The Dynamics of Regional Innovation in Ontario

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A Paper Prepared for
Local and Regional Systems of Innovation
ed. John de la Mothe and Gilles Paquet
Kluwer Academic Publishers, Amsterdam

1.0 Introduction[1]

Over the past decade, the industrial economies have witnessed a wave of economic and political change that most find difficult to comprehend. The phrase that keeps reappearing in attempts to explain this phenomenon is 'a shift in the tectonic plates' that shape our society (Stewart 1997, xvii). At the root of this change are three interrelated processes: the emergence of a new information technology paradigm that is dramatically altering the economic calculus of production and distribution throughout the industrial economies; the phenomenon of globalization which is intensifying the linkages and interdependence between the economies of Europe, North America and East Asia; and the gradual replacement of the old Taylorist and Fordist methods of mass production with a new paradigm of innovation–mediated production. A critical part of all three processes is the increasing reliance on knowledge and information in the economic activities that create value in capitalist economies.

The industrial economies are clearly entering into a new era of knowledge–based growth and innovation. While knowledge has played an ever increasing role in the process of growth since the onset of the industrial revolution, what is changing is its relative importance in relation to the other factors of production. In the eyes of commentators ranging from Bell to Drucker and Nonaka, the determining factor of production is no longer land, labour nor capital, it is knowledge (Drucker 1993, 6). This new system of knowledge–based production relies on an increasing application of the human intellect to generate new products and processes in a more productive fashion. In direct contrast to the Taylorist doctrine that utmost efficiency was generated by the separation of conception and execution, knowledge–based production relies upon a more effective integration of physical and intellectual labour. The generation and use of knowledge is no longer something that occurs in an isolated fashion in the university, government or corporate laboratory and is then transferred to the production site; rather it is applied at every phase of the conception, design, production and distribution of goods and services to enhance both the speed and efficiency with which they are delivered to the hands of the consumer (Florida and Kenney 1993, 637-52).

[1] Research support for this paper was provided in part by SSHRCC Grant No. 809-95-0009. Additional assistance for the creation of the sample was also provided by Statistics Canada. The authors are indebted to the members of the POIS research team, Allison Bramwell, Sean DiGiovanna, Denise Girard, Sarah Niles, Ammon Salter and Mikael Swayze for their invaluable assistance in the preparation and administration of the survey.

The ability to survive and prosper in this new form of knowledge–based production is linked to the process of innovation — the process by which new ideas are developed and deployed for commercial purposes in the industrial economies. The concept of innovation itself is subject to a number of different interpretations and definitions. In its narrowest sense, it is limited to the creation of new *technical* innovations that lead to the introduction of new products or processes. In its wider sense, however, it refers not only to the creation of new products, but also new forms of organization that affect the production process or new ways of organizing and accessing markets (Edquist 1997, 9). The use of the concept in its broadest sense is strongly endorsed by Lundvall, who argues for an inclusive definition. For him "innovation is a ubiquitous phenomenon in the modern economy." It involves "ongoing processes of learning, searching and exploring, which result in new products, new techniques, new forms of organisation and new markets" (1992, 8). He attaches a high degree of importance 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 his belief that innovation is increasingly tied to a process of interactive learning and collective entrepreneurship, especially in terms of the relationships between producers and users of new technology.

At its root, the process of innovation is grounded in the firm, but firms do not operate in isolation. In the process of innovating, they interact with a wide range of organizations that sustain this ability. Thus, the social and institutional settings within which the firm operates are critical for their innovative capacity. Recent work on this subject has focused attention on the way that the structure of firms and the supporting infrastructure of institutions cohere into different national or regional systems of innovation. Again, Lundvall maintains that "a system of innovation is constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful knowledge . . ." (1992, 2). The main elements of the system in his conception include: the internal organization of firms; the network of inter–firm relationships; the role of the public sector; the institutional set–up of the financial sector; and the degree of R&D intensity and the nature of R&D organization.

Lundvall's definition of a system of innovation emphasizes both the social and the interactive nature of the innovation process — characteristics that are stressed by a growing number of commentators. This central thesis found in this literature involves two key ideas

(Storper 1992; Cooke and Morgan 1993; Saxenian 1994). First, production systems exhibit a

much more finely articulated *social* division of labour, with the greater degree of specialization that is implied by this. Second, relations between firms in this more heavily externalized, transaction–intensive production system have undergone a significant *qualitative* change. In place of earlier relations dominated by short–term, price–based considerations and arm's–length exchange, firms are now said to be engaging in longer–term, closer, trust–based interaction, in which cooperation and exchange of proprietary information allow partners to compete more successfully together in national and international markets, as each one focuses on its 'core competencies'. In contrast to more conventional forms of inter–firm relations — markets and hierarchies — this alternative form of resource allocation is characterized by transactions that "occur neither through discrete exchanges nor by administrative fiat, but through networks of individuals engaged in reciprocal, preferential, mutually supportive actions" (Powell 1990, 303).

