, one of the authors is an insider observer of the Finnish innovation system and the other of the Albertan system. We possess both tacit and explicit knowledge of each innovation system, having been able to observe these systems closely, including through visits by the Finnish author to Canada and vice versa.

Our comparison of innovation systems in Finland and Alberta in their historical, economic, and social contexts contributes to the literature on innovation and innovation systems in three ways. First, by describing change in innovation systems, our study includes both the dynamic dimension and the relationships between organizations and institutions that are otherwise difficult to capture (Edquist, 2011; Lundvall et al., 2002). We suggest that our description of change over time offers an integrated view of *how* innovation systems actually work (Lundvall et al., 2002), complementing the existing research on systemic innovation, which addresses the question 'what are innovation systems and their outcomes?' Second, by capturing the logic, the 'why' of change, our comparison of two existing systems of innovation and their development offers a more grounded basis for innovation policy and practice than comparing an existing system to an abstract ideal (Edquist, 2011, p. 1743). Third, our study provides some contrary evidence to the commonly assumed path dependence, which can help both innovation practitioners and policy makers facilitate change in the system and thus innovativeness (Hart, 2009).

We begin by explaining briefly our research approach, data sources and analysis. We then describe the development of the Finnish innovation system up to the present, followed by the same for Alberta. The two systems are then compared, and we draw implications for innovation systems approach, policy and practice, and further research.

Research approach, data sources, and analysis

In order to understand how different innovation systems operate, we chose a comparative case study approach (Yin, 2003). The two cases we compare are also highly relevant and critical, as they offer a contrasting degree of change and innovation intensity (Eriksson & Kovalainen, 2008, pp. 120–122). We are interested in the 'how' and the 'why' rather than measurement of

outcomes, as well as interpretation and understanding rather than generalization. Placing the two innovation systems in their historical, social, and economic contexts helps understand their operations (Pettigrew, 2012) and offers a solid foundation for policy and practice suggestions.

Documents and interviews were the primary sources of data. We studied research reports, statistics, dissertations, annual reports, web pages, and descriptive articles about the innovation systems and their contexts in Finland, in Alberta, and Canada. We also interviewed 38 participants in the innovation systems (between 30 and 60 minutes each) – academic researchers, company executives, funding agency staff, innovation consultants – in Finland and Canada in 2011–2012. Interviews were all taped and transcribed, and the transcripts were read and analyzed by both authors. Patterns we detected across interviews and documents formed the basis of our findings, which were also informed by several visits by the Canadian researcher to Finland and vice versa, as well as by many informal discussions with participants in the innovation system both in Finland and Canada. While the interview data support the depiction of the two innovation systems presented here and corroborate other data sources, they will be featured in a follow-up paper.

How the Finnish innovation system works: From a forest sector to a knowledge economy through network-based collaboration

Finland is a large, sparsely populated country in the heavily forested northern edge of Europe and shares over 1,000 km of common border with Russia. The remote location, besides the strange language, has isolated Finland from readily accessible markets for its forest products, the driver of the country's economic engine until the recession in the early 1990s (Kaitila & Kotilainen, 2008).[2] Thriving in the harsh northern climate has been another challenge.

Finland's innovation system has evolved amidst these geographic, political, economic, and climatic conditions. They have required cultivating an ability to solve problems particular to this context. The forest industry required engineers; universities of technology (UOTs) were founded. Even today, Finnish universities graduate more engineering and science students (nearly 30% of graduates) than the OECD average of <20% (Kristensen & Lilja, 2011, p. 231), and many Finnish executives have degrees in these disciplines. All undergraduates write theses. Engineering students commonly do theirs for companies that pay them. This has strengthened ties between industry and UOTs, making it natural for companies to collaborate with universities to solve technical problems.

Thriving in Finland has required close collaboration not just between companies and UOTs but across all kinds political, social and professional boundaries. In a small country with a challenging context, this has been necessary, and the level of networking in Finland is particularly high among the OECD countries (Kaitila & Kotilainen, 2008), enhanced by personal connections between various actors across different sectors (Tainio & Lilja, 2005). This has also led to a high level of trust, further facilitating collaboration (Oinas, 2005).

