

Free Trade and the High-technology Response: A Regional Innovation System Perspective on Toronto

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Though an identifiable and significant component of the Canadian economy, the Toronto regional economy is bounded by sets of national regulations. In Canadian economic discourse, no regulations have been viewed as more important than those governing trade and foreign direct investment. Recently, however, these have been substantially modified and the regional economy has had the opportunity to respond to landmark changes in trade regulations that have stemmed first from the FTA and then the NAFTA. This paper employs the conceptual framework of Regional Innovation Systems (RIS) to report on the responses of technology intensive manufacturers to these trade agreements since they are generally regarded as changing the access of firms to the U.S. market, increasing competition at home, and fostering greater integration. In essence the paper is about the way firms, which constitute the main nodes in the innovation system, have reacted to the much more open nature of conditions which derive from the greatly increased economic permeability of Canada's boundaries with the U.S.

Regional Innovation Systems

The utility of the concept of RIS is strongly implanted in the expanding lexicon of concepts used to investigate the spatial organization of industrial activity and industrial

innovation. Its origin is not geographic theory. Rather, it has emerged from explorations of national differences in innovation systems. In particular, Freeman (1988), Lundvall (1992), Nelson (1993) and Carlsson (1995) investigated the conditions under which technology is developed, adopted and advanced and indicated the important role of national policies, industrial structures, corporate behaviour, and the institutional frameworks in which firms, individually or collectively, make their choice about investments and business connections. Under the national umbrella of policies, institutional similarities, and business practices, the focus of innovation systems research has been on the characteristics of the firms that populate the system, on the connections between firms, and between firms and educational and research institutions, other agencies, and sources of finance.

Reflecting the localization of much economic activity, regional systems have been explored in terms of market, production, and other technology-based interdependencies between firms within and between sectors, firms and other institutions such as governments, post-secondary education, business associations, and labour unions. Within the enormous range of implied interactions, the RIS concept is a pragmatic attempt to link the increasing international body of substantive research on the regional incidence of innovation with several evolving bodies of theory. These involve:

- the theory of innovation, especially heuristics such as the coupling model (Rothwell 1992, Kline and Rosenberg 1985), which explores a feedback process involving direct and indirect links between firms and sectors involved in a value chain,
- ideas on alliances and collaboration between firms or with other institutions which effect cooperative forms of knowledge exchange possibly leading to new joint technical or commercial initiatives (Ahern 1993, Cooke 2000),

- various explanations of the competitive advantages of the locational clustering of economic activities especially of small and medium sized enterprises (Piore and Sabel 1984, Best 1990, Porter 1998)
- theorizing about the social basis of economic relationships of firms or at least people employed in firms (Granovetter 1985, Asheim and Cooke 1999), and
- policy initiatives to assist the rate of innovation and ultimately, regional development (Scott and Paul 1990).

Clearly, the substantial resource strengths of the largest firms make their internal flows an important component of the system compared with connections with other firms. But the definitions of large firms are under constant assault with the transaction cost problem on one side giving way to the gains to be made from out-sourcing assembly, component design and production, and technical and business services on the other (Melody 1987, Sturgeon 1997). As a result of these and other shifts in relationships, the RIS concept is one in which the forces of change are at its core. Innovations in organization, technology, and the availability of risk capital are notable sources of system dynamics because they affect the propensity of firms to undertake R&D, the survival chances of start-up firms and, the likelihood of connections between firms to stimulate and reflect growth, especially at the regional level.

Research on regional innovation systems, as Oinas and Malecki (1999) also identify, has focused on state-of-the-art regions, variously designated as learning regions, industrial districts, clusters or innovative milieux. In all these cases, too, as indicated by the designation "learning", the analysis of change is the primary focus and the opportunities for reworking sources of knowledge and production contacts and

contractors evolve as competition, imitation, and technological change drive the process of innovation and economic growth. At least this is the positive version of the nature of regional dynamics. Other versions indicate that even in archetypal regions such as Boston's Route 128, the process can falter resulting in glitches in the continuity of the innovation process (Saxenian 1994). Moreover, we can expect considerable variance between regions in their level of success in joining the state-of-the-art club. In secondary manufacturing in Ontario (within which Toronto is the metropolitan core), for example, Gertler, Wolfe and Garkut (1998) conclude that there is limited inter-firm cooperation among firms in secondary manufacturing in Ontario and only tentative evidence that inter-firm practices such as JIT delivery to customers and joint research are leading to measurable improvements in performance. Their results suggest that the attributes of the Toronto RIS are unlikely to be at the leading edge.