This emphasis on the importance of networked relationships is rooted in recent insights into the nature of the innovation process itself. Technologies tend to develop along pathways or trajectories characterized by strong irreversibilities. These trajectories are reinforced as certain choices are made and others are foreclosed; this results from the fact that technologies are the product of interdependent choices, or 'network externalities'. They are given to a variety of user–producer and user–user interactions; as the number of users of a given technology rises, its reduces the possibilities for different patterns of use by others (Arthur 1994). One reason why technologies follow these pathways is because of the effects of technological spillovers in the economy. The knowledge of how to do certain things technologically frequently derives from the knowledge of how to do other things and it, in turn, contributes to the knowledge of how to do related things. Sometimes these spillovers follow the lines of traded input–output relationships in the economy, but often they occur along lines that are not traded. These technological spillovers are tied to knowledge and practices that are not always codified or explicit. They are frequently shared among firms or transferred from firm to firm through various forms of networks. They may also derive from other institutional arrangements, such as the particular norms and rules governing the functioning of local labour markets. These forms of collaboration and networking give rise to the existence of untraded interdependencies within a local economy (Dosi 1988, 1142-47; Storper 1995a).

Another noteworthy example of the new, more social economic relations comes in the form of increasingly common collaborative research and development in science–based

industries such as pharmaceuticals and microelectronics/computing/telecommunications (Mytelka 1991; Dodgson 1993; Hagedoorn 1993). In such sectors, collaborative relations in the form of strategic alliances between two or more firms have become a popular organizational form by which to spread the considerable costs and risks of new product development, or to bring together the mutually complementary assets (including distribution systems) of individual firms. In such arrangements, normally at least one (and frequently both) of the partners is large in size. The resulting production 'networks' and the collaborative relations between firms, and the supporting infrastructure of institutions that sustain innovation, are seen as essential responses to a new set of international competitive conditions, in which quality, differentiation, responsiveness, and time–to–market with new products have joined cost as the principal factors separating winners from losers (Best, 1990).

The ability of firms to compete effectively in the emerging information technology paradigm is determined, in part, by their ability to develop a sustained capacity for innovation along the lines discussed above. Increasingly, this implies a growing investment in, and emphasis on, research and development to feed the flow of new ideas into the production process. According to the OECD, R&D is increasingly seen as essential for enhancing a firm's capacity to absorb and make use of new knowledge of all kinds, including technological knowledge. In this sense, research is viewed not merely as a source of inventive ideas, but as an activity which contributes to the firm's absorptive capacity and its ability to solve problems. "When problems arise in the innovation process, as they are bound to do, a firm draws upon its knowledge base at that particular time, which is made up of earlier research findings and technical and practical experience" (1997, 38).

But the ability to sustain a capacity for innovation no longer depends on R&D alone. Successful firms combine a capacity for *technical* research and development with the ability to implement a wide range of new organizational practices within the firm and inter–firm practices with their network of suppliers and customers. Those who succeed are refered to as 'high performance firms'. According to Richard Florida and his collaborators, high performance firms are marked by a number of key characteristics. They rely on technical innovations to compete in export markets around the world. They effectively integrate the process of innovation between the R&D laboratory and the factory floor in a new form of

innovation–mediated production. New technologies are combined effectively with new

organizational designs to increase the productivity, efficiency and time–to–market of their entire operation. They make extensive use of new forms of work organization and greater degrees of employee involvement to achieve these goals. They invest heavily in the training of their employees as a key aspect of their commitment to continuous improvement and organizational learning. In addition, they also adopt newer, more closely networked relations with both suppliers and customers to optimize customer service, quality and flexibility. They exhibit an increasing reliance on just–in–time production techniques as part of a new relation between end–users and their suppliers. High performance operates as an integrated system that relies on the successful combination of all the factors outlined above. In a series of studies of firms in the Great Lakes economy, they assess the extent to which firms have made the transition to this new form of economic interaction (Heinz School of Public Policy and Management 1993, 19–27; cf. also Kochan and Osterman 1994). In the discussion which follows, we report on the results of a recent survey of manufacturing firms across five industrial sectors in Ontario. The concept of the high performance firm provides a benchmark against which to assess the innovative behaviour of these firms.

2.0 The Changing Geography of Production

The increased attention paid to the social and interactive dimensions of the innovation process has also been linked to an emerging debate about the new geography of production in the knowledge–based economy. This new geography is marked by a 'paradoxical consequence of globalization' (Acs, de la Mothe and Paquet 1996, 340). As the information and communication networks created by new digital technologies link the disparate economies of the globe more closely together, they simultaneously increase the importance of space and proximity. There is some irony in the fact that the information and communication technologies simultaneously increase the flexibility of firms to operate on a global basis, yet accentuate the importance of regional concentrations of related firms and industries. The reality remains that certain types of information and knowledge exchange occur more effectively through direct face-to-face contact. "Put simply, the more tacit the knowledge involved, the more important is spatial proximity between the actors taking part in the exchange" (Maskell and Malmberg 1995, 29). The reason for this is twofold: first, it is partly a function of the economics of time and distance — it is normally less costly and easier to interact with others who are close at hand; second, it involves the question of trust and understanding — the transfer of tacit knowledge is normally facilitated

by an environment or context in which the collaborators share a common set of values and

culture. Both these factors are clearly facilitated by geographic proximity.