Besides network-based collaboration, private ownership has driven innovation in the forest sector. Unlike in Alberta where the forests (and mineral rights) are owned by government, farmers in Finland have been the main owners. This has led to some of the highest timber prices in the world but also to innovations in forest management, silviculture, harvesting and transport, and in paper and pulp processing technologies, to gain efficiencies to offset the high prices of timber (Oinas, 2005). Farmers have made long-term investments to maintain forests, increasing their productivity and facilitating the domestic and international expansion of the forestry firms (Lilja, Räsänen, & Tainio, 2005, pp. 22–23).

High timber prices and the small domestic market pushed forest sector companies to

[2] The share of forest products of the Finnish exports 1920–1960 was above 80% on average, dropping to below 50% by 1980, and to about 20% in 2011 (Lilja et al., 2005, p. 25). Even at 20%, the share of forest products of the country's exports is the highest in the world. For Canada that figure in 2011 was 6%.

internationalize early, setting an example for other industries. The Soviet market was readily accessible, receiving 25% of the Finnish exports at the peak of the Soviet trade (Tainio & Lilja, 2005, p. 66). Not only did this discourage innovation; it also pushed Finland into a deep recession when the Soviet Union collapsed in 1991. The disappearance of the Soviet trade, combined with a banking crisis that followed deregulation and monetary policy missteps, triggered a deliberate economic transformation from the dominance of the forest industry to a 'knowledge society', led by the ICT sector (Tainio & Lilja, 2005).

The relevance of the political context in Finland: From statism to an enabling welfare state

Reliance on technology has been the cornerstone of the economic transformation in Finland. Technological demands of the forest sector, driven by private forest ownership and the high timber prices on one hand and by the long distance from the markets on the other, made the Finns aware of the importance of research and technological innovation early on. This motivated firms and UOTs to collaborate and develop technology, and the Finnish engineering firms and equipment manufacturers emerged as world experts on the forest sector technology (Kaitila & Kotilainen, 2008).

Continuing the focus and reliance on technology was a natural response to the collapse of the Soviet trade, the banking crisis, and increasingly globalized markets in the early 1990s. The Finnish government decided to convert the country into a 'knowledge economy', even before the breakthrough of Nokia and other ICT companies which occurred a few years later (Ylä-Anttila & Palmberg, 2007, p. 175).[3] These statistics speak to the success of the conversion: The share of the electronics industry of the Finnish exports in 1990 was 12%; by 2000 it had increased to 31%. Within the same time period, the forest sector exports declined from 39 to 29% of the total (Tainio & Lilja, 2005, p. 75).

The Finnish government used broad policy measures to transform the economy: liberalization of markets, joining the EU, and public funding of R&D. It made a big push for globalization by shifting its economic policy away from protectionism and other interventions (Leach, 2011). There were few options, as the economic recession reached crisis proportions with a record-high unemployment, which did not decline below 15% until after the mid-1990s with the ICT boom (Ylä-Anttila & Palmberg, 2007).

After more than a decade of small deregulatory steps, the Finnish financial markets and corporate ownership were opened to foreign investment in 1993. The small, inefficient banks started to merge, increasingly also with their Nordic competitors. This made more capital available for firms to expand both at home and abroad. Foreign investors also were attracted by Finnish companies, especially in the ICT sector and Nokia (Tainio & Lilja, 2005, p. 74).

Preparing to join the European Union in 1995, the Finnish government had to give up non-compliant macroeconomic interventions such as currency devaluations used to protect forestry exports. These were substituted by microeconomic measures consistent with EU regulations and aimed at long-term economic growth, such as policies on R&D, education, and technology infrastructure (Niinikoski, 2011, p. 64; Ylä-Anttila & Palmberg, 2007). Instead of 'picking winners' by supporting particular companies, the government adopted an innovation system approach, aiming to create an enabling environment by facilitating networking and collaboration between the system's participants (Kristensen & Lilja, 2011; Ylä-Anttila & Palmberg, 2007, p. 173).

Facilitating innovation

The government increased public funding for R&D significantly in the mid-1990s, to 3% of the GDP from 2%, channeled primarily through Tekes, the Finnish Technology and Innovation

[3] Nokia's CEO, Kari Kairamo, was one of the chief proponents of such a conversion in the 1980s. At that time Nokia was still a large, diversified corporation with main interests in forestry, pulp and paper, rubber tires (and boots), and TVs and other electronics. Its focus on ICT did not occur until after the government's decision to pursue 'knowledge economy' (Oinas, 2005).