Looking outside the region

In the development and application of the RIS paradigm, processes of technological and organizational change within regions tend to be privileged over shifts in institutional arrangements that change the way regional systems are bounded by national exchange rate management, tariffs, and constraints on the international mobility of labour. Yet there is recognition in the current literature that this is an area of research that merits further attention. Spatial innovation systems (Oinas and Malecki 1999) and its orthogonal twin, sectoral systems (Edquist 1997), both signal a view that extra-regional connections or inter-regional flows or contacts need closer attention than hitherto relative to internal system relationships. Perhaps, if innovation systems were modeled in more formal ways, like urban systems have been (Simmons and Bourne 1981),

changes in the way regional systems are bounded might have received more explicit attention (see also, Howells 1999). Regardless, more than lip-service needs to be given to the significance of the degree of openness of regional and national systems. In the research reported here it is assumed that free trade and investment agreements such as the NAFTA generally have a much larger potential to stimulate change in Canadian regions compared with regions in the much larger U.S. national system. The approach is to combine micro-level analysis of the behaviour of individual firms with the interest that some versions of NIS research have in institutional and regulatory change (see Edquist 1997 and his comments on the approach of Carlsson 1995).

Canadian Free Trade Impacts

Economic analysts in Canada expected that soon after the FTA was in place and tariff reductions were implemented there would be positive industrial effects. Lipsey, Schwanen and Wonnacott (1994) put it as follows (p 152): the "objective of free trade, like technological change, is....to increase productivity - that is, in many cases, to reduce the labor required to produce goods." They remark on the particularly positive effect on exports to US, compared with other markets, expected in three manufacturing activities: office, telecommunications, and precision equipment (p 150). These industries seem to demonstrate the capability of Canadian higher value-added industries to experience trade-induced expansion in production and improvement in productivity. Essentially, their argument is that higher-technology industries benefit from liberalization and its follow-through effects. ⁱ

Nevertheless, whether these increases in exports are attributable as impacts of the free trade agreements is still a question for research because there are at least two alternative explanations:

- The expansion in the US market for electronic, computing and telecommunications equipment has driven the increases in Canada's exports in technology intensive manufactures and this would have occurred without FTA.
- The rise and then decline in the exchange rate of \$Cdn after 1991 is generally viewed as a positive influence on exports and should be seen as independent of the FTA because its roots lie in Canadian monetary policy.

In the light of these two considerations, there is value in looking beyond simple export increases to evaluate the impacts of free trade. In particular, we should consider whether the trade agreements have stimulated other improved structural and performance responses by firms. Increases in **innovation** and **productivity improvements**, for example, would be important evidence of positive effects of trade liberalization because they could contribute to a sustainable (that is, competitive) pattern of industrial production.

High tech manufacturing industries were among the best Canadian performers during the 1990s when judged using average annual rates of growth of **productivity** (Table 1). Comparisons with US, however, show that the otherwise positive rates of change for electrical and electronic products and industrial and commercial machinery exhibit the greatest comparative **under-achievement** in productivity growth. These productivity comparisons have stimulated commentaries, especially by Trefler (1999) whose contention is that Canada's technology intensive activities have failed to deliver new

products at the rate they do in U.S. As a consequence he posits a "product innovation gap". A plausible interpretation, therefore, is that the Canadian innovation system, though delivering increased outputs, is not moving along an efficiency trajectory that will raise its competitive status and we can infer that the effect of the trade agreements on productivity and innovation may not be as strong as first thought. This would imply that over the ten years since the FTA, Canada has probably not made much ground on achieving its national policy goal of reversing its low scores on most indicators of the rate of innovation and technological advance and its trade deficits in key technology areas.

A methodological perspective

Most, if not all, of the discussion published on the industrial impact of the FTA and the NAFTA has been national (Schwanen 1997), rather than regional (Britton 1993), in focus. It has explored either aggregate measures of economic activity (Britton 1998) or the response of multinational firms to trade liberalization (Dunning 1994, Rhéaume and Warda 1995). While valuable in specifying aspects of the impact puzzle, these analyses are mute with respect to the influence on aggregate statistics of a small number of large firms and only some are sensitive to potential differences in response by different groups of firms - foreign and domestic firms, for example. In this case, the regional specification of the inquiry takes out of contention the influence that might be generated by inter-regional differences in opportunities to acquire inputs, to receive incentives to innovate, or to enjoy adjustment assistance. Accordingly, in this study I tackle the question whether free trade has induced Toronto's high technology firms to make significant structural changes and whether free trade has, directly or indirectly,

had impacts on the productivity of firms, their adoption of new technology, and increased product innovation.

The Region

The Toronto region (defined here as the Greater Toronto Region), Canada's largest industrial center employing 230,000 in manufacturing, is a locational concentration of technology-intensive firms. Though the auto industry is the region's largest single industrial employer the broad computer and electronic products manufacturing sector – the focus of this inquiry - generates a location quotient of more than 1.7 and Toronto is Canada's largest center of this activity. Toronto's industrial history has much to do with the scale of these new industries as firms like Nortel Networks, a producer of internet equipment, have emerged out of antecedent industrial activities such as the production of voice/telephone hardware equipment. In the early 1990s, however, Toronto weathered a severe recession that ushered in substantial sectoral restructuring. Nevertheless, Gertler (2000) shows that Toronto's GDP in manufacturing 1988-98 increased by nearly 30% and manufacturing has retained an importance (17% employment) that makes it a leader among U.S. comparators such as Minnesota (15%), Boston and Chicago (13%), Seattle (12%) and Atlanta (10%).