Thus, the new production paradigm is highly dependent on localized, or regionally–based, innovation. Innovative capabilities are often sustained through regional communities that share a certain base of knowledge and the increments to that knowledge base. Industrial geographers have long observed that patterns of production tend to aggregate over time among networks of firms drawing upon the distinctive skills and characteristics of local labour markets in specific regions. Geographer Michael Storper uses the term 'territorialization', to describe the range of economic activity that depends on resources which are territorially specific. The types of resources involved can include specific assets that are only available in a certain place, or more critically, assets whose real value emerges out of the context of particular inter–organizational or firm–market relations that depend upon geographic proximity. Relations based upon geographic proximity constitute valuable assets when they generate positive spillover effects in an economic system. The more grounded the economic activities of a region are to the specific assets of that region, the more fully territorialized are those activities (Storper 1995b).

The dynamism of these regional economies is tied to the totality of their industrial system and the broader social and cultural context within which they are embedded. The industrial system of a region includes three important dimensions: the indigenous mix of institutions and culture in the region; the structure of the industrial system; and the internal organization or industrial culture that prevails in firms in the region. The relevant range of institutions can include both public and private ones, such as universities, business and professional associations, local training or industrial institutes and other associations that may contribute to a dynamic local culture in the region. The industrial structure of the region refers to the inter–firm organization of its production system, especially the extent and nature of the relations between suppliers and customers within the individual sectors or networks of interrelated sectors, and the role played by the larger firms within the regional economy. Finally the internal organization or industrial culture of the firm includes the extent to which the production system is organized on traditional hierarchical lines or is more decentralized, the degree to which relations between management and the workforce are characterized by a cooperative or conflictual approach and the relative importance attached to training and the continuous upgrading of skills (Saxenian 1994, 7).

As noted above, more and more cases can be found of emerging cooperative relationships between networks of producers — between large assemblers and smaller suppliers in the auto

industry, between networks of small producers, such as exists in the Emilia–Romagna industrial district of Italy, and even among large producers in the computer and telecommunications industries that make up the core of the new information technologies. The growing costs of R&D, as well as the increasing complexity and knowledge–intensity of new scientific research and product development make the challenge more forbidding for individual firms — hence the growing importance of regional agglomerations of innovative firms in the collective advance of technical knowledge. The key elements of a networked regional economy include a dense complex of public and private industrial support institutions, high–grade labour market intelligence and related vocational training mechanisms, rapid diffusion of technology transfer, a high degree of interfirm networking and receptive firms well–disposed towards innovation. The very density of these networks and institutional supports is often interpreted as a sign of the vibrancy of a regional economy (Cooke and Morgan 1993, 562).

Drawing upon this insight, a number of writers suggest that the key to economic success in the future depends upon the development of closer relations among networks of firms and a broader infrastructure at the regional level on which complexes of firms can draw for support in the innovation process. According to Florida, the economic significance of regions has been dramatically increased by the shift to a knowledge–based economy.

> In this new economic environment, regions build economic advantage through their ability to mobilize and to harness knowledge and ideas. . . . In effect, regions are increasingly defined by by the same criteria and elements which comprise a knowledge–intensive firm — continuous improvement, new ideas, knowledge creation and organizational learning. Regions must adopt the principles of knowledge creation and continuous learning; they must in effect become *learning regions* (1995: 532).

One of the problems with this set of claims is that its empirical base has been rooted heavily in the experiences of a handful of colourful and much studied regional cases: notably, Emilia–Romagna in northeastern Italy, Baden–Württemberg in southwestern Germany, and California's Silicon Valley. Despite the existence of these celebrated examples, there remains considerable debate about two issues. First, the extent to which such collaborative behaviour is widely diffused to other industries and regions within the industrial world remains unclear. In particular, most research to this point has been focused on new regions of industrial growth, to the relative neglect of more mature industrial spaces, such as Ontario (Gertler 1992). In the European context, numerous efforts are underway to replicate these results. To attain this level of capability, regions are encouraged to develop a collective learning process in which the key

actors — private firms, public agences and a wide array of intermediary associations — work to enhance the broad capabilities of the region's infrastructural support for the innovation process (Morgan 1995). Some other regions, such as Wales, have enjoyed success in emulating these examples, but the extent to which the model can be generalized remains an open question. Furthermore, even in those instances where collaborative relations have been documented, there is some debate over the effectiveness or benefits arising from such activity (Harrison 1994).

