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Distinguishing Characteristics of Foreign High Technology acquisitions in Canada's Manufacturing Sector

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DISTINGUISHING CHARACTERISTICS OF FOREIGN HIGH TECHNOLOGY ACQUISITIONS IN CANADA'S MANUFACTURING SECTOR

by

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ABSTRACT: Considerable interest in the effect of mergers in high technology industries exists because this sector is seen to be strategically important for industrial policy. This paper investigates the effect of mergers in this sector, comparing them to mergers in other industries. The effect of nationality is also examined. The paper outlines the magnitude of divestitures and acquisitions. It asks how important this is relative to turnover arising from plant opening and closing. It then analyzes the impact of mergers on labour productivity, wages, and salaries.

KEY WORDS: Mergers, High Technology Industries, Turnover

INTRODUCTION

High technology industries, requiring a skilled, educated workforce, are generally acknowledged as a means to a vibrant, competitive economy, providing jobs and growth potential at a high rate of expansion.[1] Given the educational and scientific infrastructure that exists in Canada, and the difficulty of competing in certain industrial sectors with newly industrialized countries in the Far East, because of a discrepancy in unskilled labour wage rates, the incentive to transfer resources from unskilled labour-intensive products and processes up the value-added chain to the more knowledge-based high technology activities is seen as a high priority.[2]

Governments in Canada employ a number of instruments, such as taxes and grants, that directly promote high technology industries.[3] Such instruments are designed to help attain nationally set research and development (R&D) targets. There are, however, other instruments that have an indirect impact on high technology industries. One of these is the screening of investment of new foreign-owned firms into an industry, either in the form of acquisitions or the building of new plant. Such a policy has been in effect in Canada since the mid-1970s, with the introduction of the Foreign Investment Review Act, and its subsequent repeal and replacement with the 1985 Investment Canada Act. The latter gives the regulatory body less supervisory authority, but still leaves it with the responsibility of overseeing foreign acquisitions.

If foreign investment is to be used efficaciously, then the forces behind it must be fully understood. A variety of factors have been used to explain the substantial foreign, particularly U.S., ownership of Canada's manufacturing sector.[4] These factors include tariffs, control of scarce resources, and the exertion of monopoly power. Of particular importance in the present context is the view that foreign firms invest abroad because they own a technology-based asset, such as an innovation, that gives them a competitive advantage in foreign markets. The advantage derives from the fact that the asset is a public good within the firm, since the costs of creating and marketing the asset have already been incurred by the firm. As such, exploitation of the asset in another jurisdiction requires only the costs of local adaptation.

When the transaction costs of transferring technology from one country to another are sufficiently high, the favoured method of maximizing the value of the asset is through direct investment abroad, rather than an arm's-length transaction, such as a license agreement or sale. Transfer costs are posited to be high where an asset resides in an individual or research team and is not easily communicated or disembodied independent of the team. Appropriability problems may exist if the asset cannot be easily protected from imitation, through, for example, a patent or trademark. Even if the asset can be protected from imitation, the method itself--for example, secrecy--may preclude its sale or license in an arm's-length transaction.

Transfer is perceived to be particularly difficult in high technology industries. When the asset is on the leading edge of technology, not only do appropriability problems arise, but there is also likely to be greater variance in the perceived value of the asset. This makes an agreement on price and other

terms and conditions for sale or license difficult to reach. There is some evidence consistent with this view. The mean age of new technology transferred abroad within the corporation is lower than that transferred at arm's length-- 6 to 7 years compared to 9 to 13 years, depending on the study.[5]

The impact of direct foreign investment in Canada has been the subject of much debate.[6] While there has been general agreement that such investment has brought Canada considerable benefits, concern has been expressed in some quarters that foreign investment, particularly by acquisition, is likely to lead to the "underdevelopment" of the R&D function in Canada. The Task Force on the Structure of Canadian Industry, voiced a concern that has subsequently been taken up by other reports:[7]

> While the ease with which foreign capital could be imported via portfolio and direct investment, skilled manpower via immigration, and technology and entrepreneurship via direct investment has expanded the size and complexity of the economic base and increased opportunities for Canadians, it has, at the same time, diminished the pressures for Canada to develop these skills amongst Canadians to their fullest extent (1968, 20).

In this view, although direct foreign investment provides Canada with access to new technology, the R&D function is likely to reside in the foreign firm's home country. The Canadian subsidiary is regarded as a truncated firm, because of the absence of this function from its operations.

Although by no means commanding universal approval, the screening of foreign investment has been advocated as a method of increasing R&D in Canada.[8] The review agency is seen as providing encouragement to R&D by forcing foreign firms to exploit their technology-based asset through licensing and joint ventures with Canadian-owned firms, rather than by direct investment.[9] Alternately, the agency is seen as the instrument to direct the transfer of R&D functions to Canada from the home country of the foreign-owned firm. Indeed, it has been suggested that the agency could ensure that the Canadian subsidiary be given a world mandate for a particular product, whereby all the functions associated with the production, marketing, and R&D would reside in Canada.[10]

Irrespective of the merits of a review agency for inward investment into Canada, one has existed, in one form or another, for nearly twenty years. Despite this experience, different views still exist as to the appropriate approach to be adopted toward foreign investment into Canada and, in particular, whether special policies need to be implemented for the high technology sector. The object of this paper is to provide an overview of acquisitions in high technology industries in Canada, which can be used as input into the policy process.

Surveillance of foreign acquisitions in high technology industries is a form of regulation. Government regulation is useful only when a perceived problem can be shown to exist and when regulation can be efficaciously applied. This study is aimed at the former, not the latter issue. The case study approach is far better suited to understanding the complexity of the problems associated with successful intervention by regulatory authorities. Here a broad overview of the high

technology sector is used to investigate the extent to which problems exist with foreign acquisitions in high technology industries.

The paper is divided into five parts. The first section discusses the definition of the high technology sector. It is not a straightforward task to isolate the industries that should be examined.

The second section asks whether differences between high technology and other industries exist and quantifies the extent of the differences. If a specific focus of policy is to be placed on the high technology sector, it is important to know how different this sector is from other manufacturing industries.

The third section focuses, not on inter-industry differences, but on the differences between foreign and domestic firms, both in the high technology sector and in other industries. Since a foreign investment review policy focuses on only one sector of the industrial population, it is important to know whether there are differences between foreign and domestic firms in order to evaluate its usefulness.

The fourth and fifth sections address the most important issues facing government intervention. What is the magnitude of the process that it is regulating and what is its effect? In answering the first question, the fourth section of the paper outlines several factors that lead to the turnover of firms and sets the importance of the acquisition and divesture process that forms the basis of regulation in context. It asks whether the acquisition and divestiture process is important relative to entry and exit, growth and decline in the incumbent sector--all of which are also affecting the relative importance of the domestic and foreign sector. It is important to know whether this is the case if the relative size of the regulatory task and its potential benefits and costs are to be evaluated. Finally, the fifth section of the paper addresses the effects of foreign takeovers. Once more, a comparative approach is taken. Foreign takeovers are compared to domestic takeovers in the high technology sector and in the rest of the manufacturing sector. The purpose of this exercise is to ask whether there is evidence that foreign takeovers beneficially affect productivity and the income of employees.