As traditional (low) technology industries have shrunk, Toronto's educational infrastructure has attained more significance in its influence on the development of technology intensive manufacturing, as has its diversified market. Its three local universities, other research institutes and several post-secondary colleges provide both vocational responses to current labour needs and relevant research connections. Given this background, Toronto meets the requirement for this research by providing the

opportunity to sample large and small establishments of domestic firms and foreign affiliates. In the latter case, is also the location of a set of technical branch plants that are the affiliates of mainly US-based corporations. Together, Toronto's firms allow some assessment of whether size and ownership characteristics distinguish the responses of high technology manufacturing to trade liberalization. The diversity in the size and organizational and ownership characteristics of firms in the Toronto area means that the regional inquiry can be an efficient means for penetrating below the level of aggregate statistics of industrial performance measures.

The Industries

Four R&D intensive manufacturing industries Aircraft and parts, Telecommunications equipment, Electronic parts and equipment, and Scientific instruments and professional equipment have been selected as these are well represented in the region. Collectively they have a location quotient of 1.4 (based on number of establishments) and the quotient rises to 2.3 for establishments employing 200 or more. Also, the firms in the selected industries have some additional common performance characteristics. They tend to be members of supply chains linking small firms with each other and with large assembly and marketing firms. Yet, there is one interesting difference between these industries: unlike the others, the aircraft industry was already operating without trade barriers at the time of the FTA and though it is not used in any formal way as a formal "control" sector, its firms should generate different responses from the other three industry groups. Review of the national trade performance of the four industries appears to confirm (Table 2) that the Aircraft and parts industry has reacted less than the other activities to the FTA and the NAFTA. In terms of change in output and exports to the U.S. it has exhibited more modest growth between 1990 and 1997. These are

not perfect years for comparisons in terms of the recession of the early 1990s but they yield reasonable "before-and-after" comparisons. There is, moreover, no reason to anticipate that these national patterns do not apply to the segment of these industries in the Toronto region.

The Sample

A sample design, inversely related to the employment size of establishments, was developed using basic information from conventional and web-based industrial directories. The sample population was identified in an iterative manner. Initially, industrial establishments with >200 employees drawn from a directory of manufacturing firms (Ontario Manufacturers 1997) were included if they were listed either in a Canadian industrial R&D database (available at the time through the NRC website) or the technology directory available through the website of Industry Canada. At the outset, in summer 1998, postal questionnaires were sent to establishments within the four industries that met three criteria: all firms are manufacturers, they undertake R&D, and the name of a relevant contact-person was available. All contacts were telephoned to seek agreement on participation in the survey. These calls identified non-manufacturers and non-performers of R&D that were deleted from the population database. To increase the sample size, smaller (domestic) firms were added. Later, additional small firms were drawn from the Ontario directory of manufacturers for which we had no information about R&D or an appropriate contact person. The response rate for this additional part of the survey was very low and eventually it became unprofitable to attempt to add firms.

Usable replies to the questionnaire were received from a total of 66 foreign and domestic, small and large firms (Table 4): these represent an overall response rate of 27% though 39% of firms that agreed to participate completed the questionnaire.

The Survey

With the focus firmly on the FTA and the NAFTA, information has been obtained from the Toronto executives (Operations, R&D Managers, or Vice-Presidents) of the sample of establishments in the four industries. Following the Likert scale format, these respondents were asked to respond to a series of statements using 5-point scales. The statements covered a range of behaviours, responses, and structural changes that potentially described the experience of their business with North American free trade. The survey included questions about preparation for free trade, the reorganization of production, the changing importance of different activities and productivity effects. Using these assessments I have explored whether representatives of firms think there has been a trade response and whether this has taken the form of greater product innovation and technological change.

Expected Responses

Viewing trade liberalization from the standpoint of establishments as **respondents** means that we have to consider the variations in reactions likely to come from different groups of firms.

My understanding at the planning stage for this project was that **large firms** would have **anticipated** easier access to the US market. The primary factor is that the information resources of large Canadian TNCs and other large Canadian exporters are more highly developed and they, above all others, will have acted in response to the opportunities in

North American and global markets. They had the capacity to refine their international production choices to minimize the effect of trade barriers and to take advantage of new circumstances. Consequently, many **larger Canadian firms** located operations in US some time ago. An additional relevant factor is that the FTA was the objective of an active lobbying campaign by the Business Council on National Issues, which represents the views of large Canadian and foreign firms, and for this reason large firms were attuned to the gains that they could achieve.

