Structuring Innovation in Knowledge Economies

A comparative look at the collaborations and related policies supporting Ontario's innovation capacity

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Executive Summary

Today, neither firm nor institution has the necessary resources - be it knowledge, skills or costly equipment - to be self-sufficient in attaining their innovation goals and sustaining their global competitiveness. The result of this 'resource dependency' is an economic structure whose innovation processes have become distributed across a wide range of economic actors, countries and sectors – all of which is held together by are a myriad of contractual - and collaborative – arrangements.

This paper argues that there are three important realms of collaboration, each of which is differentiated by the degree and level of government involvement and the types of policies used to influence respective forms of collaboration. The first and longest standing category of collaborations is that of inter-firm collaborations, a category that recognizes mostly formal forms of collaborations between firms and related industry associations. The degree of government activities in this area is limited to ensuring that the legal framework is supportive of inter-firm collaborations or to supporting those associations that promote interfirm networking.

The second category, which came to the forefront of policy making only within the last few decades, is the more extensive realm of public-private partnerships. These collaborations constitute the primary link between firms and the public science infrastructure and enable firms to access resources – knowledge, equipment and skilled people - in support of their R&D activities.

The third, and most recent development in the area of innovation-based collaborations, relates to the governance of a locality's innovative capacity and resources. Here, collaborations are forged between local actors and various levels of government to mobilize local resources and develop and embed knowledge assets within a locality so as to develop or secure a regional competitive advantage in selected industries. These kinds of collaborative governance initiatives have been essential in developing knowledge based sectors at the city-region level throughout the US, and increasingly, in Canada.

Ontario has been supportive to various degrees of all three realms of collaborations. Indeed, it has had most success in the realm of public-private partnerships where much of its industrial policy has been focused for the past 25 years. Overall though, the province has a history of wavering commitment to many of its collaborative programs. This needs to be rectified if Ontario wishes to change its individualist industry culture and further develop the innovation capacity in the city-regions.

Introduction

Few concepts better capture the essence of contemporary innovation policy than collaborations. Be it in efforts to develop industry clusters, improve commercialization of research, or support knowledge flows and learning, collaborations in their various forms are widely viewed by policy makers as one of the best means to the desired end of enhancing innovation, and ultimately economic performance. Indeed, the logic of collaboration underpins several of Ontario's most notable industrial programs and initiatives: the Ontario Centres of Excellence (OCE) program, the MaRS facility, and the new Regional Innovation Networks (RINs) program. All are founded with the goals of making the necessary connections to achieve desired economic outcomes.

At base, the popularity of collaborations by both government and industry is well founded, reflecting the growing complexity of the innovation process in many knowledge-based industries. Today, neither firm nor institution has the necessary resources - be it knowledge, skills or costly equipment - to be self-sufficient in attaining their innovation goals and sustaining their global competitiveness. The result of this 'resource dependency' is an economic structure whose innovation processes have become distributed across a wide range of economic actors, countries and sectors – all of which is held together by are a myriad of contractual - and collaborative – arrangements.

To appreciate the significance of the current policy focus on collaborations, it is worth noting that it was only a few decades back when economic development policy was cast from neo-liberal prescriptions that advocated for market-conforming reforms and monetary-based policies. The opening of financial and capital markets, reduction of public expenditures, deregulation of businesses, privatization, lower corporate taxes and free trade, were widely held as being sufficient policies for securing economic prosperity (Williamson 1994, Gilpin 2001). True to its time, the 1984 report from Royal Commission on the Economic Union and Development Prospects for Canada, for example, went as far as to argue that there is, in fact, no role for government in aiding the transformation from slow growth mature industries to faster growing industries. [1] Much has changed, of course, since the early 1980s, not least the policy role in supporting the structure of the innovation process.

For all that collaborations have framed the accepted current discourse of innovation policy, it remains important to have a clear understanding of what they in fact achieve, and in what form, and what role governments have in shaping these relationships. This is particularly so given the ever expanding terminology used to describe them. Public-private partnerships, joint ventures, research joint ventures,

[1] "We are convinced that the private sector will move, in time, into areas of growing opportunity, particularly if governments do not impede the adjustment process and provide a generally supportive environment. Canada should not pursue targeted industrial policy to encourage growth of exports in areas of potential high growth." Canada. *Royal Commission on the Economic Union and Development Prospects for Canada* (Ottawa: Minister of Supply and Services, 1985): 198.

cluster networks, strategic partnerships, strategic alliances, industry consortia, and regional collaborative initiatives – this is but a sample of the terms describing the various collaborations arrangements, several of which have been the explicit focus of policy.

The purpose of this paper is to provide a broad overview of the literature on collaborations so as to clarify their relevance to the innovation process, identify the key trends, and stimulate a discussion around related policy issues relevant to Ontario's economy. To this end, the paper develops a typology that captures the full range of collaborative arrangements. The typology distinguishes between three distinct realms - inter-firm, public-private and local strategic - each of which is differentiated by the degree and level of government involvement and the types of policies used to influence respective forms of collaboration. The categories are also differentiated in their historical development, with the latter one, local collaborative initiatives, being the most recent trend to develop - and also the least developed in the Ontario context.

The review is supported by examples, where available and relevant, from comparable jurisdictions in Canada, the US and Europe. Where possible, the paper discusses some notable Ontario examples of successful collaborations that have had an impact on the province's innovation capacity. Before synthesizing the existing knowledge in each of these areas identified by the typology, the paper begins with a discussion of why collaborations, broadly defined, are considered important to the innovation process, and to the structure of economic activity more broadly.

From independence to interdependence: the complex reality of knowledge-based industries

The understanding of firms as autonomous entities interacting with one another solely through the price mechanism (i.e. market relations) has a well established, and defended, history in economic theory. By this understanding, there are two desired ways by which economic activity and resources are coordinated: either through planned coordination by managers who operate within a hierarchical structure of the firm, or through exchange transactions between firms operating within a competitive market. Any other form of coordination, be it collaborations, monopolies or cartels, undermines the competitive structure of the market and thus create inefficiencies. Certainly, one of the most colourful accounts of this dichotomous view comes from D. H. Robertson who, in 1923, summarized the understanding of firms as 'islands of conscious power in this ocean of unconscious co-operation like lumps of butter coagulating in a pail of buttermilk.'[2]

There have been many respected defenders of this neoclassical view including Hayek (1933), Coase (1937), and more recently Williamson (1975). Williamson elaborated upon the dichotomy with a theory of transaction costs that laid out the conditions for when one form of coordination was preferable to the other. Once economic

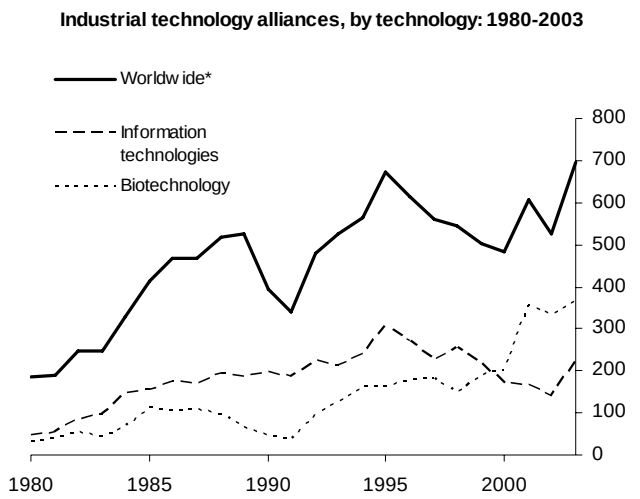
[2] Cited from R. Coase, "The Nature of the Firm". *Economica*, Vol. 4, No. 16, Nov., 1937, p. 388.

transactions became more knowledge specific, he argued, they become internalized within the firm's hierarchy, as opposed to taking place across a market interface. Markets were thus most suited to the simpler forms of exchange that did not require transaction specific investments. With this logic, there was little space for middle ground: economic organization was governed either by the independent firm or the market system.