I. A MATTER OF DEFINITION: WHAT IS A HIGH TECHNOLOGY INDUSTRY?

High technology manufacturing industries produce goods and/or processes involving the use of R&D and science that is on the frontier of man's knowledge. In some instances, the industry may generate the knowledge itself; in others, it may incorporate such knowledge in a new product. Synonyms such as "advanced technology", "core technology", "strategic technology", and "leading-edge technology" are all consistent with this general view as to what constitutes high technology.

High technology industries are usually defined in terms of their use of R&D.[11] Use or intensity is measured in a number of ways, including the ratio of R&D personnel to employment or R&D expenditures to sales. Such ratios are meant to proxy the quantity of technology embodied in the industry's sales.[12] They

have been used by governments to set R&D targets at the level of the economy[13] and the industry.[14]

Despite the widespread use of R&D intensity measures, there are a number of practical and conceptual difficulties in their application.[15] First, there are several indicators of R&D intensity that can be used, either separately or together.[16] Some of these are not always available at a sufficiently disaggregated industry level to suit the analysis at hand.[17] Second, the cut-off between high technology and other industries has to be determined.[18] Industries typically contain a mix of high technology and other outputs.[19] Third, for any given criteria, the set of high technology industries may vary through time, thereby complicating intertemporal study.[20] Fourth, high technology industries can be defined by reference to either national or international R&D intensities. The advantage of international intensities is that they probably fairly accurately reflect the magnitude of the technology embodied in an industry's output. If the R&D function in Canada is truncated, its R&D ratios may not be appropriate.

An OECD study (1986, Table 2.11, p. 59) has defined a set of high technology industries that overcome some, but not all, of the above difficulties. It is based upon eleven reference countries, not just Canada. These include Japan, the U.S., and Germany. The OECD concluded that its chosen set of high technology industries "have special characteristics enabling them to be considered together as a specific group" (ibid.,p.61).

High technology industries were defined by the OECD study where the R&D expenditure to production ratio, across the eleven reference countries, exceeded 4%.[21] In terms of the Canadian Standard Industrial Classification, ten industries, which are listed in Table 1, are used in this study to represent the high technology sector. These ten industries accounted for five of the leading Canadian manufacturing industries ranked by R&D to sales ratio, but eight out of the leading ten when a more inclusive measure of R&D is used.[22]

II. ARE HIGH TECHNOLOGY INDUSTRIES DIFFERENT?

Interest in the characteristics of high technology industries is related to advantages that these industries are seen to possess. The impression is often conveyed that high technology industries have been growing rapidly and that they have a high proportion of good "jobs", two attributes that attract government interest and support. At issue here is the extent to which this is true. If high technology industries do indeed have certain desirable characteristics, then the question as to the importance and impact of foreign ownership can be addressed.

Other characteristics are also relevant to the debate over the policy problems that are specific to high technology industries. Foreign ownership is likely to be particularly important in high technology industries, because foreign firms often have special advantages in such industries. These industries frequently are also highly concentrated. In some reports, foreign ownership is seen to bolster the anti-competitive effects of a concentrated market.[23] This raises the possibility that such investment may have adverse consequences for competition. Hence the

TABLE 1

THE HIGH TECHNOLOGY INDUSTRIES[1]

4-Digit SIC Code	Industry Title
3210	Aircraft & aircraft parts manufacturers
3180	Office & store machinery manufacturers
3340	Manufacturers of household radio & television receivers
3350	Communications equipment manufacturers
3740	Manufacturers of pharmaceuticals and medicines
3911	Instrument & related products manufacturers
3912	Clock & watch manufacturers
3913	Orthopaedic & surgical appliance manufacturers
3914	Ophthalmic goods manufacturers
3360	Manufacturers of electrical industrial equipment

1 This set is based upon OECD (1986, Table 2.11, p.59), which lists six ISIC industries as high technology: aerospace; office machines, computers; electronics and components; drugs; instruments; and electronic machinery. These are defined in more detail in OECD (1984, Table 4, p.361). These industries are then matched to the 1970 Canadian 4-digit SIC using Dominion Bureau of Statistics (1970) and Baldwin and Gorecki (1986, Table A-2, pp. 210-215).

Source: Baldwin and Gorecki (1986, Table A-2, pp. 210-215); Dominion Bureau of Statistics (1970); OECD (1984, Table 4, p.361; 1986, Table 2.11, p.59) and Special Tabulations, Business and Labour Market Analysis, Statistics Canada.

size distribution of firms in high technology and other industries needs to be examined.

Another indicator of the openness to competition is the intensity of foreign trade. Since the OECD has identified trade variables as an important source of difference between high technology and other industries, both the export and import intensities are relevant. To the extent that high technology industries are more open to international trade, concerns about competition relating to domestic market structure are less justified.

Five sets of industry characteristics are employed to contrast high technology with all other Canadian manufacturing industries. These are: R&D; foreign ownership, trade and tariffs, firm size distribution, and growth and jobs. Table 2 contains summary statistics for each of these characteristics and tests the null hypothesis that the means for each of these characteristics, across the two groups of industries, are the same.[24]

The mean level of R&D intensity is, as expected, greater in the high technology industries (2.7% of sales) than for other industries (0.2%). Nevertheless, the level of R&D in high technology industries is below the 4% cut-off used by the OECD. Thus, it could be argued that Canada does not have a high technology sector that makes much use of the results of R&D.

This would be incorrect. A more complete picture would take into account technological payments made outside Canada for R&D and other technology, in measuring the quantity of technology embodied in an industry's output. Foreign ownership is important in Canadian manufacturing industries, particularly in high technology industries. Foreign firms are more likely to import technology. Table 2 is consistent with this view. If payments for technology are added to R&D conducted in Canada, then the mean R&D intensity is raised to 4.4% of sales in high technology industries, 0.3% in other industries.[25]

Foreign ownership is also, as expected, more important in high technology than other industries. In 1970, foreign-controlled firms accounted for about 80% of the shipments of high technology industries, and half that amount in other industries. During the 1970s, the incidence of foreign ownership fell by more than 10 percentage points in the high technology group, but showed a much smaller percentage point decline in other industries. This fall in the importance of foreign ownership continued into the 1980s: for the high technology set, the level fell to 65% in 1986; for other industries, the percentage reached 36%.

In sum, over the period 1970-86, foreign ownership declined in Canada's manufacturing sector, irrespective of the technological intensity of the industry. However, the rate of decline was greatest in high technology industries. This is consistent with the observation that foreign firms have become increasingly receptive to arm's-length transactions, compared to direct investment, as a way to exploit their technology-based assets.[26]

The panel of trade and tariff characteristics presented in Table 2 is consistent with the OECD (1986) results. In high technology industries, trade was found to be more important than for other manufacturing industries. In 1979, high technology industries had mean import penetration and export intensity ratios that were twice those of low technology industries. The import and export intensities in 1979 reflected, in part, the much larger increase in intra-industry