There is thus a critical need for further investigation of the extent to which firms and their supporting infrastructure of institutions in other regions are developing similar capabilities. In the case of Ontario, despite considerable attention to these issues over the past decade, there is still a substantial lack of evidence about the extent to which it conforms, or not, to the characteristics outlined above. In an earlier paper, we outlined the nature and characteristics of the regional innovation system in Ontario at the broad macroeconomic and sociological level (Wolfe and Gertler 1997). In this paper we begin the process of supplementing that perspective with a more detailed examination of the nature and extent of innovation at the firm and inter–firm level.

3.0 The Survey Design

The survey of innovative behaviour among manufacturing firms was designed as part of a broader research effort on the regional innovation system in Ontario. The broader nature of the project and some of the issues under investigation in related parts were critical in determining the initial construction of the survey sample. The selection of firms was drawn from a list of those known to have participated in a range of Ontario government programs and research centres during the period 1990-1995 and for which we could obtain information in the 1995 Scott's Directories.[2] These included firms who participated as in industrial partners in the eight provincial Centres of Excellence, as well as firms who had some involvement with the formation of the sector strategies for the auto, computing, electrical, health, machine, tool, die and mold, plastics, aerospace and telecommunication sectors. It also included firms who had received

[2]The 1995 Scott's database covering Ontario manufacturing firms was the main source of company contact, ownership, sectoral (SIC code) and size data. Any firm that was part of the publically available lists, but which was not in Scott's was dropped from consideration. The discrepancy between the two sets of lists can be attributed largely to two factors. First, the firm may have undergone a name change. Second, the firm was a member of an industrial sector that was not one of the eight targeted sectors chosen for the study.

assistance from the Industry Research Program and the University Research Incentive Fund (URIF) administered by Technology Ontario, firms who had been clients of the Ontario Innovation and Productivity Service (OIPS), as well as a small number of firms designated as industrial partners in the joint research projects between researchers in Ontario universities and two of the Four Motors for Europe.[3] The control group sampling frame was drawn from those firms in the Scott's Directories in the same industrial sectors, but who were not identified as members of these programs or research centres.

Both the target and control groups were then further stratified on the basis of industrial sector, ownership and size. Firms were divided into eight sectors on the basis of their first four-digit SIC codes. In terms of ownership, firms were classified as being either foreign or Canadian owned. The criteria used to stratify firms by size varied by sector. For the auto, aerospace, electrical, telecommunications, computing and health sectors firms were divided into small (1-99 employees), medium (100-249 employees) and large (250 + employees) firms. The corresponding figures for the machine, tool die and mold and the plastics sectors were small (1-49 employees), medium (50-149 employees), and large (150+ employees). Once fully stratified, firms were then selected using a systematic sampling procedure with a random start. A sample of 444 firms was selected for the target group while 446 firms were selected for the control group, for a total sample size of 890 firms. Table 1 shows the sample breakdown by sector.

The survey questions drew upon elements found within a range of previous innovation surveys. A number of different surveys proved helpful in the design of our own instrument, including Statistics Canada's Survey of Growth Companies (1992), the Survey of Innovation and Advanced Technology (1993) and the Survey of Innovation (1996). In addition, we drew upon the PACE (Policies, Appropriability and Competitiveness for European Enterprises) survey (Arundel et al., 1995) of large European firms as the source for some of our questions. As indicated above, the survey of high performance firms carried out at the H. John Heinz III School of Public Policy and Management (1993) by Richard Florida and his associates provided a useful benchmark for comparing the relative performance of Ontario firms. Finally, the survey implemented in Wales as part of the EU–sponsored project (CASS, 1996), as well as the survey of advanced technology firms in Oxfordshire carried out by Helen Lawton Smith (1990) provided additional sources of ideas. The survey was pretested a number of times to control for

[3]A more detailed discussion of the industrial strategy pursued by the province of Ontario in the late 1980s and early 1990s, and the role of these individual programs is presented in Wolfe, forthcoming.

potential problems of length and complexity. At least two firm or industry association representatives in each sector were surveyed to obtain feedback about the clarity of the questions, overall organization, and potential problems that might be encountered in responding to it. As a result of the feedback obtained through this procedure, the survey was reduced in half, a number of the sections was dropped or integrated and the format of several questions was modified to reduce the possibility of response errors.

The questionnaire itself was divided into five sections. Section one asked firms to assess the competitive environments they were facing, as well the workplace technologies and innovations they were utilizing in their efforts to cope with those competitive pressures. The second section asked the firms to describe the nature of their relationships with their customers, their suppliers and other firms in their industry. Section three asked them to assess the effectiveness of various federal and Ontario government programs in assisting their firm and their industry, while the fourth section asked similar questions with regard to the role played by federal and provincial research centres. The final section asked for relevant background material such as employment levels, R&D expenditures and sales figures.