While this thinking has stood up well in theory, and indeed continues to support the basic principles of competition policy, it has not faired so well in practice. Over the last few decades, firms, driven out of a need to adapt to shorter product cycles and the faster pace of innovation have sought out forms of coordination that were neither strictly market-based nor internal to the organization of the firm. And with these interactions came declining technical self-sufficiency, putting into question the very idea that firms are best considered as autonomous actors. "Until the mid-1970's', argues Herbert Fusfeld, 'if a company wanted to get into a field, broaden its area, take any kind of strategic approach, it was reasonably likely to be able to do so with in-house technology. Or else the technology could be acquired at a reasonable cost and in a reasonable time. Steadily into the 1980's, that began to be less and less true. Companies could not do certain things because they did not have the people or they couldn't be done in a realistic time. Those were the changing pressures on industrial research." [3]

This observation has been born out by a multitude of statistics in the past decade which have shown the growing popularity of collaborative arrangements, especially in the more knowledge intensive sectors (OECD 1997, 2000). According to the National Science Foundation, there were some 695 new industrial technology alliances worldwide in 2003, an all-time peak (see Figure 1). Most of these collaborative arrangements were among companies in the United States, Europe, and Japan, and mostly in the biotechnology and information technology industries. According to the OECD (2000), by 1998, industrial technology alliances were contributing to 25 percent of the earnings of the top 1000 firms in the U.S.

Figure 1: Neither markets nor firms



*: Total worldwide figures compiled from 6 industries: IT, biotechnology, new materials, aerospace and defence automotive, and chemistry.

SOURCE: Maastricht Economic Research Institute on Innovation and Technology, Cooperative Agreements and Technology Indicators (CATI-MERIT) database, NSF, 2006

[3] From 'Science the Endless Frontier 1945-1995: Learning from the Past, Designing for the Future, Conference Highlights, 1995.

One motivator for these kinds of collaborations is that production is increasingly dependent on specialized, complex and scientifically intensive knowledge from a wider diversity of fields (See OECD 2000 for an overview). A 1997 study of paper citations in US patents, for example, found that US patents were drawing increasingly on scientific knowledge from published papers. Moreover, 73% of papers cited in U.S. patents were from public science, the implication of which is that the importance of government support of science and technology is in fact increasing (Narin, Hamilton and Olivastro 1997).

A consequence of this increasing dependence on scientific frontier is that no longer can any one firm, let alone one individual, be in command of the wide range of technological competencies needed for successful innovations. Having outsourced basic research and development to start-up companies, universities, government laboratories and to other high tech corporations, a new organizational model of the firm emerged that was far from a self-contained and self-sufficient ideal as conceived of by Hayek, Coase, and others. Rather, it is one where firms are enmeshed within an increasingly interdependent network of linkages.

And as much of the cluster literature has emphasized, an important segment of these linkages are local. In her analysis of the success of Silicon Valley, AnnaLee Saxenian (1994) found that it was the local networked economy that accounted for part of Silicon Valley's innovation performance. "By focusing on what they did best and purchasing the remainder from specialist suppliers, [the new generation of Silicon Valley firms] created a network system that spread the cost of developing new technologies, reduced product-development times and fostered reciprocal innovation."[4] Similarly Cooke and Morgan (1998: 6) have argued that "the regional level [has become] more important to the process of embedding economic coordination". "It may be", they conclude, "that regionalized networks, which can sustain close and regular interactions between public and private sectors, are the most effective scale at which to nurture the high-trust relations that are essential for learning and innovation."

Innovations in innovation theory

From the mid to late 1980s, as companies came to be more interdependent, scholars also came to understand innovation in a new light. Long viewed as a linear progression, whereby academics pursue unfettered research from which technological advances were subsequently made, the process technological change came to acquire a much more multifaceted understanding. Advances in technology have been recognized as being cumulative in nature, increasingly complex, and dependent on the coordination of a diverse array of assets and functions, many of which are within the public realm.[5] Indeed, far from a linear unidirectional process, the process of innovation has been shown to be highly interactive with complex feedback

[4] A. Saxenian, *Regional advantage* (Cambridge: Harvard University Press, 1994): 141.
[5] OECD "New Rationale and Approaches in Technology and Innovation Policy", STI Review (Paris, OECD): 10.

relationships between firms, universities, government labs, as well as between users, producers and suppliers.[6] Thus, not just universities, but an entire system of institutions and policies together with firms are now understood as important factors driving technological advances.

More recently, Henry Chesbrough has made the argument that a new model of innovation is emerging which underscores further the trend towards outsourcing of the innovation process. In what he calls 'open innovation', firms are as much managers of intellectual property as they are its creators due to the trend towards commercializing ideas that have originated outside the firm's lab. "The boundary', he writes, 'between a firm and its surrounding environment is more porous, enabling innovation to move easily between the two."[7] Industries transitioning to open innovation such as semiconductors, pharmaceuticals, biotechnology (and some more traditional industries such as banking and insurance) have had several critically important innovations from seemingly unlikely sources, all of which suggests that the 'locus of innovation … has migrated beyond the confines of the central R&D laboratories of the largest companies and is now situated among various start-ups, universities, research consortia and other outside organizations.'[8]

The implication of much of this research is that the collaborative arrangements that underpin the contemporary governance structure of the innovation process are of utmost importance in explanations of what leads to successful innovation. As Metcalfe has argued, how firms are organized *externally* has become as important as how they are organized *internally*.[9] This observation is particularly relevant from a government perspective, since the structure of external governance is much more within reach of policy than is the governance processes internal to the firm.

Three realms of collaboration

There are two conclusions from the foregoing discussion that are relevant to the remainder of this paper. First, firms in knowledge intensive industries by and large do not innovate in isolation, and second, innovation processes are structured externally not only through market relations, but also by a myriad of collaborative arrangements. The following section attempts to bring some clarity and context to these arrangements by categorizing them as three types, each of which differentiated by the type of actors and government role.

The first and longest standing category of collaborations is that of inter-firm collaborations, a category that recognizes mostly formal forms of collaborations

[6] Von Hippel, in identifying feedback between users and producers, called innovation a distributed process with informal know-how trading. Von Hippel E. *Sources of Innovation* (Cambridge, MIT Press, 1988): 6-9.
[7] H. Chesbrough, 'The era of open innovation', *MIT Sloan Management Review*, Spring 2003, 44, 3, p. 35.
[8] Chesbrough, Open Innovation, 37.
[9] Metcalfe, J.S. 2001. Institutions and Progress. CRIC Discussion Paper No. 45. Manchester: Centre for Research on Innovation and Competition, p.5.

between firms and related industry associations. The degree of government activities in this area is limited to ensuring that the legal framework is supportive of inter-firm collaborations or to supporting those associations that promote interfirm networking.

The second category, which came to the forefront of policy making only within the last few decades, is the more extensive realm of public-private partnerships (PPPs). These collaborations constitute the primary link between firms and the public science infrastructure and enable firms to access resources – knowledge, equipment and skilled people - in support of their R&D activities.

The third, and most recent development in the area of innovation-based collaborations, relates to the governance of a locality's innovative capacity and resources. Here, collaborations are forged between local actors and various levels of government to mobilize local resources and develop and embed knowledge assets within a locality so as to develop or secure a regional competitive advantage in selected industries. These kinds of collaborative governance initiatives have been essential in developing knowledge based sectors at the regional level throughout the US and increasingly in Canada.

Realm A: Inter-firm collaboration

The now common practice of entering into collaborative agreements with other firms, including ones' competitors, is one of the more remarkable features of a knowledge based industry structure. It is not so much the existence of interfirm collaborations – which are by no means new - but the increasing frequency of these arrangements especially in the area of R&D. This is all the more so given that it has only been within the last few decades that cooperation around R&D has gained acceptance by both firms and government. Indeed, in the US, prior to 1984, it was illegal for firms to cooperate with one another for research purposes, with penalties of triple damages for any sort of communication among companies in the same or related industries relating to R&D efforts.[10] Much of the concern stemmed from a conceptualization of cooperation only in terms of price coordination, with little to no recognition of a potential public good. In their review of the literature, Jorde and Teece note, 'one must look in vain before 1980 for conclusions that interfirm cooperation can be beneficial to the public.'[11]

This view changed dramatically in the 1980s at a time when Japanese success, particularly in microelectronics, drew the attention from academics and major US

[10] Section 3 of the NCRA states that: "In any action under the antitrust laws, or under any state law similar to the antitrust laws, the conduct of any person in making or performing under a contract to carry out a joint research and development venture shall not be deemed illegal per se: such conduct shall be judged on the basis of its reasonableness taking into account all relevant factors affecting competition, including, but not limited to effects on competition in properly defined relevant research and development markets. Cited from D. Gibson, and E. Rogers. *R & D collaboration on trial* (Boston: Harvard Business School Press, 1994): 80.