TABLE 2

STRUCTURAL CHARACTERISTICS OF HIGH TECHNOLOGY AND OTHER INDUSTRIES, CANADIAN MANUFACTURING SECTOR, 1970, 1979

Structural Characteristics	Industry Grouping[1]		Hypothesis: the Means Are Equal[13]
	High Technology	Other	
	Mean (Standard Error of Mean)		
	R&D characteristics[2]		
1. R&D to sales ratio[3] (%)	2.71 (0.95)	0.21 (0.03)	rejected (0.05)
2. Technology payments to sales ratio[4] (%)	1.67 (0.95)	0.05 (0.01)	not rejected
	Foreign Ownership Characteristics		
3. Proportion of industry shipments accounted for by foreign controlled[5] firms (%)			
1970	82.74 (4.23)	42.76 (2.36)	rejected (.01)
1979	70.20 (6.43)	39.70 (2.32)	rejected (.01)
	Trade and Tariff Characteristics[6]		
4. Imports as a proportion of domestic disappearance (%)			
1970	42.35 (6.53)	18.84 (1.54)	rejected (.01)
1979	59.22 (7.51)	26.84 (7.42)	rejected (.01)
5. Exports as a proportion of domestic production (%)			
1970	18.41 (4.97)	13.67 (1.77)	not rejected
1979	34.16 (8.25)	17.90 (2.59)	not rejected
6. Nominal tariff protection (%)			
1970	7.41 (1.02)	11.97 (1.18)	rejected (.01)
1978	6.30 (8.33)	10.36 (0.68)	rejected (.01)

Firm Size Distribution Characteristics			
7. The Herfindahl Index of concentration[7]			
1970	0.1693	0.1119	rejected
	(0.0288)	(0.0076)	(.10)
1979	0.1575	0.1120	not rejected
	(0.0216)	(0.0091)	
8. Average firm size (in terms of number of production and salary workers)[8] (#)			
1970	177.05	167.59	not rejected
	(44.51)	(23.79)	
1979	105.55	172.33	rejected
	(22.32)	(29.99)	(.10)
Growth and Job Characteristics			
9. Annual industry growth rate (%)			
1) unweighted, annual, 1970-79[9]	4.23	2.39	rejected
	(1.48)	(0.26)	(.10)
2) weighted, Cumulative 1970-79[10]	37.0	45.0	not tested
10. Average Annual Income[11] ($000's)			
a) Production worker			
1970	5.861	5.832	not rejected
	(0.278)	(0.112)	
1979	13.354	13.915	not rejected
	(0.544)	(0.262)	
b) Salaried Worker			
1970	8.944	8.474	not rejected
	(0.296)	(0.081)	
1979	19.072	19.061	not rejected
	(0.391)	(0.195)	
c) All workers			
1970	6.998	6.389	not rejected
	(0.334)	(0.108)	
1979	15.162	14.897	not rejected
	(0.591)	(0.251)	
Growth and Job Characteristics			
11. White collar jobs as a proportion of industry employment[12] (%)			
1970	36.18	22.96	rejected
	(3.26)	(0.78)	(.01)
1979	31.92	21.03	rejected
	(3.15)	(0.73)	(.01)

1 See Table 1 for the identity of the high technology industries. The other industries are the 167-4 digit industries into which the manufacturing sector is divided less the high technology industries. Since one variable could not be calculated for this set of other industries, the set was generally 156, not 157. However, in some instances, slightly different sample sizes are used. See notes for details.

2 Technology characteristics are the mean of the given ratio for 1975 and 1979. The R&D ratios were available at the 3-digit level and then spread to the 4-digit level -- the level of aggregation at which acquisition and other industry characteristics are available. Full details of how these R&D data are constructed may be found in Statistics Canada (1984), while Baldwin and Gorecki (1986, Table A-2, pp. 210-215) contains the 3- and 4- digit industry classification systems used herein.

3 R&D is measured as current intramural expenditures on R&D.

4 Payments made outside of Canada for R&D and other technology (net of withholding taxes).

5 A firm is defined as foreign controlled if there is effective foreign control, although the percentage of stock owned by the foreign corporation may be less than 50 per cent. Of the high technology set of industries, no published data is available for SIC = 3194 for 1970 due to confidentiality requirements of the Statistics Act. Hence, for both 1970 and 1979, the importance of foreign ownership is estimated across nine, not all ten, of the high technology industries. The impact of this omission is to bias upward the importance of foreign ownership. In 1979, for example, with all ten high technology industries included, the importance of foreign ownership declines from 70.20 per cent to 66.06 per cent.

6 For more details of the procedure used to define the tariff and trade variables, see Baldwin and Gorecki (1986, Appendix A, pp 172-182).

7 The Herfindahl index of concentration is defined as the sum of squares of the market share held by each firm. It will vary between 1 (the industry contains a single firm) and 1/N, where N is the number of firms, all of which are of equal size.

8 A firm is defined as all plants under common control in an industry -- the unconsolidated enterprise concept.

9 Annual growth rate of value of shipments in real terms, 1970-1979. For derivation, see Baldwin and Gorecki, 1986.

10 The rates of 1979 shipments divided by 1970 shipments (both measured in 1979 dollars) minus 1 and weighted by 1970 value of shipments when the weighted mean is calculated.

11 Income refers to gross earnings of workers from salaries and wages before deductions of any kind, such as income tax, unemployment insurance and pension benefits. Note that workers are defined in person-year equivalents. For further details see Statistics Canada (1979, p.26) and the next note.

12 The percentage of total industry employment (production plus salaried workers) accounted for by salaried workers. The latter are sometimes referred to as non-production workers. For details of this distinction between production and salaried workers, see Statistics Canada (1979, pp. 23-24).

13 The procedure employed computed t- statistics for the hypothesis that the means of the high technology and other industries were equal. Account was taken of whether the variances were equal or not.

Source: Special Tabulations, Business and Labour Market Analysis, Statistics Canada.

trade over the decade in high technology industries. Consistent with this pattern were the substantially lower tariffs in high technology industries.

The firm-size distribution characteristics indicate that high technology industries are more concentrated than other industries. The degree to which industry output is controlled by a small number of producers, captured by the Herfindahl index, is much greater in high technology than other industries. A similar result was recorded if an alternative measure of concentration was used, the proportion of output accounted for by the leading four producers. Average firm size in high technology industries decreased substantially over the decade; in other industries, it rose marginally. The net result was that, by the end of the decade, average firm size in high technology industries was below that in other industries, despite the higher levels of concentration.

The final set of industry characteristics refer to growth rates and the nature of the jobs created, since high technology industries frequently are thought of as providing good jobs and experiencing high growth rates. The data in Table 2 do not support this characterization of high technology industries.

The evidence on growth rates does not suggest that high technology industries in Canada are the engines of change. If growth is calculated from annual changes over the decade, the simple mean growth rate in high technology industries (4.23) is higher than that in other industries (2.39). But annual averages cover large swings in growth rates. Annual growth rates in the high technology sector had much greater variance. Moreover, growth was not spread evenly over all industries. The largest suffered from lower growth rates. As a result, the cumulative effect of change over the decade of the 1970s on the high technology sector was less than in other industries. When growth rates in the real value shipments are weighted by size of industry,[27] the mean cumulative growth rate in the high technology sector was only 37%; for all other industries, it was 45%.

Two indicators of job quality are presented in Table 2--the importance of white-collar workers and the annual incomes of production and salaried workers. High technology industries provide a markedly greater percentage of total jobs in the white-collar class compared to other industries. However, the incomes of production and salaried workers in high technology industries were not markedly better than those in other industries.[28] In 1979, for example, annual salary incomes for non-production workers in high technology industries exceeded those in other industries by only $11.00; the annual income for production workers was $561 lower. Because this result differs from the picture that some have drawn about the desirability of jobs in high technology industries, two other sources of data on relative levels of remuneration were used to verify this finding.[29] This suggests, unless high technology jobs are themselves inherently more pleasant or have greater security, that the rents, which are sometimes assumed to exist in high technology industries, are not captured by labour.