Target group firms were surveyed over the period December, 1996 through May, 1997. The control group was surveyed over the period May, 1997 to October, 1997. Firms were initially contacted by phone to assess their willingness to participate and to obtain appropriate contact names. Firms that agreed to participate received a survey, cover letter, and business reply envelope, with these materials being sent to the contact person. The cover letter explained the purpose of the survey, under whose auspices it was being carried out, the type of information that would be gathered, an estimation of the amount effort required to complete the survey, assurances regarding confidentiality protocols, contact information and a promise to provide an executive summary of the survey results that the firms could use for benchmarking pruposes.

For the purpose of this study, the sampling unit was set at the plant or establishment level, not at the level of the company as a whole. This influenced decisions regarding which individuals would be contacted within the company. In the case of larger firms, efforts were made to contact plant managers, while for small firms, the focus was on senior executives at the level of vice president or president. If a questionnaire was not received within two to three weeks of the initial mailing, follow–up phone calls were made to determine if the firm was still willing to participate and to address any concerns the firm's representative might have regarding the survey. An offer to send another survey to the firm was also made if the firm agreed to

complete the survey at this point.

Reasons for refusal to participate varied. One of the most common was the length and complexity of the survey and the effort required to complete it. This clearly influenced the overall response rate. Another response provided by a number of smaller firms, especially within the control group, concerned their lack of innovative behaviour. Because they did not utilize a large number of the workplace innovations or advanced process technologies listed in the survey, they felt they could not make a meaningful contribution.[4] At the time of writing, the overall number of respondents stood at 237, for a response rate of 27%. Though these rates may appear low, they are probably respectable given the issues of length and complexity noted above.

4.0 High Performance in Ontario: How Innovative Are Its Manufacturers?

As the preceding discussion makes clear, the concept of 'high performance' can be disaggregated into a number of distinct dimensions or elements. For our analysis of the current picture within Ontario manufacturing, we have employed a set of indicators which, taken together, provide a well–rounded and holistic assessment of the degree to which innovative practices — broadly defined — have been adopted to transform the workplace and the social organization of production. Our indicators fall neatly into two complementary groups: those that reflect the use of innovative practices *inside* individual establishments and those that indicate the development of innovative practices in *inter–firm relations*. Our approach here follows the recent literature on networks and regional development (Cooke and Morgan, 1993), which argues that the adoption of 'network relations' is transforming practices not only between firms but also in–house, through the adoption of progressive forms of workplace reorganization. Our specific indicators in these two categories are listed below.

<u>Innovative Practices Internal to the Establishment</u>:

Research and development expenditures
Training practices
Adoption and use of advanced process technologies
Adoption and use of innovative workplace organization

[4] This response might indicate a potential response bias within the survey. It would seem to indicate that we may have a disproportionate number of responses from more 'advanced' firms within the control group, i.e. those firms who are more likely to engage in the type of activities covered by the survey instrument. If this is true, the proportion of advanced firms within our sample may be far greater than one would find within industry as a whole. One way to control for this bias is to compare the responses within our sample to those obtained from previous surveys, especially the Statistics Canada surveys on innovation noted above.

Innovative Practices in Inter-Firm Relations:

Collaborative relations with suppliers
Collaborative relations with customers
Collaborative relations with other firms in the same industry

In the discussion that follows, we investigate each of these dimensions individually. For the sake of this analysis, we combine both the 'target' group and 'control' establishments to construct an aggregate picture. Where appropriate, we disaggregate the sample according to principal dimensions such as establishment size, sector, and ownership in order to sketch a more detailed picture of how the adoption of these practices might vary across different subsets of the firms in the study.

41. Transforming the Workplace: How Innovative are Ontario Manufacturers' Internal Practices?

One of the most widely used indicators of innovative activity by firms is the amount of money spent on the performance of research and development. In Table 2, we adopt the standard classifications used by the OECD to assess the intensity of R&D expenditures by our sample firms and to investigate how this has changed between 1989 and 1995. At the start of this period, the sample of firms appears to be somewhat bifurcated between low and high R&D performers: nearly one–half of all establishments fell into the low category (devoting less than one percent of their sales to R&D expenditures), with just over one–third in the high category. Over time, the proportion in the low category declines steadily, with most firms apparently shifting into the medium category of R&D intensity. However, the proportion of establishments spending more than three percent of sales on R&D (and therefore falling into the high category) has not risen significantly over the six years. This result is broadly similar to that reported in the most recent Statistics Canada service bulletin. R&D intensity was higher for small firms and decreased as the size of the firm's employment increased (1997, 5).

Based on previous research, we would expect the degree of R&D intensity to vary strongly by sector (Wolfe and Gertler, 1997). For example, aggregate statistics indicate that Ontario's most prominent R&D performers (in both absolute and relative terms) are found in sectors such as telecommunications equipment, computing, software, and pharmaceuticals. At the same time, important sectors such as automotive assembly and parts have been shown to perform notoriously low levels of R&D in Ontario. The findings from our survey (Table 3)

confirm this pattern. The computing, telecom, and electrical/electronic equipment group has by far the largest share of establishments in the high category, followed by the health products group (which includes both pharmaceuticals firms and producers of medical instruments and products). The transportation equipment sector (made up of automotive and aerospace producers) performs according to form, with a relatively small proportion of its establishments in the high category and a large share in the low category. Only the plastics industry fares less well on this indicator, with nearly 60 per cent of establishments spending less than one percent of their sales on R&D. Furthermore, the changes in shares between 1989 and 1995 appear to accentuate the inter–sectoral differences just summarized. Hence, the computing/telecom/electrical group leads all other sectors with the best improvement in the high category. The transportation equipment group actually saw the share of its establishments in the high category fall by more than two percentage points over this period, although the medium category did undergo a significant expansion of its share (up nearly 13 points).