[11] Jorde T. and D. Teece 'Antitrust Policy and Innovation: Taking Account of Performance Competition and Competitor Cooperation' Journal of Institutional and Theoretical Economics, 147 (1) March 1991 118-44.

high tech companies, who came to recognize the link between Japanese collaborative arrangements and their technological prowess.[12] In this early re-examining, cooperation was identified as a necessary coordination mechanism to overcome many of the risks associated with technological innovation. The fast pace of technological change, the uncertainty associated with commercialization, the rapid foreshortening of product life cycles and the significant increase in development costs made for a high risk and investment climate (Jorde and Teece 1989, Hagedoorn 1996, Freeman and Soete 1997). Strategic alliances that allow for co-development, or the sharing of complementary assets, such as manufacturing facilities, were thus seen as one way of reducing this risk.

Cooperation was also being used to overcome the problem of 'technology spillover'. In the old organizational model of the firm, where products were invented by large in-house R&D labs, there was significant risk of competitors bringing imitations to market first without having had the expense of research. As such there was a disincentive to innovate. By sharing research development and manufacturing costs, such appropriation problems could be shared and the incentive to develop new technologies, re-established.[13]

Other benefits of cooperation include the reduction of wasteful duplication efforts and using cooperative arrangements to coordinate complementary investments for products that require support services or supporting systems to fully realize their potential. Establishing manufacturing or product standards for technology systems is particularly relevant here. Finally interfirm collaboration has been identified as a way of accessing sources of knowledge, when, increasingly, no one firm was able to internalize all the necessary knowledge that went into their increasingly complex products (Teece 1986).

The informal aspect

By the late 1980s and early 1990s, researchers, looking to the success of Silicon Valley and 'Third Italy'[14], began to understand cooperative arrangements as central to the learning process involved in not only gaining access to information but also the building of new competencies and the acquisition of new skills. In a world where knowledge and information are both becoming more valuable and increasing at a rapid rate, the greatest threat faced by economic actors is the constant devaluation of their existing stock of knowledge (Lundvall 1998, 408). The capacity to learn is thus essential for maintaining access to, and control over, the rapidly expanding knowledge frontier in the understanding that an existing stock of knowledge assets affords but a fleeting competitive advantage.

[12] One such arrangement was the VSLI (Very Large Scale Integrated Circuit) project which brought together 5 Japanese firms to compete with IBM.
[13] H. Chesbrough, 'Is The Central R&D Lab Obsolete?' *Technology Review*, MIT, April 24, 2001
[14] Third Italy refers to the numerous small-scale, innovative production units located mostly in the regions of the North East (Veneto, Friuli), Emilia and Central Italy (Tuscany, Marches). Known as industrial districts, they comprise 'Terza Italia' when contrasted with the economy of the North and the mostly 'backward' economy of the South.

Yet as Lundvall stresses, learning, far from being an individual affair, is fundamentally an interactive process that always requires the presence of networks (1992). Indeed, both Freeman (1987) and Lundvall (1992) emphasize the relative importance attached to the patterns of interaction between firms as part of a collective learning process in the acquisition and use of new technical knowledge. This flows from their belief that innovation is increasingly tied to a process of interactive learning and collective entrepreneurship, especially in terms of the relationship between producers and users

Another development to have emerged in the 1990s was an understanding of the role of trust and social capital (shared norms and values) in supporting cooperation. These soft aspects facilitate coordination and cooperation among individuals, firms and sectors for their mutual advantage. Authors, such as Storper (1996), Cooke (1997) and Saxenian (1994) underscore the critical role played by trust, customary rules and reputation in stabilizing the kind of long-term relationships that underpin interfirm learning. And consequent to this recognition of trust came a renewed awareness of the regional aspect to interfirm cooperation. Trust and other aspects of social capital cooperation, were shown to be regionally embedded in localities (Putnam 1993, Cooke 1997) with shared interests and understanding.

Varieties of inter-firm collaborations

One important aspect to understanding variation in the types of collaborations between firms is that the nature and motives for collaborations vary by industry. In their comparison of the telecommunications equipment and biotechnology industries, Pisano et al. (1988) find that the nature of technological change of each industry affects both the motives and characteristics of collaborations. In the telecommunications equipment industry, for example, access to various component technologies to ensure compatibility is an important driver of collaborations, whereas in the biotechnology industry collaborations are driven by a need to gain access to new products or to transfer know how from the laboratory to the manufacturing plant.[15]

Generally though, inter-firm collaborations can be classified as either vertical or horizontal. In vertical arrangements, firms establish strategic alliances with suppliers and users within the production chain for the purpose of improving products or production processes. Forms include: exclusive manufacturing rights, joint R&D or co-development agreements or co-marketing arrangements. In his seminal research into the distributed nature of innovation, Von Hippel (1988) found that users and suppliers were as important as the product manufacturers themselves in developing and driving product innovations. Several other scholars have made similar observations on the interdependence between users and producers in successful innovation. Lundvall (1998) has stressed the importance of user-producer interactions in accessing learning-by-doing knowledge from either the user integrating new

[15] See Pisano G. W. Shan and D. Teece, 'Joint Ventures and Collaborations in the Biotechnology Industry' in D. Mowery (ed) International Collaborative Ventures in US Manufacturing, Ballinger, 1988 183-222.

equipment into their processes or the producer understanding new market opportunities.[16] This is particularly the case with complex and specialized equipment, which can require a much closer coupling of user and producers and an intimate understanding of user needs (Lundvall 1998, Gertler 2004).[17] Accessing complementary assets can be another driver of collaboration especially when the successful commercialization of a product depends on a 'bottleneck asset that has only one possible supplier' (Teece 1991).

Horizontal arrangements have received much wider attention of late than have vertical collaborations, not least because of the broad interest in the more informal innovation networks and regional clusters. Yet there are formal forms of inter-firm collaborations that have been an important feature to knowledge industries, namely joint product development agreements and research consortia. What distinguishes these types of horizontal strategic alliances from the vertical counterparts is the fact that it is typically competitors (firms within the same or closely related industries) who are pooling activities and resources towards certain common goals such as the development of common technologies.

Industry research consortia became popular after the widely hailed success of Japan's VLSI program and Fifth Generation Computing project in 1970s and early 1980s, prompting the US and other countries to follow suit with their own consortia. The Microelectronics and Computer Technology Corporation (MCC), for example, is known for not only being the first major private sector research consortia in the US, but also one that brought a shift of attitudes among firms that were accustomed to competing with one another, and which required an amendment to the federal antitrust legislation in the US which had long legislated against R&D cooperation.[18] Arguably, the most famous research consortia in North America is SEMATECH (SEMiconductor MAnufacturing TECHnology) in Austin, Texas. When it was established in 1987, it was the largest public-private research consortium in the US, whose purpose has been to strengthen the country's semiconductor manufacturing by leveraging resources and sharing risk in efforts to overcome common manufacturing problems in semiconductor production.

The territorial dimension of collaborations: the regional cluster

The popularity of regional clusters, both as a theoretical unit of analysis and as a lens for developing regionally focused innovation policy, is undeniable. Throughout most of Europe and North America, national and subnational governments have taken to

[16] B.A. Lundvall, 'Innovation as an interactive process: from user-producer interaction to the national system of innovation'. In Dosi et al. Technical Change and Economic Theory, Pinter Publishers: New York 1988.

[17] In Teece Technological Development and the Organization of Industry, In Technology and Productivity: The Challenge of Economic Policy OECD 1991 409-417.
Gertler M. *Manufacturing Culture: the institutional geography of industrial practice*, New York: Oxford University Press 2004.

[18] As Gibson and Rogers (p.190) point out, MCC challenged a long-standing belief among its members in the value of rigorous competition and free enterprise, forcing managers to 'transcend their competitive instincts and provincial concerns to learn how to collaborate in goal-directed long-term R&D.

cluster based economic development in efforts to emulate, if not reproduce, the success of the most innovative regions, notably Silicon Valley, within their political boundaries. Yet such popularity has brought with it a considerable a lack of concision as to just what is a cluster (Maskell and Kebir 2005, Isaksen and Hauge 2002, Martin and Sunley 2003). While most scholars and practitioners will accept that clusters are a geographical concentration of interdependent firms with similar or closely related capabilities (Porter 2000, Maskell and Kebir 2005, Rosenfeld 2002), there is wide variation in understanding of what constitutes a legitimate geographic span, and in what is a legitimate structure of interdependence between firms.