In sum, high technology industries do exhibit several of the characteristics that have caused them to receive special attention compared to other manufacturing industries: R&D intensity is higher; foreign ownership is greater; openness to foreign competition is more marked; white-collar jobs are more prevalent; concentration is somewhat higher. Nevertheless, not all of the *a priori*

expectations were confirmed. Growth rates were generally not higher, and incomes of production and salaried workers were not noticeably different in high technology than in other industries. High technology industries would thus appear not to be the engine of high income jobs, although a greater percentage of employment therein was in the white-collar class.

III. CHARACTERISTICS OF FOREIGN AND DOMESTIC FIRMS

While the characteristics of high and low technology industries differ in some important respects, this comparison alone cannot depict the extent to which there should be a particular interest in the performance of foreign-owned firms in this sector compared to other sectors. Information is required on the extent to which foreign firms differ from domestic firms in the high technology sector and whether these differences are reflected in other sectors. To this end, certain characteristics of foreign and domestic firms are compared in high technology and other industries.

The characteristics examined here are: the degree of firm and plant specialization, labour productivity, incomes of production and salaried workers, and the importance of white-collar jobs. For each industry, the ratio of the mean value of each characteristic for all foreign-owned plants was divided by the mean for all Canadian-owned plants. The mean value of this ratio, calculated separately across all of the high technology and other industries for which there were observations, is reported in Table 3. The standard error of each mean value is provided in brackets.

For all industries, the parents of foreign-owned plants[30] were more diversified across industries; within each industry, foreign-owned plants were more specialized. Foreign-owned plants were more productive, but paid incomes to production and salary workers that were much the same as those paid by domestically owned firms. Finally, foreign-owned plants tended to have a larger proportion of their total workforce classified as white-collar workers.

The difference between foreign and Canadian-owned plants in the high technology sector compared to all other industries depicted in Table 3 is one of degree. In order to provide a more precise test than is available from the industry means utilized in Table 3 and to distinguish both industry and ownership effects simultaneously, the characteristics of all plants were, separately, regressed on dummy variables representing the domestic ownership of the plant, DOM, and whether it was in a high technology industry, HITECH. An interactive variable, DOM.HITECH, was used to capture the additional advantage (disadvantage) suffered by domestic plants in high technology industries. The signs and significance of the resulting coefficient estimates are presented in Table 4, along with the net effect of being a domestic firm in a high technology industry (NET).

In general, domestically owned plants, compared to foreign-owned plants, were: part of a parent that was more specialized, less specialized themselves, less productive, and characterized by lower production and salary incomes. On the other hand, domestic plants in high technology industries were more specialized and belonged to parents that were more diversified than their domestic

TABLE 3

THE RATIO OF SELECTED CHARACTERISTICS OF FOREIGN TO CANADIAN OWNED PLANTS, ACROSS HIGH TECHNOLOGY AND OTHER INDUSTRIES[1], CANADIAN MANUFACTURING SECTOR, 1970-1979

Characteristics	Industry Grouping	
	High Technology	Other
	Mean Ratio of Foreign to Canadian Owned Plants[2] (Standard Error of Mean)	
Firm Specialization[3]		
1970	0.81	0.79
	(.031)	(.025)
1979	0.83	0.80
	(.027)	(.020)
Plant Specialization[4]		
1970	1.36	1.17
	(.161)	(.037)
1979	1.27	1.17
	(.112)	(.032)
Labour Productivity		
a) Value Added Per Employee[5]		
1970	1.27	1.31
	(.110)	(.032)
1979	1.27	1.42
	(.071)	(.040)
b) Shipments Per Employee[5]		
1970	1.54	1.32
	(.253)	(.039)
1979	1.26	1.44
	(.093)	(.071)
Annual Average Income[6]		
a) Production Worker		
1970	1.04	1.11
	(.044)	(.012)
1979	0.99	1.08
	(.051)	(.012)
b) Salaried Worker		
1970	1.05	1.10
	(.042)	(.011)
1979	1.02	1.00
	(.032)	(.017)

White collar jobs as a proportion of industry employment[7]		
1970	1.17	1.18
	(.162)	(.029)
1979	1.07	1.20
	(.110)	(.033)

1. The definition of the industry groups is found in note 1, Table 2.
2. The ratios were calculated by taking the mean value of a characteristic for foreign and domestic plants in each 4-digit industry and dividing the former by the latter, then taking the average across all 4-digit industries in the particular industry grouping.
3. Firm specialization is the Herfindahl of the parent's specialization across all 4-digit industries in manufacturing, mining and logging.
4. Plant specialization is the Herfindahl of plant shipments at the 4-digit ICC commodity level. There are 2,336 4-digit ICC commodities. Details of the calculation of the Herfindahl Index at the plant level are found in Baldwin and Gorecki (1986, p. 179).
5. Total employment is defined as all production and salaried workers.
6. See note 10 to Table 2.
7. See note 11 to Table 2.

Source: Special Tabulations, Business and Labour Market Analysis, Statistics Canada.

TABLE 4

RESULTS OF THE REGRESSION[1] OF PLANT CHARACTERISTICS ON INDUSTRY AND OWNERSHIP DUMMY VARIABLES, CANADIAN MANUFACTURING SECTOR, 1979

	Characteristic[2]				
				Annual Average Income	
Dummy Variables	Firm Specialization	Plant Specialization	Labour Productivity	Production Worker	Salaried Worker
DOM	+*	-*	-*	-*	-*
HITECH	+*	-*	-*	-*	-
DOM. HITECH	-*	+*	+*	+*	+
NET	+*	+*	-*	0	+

1. A separate regression was estimated for each plant characteristic. The independent variables were: DOM = 1, when the plant is domestically-owned, zero otherwise; HITECH = 1, when the industry to which the plant is classified is high technology, zero otherwise; and the product of DOM and HITECH. NET is the net effect of being a domestic plant in a high technology industry (i.e., DOM + DOM. HITECH). The regression was estimated across all plants for 1979 in the Canadian manufacturing sector.
2. The characteristics are defined in Table 3. Labour productivity is measured as value added per worker.

* Significant at the 1% level.

Source: Special Tabulations, Business and Labour Market Analysis Group, Statistics Canada

counterparts in other industries. They suffered less of a productivity disadvantage, though on net were still significantly less productive than foreign plants. The annual production worker income differential between domestic and foreign plants was also less in high technology industries and not significantly different from zero. There was no significant differential in salary income.[31]

In summary, the difference between foreign and domestic plants in high technology industries is less than that found elsewhere. If a regulatory policy of intervention in high technology industries is to be based on the notion that domestic plants suffer a particularly large disadvantage in the high technology sector, these data show that the policy would be ill-conceived.

IV. DIVESTITURES AND ACQUISITIONS IN HIGH TECHNOLOGY INDUSTRIES

Research Methodology

The role of screening acquisitions in high technology industries will depend not only on the importance of acquisitions but also on the significance of other forms of firm turnover, such as the building of new plant. If the dominant method of firm turnover in high technology industries is foreign acquisition and divestiture, then the potential role for screening will be substantial, particularly if the numbers involved are small. Similarly, the potential effect (beneficial or otherwise) will be large. On the other hand, if plant acquisition is relatively unimportant, compared to plant opening or closing, then the role for a screening agency that concentrates on acquisitions will be that much more limited. Other policy instruments will be required to control foreign ownership in high technology industries.