By contrast, I expected that the prior actions of **small Canadian manufacturing firms** would have been constrained much more by trade barriers and they would have been less likely to have made production choices that anticipated North American free trade. They are more likely to have varied more in their responses to improved access to the US market. Some that are strongly focused on domestic sales will have concentrated on meeting or avoiding increased competition from US firms though opinion at the time of the FTA was that these smaller import-competing firms had less capacity to adjust (Steed, 1988). Others intent on obtaining U.S. sales will have had to develop appropriate marketing and technological strategies. Evidence from a national survey of SMEs (Baldwin 1995) indicates that in explaining success, market access is ranked behind only R&D capability. This implies strongly that the FTA and the NAFTA were important catalysts for some SMEs.

Foreign TNCs, especially firms headquartered in US, have faced different circumstances from those encountered by Canadian-owned firms. Multinational firms, more than any others had been restructuring their production and distribution systems on regional and global bases (Safarian 1996). The affiliates of U.S. firms escape any

NTBs but they have not been immune to organizational changes related closely to the prospect and reality of free trade. In a 1994 survey of managers of Canadian subsidiaries, 42% had experienced a modification in relationships with their parent and the majority reporting change indicate reduced autonomy, especially for firms in high technology manufacturing (Rhéaume and Warda, 1995). The principle behind these kinds of changes is that to survive within the corporation and to succeed within the market these firms must use the latest technology and develop a rationalized mode of operation. The reduction in autonomy, however, usually reflects increased ties with other parts of the firm organized on North American or global linesⁱⁱ.

Bearing these inter-firm differences in mind, the foundation of the survey is six groups of **potential responses** to free trade that have received systematic attention in research on actual, or possible, reactions by firms to the new trade regime or to business conditions associated with the introduction of the FTA and the NAFTA (Table 5).

In the 1980s, many large companies (as noted) avoided or minimized the importance of international trade barriers. Traditionally, restrictions on trade access to U.S. and other markets influenced the location of investments, but tariff reductions under successive GATT Rounds changed the foundation for corporate strategies in North America and elsewhere. Thus, before the FTA, firms initiated the process of "rationalizing and integrating their sourcing, production, and distribution systems" (Blank and Haar, 1998, 21). To a considerable extent, the FTA and the NAFTA intensified trends already underway. In the survey I probed the extent to which there was effective **preparation for free trade** by asking whether in 1980s firms made investments in production and product technology that proved appropriate for the firms in the free trade environment

(statement I, Table 5). All firms could have anticipated the changes but I am persuaded that it is large domestic firms that would be more consistent in developing and implementing a strategic response before the FTA and that they have done so because they have followed a strong export focus.

The **rationalization of production** has been occurring throughout manufacturing in response to free trade and for other reasons and probably for all types of firms. There are variations in the forms that this takes. There is some evidence, for example, that Canadian parent firms have tended to focus on the expansion of marketing activities and have invested in additional production capacity in U.S. (Krajewski, 1992). In the survey, I have also inquired whether increased competition, an outcome of the FTA and NAFTA, has generated a consequent need for specialization: the trade-linked reduction in the variety of an establishment's products is explored in the survey (statement II, Table 5). Unlike medium and low technology industries, many of which have had to shift production from a domestic market orientation, and broad product range, I expected most technology intensive firms to have developed a highly focused product strategy before the FTA and many to be engaged in international markets. Their technologically based core competencies would lead them to a high degree of product specialization.

The trends towards increased **outsourcing** and reduced in-house production have been recognized as important options for firms reorganizing their value chains to maximize core competencies and to eliminate the cost-penalties associated with under-scaled plants. Outsourcing is characteristic of lean production and frequently identified as a feature of the auto industry in which JIT systems are commonplace. It has also

become an important component of other systems of production that are attempting to be agile and flexible (Blank and Haas, 1998). Contract manufacturers allow this kind of choice and have emerged also in the broad field of electronics in North America and elsewhere (Sturgeon 1997). While firms such as Nortel Networks and Hewlett Packard have sold plants to contract manufacturers, outsourcing is not restricted to large firms. Certainly, one thrust of the literature on the “new competition” is that among small firms, out-sourcing compensates for limited scale (Best 1990). For these reasons, I sought through the survey to establish whether the FTA has stimulated the need for production efficiency by increased use of sub-contracting and/or the out-sourcing of product assembly (statement IV). Related statements probed whether increased out-sourcing of components and sub-assemblies had been chosen in the period since the NAFTA and if in-house production had declined in importance since 1989 (statements VIII and VI). Domestic respondents could be sub-contractors and so establishments were asked whether increased contract production had been undertaken over the past 5 years (statement X).