Nonetheless, one of the fundamental assumptions of regional innovation clusters is that relationships develop within a geographical area among local economic actors. Clusters, according to Isaksen and Hauge, require a critical mass of firms that all form part of a local network often in the form of a production system that may include subcontractors (i.e. vertical links) and involve 'horizontal cooperation between firms in the same production state'.

These relationships subsequently generate a localized dynamic process of collective learning and an improved innovation performance (Maskell and Kebir, 2005). "The learning process within an innovation network' writes Lundvall, 'is based upon a constant exchange of knowledge, as well as the collective production and exploitation of new knowledge, founded on mutual trust." By extension, the competitive performance of a region can be understood as being determined more by the kind of interactions between the actors and less by the characteristics of the actors themselves (Ohler 2001).

The implication of these observations is that there is a regional specificity to the quality of the interactions, which are themselves underpinned by specific institutional milieu of trust, shared interests and understandings (Castells and Hall 1994, Saxenian 1994). As Lundvall and Borrás write: "The territorial dimension of networking activities is not a subsidiary factor, but rather a primordial one. Networks function best as innovative social organisms when they exploit the different areas of tacit knowledge of regional or local interests and associations, including firms and enterprise support agencies."[19]

The localized networks of formal and informal collaborative arrangements thus act to anchor economic capabilities at a time when economic globalization is dispersing firms and production capacity. In Maskell's terms, these institutionalized interactions help explain why some regions continue to be 'sticky' in attracting strong concentrations of firms in related activities.

In summarizing the regional aspect, Lundvall and Borrás points to three dimensions that tie innovation networks to a locality:

[19] Bengt-Åke Lundvall and Susana Borrás, The globalising learning economy: Implications for innovation policy, Report based on contributions from seven projects under the TSER programme DG XII, Commission of the European Union, 1997, p. 108.

- "the capacity for developing human capital, as well as interactions between firms, schools, colleges and those responsible for vocational training is normally localised;
- networks of formal and, more usually, informal contacts between network members are made possible through casual or planned meetings, information exchanges and customer-supplier relationships;
- synergies, or an innovative 'surplus', can emerge from the shared cultural, psychological or political perspectives of those engaged in the same specialisation in the same economic space or region." [20]

Policy experience: Ontario and abroad

The role of government in shaping the inter-firm collaborative environment varies by type of collaborations. Generally, for vertical inter-firm collaborations, firm strategy together with the dynamics of the industry and technological change matter much more than policy. However, in the area of horizontal collaborations, policy and public sector players have been important. In the following section, the government role is elaborated on, with references made to experiences in Ontario and abroad.

Legislation

A notable, if not obvious, example of how government legislation can affect inter-firm cooperation came to the fore with the amendments to the Sherman Antitrust Act of 1890. Up until the passing of the National Cooperative Research Act (NCRA) of 1984 by the Reagan administration, US firms were prohibited from engaging in cooperative research and development with their counterparts in the same or related industries. Though the NCRA did not grant immunity per se to antitrust action in cooperative research, it did nonetheless make it conditionally legal and indeed influential. In the decade that followed some 450 research joint ventures had been registered with the US Justice Department under the terms of NCRA (Link 1995), the impact of which has been an improved technology trade balance in sectors that have made use of joint research ventures.[21] In 1993 the legislation was amended a second time with the explicit goals of 'promoting innovation, facilitating trade, and strengthening the competitiveness' of US industry in world markets relaxing further restrictions on cooperative production activities. As of 2003, there were 524 industrial technology alliances registered under the NCRA (Science and Engineering Indicators, 2006).

[20] Bengt-Åke Lundvall and Susana Borrás, The globalising learning economy: Implications for innovation policy, Report based on contributions from seven projects under the TSER programme DG XII, Commission of the European Union, 1997, p. 109.

[21] A study by DeCourcy on the economic impact of the NCRA revealed that the trade balance in industries with participants in cooperative R&D is approximately $620 million higher than the trade balance in industries without participants in cooperative R&D, suggesting that the NCRA has had a real impact of economic competitiveness. Julie DeCourcy, 'Research Joint Ventures and International Competitiveness: Evidence from the National Cooperative Research Act', *Economics of Innovation and New Technology*, forthcoming.

Research consortia

As industry-led, collaborative ventures established to fund and manage research, research consortia are popular with governments seeking to increase collaboration, boost private sector investment in R&D, and establish or secure a competitive foothold in a knowledge-based industry. Governments have typically played a more active role in providing direct financial support to research consortia. Again, SEMATECH in the US is a good example, having initially received some $1 billion in support by the federal government.

Though Canada, and Ontario more specifically, has had limited experience in supporting research joint ventures, both governments did play a role in financing Canada's first research consortia, the little known Canadian Semiconductor Design Association (CSDA). Founded in 1984, CSDA was a private R&D consortia consisting of five Ontario-based microelectronics firms that sought cooperation on core design capability to help overcome resource limitations.[22] This was Canada's first such consortia and came a year after the US-based MCC initiative in Austin Texas. In their second year of operation, CSDA received a one time grant of $500,000 from NRC's Industrial Research Assistance Program (IRAP) helping seed their cooperative work. In 1988, the provincial government stepped in with $22 million over five years, helping stabilize the initiative through the economic recession of the early 1990s.[23]

The consortium made each other's R&D results available to one another and supported prototype work and some process development work, funding 50% of costs, with a remarkable degree of success. According to the director at the time, who kept track of sales records, CSDA had supported the R&D for products that would later go on to generate $490 million over ten years.[24] CSDA is credited to having been very important to its members' survival during the recession by enabling them to continue R&D at a time of constrained revenues. By 2000, the consortium was folded into the Strategic Microelectronics Council (SMC), a policy and lobbying association that then became the sole voice for the microelectronics industry.

Joint ventures

In the US, the Advanced Technology Program has been an important supporter of joint ventures between firms. The program began operations in 1990 with the goal of funding early-stage development of innovative technologies that show promise of significant commercial payoffs and widespread national benefits. Between 1990 and September 2002, ATP awarded $1.9 billion on a competitive basis, 60 % of which supported joint ventures involving over a thousand participants (NSB 2006). As of this year, however, the ATP will not be awarding any further funds as articulated in the FY2006 budget.

[22] The five firms were Mitel Semiconductor, Tundra (then Calmos), Zarlink, Mosaid and Gennum.
[23] Interview with past director of CSDA, 2005.
[24] Interview, CSDA, 2005.

Cluster networks

Given the emphasis on knowledge exchange within clusters, collaborations are often an integral component of cluster policies. In fact, according to reviews by Raines (2000), Nauwelaers (2003) and Boekhold and McKibbins (2003), policies that seek to foster cluster networks make up the majority of direct cluster initiatives, especially in Europe. Typical goals of these kinds of cluster policies include:

- promoting awareness of the regional cluster through marketing;
- facilitating informal contacts among key actors in the region;
- creating new linkages by bringing firms together through brokerage;
- financially supporting networks and interfirm co-operation; and
- supporting collaborative facilities and technical services. (adapted from Lundvall 1997)

These kinds of 'synergy facilitating' policies can target emerging clusters as much as existing industries. In the case of the latter, established industries are encouraged to collaborate more so as to take advantage of local opportunities and knowledge capacity to become more competitive in global technology markets.

It should be noted that the range of actors supporting these networks can vary considerably by country. In the US, these types of collaborative initiatives are often grassroots, compared to Europe, where it is often national or regional governments that seek to develop and support these networks. In Canada, as well as Ontario, it can be a mix of all three levels which takes a lead. At the federal level, the National Research Council has made the promotion of local networks an important part of their cluster initiative.[25] In Ontario, support for networks has typically been delivered in an ad hoc manner, with various industry and regional associations, given financial support, often as seed money.