Funding Agency. The private sector's share of R&D spending in Finland also increased, from about 60% in the 1990s (Kaitila & Kotilainen, 2008, p. 364) to over 70% in 2011 (Statistics Finland, 2012b). This is remarkable in that private R&D investment had been very low by international standards just a few decades earlier. Additional government funding was also given to an industrial cluster program (40% funded by its industry participants), with new research clusters in areas of perceived strengths such as food, wood, telecommunications, welfare, and environment, in order to facilitate innovation and job creation (Niinikoski, 2011, p. 72). This was another measure boosting collaboration between companies, academic researchers, and government applied research centers.

Besides education policy and laws governing intellectual property (IP) (described later), the government has used three key organizations as innovation policy vehicles: The national Research and Innovation Council (RIC), The Finnish Innovation Fund (Sitra), and Tekes.[4] The RIC (formerly the Science and Technology Policy Council), a high-level coordinating institution chaired by Prime Minister, has been a continual influence on the Finnish science and innovation policy since 1960s, working closely with the Ministries of Education and of Employment and the Economy. Based on a review in 1990, the RIC outlined the national industrial strategy for the conversion into a knowledge economy and upgraded the national innovation system into an enabling environment to increase network-based collaboration (Niinikoski, 2011, p. 57).

Sitra, The Finnish Innovation Fund, is an independent foundation started in 1967 reporting to the Parliament. Funded solely by the returns to its endowment, it facilitates innovation by providing otherwise scarce venture capital to new business start-ups.

Tekes, The Finnish Funding Agency for Technology and Innovation, was founded in 1983 to fund collaborative research between UOTs and companies as well as company development projects. Collaboration between companies and academic researchers is a condition of funding. This is a unique model that pushes both companies and university researchers to seek collaboration, leading to more innovations than with both parties working alone.[5]

The education system has been an important vehicle for facilitating innovation and economic transformation in Finland as the producer of 'knowledge workers'. It underwent a significant transformation in the 1990s to align with the major European countries and to improve the overall education level required in a knowledge society. Post-secondary education was divided between universities (tasked with basic research and comprehensive education from undergraduate to doctoral levels) and polytechnics (focused on applied research and undergraduate teaching), and enrollment in engineering and sciences was increased. Fewer and larger higher education units were created, such as the 'Innovation University' Aalto that could produce high-quality research and develop scientific knowledge through centers of excellence for the globally competitive research clusters such as telecommunications, metal processing, and clean technology (Niinikoski, 2011, p. 59).

Teaching of mathematics and the natural sciences throughout primary and secondary education was also increased. Finland consistently places among the top in educational attainment, including in math and sciences, in the international PISA comparison.

Intellectual property rights are another innovation policy vehicle. Until a change in the legislation in 2005, Finnish universities did not claim IP of the inventions made by faculty. Instead, the inventors owned their IP, encouraging spinoff firms. Since IP law was changed, universities can claim part of IP of faculty's inventions for

[4] For a comprehensive overview of Finland's national innovation system, see e.g., (Kaitila & Kotilainen, 2008; Lovio & Välikangas, 2010; Ylä-Anttila & Palmberg, 2007).

[5] Evaluation of the performance of an innovation system is not straight-forward, but some indicators can be found at the website of Tekes (http://www.tekes.fi/en/community/Results_and_impact/468/Results_and_impact/1283). For Alberta public innovation system indicators, see Alberta Innovates (http://www.albertainnovates.ca/success/). Both accessed 28 August 2012.

the purpose of collaborative commercialization (Kaitila & Kotilainen, 2008). This seems to be more effective than the universities taking over IP and attempting technology transfer without the inventors' involvement. Table 1 summarizes the key aspects of the Finnish innovation system's operations.

How the Alberta innovation system works in its national context: Impact of statism

Canadian provinces are relatively autonomous administrative divisions with their own parliaments, legislation, and taxation. They are responsible for education and health care and have ministries also in other areas, such as energy, tourism, agriculture, and aboriginal affairs in Alberta.