The trade agreements have had the power to stimulate the broader **reorganization of firms**. Some companies have been prompted to renovate their mix of activities in favour of increased marketing and distribution and reduced importance of production (statement XI). When applied to foreign affiliates this produces the "hollowing-out" thesis, which applies particularly to branch plants with limited autonomy to pursue non-Canadian markets and which have been reduced to distribution functions. I obtained information on the greater integration of foreign affiliates with their parents (statement X). I expected affiliates to have become more strongly connected to their parent firms (Rhéaume and Warda, 1995). For foreign affiliates, possibly the most significant shift in

organizational status is acquiring a product mandate (statement XII). Although previous research is sketchy, I did not expect that all would have been operating under product mandates; rather, some, even in these research intensive activities, would have been serving primarily domestic consumer or business markets. Nevertheless, the FTA not only made it feasible but also imperative to rationalize production in North America and generate organizational changes that would refocus the activities of these affiliates. Among the options for firms destined to retain manufacturing functions, a mandate is the most likely as this would allow some realization of Toronto's advantages including access to skilled labour especially R&D workers. For foreign and domestic firms I expected that a strong influence of free trade would manifest itself in the need for a higher level of strategic planning in order to initiate changes in technology, production and marketing (statement XI).

The literature on trade impacts, reviewed above, leads to the expectation that trade liberalization will have promoted **product and process innovations** and these responses and the realization of **productivity** gains (statements VII and III, Table 5) were included in the survey. The stimulation of investment in new production technology (statement V) also was evaluated. I anticipated that some high technology affiliates would find that the new trade regime would have pushed firms without product mandates to seek positions within their corporations to design and produce for global markets. All firms in the survey do R&D (a requirement for inclusion) but it is quite plausible that some domestic firms have responded by increasing their rate of product innovation even if they rely on other firms to undertake most of their manufacturing production.

Given the earlier discussion about shifts in the **exchange value of \$Cdn** (see above), it was important to enquire about the extent to which there was a direct link between increased exports and the 1991 decline in the Canadian dollar (statement XV). While some high technology firms might have viewed this downshift as a windfall, other firms may have been able to compete whereas previously they had not and this is a way of uncovering clues to an additional aspect of the competitiveness of firms and the status of the Toronto RIS.

RESULTS of the SURVEY

Local vs International Connections

The sensitivity of the sample firms to the trade agreements should be reflected by the importance of export markets since these are significant for the particular industries included in the survey (see above). Surprisingly, 39% of surveyed establishments reported that they **export** one-quarter or less of their sales. Exports have a bimodal distribution (Table 6a) indicating that some establishments are oriented strongly to the domestic market and the stimulus of trade liberalization for them continues to be in response to increased competition at home. The strong inter-firm differences in export orientation (see Table 6 b) involve a significant ($p=0.026$) foreign-domestic divide with 56% of foreign firms in the low export category. Though this pattern is consistent with other data for foreign subsidiaries of high technology firms (see Rhéaume and Warda, 1995), it is still surprising a decade after the FTA, to find that the primary function of some foreign affiliates is to supply the Canadian market.

Connections of Toronto firms with **local suppliers** are strong, too, (the mean proportion of material inputs from the region is 34% and another 21% come from other Canadian locations - Table 7). Inter-firm differences show foreign affiliates being more limited users of local inputs and in this they conform to the general pattern of foreign firms in secondary manufacturing. Given the importance of local inputs it is plausible that contract manufacturing is the explanation - the majority of firms (84%) obtained some form of contract manufacturing - mainly the manufacture of parts and subassemblies - in the GTA. Size is a significant discriminator with proportionally more small firms (and establishments) more dependent on local inputs than larger competitors which deploy resources to seek preferable suppliers, contractors, and partners [$X^2=16.092$ ($p=0.000$)]. Though 36% of respondents recognized that the region has a limited supply capability (possibly a consequence of its scale and industrial diversity), only 8 of 66 respondents indicated that they had reduced the importance of local supplier/contractor relations, and thus local and domestic connections remain strong.

Toronto firms exhibit high variability. Some are established exporters and the Canadian market has long ago been a small fraction of their business. Others, however, focus on the domestic market and for that reason, among others, the aggregate response to trade liberalization does not appear to have been one of impressive changes. Though a preliminary result, this seems to be in accord with the productivity and innovation thesis outlined above. Nevertheless, as argued earlier, these are only two of a feasible set of indicators of trade response.

Business Responses to Free Trade

There is substantial variation in the views expressed by firms about the business statements used in the survey though few firms failed to provide at least one “agreed” or “agreed strongly” assessment. There is also a substantial proportion of negative responses and only modest frequencies for “neutral”ⁱⁱⁱ scores implying that on average firms evaluated the prepared statements in a selective manner. The systematic influence of key structural variables on the response patterns were evaluated using difference of means tests (Table 8).

Firms were prepared fairly well for market integration, at least the investments in product and production technology that they made in 1980s were viewed as a good fit for the free trade environment. This variable achieved the highest mean response (3.5) but as expected, significantly lower levels of agreement came from small establishments

Production has been reorganized and this is revealed by increased outsourcing in the period since the NAFTA came into effect, the reaction of larger establishments being significantly stronger. The pattern of response for the post-NAFTA stage is stronger than for the whole post-FTA period and this may well be due to a lag in reaction time to the FTA.