Realm B: Public - private collaborations

Public-private collaborations (or partnerships (PPP)) share much in common with the previous realm of inter-firm collaborations. Each facilitate knowledge transfer, technology diffusion and learning, each is an important contributor to cluster networks, and both help reduce the cost and risk related to commercializing new technologies. Moreover, as with interfirm collaborations, PPPs have become an ever more common feature of the knowledge economy. In the US alone there have been

[25] As part of its commitment to Canada's Innovation Strategy, the National Research Council of Canada has invested over $500 million since 2001 in a series of cluster initiatives aimed at developing regional capacity in science and technology based innovation, with the broader goal of supporting national economic growth. These fourteen initiatives have been funded in three separate rounds. They are multifaceted in their design and support the knowledge infrastructure as well as the process of clustering. Engaging in community consultation, fostering linkages within the cluster and supporting the process of attracting inward investment are important complementary elements to the provision of specialized research infrastructure and highly skilled personnel for each of the initiatives.

approximately three thousand active cooperative R&D agreements between industry and federal laboratories each year since the mid 1990s.[26]

Yet there are several important differences between these two realms that warrant separate consideration. Most notable is that government is a visible partner, as represented directly either by a department, or indirectly through universities and public research institutions. PPPs are also almost always formal, involving contractual agreements specifying terms. And, the agreements typically identify a set of shared objectives which are well defined and in step with specific government policy or program objectives. They also involve some co-governance process and co-investment in the form of money, facilities, human resources, knowledge or technology, for example (OECD 2004: 89). Moreover, unlike interfirm collaborations, PPPs provide the most direct link between industry and the public science base.

Finally, with government as one of the partners, the scope of government policy to affect public-private partnerships is considerably greater than for inter-firm relations, given its key role and jurisdiction in supporting the public research infrastructure on which they depend. Indeed, Ontario has considerable policy experience in the public-private realm, be it in creating Technology Centres and later the Ontario Centres of Excellence program (COE), to the more recent Beacon Project.[27]

Theoretical context for public private partnerships

There are several theoretical concepts that have been developed over the last few decades that give both focus, and a broader context, to the links between firms and the public research infrastructure. One of the more popular constructs which embodies PPPs is the notion of 'triple helix' which gives emphasis to the role of the university in 'improving the conditions for innovation in a knowledge based society'. Henry Etzkowitz, one of its chief proponents, argues that in the triple helix model, industry operates as the locus of production, government as the source of contractual relations that guarantee stable interactions and exchange, and the university as a source of new knowledge and technology. The triple helix thus 'denotes a transformation in the relationship among university, industry and government' where 'the traditional match of institutions to function is superseded' (Etzkowitz, 2003). From a policy standpoint, however, apart from recognizing that interactions between university, government and industry are important, the concept is too loose to offer a useful lens through which to develop public private partnerships.

Much more influential and useful has been the concept of innovation systems as developed by Freeman (1987) and Lundvall (1988, 1992). Innovation systems give emphasis to the formal institutional structure supporting innovation processes within a national or regional economy, and to the interconnections between the various institutions. In the terminology of Metcalfe (1995), the creation, storage and transfer of knowledge and skills and artefacts which define new technologies is the outcome of a system of distinct *interconnected* institutions that comprise an innovation system

[26] Science and Engineering Statistics, 2006, National Science Foundation.
[27] Discussion of these programs follows on pages 16 and 20.

(emphasis added). By acting as the channel through which knowledge is created and transferred between firms and public research institutions, public private collaborations are thus an essential feature to the innovation system. Indeed from the standpoint of policy, they are often a key focus area for improving failures in the innovation system brought about through "the lack of interaction between the actors in the system, mismatches between basic research in the public sector and more applied research in industry, malfunctioning of technology transfer institutions, and information and absorptive deficiencies on the part of industry may all limit innovation and the diffusion of knowledge". As Lundvall and Borrus note, governments can provide the foundations for effective partnering among the elements in the system in their efforts to improve interactions.

Public-private partnerships at work

There are innumerable examples from which to draw upon to illustrate the impact of public private partnerships on innovation. Ontario has had many such success stories, dating back for decades. It was, for example, through a partnership with the Department of Trade and Industry Canada in 1970 that Control Data Corporation, a large computer company from the US, established a successful an R&D centre in Toronto. The centre would later develop CDC's most profitable and cost-effective computer. And when the centre closed in 1992, it had developed technological competencies in the region that were quickly absorbed by other microelectronics firms.

A more recent and notable example of how PPPs support innovation is in the story of ATI Technologies. Its founder, Kwok Yuen Ho was an immigrant from Hong Kong who came to Toronto in 1983 impressed by "a lot of open space and lots of opportunity".[28] With an electrical engineering degree from a top Taiwanese university and work experience in several large Hong Kong based electronic firms, Ho, together with two other Hong Kong engineering émigrés, created Array Technologies Inc. in 1985. By the end of the first year, the company had designed a successful graphics-enhancing chip, which it had sold to Commodore at a volume of 7000 a week. Fifteen years later, ATI had grown to become the dominant supplier of graphic accelerator chips, and by 2004, the second largest fabless chip design company in the world with some $2 billion in annual revenue.[29] According to a senior executive at the firm, ATI is currently linked to some 12 spin-off companies, many of whom remain in the Greater Toronto Area (GTA), including Genesis, the second largest microelectronics firm in the region.[30]

ATI's links to the GTA, however, extend beyond its spin out companies. In fact, ATI owes much of its early rapid success to the federally-funded Microelectronics Development Centre (MDC) based at the University of Toronto, which provided the firm with its first five microchips. The founders, when starting their firm, had the expertise in graphic cards but very little money and no chip design knowledge or

[28] Business week, 'From Rags to 3-D Chips: How K.Y. Ho traded Chinese woes for high-tech wealth', June 21, 1999.
[29] IC Insights, 2004.
[30] Source: interview, 2005.

capability. The company's concept was to develop a single chip that would incorporate all graphic standards of the day, thus making all computer applications compatible with the various displays that were on the market.[31] In 1985, MDC was approached by ATI to be their chip designer, which they continued to be under a public-private partnership agreement until ATI developed their own internal capacity. This was done by employing MDC engineers, once the program had been closed in 1986.

MDC was typical of the new approach to industry support that took root in the 1980s in Canada and Ontario. Created by the Department of Trade and Industry Canada, MDC was a part of a national program that supported twelve technology and industry focused centers housed within universities across the countries. Each was given five-years of funding in the order of $1 million a year after which the centers would close. In the five years of its existence, between 1983 and 1986, MDC was considered only modestly successful.[32] It did nonetheless create one of the first ASIC (Application Specific Integrated Circuits) design facilities in Canada, acting as consultants, providing advice and design expertise to help small companies take advantage of microelectronics.

In Ontario, in the year prior to MDC's establishment, the Davis government funded several Technology Centers across the province similar in concept to MDC. Funded through the government's BILD (Board of Industrial Leadership and Development), the centers were significant to the extent that they represented a shift away from a focus on manufacturing and import substitution that had characterized much of the province's earlier industrial policies, to a more strategic focus on technology. These technology centres were later replaced by Ontario's COE program in 1986. In its first decade, the COE program funded seven university-based centers with the goal of commercializing research through the linking of industrial and academic research. It was the first of its kind in Canada and, in fact, prompted the federal government to create their own version, the Network Centres of Excellence initiative. [33]

The COE program has since been cut back, reorganized, and refocused. In 1997, the centres were consolidated to 4 from the original 7, with cuts in funding. And in 2004, the program was reorganized again as one centre, headquartered in Toronto, but expanded to 5 divisions.[34] Currently these divisions operate with a budget of $34.3 million, with the mandate to fund R&D projects and support training and commercialization in the areas of: communications and information technology; earth and environmental technologies; energy; materials and manufacturing; and photonics.

[31] Until ATI's innovation, certain computer applications such as spreadsheets, only worked with certain displays. At the time there were 4-5 graphics standards each supported by discrete chips. Source: interview, 2005.

[32] A part from ATI, the only other startup company affiliated with MDC was Semi-Tech, a company that focused primarily on computer assembly. The founder, James Henry Ting, had within a decade built Semi-Tech Group into one of Canada's fastest growing businesses and 10th largest employer in Canada acquiring some 120 companies mostly in East Asia. By 2000 however, the company collapse with some $2 billion in debt, making it Hong Kong's largest bankruptcy in history. See http://www.asianpacificpost.com/news/article/81.html

[33] D. Fisher, et al. 'Changes In Academy/Industry/State Relations In Canada', 310.

[34] The fifth centre, The Centre for Energy, was officially launched in 2005.