There has also been a strong contention over the years that R&D performance varies considerably by nationality of ownership. In particular, a vivid debate has raged over the extent to which foreign–owned firms perform their share of R&D in Canada. More recent evidence has suggested that apparent differences between Canadian and foreign–owned firms may instead result from systematic differences in establishment size between these two groups. One study suggests that, on balance, "it is probably the smaller size of Canadian firms that accounts for their observed higher R&D intensity" (Holbrook and Squires 1996, 373).

In Table 4, we disaggregate R&D performance by ownership and establishment size (measured in terms of employment) in order to examine the validity of these two perspectives. Some fascinating patterns emerge. For small and medium–sized enterprises (SMEs), the differences between Canadian and foreign–owned firms is striking and verges on statistically significant at the $p = .05$ level. Almost one–half of Canadian establishments fall into the high R&D intensity category, compared to a share of less than one–quarter for foreign–owned establishments. For the low intensity category, the shares are almost reversed. At the upper end of the size distribution (establishments employing 250+ workers), similar differences emerge when comparing Canadian and foreign–owned establishments in the high R&D intensity category. However, this difference all but disappears when comparing shares in the medium and low categories. Overall, SMEs emerge as a more R&D intensive group than do larger

establishments. Moreover, this size difference is especially marked within the Canadian–owned firms. The results obtained in this part of the survey are quite close to those reported by Statistics Canada in its latest review of the effect of foreign ownership on R&D performance. Since 1990, the proportion of revenue targetted to R&D by Canadian firms has risen, while that of foreign–controlled firms has declined (1997).[5]

If there is a central core to the high–performance firm envisioned by Florida and others, it is in the transformation occurring in the way work is organized and performed. A key aspect of this is the effort devoted to training by employers. Training expenditures expressed as a share of annual sales is one simple measure of this effort (see Table 5). What is clear from this table is that the extent of training effort by firms in our sample has increased quite markedly over the 1989–1995 period. The share of establishments within the low category declined steadily from 56 to 36 per cent. This decline of 20 points was equally shared as gains by the medium and high categories.[6]

When one disaggregates this information by sector, the pattern that emerges is strikingly different from the sectoral patterns for R&D intensity. Virtually across the board, changes since 1989 show that all sectors have seen their distributions shift upwards in favour of the medium and high categories. Moreover, the computing/telecom/electrical group (a strong R&D performer) also scores well on training intensity, but the plastics sector actually registers a larger proportion of establishments in the high category. In general, there is much less differentiation between sectors on the dimension of training intensity than was seen in the case of R&D intensity, suggesting that the move toward greater training effort is widespread and pervasive.

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[5] This seems to contradict the results of the Holbrook and Squire's study whose results were based on data from the period 1981-89. The results of our survey and those reported in the Statistics Canada service bulletin may signify that there has been a significant shift in the R&D behaviour of Canadian and foreign-owned firms reflecting significant changes in the external policy environment — such as the implementation of the free trade agreements. Alternatively, the different results may be explained by the more sophisticated modelling undertaken in the Holbrook and Squires studies. This is clearly an area where further research is required at both the national and regional levels.

[6] Attempts to compare these results with those reported in the recent Ekos Workplace Training Survey are complicated by the different methods used to evaluate training effort. The Ekos survey does warn, however, of the difficulty in evaluating the level of training expenditures by individual firms due to the inconsistency in accounting methods used to track those expenditures. With this caveat in mind, and recognizing the significant differences in the samples surveyed in the two studies, our results appear to differ from theirs on two important dimensions: we report a higher incidence of training expenditures among the smaller firms, while they report the opposite and they postulate that there has been a decline in the level of training incidence over the period 1991-95 (Betcherman et al. 1997, 22-37).

Only when we disaggregate the analysis by size of establishment (Table 6) do we see any real variation. Here, large plants emerge as relative underperformers when compared to small and medium establishments. And a further important distinction becomes evident when training effort is compared for Canadian and foreign–owned establishments (while again controlling for size) (Table 7). Within the SME category, Canadian–owned plants are significantly more likely to engage in a high training effort than are foreign–owned establishments (of which nearly two–thirds are found in the low category). Although a similar pattern emerges for large enterprises, this difference is most evident within the high category but is greatly diminished for the lowest category (Table 8).