The national context affects the Alberta innovation system in a number of ways. The federal government restricts competition by imposing tariffs on many imported goods and by controlling foreign investment in several sectors, including oil and gas. Foreign competition is also constrained in such key industries as finance, telecommunications, and transportation. These regulations reduce global competitiveness, not only in these industries but also in others where firms have to contend with higher costs of capital, telecommunications, and transportation. Besides the lack of competition, high tax rates and the low rate of savings among Canadians were found in a recent study to contribute to low capital formation, thus deterring investment in technology and innovation and contributing to Canada's dismal productivity growth: Canada was in the 15th place of 18 OECD nations 1985–2006, with Alberta its worst province (Coyne, 2012).

Another federal influence on the Alberta innovation system is the funding for university research. While provincial governments are responsible for operational funding of higher education, three federal funding councils are the primary sources for research funding: The Natural

Table 1: How innovation systems in Finland and Alberta work

Finland	Alberta
'An enabling welfare state': Facilitating innovation	'The state knows best': Controlling innovation
• Capital formation: Liberalized foreign ownership and banking	• Restricted capital formation: Federally regulated foreign ownership and banking
• Private ownership of resources	• Public ownership of resources (mineral rights, forests) & collection of royalties
• Not attempting to pick winners – letting markets choose winners instead	• Attempting to pick winners
Integrated innovation policy	Fragmented innovation policy
• High-level coordination: Research and innovation council (RIC) chaired by Prime Minister	• Lower-level coordination: Alberta research & innovation authority (ARIA) advisory only to minister of enterprise and advanced education
• All policy vehicles facilitating networking and collaboration to create innovations: Tekes, strategic industry clusters, Sitra, education policy (training knowledge workers, enhancing collaboration), IP, etc.	• Four separate Alberta innovates corporations (under the ministry of enterprise and advanced education)
	• Other policy vehicles (education policy, IP, venture capital) not aligned with supporting innovation
Network-based collaboration across industry and university boundaries	Separate public and private innovation systems
• Engineering culture in many sectors: Firms collaborate with universities of technology	• Energy firms collaborate with engineering faculties, run their own research consortia and a private research alliance
• Tekes research and R&D funding tied to collaboration	• Most university research funding from federal funding councils; not tied to collaboration
• Strategic industry research clusters: Collaboration between industry participants and university researchers	• Public innovation system funds research chairs at universities and government–industry partnerships, but not university–industry collaboration

Sciences and Engineering Research Council (NSERC), the Social Sciences and Humanities Research Council (SSHRC), and the Canadian Institutes of Health Research (CIHR). The implication for innovation is that this system does not incentivize research collaboration between universities and industry, a key aspect of the Finnish innovation system. The NSERC's special partnership grants are an exception, but collaboration is not a condition of most research grants.

Alberta's transformation from ranching and farming to a global energy producer

Like Finland, Alberta's economy underwent a transformation, from ranching and farming to being a global energy producer, although some decades earlier. After the decline of the fur trade and the extinction of the plains bison, ranching and farming became the initial engine of Alberta's economy in the late 1800s. By 2011, however, agricultural products accounted for only 10% of Alberta's exports, while energy claimed a lion's share at 79%. The transformation started in 1914 with the first oil discovery and accelerated in the 1950s. Today, Alberta holds most of Canada's proven oil and gas reserves, including the oil sands that make Canada the third largest holder of hydrocarbon reserves in the world after Venezuela and Saudi Arabia. Thanks to the Alberta oil sands, Canada is the only major oil and gas producer in the world that has been continually increasing its production, with growth projected at least until 2020 (Alberta Enterprise and Advanced Education, 2012a).

Unlike Finland's economic crisis in the early 1990s, Alberta has not experienced as significant a jolt that would have prompted diversification away from the dominance of oil and gas. However, a federal intervention, the National Energy Program (NEP) in 1980 came close. Besides regulating oil prices, it restricted foreign ownership of Canadian energy companies and increased the petroleum revenue tax and the federal share of it. Although it failed to generate the anticipated tax revenues as the oil prices and investment declined, the NEP devastated Alberta, plummeting its GDP and the real estate prices and increasing bankruptcies by 150%.