Policy experience: Ontario and abroad

Public-private partnerships offer a unique set of policy challenges from interfirm collaborations of Realm A. To begin, the motivations between parties entering into a public-private agreement are likely to be less aligned than say an R&D joint venture between two firms.[35] Whereas the government is interested in fostering innovation-led economic development, global competitiveness, or in improving the cost effectiveness of publicly supported research and development, firms inherently have more selfish goals. Reducing their research costs, accessing testing equipment and capabilities, enhancing there reputation through institutional affiliations or simply gaining access to business subsidies are but a sample of the many possible motivations for why firms enter into public private partnerships. More often than not, firms simply want to collaborate with public institutions so as to be able to hire suitable candidates.[36] Public private arrangements must therefore bridge potentially contradicting motivations, which make the management of such arrangements more difficult. Agreement of intellectual property rights and level of commitment can, for example, be issues that determine the success or failure of such a partnership.

Legislation

In both the US and Canada, legislation has played a significant role in increasingly the popularity of public-private partnerships. From the early 1980's, the US enacted a series laws that incentivized collaborations between firms and public sector institutions. The first of such acts was the Stevenson-Wydler Technology Innovation Act of 1980, which made the technology transfer of federally owned or originated technology an explicit mission of federal laboratories. Along with recognizing the importance of improved information dissemination from the Federal government to private industry, the act also required Federal laboratories to take a more active role in cooperation with potential users of its technology. In the same year, the Bayh-Dole Act was passed which required any recipient of federal R&D funding - universities, non-profits, SMEs - to obtain and transfer patents and licenses of any scientific discovery that they patented. As with the Stevenson-Wydler Act, which applies to national laboratories, the intent of the Bayh-Dole Act was to encourage the commercialization of any intellectual property stemming from federally supported research, which prior to the act, were not being developed or patented, due to a lack of incentives. This opened up opportunities for non-US governments and firms to do so.

In 1982, the Small Business Innovation Development Act established the Small Business Innovation Research (SBIR) program requiring all federal agencies with research budgets in excess of $100 million to set aside 2.5 percent of their budget for R&D projects with small businesses. By redirecting Federal agencies' R&D funds to small firms, SBIR does not provide additional funds but rather encourages

[35] For more information on these kinds of challenges see OECD. 2004. 'Public/Private Partnerships For Innovation' in Science, Technology and Industry Outlook,Paris: OECD.
[36] Wolfe D. and M. Lucas (2005). *Global Networks and Local Linkages*, Montreal: McGill Queen's University Press.

partnerships between SMEs and federal agencies in areas relevant to the R&D mandate of the organization, ultimately supporting technology transfer.

Two years later came the National Cooperative Research Act (NCRA). In conferring legal status to firms engaged in cooperative research, the act amended the Sherman Antitrust Act of 1890, which for more than a hundred years threatened firms with triple damages for any sort of communication among companies in the same or related industries relating to R&D efforts.

The legislative shift towards increased public-private collaboration continued a pace with the 1986 passing of the Federal Technology Transfer Act that made it legal for government laboratories to enter into CRADAs (Cooperative Research and Development Agreement) with private industry. This was later extended to include all contractor-operated labs (including Federally Funded Research and Development Centers) with the 1989 passing of the National Competitiveness Technology Transfer Act. Through CRADAs, federal agencies, encouraged by a budget allocation, are now permitted to conduct joint research on particular technical problems with industrial or institutional organizations while also protecting any intellectual property that may be developed. In 2003, federal laboratories participated in a total of 2,936 CRADAs, up 4.3% from a year earlier but still below the 3,500 peak in FY 1996 (NSB 2006).

Canada's legislative shift towards supporting public private partnerships began in 1986, with the introduction of a matching funds policy for the research granting councils, which increased overall levels of support by matching private sector funding of university research with equivalent increases in granting council budgets of up to $369 million over four years. Three years later, the federal government launched what some have described as 'the most dramatic change in the nation's science policy since the creation of the National Research Council in 1916', namely the Networks of Centres of Excellence (NCE) Program, which itself was modelled on Ontario's Centres of Excellence program. To be administered by the three granting councils responsible for university research, the program would establish networks of researchers and scientists across the country who would focus on long-term applied science in collaboration with Canadian firms and 'somewhat' guided by the needs of industry. Moreover, it would seek to 'reshape the culture of academic science around the dual goals of understanding and utility.' In short the NCE programs, with its support for industry-led and results-driven R&D, was the response to a major concern at the time, that of Canada's long-term competitiveness.

Two other Canadian policy changes of the late 1980s are worth noting for their impact on increasing the collaborative role of the federal government. The first was the establishment of the National Advisory Board on Science and Technology (NABST) which, with heavier business representation, made a concerted effort to re-orient national laboratories to have a more commercial focus. And in 1989, in keeping the pro-business ideology of the government, came a change of leadership of the country's primary research and development agency, the National Research Council of Canada (NRC). Having been criticized for inadequate industry relevance of its R&D activities, NRC was appointed a new president with a conviction that the agency must make a tangible contribution to the Canadian economy, lest it perish as a national institution. With this vision, came performance-oriented management and a

refashioning of disciplinary divisions into technology-focused institutions governed in part by business led advisory boards, laying the groundwork for a more innovation- and partnership- focused NRC.

In summary, over the course of two decades, legislative changes were enacted in the US and Canada that effectively institutionalized and encouraged collaboration among firms, universities and government labs and agencies. The result has been an environment supportive of the growing number of complex non-market relationships that very much underpin the knowledge generating capacity of knowledge based industry.

Public research institutes

Next to legislation, the other component to public private partnerships is the public research infrastructure itself. Establishing new technology centres, either on their own or in universities, has been a proven way in Canada of developing new scientific and industrial capabilities in the country, which can then leveraged through partnerships. The most recent example of this approach in Ontario is the Beacon Project, based the Ontario University Institute for Technology, which is intended to develop state-of-the-art flexible manufacturing capabilities and environmental technologies for the automotive industry. Supported by GM to the tune of more than $2.5 billion, the Project involves three of GM Canada's manufacturing facilities as well as its Canadian Engineering Centre. The Project will also involve a number of university partners in an R&D oriented 'Automotive Innovation Network', with the stated goal of helping address the 'commercialization gap'.[37]

These kinds of capability centres can have an impact long after they have had their funding withdrawn. As the ATI example illustrated, MDC, though financially unviable, nonetheless had the effect of building up a capability in the region helping establish Canada as one of the few centres in the world with a specialization in microelectronic design.[38]

Another example of how such investments continue to yield dividends for the regional economy was the collapse of a public private partnership between the Federal Government and Northern Electric in 1962. At the request by the Defence Research Board and the National Research Council, Northern Electric entered into a collaborative program to build a semiconductor manufacturing capacity, the result of which was the creation of the Advanced Devices Centre (ADC). In 1968 ADC was incorporated as a separate company, Microsystems International Ltd (MIL), again in partnership with the Federal government who provided some $37 million in subsides and loans.[39] Through this partnership, MIL acquired chip-manufacturing processes from Intel and a plant in Malaysia, became the world's second largest supplier of DRAM memory chips in the early 1970s, after Intel. In 1975, unable to keep up with

[37] See "Government of Canada Announces $200 Million for Innovative GM Beacon Project", *Industry Canada*, http://www.ic.gc.ca/cmb/welcomeic.nsf/

[38] In a 2003 global ranking of top fabless IC design firms, there were only three countries with firms in the top 30, the US (20 firms), Taiwan (6 firms), and Canada (4 firms). http://www.icinsights.com/news/releases/press20031201.html

[39] D. Thomas, *Knights of the New Technology* (Key Porter Books: Toronto, 1983): 26.

the fast pace of the semiconductor industry, MIL went bankrupt, and the facilities were repurchased by Northern Telecom. MIL had nonetheless made its mark. Out of its collapse, the Ottawa region established much of its initial microelectronics industry - Newbridge, Mitel, Mosaid, Calian - from the entrepreneurs and experienced pool of engineers and scientist who had worked for MIL.

In summary, both legislation and investment in public research infrastructure are essential to enhancing the role of PPPs in the innovation process. The recent federal report on commercialization titled 'People and Excellence: The Heart of Successful Commercialization' (2006) captures much of this policy approach and indeed, recommends initiatives that are similar to successful programs in the US. For example it recommends the creation of a commercialization fund to finance large-scale private–public sector research and expand and develop programs to train highly qualified personnel in key knowledge areas. It also recommends increasing the commercialization involvement of SMEs, through a Canadian SME Partnerships Initiative similar in design to the American SBIR program.