Knowledge of the turnover process is important for an even more fundamental reason. Firm turnover implies change. Change means that *ex ante* plans are not realized. In a world where this is prevalent, it is difficult for governments to extract concessions from firms, for several reasons. First, firms are coming and going at such a rate that the administrative process will prove to be extremely costly. Second, change implies that it is difficult to predict success and, therefore, to forecast the profit potential or rent that can be extracted from the entrant by a monitoring agency. It means that *ex ante* agreements will have to be modified, thereby increasing the costs of the administrative process.

The importance of the turnover process is assessed here by an examination first, of the magnitude of turnover and, then, of its impact. The amount of turnover in high technology industries is compared to that elsewhere in the Canadian manufacturing sector. This provides one indicator of the magnitude of the phenomenon. It reveals how concentrated the various components of turnover are, and whether the high technology sector is characterized by more or less activity than other industries. Second, the intensity of turnover in each of these sectors is outlined. This gives another indicator of magnitude that also provides a first impression of the impact of the process. Third, differences between the characteristics of foreign and domestic entrants and exits, acquisitions and

divestitures are presented in order to complete the analysis of the impact of turnover.

Firm divestiture and acquisition need to be set in the context of the overall process of firm turnover. Firm turnover is broadly defined as the rise and fall of producers. Some gain market share, others lose share. In some instances, firms may decline to the point that they exit, to be replaced, in part, by new producers. As part of this process, firms build plants, close others, and expand already existing facilities. In addition, firms expand and decline, enter and exit industries, through ownership changes.

Using a specially created database at Statistics Canada, relying on the Census of Manufactures, the firm-turnover process in Canada's manufacturing sector during the 1970s can be described in detail.[32] Individual firms and plants are assigned unique identifiers, so that they can be both linked and tracked through time. Country of control and various other characteristics are also recorded.

Two categories of entrants and exits were chosen for analysis here. These are: acquisitions and divestitures that bring new firms into an industry (acquisition entrants) or are associated with firms leaving an industry (divestiture exits); entrants via plant openings (greenfield entrants) and firms that exit by closing plant (closedown exits). An additional category of plant openings and closings by continuing or incumbent firms was also employed.

Acquisitions and divestitures include plants that physically existed in both 1970 and 1979, but that underwent a control or ownership change in that period that resulted in the entry or exit of a firm. Closures and openings include plants that died or were born in a particular 4-digit SIC industry. Closures include plants that existed in 1970, but not 1979; openings include plants that existed in 1979, but not 1970.[33] Thus, closures refer to all plants from the 1970 population that exited in any one of the next nine years; openings to plants in the 1979 population that were born in any one of the previous nine years. It is the cumulative impact of entry and exit over the 1970s, not the transitory or short-term impact that is being measured here.[34]

While there are other dimensions to turnover, such as growth and decline in the incumbent sector and horizontal mergers, it is the entry process (particularly via acquisition) that provides the focal point for intervention by the foreign investment review process and is, therefore, the focus of this study.

The Importance of High Technology Industries in the Firm Turnover Process

In characterising the firm turnover process, the first issue to be addressed is the extent to which high technology industries account for a large proportion of all acquisitions and divestitures, openings and closings in the manufacturing sector. Importance is measured here by value added. The distribution of value added for each plant/firm category across the high technology and other industry groupings, as well as the distribution of manufacturing sector value added, is presented in Table 5.

TABLE 5

THE DISTRIBUTION OF PLANT DIVESTITURES, ACQUISITIONS, CLOSURES AND OPENINGS, HIGH TECHNOLOGY AND OTHER INDUSTRIES, BY VALUE ADDED, CANADIAN MANUFACTURING SECTOR, 1970-1979.

Plant/Firm Category	Industry Grouping		
	High Technology[1]	Other[2]	Total
	Distribution of Value Added in Each Category[3]		
Plant Divestitures[4]			
Exiting Firms	8.28	91.72	100
Continuing Firms	13.97	86.03	100
Plant Closures[5]			
Exiting Firms	7.08	92.92	100
Continuing Firms	14.01	85.99	100
Industry Value Added			
1970	9.29	90.71	100
Plant Acquisitions[6]			
Entering Firms	10.81	89.19	100
Continuing Firms	1.75	98.25	100
Plant Openings[7]			
Entering Firms	6.66	93.34	100
Continuing Firms	10.93	89.07	100
Industry Value Added			
1979	7.84	92.16	100

1. See Table 1 for the identity of the 10 high technology industries.
2. The other industries are the 167 4-digit industries into which the manufacturing sector is divided less the high technology industries. Since one of the characteristics in Table 2 could not be calculated for this set of industries the set is 156 rather than 157.
3. Divestitures and closures refer to the distribution of value added as of 1970; acquisitions and openings as of 1979.
4. Divestitures refer to plants that were classified to the industry in both 1970 and 1979, but owned by a different firm in 1970 and 1979. In some instances, the owning firm no longer existed in 1979, (exiting firms); in others, it still existed in 1979 (continuing firms).
5. Closures refer to plants that were classified to the industry in 1970 but not 1979. In some instances, the owning firm no longer existed in 1979 (exiting firm); in others, it continued to exist in 1979 (continuing firms).
6. Acquisitions refer to plants that were classified to the industry in 1970 and 1979, but owned in 1979 by a new firm (entering firms); in others, a firm that existed in 1970 and 1979 in the industry (a continuing firm).
7. Openings refer to plants that were classified to the industry in 1979, but not 1970. In some circumstances,

The importance of high technology industries in accounting for plant acquisitions and divestitures, openings and closings, is about what would be expected on the basis of their share of manufacturing sector value added. It is generally somewhat less in the case of firm entry and exit; somewhat more for continuing firms.[35] High technology industries, for example, accounted for, in 1979, 7.8% of manufacturing sector value added, but 6.7 and 10.9% of the value added involved in plant openings by entering and continuing firms, respectively.

On the basis of this data, turnover is neither inordinately high nor low in high technology industries relative to that taking place elsewhere.[36] On the one hand, this means that potential regulation of this sector cannot be justified on the basis of the paucity of cases that would have to be examined relative to intervention elsewhere. On the other hand, it does not point to this sector as being particularly active and, therefore, offering greater potential for problems to arise.

The role of foreign firms in the turnover process is explored with the aid of Table 6. The percentage of value added in each turnover category accounted for by foreign firms is presented, along with the percentage of total value added in each industry grouping accounted for by foreign firms. Thus, for example, of the value added involved in plant acquisitions by entering firms in high technology industries, 50.1% was accounted for by foreign entering firms while foreign firms accounted for 69.9% of total value added in high technology industries.

In the high technology industries, the firm turnover process, is dominated by foreign-owned firms. Foreign firm activity is not confined to just plant acquisition and divestiture, but also plays an important role in the plant opening and closing process. The role of foreign-owned firms tends to be much less important with respect to plant acquisitions and openings by entering firms, compared to plant divestiture and closure by exiting firms, reflecting the fall in the importance of foreign ownership in high technology industries in the 1970s. In contrast, in other industries, foreign firms play a much less important role. These results are not altogether surprising, in view of the difference in the importance of foreign and domestic firms across these two groups of industries.