Reduced product range - the specialization variable - has the lowest mean score (2.3) suggesting that this response to free trade is not a strategy that fits technology intensive firms. Even so, small firms have a significantly lower mean score (2.0) and this is consistent with specialization being part of their basic make-up. A small group of firms -

6 of them - agreed to the specialization thesis; these are all foreign affiliates for whom increased productivity was also an outcome of free trade. Only 32% of firms disagreed that the FTA increased productivity but the mean score would have been more than 3.0 without the significantly negative responses of Aerospace firms.

The effect of the dollar's decline in 1991 boosted the exports of a substantial proportion of small firms. The mean score for all respondents, however, is lowered significantly by the responses of large firms and by foreign affiliates; the latter either were locked into integrated trade arrangements or were minor exporters (see above).

There is a shift to increased marketing or distribution activities as a result of the opportunities presented by free trade though the mean score in Table 5 is depressed by the responses of Aerospace firms which, as anticipated, register little effect from the trade agreements. Many firms admit that the new trade regime has required more strategic planning on their part. Again, this is not the reaction of Aerospace firms, which differ significantly from the others because their product design and marketing have been oriented predominantly to an international market.

Foreign affiliates agreed quite strongly that they have experienced closer integration with their parents as a result of the new trade environment. Though about half of these firms had product mandates in 1989, in the periods defined by the two trade agreements, most of the other 50% of the sample became more closely integrated.

In summary, several expected effects of trade liberalization are supported including the propositions that investments in 1980s anticipated free trade, that there was increased

outsourcing, increased marketing/distribution compared with production activity, increased strategic planning and closer integration of foreign affiliates with parent organizations. We have seen, too, that ownership and scale of firm are important in understanding the reactions of firms to the new market situation. Aerospace firms, as anticipated, record much more limited impacts than firms in the other three industries. Nevertheless, some ideas such as the specialization thesis seem to be out of place and more suited to firms in medium technology industries.

The core hypothesis

More important is that the mean values (Table 8) provide only limited evidence supporting the core research hypothesis that connects productivity, innovation and technology to the increased opportunities and other competitive stimuli of the new trade regime. Furthermore, unlike most of the results reviewed above, the positive and negative responses cut across ownership and size categories. The relatively low mean values reflect the distribution of firms across the full range of possible reactions to the statements in the questionnaire (XI, XII, and XIII, Table 5) and also the greater frequency of negative responses. Nevertheless, these and other indicators of trade response co-vary, and this implies that it is feasible to develop a more general measure of innovative response reflecting the consistency in the scores for firms on the individual variables. This general measure can then be used for further analysis.

Principal components analysis (Rummel 1970, Oppenheim 1992, Baldwin and Johnson 1995, Hair 1995) is an effective means^{iv} of constructing such a dimension describing increases in innovation and productivity (Table 6). The full data set shown in Table 5 has been explored and the loadings on the first (rotated) component verify that the

innovation and productivity impacts of free trade are further associated with the broader reorganization of firms, indicated by increased strategic planning and marketing/distribution activities. This clearly suggests that for firms to realize innovation and productivity stimuli from trade liberalization, associated organizational changes and some measure of business restructuring is required. This makes sense though the patterns of restructuring may differ between groups of firms and this prompts the analysis of the component scores in terms of the structural parameters used above.

Systematic evaluation of the influence of the structural factors shows that non-aerospace firms record a significantly ($p=0.005$) positive impact of trade liberalization conforming to the different pre—FTA tariff situation of Aerospace products. Firms exporting a large proportion of their sales (75%+) register, by means of their innovation scores, a significantly smaller ($p=0.006$) impact of trade liberalization. This implies that these firms did not need the FTA to galvanize them into a higher level of innovative activity. Conversely the stronger innovative response of weak exporters implies that these firms are innovating to compete at home, or recognizing that even their current access to the U.S. or other markets requires increased product innovation or new production technology. Among the variety of circumstances that might fit this pattern two are testable if foreign affiliates and domestic establishments which are organizationally distinct, are treated as sub-samples. Foreign affiliates with “new” product mandates are finding that they are now being drawn into (increased) exports through corporate reorganization. The positive impact of this on innovation is attributable to trade liberalization and affiliates rating new product mandates as an outcome of free trade (a 4 or 5 on the 5-point scale) have a significantly greater mean

innovation score ($p=0.008$). For other affiliates, the trade agreements have generated a "business-as-usual" response.

Domestic firms were asked if they had been induced to increase their **rate of product development** and small domestic firms indicate significantly more agreement with the idea that the FTA had stimulated their rate of product development. There is a significant positive ($p=0.000$) relationship between this and innovation scores establishing consistency in the responses of domestic firms. It is interesting that there is a mix of reactions ranging from strongly positive ($n=6$) to strongly negative ($n=18$). The negative reactions belong to aerospace firms, firms that are almost exclusively export-oriented, and contract manufacturers. The first two of these characteristics fit the results obtained for the whole sample but contract manufacturers are an interesting group that we should expect would have to innovate in terms of their production technology to compete (mainly within the region). This interpretation is supported by the significantly higher (mean) innovation score for contract manufacturers, than other producers ($p=0.027$).