Realm C: Local strategic collaborations

This paper has thus far discussed two well established categories of collaboration supporting the innovation process, both of which have become well entrenched features of firm strategy and state industrial policy. In this last section, a more recent trend in collaborations is discussed, one which attends to a different dynamic of the innovation process and which involves an entirely different set of actors and policy issues from the other two modes.

This third realm caters to the local organization of the innovation process – that is the local collaborative structures that support knowledge intensive economic activities within a particular locality. At a time when locational competition for firms is global, this kind of local coordination can be a determining factor in whether a locality succeeds or fails in its attempt to position itself as a centre for value added production in the most promising high tech industries.

Typically, these collaborations involve an arrangement of mostly local actors, including civic leaders, municipal government officials and the local university, who cooperate with one another towards securing the long term economic sustainability and development of the local industry, especially high tech sectors (Creutzberg 2005, Henton et al. 1997). The growing importance of this kind of collaboration stems in part from the fact that as the innovation process has come to involve more non-firm actors, a space has opened at the local level for local individuals to shape and influence the development of key institutions that affect innovation and its geography. Creating technology incubators and technology transfer organizations, adapting college and university curriculums to the needs of leading edge local industries and securing a new research consortium within the locality are examples of collaborative outcomes that are increasingly realized locally.

This type of governance has been employed extensively in some of the most successful technology regions in the US and to a lesser extent in Canada. In Austin,

for example, the efforts of local civic leaders in forging cross jurisdictional collaborations to mobilize and develop resources in support of local high tech industry has been at the heart of its economic transformation. Once predominantly a government and university town, Austin's civic leaders, guided by a series of strategic plans, slowly developed an institutional base that has given the region a significant competitive advantage in semiconductor design and manufacturing, software and computers. Through a combination of careful coordination and good fortune, the region secured both MCC and SEMATECH, developed a set of associations supporting the incubation and growth of technology firms, and strategically recruited a number of large multinational R&D establishments thus developing a critical mass of high tech activity.

These collaborations typically deal with much more than economic development aspects, which is in part one of the reasons for their importance. At a time when there is a growing recognition of the interdependence between economic vitality of a region and social and physical infrastructure, many economic development initiatives require a multi-jurisdictional response if they are to be successful. Making improvements to the local quality of life and to the transportation system can, for example, be essential to successfully drawing in highly skilled people and innovative firms to the region.

Such cross-jurisdictional governance, however, can often only be achieved under local leadership. Upper level governments are often unwilling to respond to the specific demands of a particular locality unless their response can be made available to all regions within their jurisdiction. With a broader mandate, non-local governments are not well positioned to engage in regionally-focused strategic governance processes. This can create a 'responsibility gap' that can often only be filled by actors operating within a local context. (Creutzberg 2005, Innes and Rongerude 2005)

This is particularly so in Canada where the pressure to offer generic and consistent policy positions at the national level is strong. As Donald Savoie writes: 'Provinces have come to expect Ottawa to work toward a fair distribution of economic activity throughout the country, with some smaller provincial governments claiming that this is in fact the federal government's main responsibilities.'[40] He adds that Federal government involvement has been necessary to avoid 'me first' provincial economic activities. Under these political pressures, and with their broader portfolio of responsibilities shaping their priorities, upper levels of government are constrained in their ability to take on the necessary leadership to resolve specific issues of importance to local economic affairs. For municipal governments, the problem can be the reverse whereby without some form of coordination, they cannot address broader more regional problems that extend beyond their jurisdiction.

Local strategic collaborations can address this gap, and provide a degree of strategic attention to the local needs that are too far removed from the basic responsibilities of governments, or are beyond the policy process itself. Several initiatives that transpire

[40] D. Savoie (1986), *Regional Economic Development: Canada's Search for Solutions* (Toronto: Toronto University Press), 139.

from local strategic collaborations, particularly those that are related to creating associative support mechanism, are often supported outside of the policy process and are thus beyond the reach of party politics. Also, resources for infrastructure may, in fact, be available from upper levels of government, but without local individuals committed to drawing them down, they go unused, caught in a web of 'dysfunctional relationships' between different levels of governments. Local collaboration can therefore be important to helping realize, enhance and embed strategic investments by both firms and upper levels of government.

Key actors in local strategic collaborations

Unlike interfirm collaborations and public private partnerships, the types of actors involved in local strategic collaborations are much less well defined. Typically they involve civic leaders, regional organizations and municipal officials who are only loosely organized in what can be considered as a governance network. According to Henton and colleagues (1997), these actors form what the authors call an economic community. However defined, membership typically is not fixed but includes only those whose authority or expertise is needed to resolve a particular public problem. More often than not though there is an organization underpinning much of the collaboration in a given region, as the following examples will illustrate.

Local strategic collaborations at work

Because local strategic collaborative initiatives cater to issues and institutional deficits that are specific to a particular locality innovation capacity, there is no one type of outcome. Collaborative efforts can take shape around: strategic planning, a process that identifies a future development trajectory and lays out a plan for achieving it; the engagement of local firms to understand their needs and encourage expansion locally; and to developing the necessary support organizations to help firms develop technologies (e.g. incubators) and transition to a larger size. The following examples are intended only to give an idea of how such collaborations work and what they can achieve.

Talent attraction

In the 1990s, as part of a broader science- and technology-based economic development effort, a local association called the Georgia Research Alliance launched an initiative called 'Eminent Scholars' program to build up a talent base in the region. The program sought to establish state universities as leaders in certain technology areas: the University of Georgia as a leader in environmental technology, Georgia Tech in telecommunications, and Emory in biotechnology. This non-profit organization successfully recruited academic superstars to the universities by drawing on public and private funds to establish $US 3.5 million for research chairs and to provide equipment and lab space (Lambright 2000). These efforts resulted in the winning of several major grants from the National Science Foundation, helping the state establish what it considered was an engine for its economic growth.

Strategic recruitment

In Austin, Texas, informal collaborations between the Chamber of Commerce, the University of Texas at Austin, local leaders and municipal officials have been pivotal not only in the recruitment of anchor firms but also in the development of strategic plans which identify target firms and industries. This kind of collaboration brings together various expertises including: the university's understanding and credibility in relevant R&D areas, the chamber's experience in recruiting firms, and leaders who can uphold a long term socio-economic vision for the locality. In Austin, this kind of coordination has been long standing. In 1957, the chamber of commerce and the university produced the region's first strategic planning report, partly out of a desire to create a local employment base for graduating students. In these early days, the university's involvement went as far as to encourage faculty, on their visits to other cities, to make personal visits to officials of targeted companies to inform them of the University's resources.[41] More recently, in the 1990s, when the region successfully recruited Samsung, the faculty again proved to be important to the bid, demonstrating the university's research strengths. These kinds of collaborations help not only align interests within the locality but also help show a united commitment to helping firms succeed in their relocation.

In the Greater Toronto Area, the Toronto City Summit Alliance has been an important leader in forging these kinds of collaborations, especially in the area of research. Under the Toronto Regional Research Alliance, the group has made a concerted effort to bring a federal research institute to Toronto, and has almost succeeded. An election announcement in December 2005 from the outgoing Liberal government promised a new NRC facility.

Skills development

One of the more common initiatives spearheaded by local strategic collaborations is the tailoring of local college and university curricula to meet the skill requirements of local firms. In Winnipeg, for example, collaborations between local biomedical firms and the community college has led to the development of programs in biosciences to support local biomedical manufacturing. Red River College also offers training programs for MRI technicians in support of National Research Council's local research facility, and a program on intellectual property and management. Similarly in Austin, the community college, in collaboration with industry and other local organizations, has developed a degree program tailored to semiconductor manufacturing technology.

The IC^2 Institute at the University of Texas at Austin is also noteworthy in the area of skills development. This institute has been a central collaborator in developing programs around technology commercialization, to the benefit of the local talent pool. In addition to offering commercialization training initiatives, such as IC2's Accelerated Technology Assessment and Commercialization (ATAC) program, the institute runs a one year master's program in conjunction with the university on science and technology commercialization, both of which benefit from collaborations

[41] Robbins, *The Town*, 3.

with other organizations. As part of this program, for example, students are encouraged to build business plans around specific technologies that are made available from the University's technology commercialization. Along with transferring technology out of the universities, these kinds of programs help transfer the necessary skills to implement commercialization into the local community.