One of the main forces underlying the drive to increase training efforts is, according to the literature on 'intelligent manufacturing', the growing use of advanced manufacturing technologies that make greater demands on the skills of operators. Tables 9 and 10 provide a window on the extent to which these advanced process technologies (APTs) have been implemented by firms in our sample. The first of these shows clearly that the likelihood of adopting at least one APT (from a list of twelve different types) rises consistently with establishment size. Of the large plants, fully 100 per cent indicate that they are making use of at least one APT. Our survey also requested that respondents indicate how extensively such technologies were used in their operations (see Table 10). Here, we see that the most extensively adopted technologies are (in order) computer–aided design (CAD), materials requirements or manufacturing resource planning (MRP), programmable controllers, computer numerically controlled (CNC) machines, and technical data or factory networks. By way of comparison, these results are quite similar to those reported in Baldwin, Sabourin and Rafiquzzaman (1996, Table 5, p. 18), based on Statistics Canada's 1993 Survey of Innovation and Advanced Technology. This earlier study reported that the most frequently adopted technologies (weighted by the shipments produced by adopting firms) included CAD, programmable controllers, computers for factory control, and technical data or factory networks. Table 10 also allows us to examine the extent of use of each technology by sector. For nine out of twelve technologies, the transportation equipment group exhibits the highest average extent of use, suggesting that the stringent technical requirements of the automotive and aerospace assemblers has compelled suppliers to upgrade their process techologies quite extensively, even if these firms are not intensive performers of R&D.

It is important to go beyond the adoption of advanced process technologies and to

consider other, more holistic approaches to transforming the workplace from within. As Kochan and Osterman (1994) argue, these complementary changes are considerably more profound — and more challenging to implement successfully — than the simple adoption of new machinery, since they imply the introduction of fundamentally different relations between workers and managers, and new ways of organizing the work process itself, in order to achieve the 'high performance' or 'mutual-gains enterprise'. Our survey collected information on the extent of use of nine distinct forms of workplace innovation (see Table 11). The most extensively adopted innovative practices were the involvement of shop floor employees in production planning, profit–sharing and other forms of incentive–based pay, and ISO 9000 certification. However, concurrent/simultaneous engineering (in which product innovations are developed by multi–function task forces integrating research and development, production, and marketing), and quality circles/total quality management were close behind the leaders. In every case, large establishments were the most extensive adopters of these innovative practices.

Investigating the sectoral incidence of these workplace innovations (Table 12), there appears to be little obvious correspondence between the patterns evident here and those evident in Table 10 reporting APT use. Where the transportation group stood out in the earlier table, this is no longer the case in the current analysis. Here the most prominent sector (measured by mean scores on extent of use) is plastic products, which is the most extensive adopter of joint labour–management committees, profit–sharing/incentive–based pay, frequent job rotation, and statistical process control.

Having examined a variety of indicators of innovative practice internal to the firm, and having found a number of encouraging signs, one is naturally led to question the extent to which the use of such practices might have brought about tangible improvements in the adopting firms' competitive performance. While this relationship is undoubtedly a complex one requiring an extensive analysis on its own, a preliminary examination is provided in Table 13. Here we find that strong R&D performers in 1989 were also, on the whole, those establishments most likely to generate the highest growth rates in employment in the subsequent 1989–1995 period. We also see that the most training-intensive workplaces in 1989 were also strong job creators in the ensuing six years of recession and recovery. Hence, on the basis of this very preliminary examination, there appears to be tentative support for the argument that adoption of progressive internal practices leads to superior economic performance subsequently.

4.2 Transforming Inter–Firm Relations: How Innovative are Ontario Manufacturers' External Practices?

As our introduction to this chapter makes clear, the shift toward more knowledge–based production depends not only on the introduction of new work methods inside the firm, but is increasingly predicated on a reorganization of the social division of labour in production systems. Industrial organization is being restructured in order to foster the interaction of individual firms with one another and to support the creation of *collective learning processes*. As a way of tracking the extent to which such inter–firm learning processes are taking hold in Ontario manufacturing, we asked our respondents a series of questions about their current inter–firm practices and how these are changing. The results provide a fascinating perspective on these developments in Ontario for the first time.

Establishments surveyed were asked to indicate the extent to which they have developed close, collaborative interaction with their customers, suppliers and other firms in the same industry (i.e. potential competitors) with respect to six distinct activities (see Table 14). The findings paint an interesting picture of the extent and precise ways in which collaborative practices are being adopted. First, it is immediately evident that manufacturers in Ontario are adopting collaborative interaction for *vertical* relationships with their customers and suppliers up and down the supply chain. These appear to be notably more prevalent than *horizontal* collaboration with potential competitor firms in the same industry. Second, among the vertical relationships, firms are more likely to characterize their relations with customers as collaborative, compared to their relations with suppliers. Third, the tendency to move towards more collaborative inter–firm relations appears to be strongest (for the most part) amongst the larger establishments in our sample. Interesting exceptions to this pattern include research and joint production scheduling with customers, where small establishments show mean scores equal to those of large establishments, and in process/product design and product development, where mean scores for small plants are only marginally lower than those for large ones. These findings seem to suggest that co–operative relationships are easier to establish and maintain when the firms involved are not in direct competition with one another. This result is quite logical and predictable within an Anglo–American framework of macro–regulation, in which there remain systemic disincentives against inter–firm co–operation (Gertler, 1997).