Conclusions

Compared with firms in low and medium technology industries, we are inclined to think of high technology manufacturers as a group of **strategically similar** firms; they are technologically-based individually, and in terms of the regional and national systems of which they are a part. Furthermore, we tend to associate technology intensive firms with highly focused product and innovation strategies. The logic is that the core competencies of these firms are used to produce innovative products and consistent

with this, we expect them to pursue specialized markets and sources of inputs. Some firms may find sales opportunities and sources of inputs within regional innovation systems but the geographic reach of firms is likely to be extensive as a result of product specializations. In the Canadian context, prior to the FTA, Toronto's firms had to contend with limitations of scale and variety in their own region and the Canadian system as a whole, and the existence of trade barriers that have had the potential to limit international sales. In this respect, Canadian circumstances and those in the U.S. were quite dissimilar prior to the FTA and the NAFTA, while the agreements have presented Toronto firms with more extensive opportunities on the one hand and more intensive competition at home, on the other.

The most obvious conclusion from this research project is that there have been substantially different responses by firms to the increased permeability of the international boundary of the regional system. There is considerable variation, for example, in production and market strategies. One of the region's largest firms - Nortel Networks - has for a long time been a heavy investor in other economies, especially the U.S., where it successfully recruits R&D workers and secures sales as a "local" firm. In this it exemplifies one archetype of Canadian firm. Moreover, within the period of the new trade regime it has located the lion's share of new R&D expenditure and administrative work outside Canada, and has completed a program of converting itself from a company with a large production workforce to one that is heavily reliant on contract manufacturers. In this respect, it and other high technology firms in the Toronto region are following the same trajectory as international competitor firms and in pursuing the outsourcing option they are making similar choices to firms in activities that depend on much lower R&D intensities.

It is plausible that because of its prior locational and investment strategy, trade liberalization has had minimal influence on Nortel's choices and the nature of technological innovation and international market competition, especially in internet equipment, has in its case been the factor promoting change. Yet, **outsourcing**, a practice which Nortel has embraced, has increased generally among firms in the region and when asked by means of the survey questionnaire, outsourcing and reduced in-house production are described as outcomes of the new trade regime - presumably because of increased competition and market access. While large (domestic) establishments responded most strongly this way the choice of foreign affiliates was to simplify their production tasks (reduce the product range) as they experienced much more highly integrated relationships with their parents even when a global or North American product mandate was gained. Paradoxically, small domestically-owned firms (and establishments) do not seem to have been induced to outsource as strongly as our knowledge of non-Canadian regional production systems suggests is possible (Best, 1990). The response is understandable for contract manufacturers - but these are only about 30% of the small firms in the sample. Only about the same proportion subcontract some final product manufacture. This all suggests that small high technology manufacturing firms predominantly remain as regionally focused performers of R&D and production activities and are not strongly influenced in their production arrangements by the trade agreements. This conforms to the proposition that SMEs would be less capable of adjusting, even in this region.

Though high technology firms are in many ways distinctly different from low and medium technology manufacturers, free trade has not elicited a simple response or

coherent assessment. In particular, there are great variations in the degree to which **innovation and productivity increases** are perceived as outcomes of the new trade environment. Positive changes are not a universal outcome - in fact they are a minority response - though there are some firms that have made significant gains. Moreover, the responses in this sphere by domestic firms and foreign affiliates differ because of their dissimilar organizational circumstances. The most attractive inference seems to be that the Toronto region has a small number of high technology manufacturers that have responded to the new trade regime. The domestic firms among them have joined the group that had invested in the U.S. market and global sourcing systems at a much earlier stage and whose actions preempted any significant response to the FTA or NAFTA. The foreign affiliates that have responded now have product mandates and in that respect are more like the foreign firms that had earlier decided that the Toronto RIS contains human resources that merit a specialized technological mission by the parent firm. For the majority of firms, however, the effects of the new trade regime seem to be modest, supporting the inference that Toronto region has a **small number** of firms that are strongly competitive in international markets.

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TABLE 1: Canada-U.S. Comparisons of Productivity Growth

	R&D Intensity		Labour Productivity growth 1989-97	
	Canada 1995	U.S. 1994	Canada	U.S.
Selected industries+				
Electronics/Other electric eq	7.1	5.3	4.3	13.9
Ind. Machinery & eq	0.8	2.4	1.6	7.9
All manufacturing	1.8	2.9	2.3	2.9

TABLE 2: Performance indicators, selected industries, Canada 1990-97

Industries	Increase in manufactured shipments %	Increase in exports to US %
Aircraft and parts (SIC 3211)	12.1	35.8
Telecommunications equipment (SIC 3351,3359)	38.2	248.9
Electronics equipment (SIC 3352, 3361)	174.2	99.0
Instruments (SIC 3911, 1912)	20.9	130.0