The Intensity of the Firm Turnover Process in High Technology Industries

The analysis of the distribution of the turnover process, presented above, does not reveal the intensity of turnover in an individual sector. Intensity of turnover is one measure of the importance of the process. In this section, the intensity of turnover is examined by asking the following questions. What percentage of industry shipments are accounted for by acquisitions and divestitures, plant openings and closings? Are there important differences between high technology and other industries? Do foreign firms play different roles in the various plant/firm categories and/or between high technology and other industries? It is to these issues that attention now turns. Earlier work suggested considerable inter-industry variation in the importance of firm turnover, raising the possibility that this process is markedly different in high technology industries.[37]

TABLE 6

THE DISTRIBUTION OF PLANT DIVESTITURES, ACQUISITIONS, CLOSURES AND OPENINGS ACCOUNTED FOR BY FOREIGN-CONTROLLED FIRMS, ACROSS HIGH TECHNOLOGY AND OTHER INDUSTRIES, BY VALUE ADDED[1], CANADIAN MANUFACTURING SECTOR, 1970-1979[2]

Plant/Firm Category	Industry Grouping	
	High Technology	Other
	Proportion Foreign-controlled (%)	
Plant Divestitures		
Exiting Firms	78.74	37.54
Continuing Firms	100.0	63.99
Plant Closures		
Exiting Firms	75.61	29.30
Continuing Firms	47.88	62.08
Industry Value Added		
1970	81.64	49.03
Plant Acquisitions		
Entering Firms	50.09	42.02
Continuing Firms	91.84	27.96
Plant Openings		
Entering Firms	46.58	28.14
Continuing Firms	56.73	56.43
Industry Value Added		
1979	69.85	45.65

1. The industry value added ratios are weighted averages taken across all industries in a group.
2. The industry groupings and plant/firm categories are defined in the notes to Table 5.

Source: Special Tabulations, Business and Labour Markets Analysis Group, Statistics Canada.

A broad overview of the components of the turnover process is provided in Table 7. As a compact summary measure, the average share gained and lost for firms in each of the entry categories--greenfield entry and closedown exit, acquisition entry and divestiture exit--is given. This is one-half the sum of the market share of entrants in 1979 plus the market share of exits in 1970. It provides an approximation to the amount of market share that is being shifted by that particular component of the turnover process. In addition, the average share transferred in incumbent or continuing firms as a result of market share gain and decline is also given. This is one-half of the market share gains plus market share losses between 1970 and 1979 of incumbent firms.[38] Once more, it proxies the turnover caused by this process.[39]

Previous work (Baldwin and Gorecki, 1989) has demonstrated that a considerable portion of total market share was transferred as a result of both entry and exit, as well as growth and decline in incumbents in the Canadian manufacturing sector between 1970 and 1979. These results are mirrored for other industries, which make up most of the manufacturing sector. Together greenfield entry and closedown exit, as well as growth and decline in the continuing sector (rows 1 and 2), transferred some 36% of market share from losers to gainers. There is not much difference in the high technology industries, where some 35% of market share was transferred.

Most descriptions of entry and exit consider only greenfield entry or closedown exit. Yet the merger process that takes firms into and out of an industry has been demonstrated elsewhere (Baldwin and Gorecki, 1987) to be also quite important. This is confirmed in Table 7 for both industry groupings (row 3). The amount of market share that is being transferred as a result of acquisition entry and divestiture exit is 8% in high technology industries, 10% in other industries. This is about half as large as the other two components.

Together, the first three categories in Table 7 indicate that turnover transferred a substantial amount of market share over the decade from one group of firms to another. The first three rows, however, cannot be added to provide an overall measure of turnover, because that would involve some double counting. The market share turnover in plants that are acquired and divested is already included in row 2 since, for these calculations, these plants are considered as ongoing entities. The final row of Table 7 provides a summary of the total share being shifted that avoids double-counting acquisitions and divestitures.[40] In total, 44% of market share was transferred in other industries and 42% was transferred in high technology industries. These differences do not appear to be meaningful in an economic sense. These turnover statistics do not suggest there is anything particularly unique about the high technology sector that would warrant special regulatory attention.

A more disaggregated picture of the firm turnover process is presented in Table 8, which details rates of entry and exit for various plant/firm categories, for high technology and other industries. There is considerable similarity in the pattern and importance of entry and exit rates across high technology and other industries. The plant closure rate and the plant opening rate for entrants and exits varied between 16.1 and 18.2% across the two industry groupings. Differences occurred, however, with respect to entry and exit via acquisitions and

TABLE 7

FIRM TURNOVER MEASURES ACROSS HIGH TECHNOLOGY AND OTHER INDUSTRIES, CANADIAN MANUFACTURING SECTOR, 1970-79[1]

Plant/Firm Category	Industry Grouping	
	High Technology	Other
	Average Market Share Transferred (Standard Error of Mean)	
1) Plant Opening and Closing by Entering and Exiting Firms[2]	19.6 (4.7)	20.1 (1.1)
2) Growth and Decline of Continuing Firms[3]	15.4 (2.0)	16.1 (0.4)
3) Plant Acquisitions and Divestitures by Entrants[4] and Exiting Firms	8.1 (2.9)	10.3 (1.1)
4) Total turnover[5]	41.8 (4.0)	44.3 (1.3)

1. The industry groupings and the plant/firm categories are defined in the notes to Table 5.
2. Firm turnover due to entry and exit is one-half the sum of the absolute value of share change due greenfield entry plus closedown exit.
3. Firm turnover in the continuing sector is one-half the sum of the absolute value of share change between 1970 and 1979 of incumbents. For this calculation, firms that were acquired by entrants or divested by exits were considered as ongoing entities.
4. Firm turnover due to the merger process is one-half the sum of the absolute value of the market share due to acquisition entry plus divestiture exit.
5. Total turnover is one-half the sum of the absolute value of all share change, where acquisition entrants and divestiture exits are included as entry and exits rather than as ongoing entities.

Source: Special Tabulations, Business and Labour Market Analysis Group, Statistics Canada.

TABLE 8

THE SHARE OF INDUSTRY SHIPMENTS ACCOUNTED FOR BY DIVESTITURES, ACQUISITIONS, CLOSURES AND OPENINGS, HIGH TECHNOLOGY AND OTHER INDUSTRIES, CANADIAN MANUFACTURING SECTOR, 1970-79[1]

Share of Industry Shipments Accounted for by various plant/ firm categories	Industry Grouping	
	High Technology	Other
	Mean Market Share[2] (Standard Error of Mean)	
Plant Divestitures		
Exiting Firms	8.7	13.0
	(2.9)	(1.0)
Plant Closures		
Exiting Firms	17.8	18.2
	(6.6)	(1.2)
Continuing Firms	4.8	4.6
	(2.4)	(0.5)
Total	22.6	22.8
	(6.2)	(1.2)
Plant Acquisitions		
Entering Firms	9.4	10.8
	(2.8)	(1.0)
Plant Openings		
Entering Firms	17.6	16.1
	(3.8)	(1.2)
Continuing Firms	5.8	5.2
	(1.8)	(0.5)
Total	23.3	21.2
	(3.6)	(1.2)

1. The industry groupings and plant/firm categories are defined in the notes to Table 5.
2. The mean of the share of each plant/firm category for each industry grouping.

Source: Special Tabulations, Business and Labour Market Analysis, Statistics Canada.

divestitures. These rates were lower, particularly divestitures, in high technology than other industries. Thus, where foreign ownership fell most dramatically, entry and exit via plant opening and closing were more intense relative to entry and exit via plant acquisition and divestiture. The role of an investment review agency that oversees only mergers is less important in this situation.