The NEP prompted a public discussion about diversifying Alberta's economy that has been reinvigorated by subsequent recessions or significant declines in the world oil prices that threaten government revenues (Simpson & Murgatroyd, 2012). However, diversification remains elusive. The incentive is missing, as demand for fossil fuels shows no sign of abating, and the oil and gas production has brought the province significant prosperity: The median income in Alberta is about 30% higher than the Canadian average, and the tax rates are the country's lowest (Canada Revenue Agency, 2013). Add the relative political and economic stability and the oil and gas royalties (mineral rights are held by the crown), and the missing incentive for economic diversification and innovation outside of the energy sector is clear. Alberta's situation parallels that of other jurisdictions awash with natural resources and with low rates of innovation and productivity growth, such as Norway (Kaitila & Kotilainen, 2008) and Russia (Klochikhin, 2012).

Another aspect of Alberta's context is the easy access and proximity to the vast American market. Like the rest of Canada, Alberta has been able to ship its natural resources and agricultural products there easily: The United States absorbed 87% of Alberta's exports in 2011 (Alberta Exports, 2012). This has not provided much incentive to invest in innovation (Council of Canadian Academies, 2009).

Alberta's innovation systems: Non-integrated public and private efforts

Despite the disincentives for innovation and economic diversification, the Alberta policy makers have been aware of the vulnerability of one primary source of income, oil and gas royalties. They have created various programs to facilitate innovation as a means to prosperity, productivity improvement, and economic diversification (Simpson & Murgatroyd, 2012; The Premier's Council for Economic Strategy, 2011). However, unlike in Finland, these initiatives have not resulted in a system of network collaboration between industry, funding bodies, academic researchers, and government organizations.

Instead, separate public and private innovation systems with very different structures and ways of operating have evolved.

The public innovation system was most recently reorganized in 2010, motivated primarily by operational effectiveness and efficiency. At least 10 different government entities (including a former key player, the Alberta Oil Sands Technology and Research Authority) were integrated into four corporations under the Ministry of Enterprise and Advanced Education: Alberta Innovates Biosolutions, Alberta Innovates Energy & Environment Solutions, Alberta Innovates Health Solutions, and Alberta Innovates Technology Futures. Their mandate is to facilitate innovation, with a total annual budget of about $1 billion (0.03% of the GDP of about $295 billion in 2011, in contrast to over 3% in Finland). The budget is allocated to university research chairs, advising university centers of excellence, and sponsoring companies' technology development (Alberta Enterprise and Advanced Education, 2012b). A senior executive at one Alberta Innovates Corporation commented on deciding which company proposals to fund: 'We are in the business of picking winners'.

Alberta Innovates also includes Alberta Research and Innovation Authority (ARIA) comprised of Canadian and international innovation experts. Unlike Finland's RIC that is chaired by the Prime Minister and has the most powerful Ministers as members, facilitating their collaboration, ARIA merely advises the Minister of Enterprise and Advanced Education.

A separate private sector innovation system thrives in Alberta, primarily in the energy industry. That sector's innovation system is characterized by collaborative research between the oil companies and service firms, prompted by the significant oil price drops and recessions in the 1980s and 1990s. The service firms are important conduits, spreading innovations to several productions companies. Member-funded research consortia, such as the Petroleum Technology Alliance of Canada (PTAC) with over 200 company members, have developed or commercialized significant new technologies, such as the Steam-Assisted Gravity Drainage (used to extract heavy oil).

In addition to collaborating with each other and service firms, many large energy companies work closely with universities (that are also members of PTAC), particularly engineering schools, to fund research that directly helps them solve technical problems through research chairs and by sponsoring graduate students (Berkow, 2012). The motivation to extract oil from declining or unconventional reservoirs and to minimize the environmental impact of oil production drives these innovation activities.

Unlike in Finland where the public definition of innovation was expanded in 2007 to include – and public funding was extended for – non-technical innovations, technological innovation is emphasized in Alberta. Many of the interviewed experts said that the development and commercialization of technology or other marketable products are not the sole focus of the innovation system, but we found no evidence of either public or private funding for development of business innovations (such as new business models, new modes of globalizing, or marketing).

The public education institutions are also an element of the Alberta innovation system. Although their research mostly funded federally, they nevertheless produce graduates who will participate in the private or public systems of innovation. There has been no significant post-secondary education reform, although the Campus Alberta initiative was created in 2007 to coordinate between the 28 institutions (six universities as well as polytechnics, regional colleges, and independent colleges). Unlike in Finland, there is no undergraduate thesis requirement, which has ramifications for the research competence of graduates. About 23% of university graduates in Alberta had degrees in engineering, mathematics, or physical sciences in 2008, compared to 30% in Finland. However, Alberta easily attracts such graduates from elsewhere. The co-operative education system where post-secondary students have work terms at companies is well established in Alberta, but only a fraction of graduates participate in it.