Source: Industry Canada website

Note: Raw data are in constant (1986) \$

Table 3: Toronto Survey: Response Rates

	Foreign affiliates	Domestic firms	Additional smaller domestic firms	Total
Identified	58	122	44	244
Declined to participate	0	28	25	53
Sent questionnaire	58	94	19	171
Participants	25	37	4	66
Response Rate	43%	30%	9%	27%
Questionnaire completion rate	43%	39%	21%	39%

TABLE 4: Toronto Survey: Structure

a. Industry classification and Ownership

Industry	Ownership of Firm		Total
	Foreign	Domestic	
Telecommunications	5	13	18
Electronic Parts and Components	10	18	28
Aerospace	3	4	7
Scientific and Professional Equipment	7	6	13
Total	25	41	66

b. Establishment size and Ownership

Establishment size	Ownership of firm		Total
	Foreign	Domestic	
Small	14	30	44
Large	11	11	22
Total	25	41	66

c. Industry and establishment size

Industry classification	Establishment size		Total
	Small	Large	
Telecommunications	14	4	18
Electronic Parts and Components	19	9	28
Aerospace	2	5	7
Scientific and Professional Equipment	9	4	13
Total	44	22	66

TABLE 5: Survey Statements organized by Potential structural impacts of free trade

1	Preparation for free trade
I	Production and product technology in 1980s appropriate for FT environment
2	Rationalization of production
II	Opportunity to reduce its range of products
3	Out-sourcing
III	Sub-contracted or out-sourced increased amount of product assembly
IV	In-house production reduced
V	Greater out-sourcing of components / sub-assemblies
VI	Increased contract manufacturing for other firms - domestic firms
4	Reorganization of firms
VII	Increased level of strategic planning
VIII	Marketing / Distribution functions more important compared with manufacturing
IX	Closer integration with parent - foreign firms
X	New product mandates since FTA - foreign firms
5	Product and process innovations
XI	Stimulated to invest in new production technology
XII	Led to increases in productivity
XIII	Greater product innovation
XIV	Induced rate of product development - domestic firms
6	Reduced exchange value of \$Cdn
XV	Decline in \$Cdn has boosted export sales

TABLE 6: Export orientation: Toronto sample

Percent of sales exported	Foreign	Domestic	Total
0-25	14	11	25
26-50	1	4	5
51-75	1	5	6
76-100	9	19	28
Total	25	39	64

0-25	14	11	25
26-100	11	28	39
Total	25	39	64

$X^2=4.944$ (0.026)

TABLE 7: Frequency of Input shares from Greater Toronto Area: Sample

	# Foreign affiliates	# Domestic firms	Total firms
0-25 %	15	14	29
26-100 %	4	23	27
Total %	19	37	56

$\chi^2=8.497$ (0.000)

TABLE 8: Average scores for Trade Response Statements

	N	Mean	Standard deviation	Coefficient of Variation %
Production and product technology in 1980s appropriate for FT environment	66	3.5	1.0	29.0
Greater out-sourcing of components / sub-assemblies	66	3.3	1.2	37.6
Marketing / Distribution functions more important compared with manufacturing	66	3.2	1.2	37.9
Sub-contracted or out-sourced increased amount of product assembly	66	3.1	1.4	44.6
Increased level of strategic planning	66	3.1	1.1	34.3
Decline in \$Cdn has boosted export sales	66	3.0	1.1	37.7
Led to increases in productivity	66	2.9	1.0	34.7
Stimulated to invest in new production technology	66	2.7	1.1	42.3
Greater product innovation	66	2.7	1.0	37.6
In-house production reduced	66	2.5	1.4	56.0
Opportunity to reduce its range of products	66	2.3	1.0	42.4
Closer integration with parent since FTA (foreign)	25	4.0	0.9	22.8
Induced rate of product development domestic firms	40	2.7	1.0	38.6
New product mandates since FTA (foreign)	25	2.6	1.2	48.0
Increased contract manufacturing for other firms - domestic firms	41	2.5	1.1	44.4

TABLE 9: First Component Trade Response: Increases in innovation and productivity

		Rotated Loadings >0.130
XI	Stimulated to invest in new production technology	0.736
XII	Led to increases in productivity	0.855
XIII	Greater product innovation	0.771
VII	Increased level of strategic planning	0.834
II	FTA reduced product range	0.574
VIII	Marketing / Distribution functions are more important since FTA	0.741

Note: Varimax rotation; 32% variance associated with first principal component

ⁱ Tariff reductions were less than in some product areas such as furniture, clothing and textiles and were in the range of 5—10%. Neither of the trade agreements resolved NTBs especially in the U.S. and for that reason “freer” trade is sometimes applied as a more apt description.

ⁱⁱ Blank and Haas (1998) give the example of parent head-offices orchestrating the changes for some high technology firms, such as GE. In this case, the parent company acquired the Canadian financial entity so that full integration of the Canadian unit could occur with the company's U.S. Strategic Business Units.

ⁱⁱⁱ On average these are 30% of the possible frequencies for statements intended for all respondents.

^{iv} An alternative would be to develop a Likert scale incorporating variables from the survey.