The Effect of the Firm Turnover Process on Foreign and Domestic Ownership in High Technology Industries

The process that leads to change in the market share of foreign and domestically owned firms in high technology industries is presented in Table 9. The sources of market share change use the plant/firm turnover categories identified earlier. Plant closures and divestitures refer to market shares as of 1970; plant openings and acquisitions to 1979. The net effect of plant turnover on foreign and domestic market share is shown in the last column of Table 9.

The plant opening and closing process in the foreign sector contributed, on balance, to lower foreign ownership. The net effect of plants created by new and continuing foreign firms less the plants closed by exiting and continuing foreign firms was to decrease foreign firm market share by 6.6 percentage points. On the other hand, the effect of the plant entry and exit part of the turnover process in the domestic sector was to increase its market share by 7.3 percentage points.

The net contribution of the divestiture of foreign plant to domestic firms and the acquisition of plants by foreign firms from domestic firms was a decline of 0.8 percentage points in the foreign sector. Acquisition and divestiture between the domestic and foreign sectors would have contributed a positive 1.5 percentage points to the domestic sector. As noted before, in high technology industries, the share of foreign ownership fell by about 10 percentage points in the 1970s. It is evident that most of the decline in the foreign sector and the growth in the domestic sector was the result of a difference between plant closures and openings. The remainder was due to foreign firms losing market share to domestic firms. Neither of these aspects of turnover is amenable to direct control by the investment review agency that focuses mainly or exclusively on mergers.

V. THE IMPACT OF ACQUISITIONS AND DIVESTITURES

Previous Work

That turnover is large in both high technology and other industries attests to the pervasiveness of competition in the Canadian manufacturing sector. While there are variations in some of the components of turnover across industries, high technology industries are not that different from other industries with regards to the intensity of market share turnover. While foreign ownership and, to a lesser extent, concentration is greater in high technology than in other industries, differences in the degree of turnover do not suggest that the combination of concentration and foreign ownership has led to any major diminution in the effects

TABLE 9

MARKET SHARE CHANGES IN THE FOREIGN AND DOMESTIC SECTOR FROM ENTRY AND EXIT, HIGH TECHNOLOGY INDUSTRIES, CANADIAN MANUFACTURING SECTOR, 1970-79[1]

Plant/firm Category Share, 1970[2]	Mean Market Share, 1970[2] (%)	Plant/firm Category	Mean Market Share, 1979 (%)	Net change in Market Share, 1979-1970
Panel A: Foreign Sector				
Plant Closures		Plant Openings		
Exiting Firms	14.4	Entering Firms	7.3	{-6.6
Continuing Firms	3.2	Continuing Firms	3.7	
Plant Divestitures by Exiting Firms		Plant Acquisitions by Entering Firms		
To Domestic Firms	1.93	From Domestic Firms	1.14	-0.79
To Foreign Firms	4.83	From Foreign Firms	4.99	
Panel B: Domestic Sector				
Plant Closures		Plant Openings		
Exiting Firms	3.5	Entering Firms	10.3	{+7.3
Continuing Firms	1.6	Continuing Firms	2.1	
Plant Divestitures by Exiting Firms		Plant Acquisitions by Entering Firms		
To Domestic Firms	0.95	From Domestic Firms	0.89	
To Foreign Firms	0.94	From Foreign Firms	2.40	+1.46

1. The plant/firm categories are defined in the notes to Table 5, the high technology industries in Table 1.
2. The mean of the share for each plant/firm category. Market share is measured in shipments.

Source: Special Tabulations, Business Market and Labour Analysis Group, Statistics Canada.

of the competitive process--at least not if the latter is measured in terms of the outcome of the battle for market share as it is here, rather than in some structural characteristic like concentration.[41]

The importance of the merger process needs, however, to be set in a broader context. There is a substantial body of studies, primarily U.S., that argue that mergers involve a churning of resources that at best has inconsequential effects and at worst is detrimental to the allocation of resources. Many of these studies have found that mergers are, in general, failures.[42] Some Canadian studies associated with the Royal Commission on Corporate Concentration (1978) found similar results for Canada. It should be noted that not all studies have found these negative results. A number of event studies that are based on stock market data have found positive effects of mergers--for the shareholders of acquired firms in the United States and for shareholders of both acquired and acquiring firms in Canada.[43]

The desirability of a regulatory policy that oversees foreign acquisitions depends to a large extent on the benefits and costs that will be associated with the resulting interference with the market for corporate control. If that market does very little to improve the allocation of resources, interference promises little damage. Even if the benefits are somewhat difficult to quantify, that there are few potential costs suggests that regulation will have an innocuous effect. On the other hand, when mergers have a real effect, the case for regulation must meet more rigorous standards.

Very little work has been done on the effects of mergers--especially foreign mergers in Canada. Therefore, this study breaks new ground in trying to provide a broad overview of the effects of mergers in the high technology sector. The importance of the turnover process is measured by its impact on size, productivity growth, and the change in worker remuneration. While this list of attributes is not comprehensive, it at least starts the process by making use of some of the characteristics that should be examined.[44] In previous work, we have investigated the contribution that turnover made to productivity growth in the 1970s in the manufacturing sector as a whole (Baldwin and Gorecki, 1991b). Closedown exits were found to be less productive than average in 1970; greenfield entrants to be more productive than average in 1979. Plants closed by continuing firms were characterized by average productivity in 1970; but new plants opened by incumbent firms were very much above the average in 1979. Finally, those continuing plants gaining share over the decade, had become about one third more productive by 1979 than those losing market share over the decade; there was no significant difference between the two groups in 1970.

The replacement of exits and declining firms by entrants and growing firms contributed to productivity growth during the decade. Estimates of the contribution made to the increase in real output per worker indicated about half of this growth was due to market share turnover.

Not all turnover is associated with plant openings and closures. A large amount of market share is also transferred as a result of ownership changes associated with acquisition entry and divestiture exit. The extent to which this has demonstrable effects on productivity has been investigated by Baldwin and Gorecki (1990b). In the short run, these mergers had a positive effect on both

market share and productivity. In the long run, both effects are harder to discern. Acquisitions associated with entry and divestitures associated with exit, on average, increased output per worker slightly; they had a greater effect on profitability. While the results of this process are not as significant as for turnover associated with plant openings and closings, they are important in that they do not suggest that merger activity has the deleterious consequences that some U.S. studies have found and they correspond to results emerging from the use of similar longitudinal data bases for the U.S. manufacturing sector.[45]

Relative Characteristics of Foreign and Domestic Plants

In order to describe the effect of turnover in the high technology sector, the characteristics of acquisitions and divestitures in both high technology and other industries were compared. These characteristics included plant specialization, parent specialization, size, labour productivity, production and salary worker income, and the importance of white-collar workers. A comparison of the characteristics of merged plant in 1970 and 1979 allows inferences about the effect of the mergers to be drawn. A comparison of the characteristics of plants acquired and divested to those of plants that are opened or closed allows the relative importance of the merger process to be assessed.

Each characteristic was calculated for each of the entry categories using 1979 data and for each of the exit categories using 1970 data.[46] In order to provide a reference point, the average characteristics of each turnover category were calculated relative to the same characteristic for continuing plants in the same 4-digit industry that did not change ownership between 1970 and 1979. These ratios were then summarized for all industries in a category.