Although Alberta also ranks near the top of the international PISA comparisons in K-12 educational achievement and has collaborated with Finland on primary–secondary education

reform since 2008, there are some key differences. For example, while in Finland the math and science content in elementary and secondary curricula was increased in the 1990s, it was recently reduced in Alberta.

The final element of the Alberta innovation system, IP rights, is similarly protected in Alberta and in Finland. However, one key difference is the universities' treatment of the IP created by faculty. In Finland the inventors held the sole rights to their IP regardless where the invention was created until 2007. Thereafter universities were granted partial rights, which encourages spinoff companies. In Alberta, as in the rest of Canada, universities' treatment of IP varies. Some claim IP to inventions created at their facilities, others do not. However, the universities' commercialization efforts have failed to create revenue and were unilaterally criticized by the interviewed experts who advocated the Open Innovation approach where the inventors decide whether and how to commercialize their inventions.

Comparing the development of innovation systems in Finland and Alberta: Implications for theory, policy, and practice

We have compared changes in and operations of two innovation systems: One in Finland that has undergone radical and incremental change which has led to increased network-based collaboration and innovation intensity, and the other in Alberta with much less change, a more hierarchical approach, and more modest outcomes. While our focus on just two innovation systems could be considered a limitation of our study, our aim was not to provide universal generalizations for all innovation systems. Instead, the desire to understand how different innovation systems with different outcomes work made us adopt a contextual, comparative case study approach, yielding the following conclusions (see Table 1 for a summary). The broad implications discussed in the final section can be used by policy makers and innovation practitioners who want to shift to an open innovation approach.

The difference in the success of innovation outcomes does not lie in the national or regional characteristics but in the way the two systems work. The Finnish system has an integrated innovation policy facilitating networked collaboration, guided at the highest level through the RIC chaired by the Prime Minister. Policy elements such as Tekes' technology and research grants that require university–industry collaboration and strategic industry cluster program have intensified network formation and network-based collaboration (Kaitila & Kotilainen, 2008; Oinas, 2005). The undergraduate thesis requirement has also strengthened ties between universities and industry. In Alberta, on the other hand, the public and private innovation systems operate separately, and the innovation policy aimed at controlling innovation by 'picking winners' is more fragmented with four separate innovation corporations and without a high-level guiding mechanism and clear goals. The lack of undergraduate theses is a missed connection between universities and industry.

While Finland created government mechanisms to guide innovation, it also moved away from state control. Markets were liberalized significantly, and both Sitra and Tekes operate as independent agencies funding business start-ups and R&D and research projects, based on business and researcher proposals and with direct accountability. Tekes funds a large number of competitive proposals, letting markets determine winners.

In contrast, Alberta has a more statist approach to its public innovation system, exacerbated by federal interventions. The Alberta Innovates corporations attempt to pick a limited number of winning business proposals and focus on supporting collaboration between government research laboratories and universities, as opposed to facilitating university–industry collaboration or other networking. Supporting a relative small number of industry research chairs has not so far led to many tangible innovations.[6] The private innovation system in Alberta (particularly in the oil and gas industry), however, is based on networked collaboration between producers, service firms, and universities.

The Finnish innovation system has recently changed incrementally by extending emphasis and funding also on non-technical innovations,

[6] Alberta Innovates (http://www.albertainnovates.ca/success/). Accessed 28 August 2012.

in areas such as business models and social welfare (Niinikoski, 2011). In Alberta, so far the innovation policy has been focused on technological innovation.

Implications for innovation systems approach

Our comparison of the two innovation systems' development builds upon the existing systemic research on innovation that has identified various organizations, institutions, and activities as important elements of innovation systems (Edquist, 2011; Edquist & Hommen, 2008; Arundel et al., 2007).