When one approaches the same issue from the perspective of individual sectors (Table 15), further interesting patterns emerge. When it comes to collaborating with customers, the

most active sectors appear to be transportation equipment (judging by the number of times that this sector shows the highest mean scores for a given form of activity). As for relations with suppliers, the plastics sector registers more top mean scores than any other sector, followed by the transportation equipment group. As for relations with other firms in the same industry, while again these scores are generally much lower, the sector emerging as most collaborative in a horizontal sense is health products.

Our survey also gathered information about the prevalence of specific innovative inter–firm practices. Up until now, most of the analysis of such developments has remained anecdotal and piecemeal, focussing on individual case studies. The importance of these data is that they allow us to draw some *general* conclusions about the degree to which such practices have in fact diffused throughout the Ontario economy. From Table 16, we see that just–in–time (JIT) delivery relationships with customers and suppliers are the most prevalent form of innovative inter–firm practice, followed closely by the outsourcing of parts and components production. No other innovation on this list produces a score higher than the midpoint on the scale (3.0), although the mean score for strategic alliances and joint ventures is at this level. The other noteworthy pattern concerns establishment size. With two exceptions (strategic alliances/joint ventures and EDI), small plants record the highest mean scores, indicating the most extensive use of these specific forms of inter–firm interaction. Especially prevalent here are outsourcing (all types) and JIT (with both customers and suppliers). While the results reported in Table 14 suggested that, in many cases, large establishments were most likely to engage in innovative inter–firm relations, the balance seems to shift clearly in favour of small enterprises when the analysis focusses on these specific forms and practices.

One way to reconcile these two sets of findings is to infer that, while small firms are most likely to engage in specific practices such as outsourcing and JIT, they do so in the context of a relationship (possibly with larger firms) which is not overwhelmingly collaborative in nature. In other words, they could be subject to exploitive or ‘unenlightened’ treatment by such partner firms — again, a finding that is wholly consistent with earlier analyses of the difficulty of superimposing collaborative practices on top of a deeply engrained business culture which privileges aggressive competition and rugged individualism (Wolfe and Gertler, 1997; cf. also Harrison, 1994).

As with the measures of internal innovative practices examined in section 4.1, it makes

sense to examine, at least in a preliminary way, the extent to which the adoption of innovative inter–firm practices is associated with better subsequent establishment performance. For this we turn to Table 17, which provides the analysis for two specific dimensions of inter–firm practice. This table suggests that those establishments that have moved farthest to adopt practices such as joint research and just–in–time delivery relationships with their customers have also generated higher than average employment growth over the 1989 to 1995 period. Once again, it is reassuring to find at least tentative evidence that such practices might lead to tangibly better overall results in terms of key indicators, such as job creation.

5.0 Conclusion

The evidence adduced from this preliminary analysis of our survey results provides limited support for the hypotheses sketched in the first part of the paper. While there does appear to be some indication that firms in Ontario's manufacturing sector are moving in the direction of the 'high performance' model outlined by Florida, there is less substantial evidence that they are also building the kind of densely networked regional economy described by Cooke and Morgan. In part, these results are quite consistent with those of our earlier macroeconomic and sociological examination of the regional innovation system where we concluded that many features of the regulatory context surrounding the workplace in Ontario discourage and militate against the types of meaningful inter–firm cooperation found in the European regional economies. Cooperation between firms is more difficult to achieve when, as a result of a highly decentralized training regime and a system of labour market regulation that encourages frequent turnover and instability, potential cooperators undermine a sense of mutual trust by poaching each other's skilled workers. Similarly, the flexibility and emphasis on short–term results engendered by the structure of Ontario's capital markets and system of industrial finance also militates against the establishment of the long–term, cooperative relations found among firms in some European regions that operate under a different financial regime. It may prove difficult to achieve more meaningful levels of cooperation among networks of firms in Ontario unless greater attention is paid to these broader regulatory factors.

On the more positive side, however, the survey provides strong confirmation for the view that firms in Ontario are responding to the challenge of globalization and closer integration into a continental market under the conditions of the North American Free Trade Agreement. Along most of the dimensions identified as elements of the high performance model — growing R&D intensity, increased training effort, relatively more extensive adoption and use of advanced

process technologies, the shift to more innovative workplace practices and closer relations with buyers and suppliers — firms in Ontario display strong evidence of moving towards the positive end of the spectrum. Thus they seem to be matching the benchmark set by their counterparts in the proximate states south of the Great Lakes. This augurs well for the ability of Ontario to compete in the new continental economy emerging in the wake of the free trade agreements.

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