One other case of note in Ontario is the well-regarded Ottawa Centre for Research and Innovation (OCRI), a non-profit, partnership organization responsible for developing the Ottawa region's knowledge-based economy. OCRI has been an important strategic catalyser of local collaborations and mobilizer of resources to develop the region's infrastructure, market the region and provide integrated support for Ottawa's talent pool. In the latter area, OCRI, through its TalentWorks initiative, brings together human resources available to the city and tailors them around the specific needs and gaps of the local labour pool. In so doing, the initiatives aim to 'develop, attract, and retain qualified workers for targeted sectors of the local economy'.[42]

Research capacity

University faculty can play a critical role in developing a research capacity in a locality simply in the process of applying for grants from federal and or provincial funding agencies. Such localizing of investment can have an important impact on the local development of knowledge intensive industries. Micronet, a National Centre of Excellence, was, for example, established at the University of Toronto under the leadership of a professor in the Department of Electrical and Computer Engineering, though without any local coordination. The centre, however, is accredited with supporting 12 spin-offs, a few of which are based in Toronto and have helped establish Toronto as a centre for specialized chip design.[43]

When coordinated through local strategic collaborations, university faculty, with their ability to localize investment, can have an important impact on an area's industrial capacity. For example, this professor-led approach has been an important dimension to Austin's strategy to diversify its economy. In 2002, Ted Rappaport, a prominent wireless technology researcher, was recruited by the University of Texas at Austin and a group of civic leaders, with the expectation that he would seed a wireless industry cluster in the region as he had done previously at Virginia Tech. Within a year of his arrival, Rappaport had encouraged the relocation of one start-up, Alereon Inc., to move to Austin from Huntsville, Alabama with the assistance of a local venture capital firm, Austin Ventures, and has helped spur the creation of a new technology association tied to the ATC, called the Austin Wireless Alliance.

[42] For more information, see http://www.ocri.ca/talentworks/about.asp.

[43] Toronto is a recognized leading centre in Field Programmable Gate Arrays design, due in part to highly regarded faculty members who have drawn in firms to the area along with creating their own firms.

Policy experience in Ontario and abroad

On the whole there is very little policy experience with this kind of local strategic collaboration. Generally, government support for these collaborations is given on a case by case basis. And given that the key actors are local, upper levels of government have typically not taken a lead. There are exceptions, however, with Ontario being one of them.

As part of its Ontario Commercialization Network program, the Ontario government rolled out its Regional Innovation Networks (RIN) program across the province in 2004 as a follow-on to the now terminated BCIP program. A total of 11 regional networks were given three years of nominal funding to link together regional actors to create and support partnerships among business, institutions and local governments for the purpose of promoting innovation. Their expected outcomes include regional strategic planning, and the development of linkages to enable access to commercialization services and other relevant organizations such as the Ontario Centres of Excellence.

Though no evaluations have yet been carried out on their impact, there is some anecdotal evidence that these programs may be having their intended effect.[44] In London, for example, the RIN has had a catalytic effect on the governance structure, recasting local linkages around two main bodies, and bringing in significant private sector support. The first of these bodies is the Stiller Centre for Technology Commercialization, the institutional home of the RIN, whose mandate is carried out in alliance with the London TechAlliance, an association, and the University of Western Ontario. Located in the University Research Park, this centre offers a range of services to assist in commercialization, and acts as a broker between university scientists and the area's firms. According to one stakeholder, RIN has helped generate a significant amount of new activity between private firms and the University. The other body is the London Regional Development Board, an interim organization composed of business leaders that has been established to create new economic development strategies for the city and to allocate economic development resources.

Summary

The following table summarizes the categories of collaborations reviewed in the foregoing section. These categories are meant to provide a broad framework from which to clarify the various roles government can play in developing and supporting collaborations that underpin a significant and important part of the innovation dynamic. For all the emphasis placed on collaborations, it should be noted, of course, that such forms of coordination, transpire in the context of a much dominant mode of economic coordination, namely the competitive market.

[44] The following information comes from a forthcoming case study (June 2006) on London's Regional Innovation Network, prepared by Jen Nelles from the University of Toronto.

Table 1: Three realms of collaborations supporting the innovation process.

Collaborations	Innovation goals	Examples	Main actors	Policy levers
Inter-firm	Product development, Access knowledge & equipment Learning	R&D Joint ventures Research consortia (CSDA & MCC) Cluster networks	Firms	Grants conditional to collaborations Legislation Network support
Public-private	Tech transfer from public science base Knowledge generation and learning Training and skills development	CRADAs, Ontario Centres of Excellence	Firms Public research institutes Provincial & federal government	Investment in public research institutes
Local strategic	Adaptation and development of local institutions in support of local innovation capacity	Curriculum development Strategic recruitment Innovation support organizations	Civic leaders, local organizations colleges and universities municipal officials	Network support

Some challenges

Culture can often to be the largest barrier to efforts aimed at fostering collaborations. This is especially so in Ontario whose Anglo-Protestant heritage gives primacy to the ideal of rugged individualism, independence and competitiveness. Indeed, the tendency to compete rather than cooperate is a long recognized cultural dimension of the GTA, and has been problematic for some of the region's industry associations. One experienced Information Technology (IT) leader and association founder noted in an interview that there has never been a culture in Toronto for having private sector support for organizations, such as the now defunct SMART Toronto, and that the interest in it was 'brand new' at the time of its founding in 1995.

These observations corroborate the findings of a study of Canadian industry in the late 1980s by Atkinson and Coleman. They find that throughout Canada there is a strong firm-centered industry culture that is protective of their autonomy and suspicious of government intervention. The authors add that this attitude is even reflected in their associations which champion their members' independence and maintain a suspicion towards cooperating with the state over issues of economic policy. These values, they argue, were in fact strengthened by Canadian industry's preference for capital market system and retained earnings for investment which enabled them to retain their independence from the banking system and the state. "Without the experience' they argue, 'of direct intervention by banks in the internal

affairs of business, firms have been free to celebrate the virtues of independent management and to be skeptical about the competence of governments in industrial matters."

From a policy standpoint, culture is not something that can be readily changed. In the US in the early 1980s, it was necessity that drove a shift in perceptions over the value of R&D collaborations. According to Gibson and Rogers (1994), there was considerable reticence at first around the idea of cooperating through an R&D consortium, a reticence that was ultimately overcome by a very real concern over the growing competitiveness of Japan. However, the changes in legislation undoubtedly have had an impact on cultural perceptions over collaboration, not only among firms who sought government support, but also among universities receiving federal funding.

In the area of local strategic collaborations, the challenge lies not only with fostering collaborations within the community but also with the institutions of government themselves. In order for local strategic collaborations to be effective, there needs to be acknowledgement from upper levels of government of their value, and a willingness to concentrate research capabilities rather than distribute them across a wider jurisdiction. Indeed, in essence, local strategic collaborations is all about tailoring and strengthening local knowledge capacities so as to create a competitive advantage in global technology markets. Without support for such a concentration by federal and provincial governments, a particularly locality can not achieve a critical mass of firms, talent and infrastructure.

Accepting local strategic collaborations also requires that more flexibility in resource allocation and government programs so that local actors, guided by their strategic plans, can determine for themselves, which investments they need to enhance regional strengths. The conception here is that national and provincial governments offer a 'vending machine model' of program delivery which allows for such local tailoring.[45]

Conclusion

Ontario has a respectable history of recognizing the value of collaborations in its industrial policies and programs. In the early 1980s, it was a leader in establishing technology centres within universities and later the OCE program in the mid 1980s, two programs where collaborations permeate their very structure. This recognition has continued with the Beacon Project, and the pioneering RIN program. Indeed, through various programs and initiatives, the Ontario government has been supportive of all three realms of collaborations to varying degrees.

The province, however, also has a history of wavering commitment to these very programs. The OCE program has experienced a notable reduction in number of networks and in funding. And much of its support to cluster networks, through

[45] See D. Kettl, 'Managing Indirect Government'. In L. Salamon (ed.) *The Tools of Government* New York: Oxford, 2002.

associations for example, is often ad hoc, temporary and nominal, which can make it difficult for collaborative initiatives to establish themselves. If Ontario wishes to change its individualist industry culture and further develop the innovation capacity in the city-regions, a stronger commitment to collaborative initiatives in all three realms will be needed.

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