First, by describing change over time, we connect organizations, institutions, and activities and show how the innovation systems work and change. Second, including the historical, social and economic context allows us to better answer the 'why' of innovation system change (Pettigrew, 2012; Sminia, 2009). For example, contextual elements such as type and quantity of natural resources, distance from and access to markets, size of the domestic market, type of neighbors (size, political ideology), language, external shocks (economic crises), and economic growth help explain why and how the innovation systems work (Klochikhin, 2012).

Third, our study provides some contrary evidence to the idea of path dependence dominant in the innovation systems literature. The Finnish case shows that the innovation system does not 'lock in' as a consequence of positive changes but can and will undergo both radical and incremental changes (Garud et al., 2010), even in the absence of external shocks (such as economic crises), given high-level guidance, integration, sufficient resources, and an enabling approach that encourages problem solving based on network formation and collaboration. The Albertan case reinforces this by showing that the lack of high-level guidance, integration, and resources is not conducive to changing the innovation system, particularly with a controlling versus an enabling approach, when the rate of economic growth does not incentivize change, and the private innovation system thrives.

Given that we compare just two small innovation systems, we suggest further comparative, contextual research on innovation system operations and change to confirm our conclusions and to further solidify the basis for policy and practice recommendations.

Implications for innovation policy

Following Edquist's (2011, p. 1728) broad definition of innovation policy as 'actions by public organizations that influence innovation processes', we draw the following policy implications.

Become an enabler instead of attempting to control innovation

This means both removing obstacles to competition, such as restrictions to foreign ownership and other forms of protectionism as well as government ownership of resources, and facilitating network formation and collaboration. Innovation cannot be controlled by public policy and government ownership, as the Finns learned when they liberalized their previously state-controlled economy and gave up attempts to pick and support winners and focused on enabling network-based collaboration instead.

Adopt and implement an integrated innovation policy with a clear goal

Adopting the goal of increasing innovations – first technological and later also other kinds – as a means to economic growth and welfare allowed the Finnish government to have an integrated innovation policy. Everything public organizations have done has been geared toward facilitating innovation networks: The education policies to produce more knowledge workers and to increase university–industry collaboration, Tekes' requirement of collaboration as a condition of funding a large numbers of projects, and the formation of industry clusters to tackle joint research projects with universities and the government applied research center.

It has been argued that if a country or a region has won in the 'contextual lottery' and can achieve prosperity merely by shipping plentiful natural resources to easily accessed markets, innovation policy is not needed (Klochikhin, 2012). This may be the case in Alberta. Its GDP has grown at an average annual rate of 3.4%

for the last 20 years, and its GDP per capita is the highest in North America. However, while we can argue that Alberta does not need innovation policy, the government has nevertheless tried to implement one, although not with much impact. It has been sensitive to the vulnerability of one primary source of income, oil and gas royalties, and has made efforts to diversify the economy and support innovation also outside of oil and gas. Given the government's modest accomplishments, our policy recommendations might be useful also in Alberta and other wealthy jurisdictions.

The Finnish case has shown that depending on one primary source of income – even when it is based on renewable natural resources – cannot sustain an economy in the face of global competition. Innovation policy there has helped diversify the economy and boost economic growth.[7] The least a rich country or region could do to facilitate innovation is to remove obstacles to competition and to encourage the education system to cultivate research-minded problem solvers.

Implications for innovation practice

The primary focus of our paper has been on understanding how and why innovation systems work, and therefore we suggested mostly policy implications. However, a broad suggestion for innovation practitioners in companies, universities, and public research institutes arises as well: Embrace open innovation by building networks beyond your own domain (from industry to researchers and vice versa, both domestically and internationally) and collaborating in R&D and in non-technical innovation as well. This would equip business firms with the flexibility to deal with externally imposed continuous change and a sustainable means of wealth creation, the end goal of the innovation process.

Such an approach is necessary in a small country like Finland, especially given the growing global competition in the forest sector and the decline of its once dominant technology company Nokia. A small province like Alberta would also benefit from such an approach, given the unpredictability of the world petroleum prices, discoveries elsewhere (such as shale gas in the United States), and environmentalist opposition to fossil fuels and to pipelines for their transportation.

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[7] The average annual GDP growth rate in Finland 1986–1996, prior to the significant changes in innovation policy (including economic liberalization and the change in the role of the government), was approximately 1.4%. After the changes were implemented (and before the financial crisis), 1997–2007, the annual GDP growth rate was approximately 3.8% (Leach, 2011, p. 12).

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