Two summary measures were calculated. One was the mean of the ratios for each industry. The second was calculated by summing across all industries to calculate the average characteristic of a category.[47] The second measure was a weighted average of individual industry characteristics and takes into account the relative importance of the categories across industries. Both the unweighted and weighted measures provided a similar picture of the amount of change taking place. They did, however, give quite different summary ratios, since characteristics of entrants vary across industries, and the intensity of entry is related to these values.[48] The weighted measures are emphasized in this section, because they capture the total effect of a category rather than its average effect.

Impact of Firm Turnover

Tables 10 and 11 capture a number of weighted relative characteristics for three entry and exit categories, for high technology and other industries, respectively. On the entry side, these are plant openings associated with entering firms (greenfield entrants), plant closures by continuing firms, and plants that were acquired by entering firms (acquisition entrants) from exiting firms. On the exit side, the categories are plant closures made by exiting firms (closedown exits),

TABLE 10

THE CHARACTERISTICS OF ENTRANTS AND EXITS, HIGH TECHNOLOGY INDUSTRIES[1], RELATIVE TO NON-MERGED CONTINUING PLANT, CANADIAN MANUFACTURING SECTOR, 1970-1979

Plant/Firm Category[3]	Characteristic[2]			
		Annual Average Income		
	Labour Productivity	Production Workers	Salaried Workers	White Collar jobs as a proportion of industry Employment
	Ratio of characteristics for plant/firm category to non-merged continuing plants[4]			
Plant Openings				
Entering Firms	0.84	0.80	0.88	0.37
Plant Closings				
Exiting Firms	0.69	0.79	0.85	0.30
Plant Openings				
Continuing Firms	1.06	1.00	1.02	0.93
Plant Closings				
Continuing Firms	0.58	0.93	0.97	0.95
Plant Acquisitions				
Entering Firms	0.98	0.91	0.90	0.84
Plant Divestitures				
Exiting Firms	0.62	0.97	0.94	1.03

1. High technology industries are defined in Table 1.
2. All of these characteristics are defined in the notes to Table 3. The productivity measure is value added per worker.
3. The plant/firm categories are defined in the notes to Table 5.
4. Each ratio presented in the table is the weighted industry average across the set of industries. For example, productivity was defined as the total value added divided by total number of employees.

Source: Special Tabulations, Business and Labour Market Analysis, Statistics Canada.

TABLE 11

THE CHARACTERISTICS OF ENTRANTS AND EXITS, OTHER INDUSTRIES, RELATIVE TO NON MERGED CONTINUING PLANT CANADIAN MANUFACTURING SECTOR, 1970-79[1]

Plant/Firm Category	Characteristic			
		Annual Average Income		
	Labour Productivity	Production Workers	Salaried Workers	White Collar jobs as a proportion of industry Employment
	Ratio of characteristics for plant/firm category to non-merged continuing plants[4]			
Plant Openings				
Entering Firms	0.85	0.86	0.94	0.44
Plant Closings				
Exiting Firms	0.68	0.81	0.89	0.43
Plant Openings				
Continuing Firms	1.11	0.98	0.97	0.83
Plant Closings				
Continuing Firms	0.83	0.93	0.91	0.95
Plant Acquisitions				
Entering Firms	0.95	0.98	0.95	1.30
Plant Divestitures				
Exiting Firms	0.91	0.98	0.97	1.30

1. For definitions of characteristics, plant/firm categories and the ratio see notes to Table 10. The sample of other industries is defined in Table 2.

Source: Special Tabulations, Business and Labour Market Analysis Group, Statistics Canada

plant closures by continuing firms, and plants that were divested by exiting firms (divestiture exits) and acquired by entrants.[49]

Turnover that is caused by the opening and closing of plant affects a very different part of the firm-size distribution than does turnover that is associated with ownership changes.[50] The plants of greenfield entrants are generally smaller than average, are more specialized, and are owned by firms that span fewer industries. The plant openings of continuing firms tend to be more representative of the continuing sector. The plants that are acquired by entering firms are larger than average, are more specialized than average, and are acquired by firms that are diversified across more industries. Because of these differences, it is useful to consider the effects of each separately.

In order to evaluate the effect of plant entry and exit, the direction of the replacement process needs to be ascertained.[51] Since greenfield entrants primarily replace closedown exits, and plant openings by continuing firms primarily replace plant closures by continuing firms, it is the difference in the relative characteristic--i.e., productivity--within each of these matched pairings that is compared here.

The replacement of old with new plants has a similar productivity-enhancing effect in both high technology and other industries. Within each set of pairings and for both high technology and other industries, new plants were relatively more productive than closed plants. For example, in high technology industries, Table 10 shows that the productivity of greenfield entrants in 1979 was 84% of the continuing sector that did not experience control changes; that of closedown exits was only 69% in 1970--for a gain of 15 percentage points.[52]

In other industries, the plant birth and death process was also accompanied by a slight increase in production worker income. Closed plants paid relatively lower incomes to production workers in 1970 than did the new plants as of 1979. The same can be said of the salary rate. In high technology industries a similar pattern occurred, except that the increase in production worker incomes was less pronounced in the case of firm closedowns and greenfield entrants. Improvements in relative productivity were, therefore, accompanied by improvements in the incomes of workers.

In terms of the plant entry and exit process, one of the most marked differences between high technology and other industries can be seen in the effect of entry and exit on the employment of white-collar workers. For greenfield entry in high technology industries, white-collar workers increase in importance, with virtually no effect in other industries. In contrast, in plant openings by continuing firms, there is little change in high technology industries, but there is a substantial decline in the case of other manufacturing industries.

While there are considerable similarities in the productivity and salary income changes that occur in the plant turnover categories between high technology and other industries, this is not the case in the acquisition and divestiture merger categories. In other industries, there was little long-term gain from merger. Relative productivity increased marginally. The remuneration of production workers was unchanged. The remuneration of salaried workers decreased marginally. The proportion of non-production workers remained constant.

In contrast, relative productivity increased substantially in high technology industries.

It was postulated that high technology industries offered fertile opportunities for foreign investment, because these industries generally utilized special assets that were not easily transferred except through direct investment. Not all such investment need be of the greenfield variety. Indeed, where plant scale is large and concentration high, the preferred entry route will often be by acquisition of existing facilities. The corollary, then, is that in such industries a larger portion of mergers will be undertaken to transfer the special technological asset that is fundamental to the production process and that mergers will, on average, be more successful here than elsewhere. The results confirm this hypothesis.[53] Average productivity increases dramatically compared to its course in other industries.

There is also some indication that these mergers serve to restrain costs. Average remuneration of both production and non-production workers fell. In addition, the percentage of industry employment accounted for by non-production workers declined.

Impact of Foreign and Domestic Firm Turnover

It is important to evaluate the relative success of foreign as opposed to domestic firms in the turnover process. Differences between foreign and domestic firms in the high technology industries were, therefore, investigated. Domestic greenfield entrants were 70% as productive as continuing plants but domestic closedown exits were 62% as productive as continuing plants. The relative productivity of plant openings by continuing domestic firms was 87%, plant closings, 68%. The gain in each of the domestic categories was, therefore, substantial. The productivity of foreign greenfield entrants as of 1979 was 85% of continuing plants that did not merge[54]; foreign closedowns were 82% as productive as continuing plants in 1970. The relative productivity of plant openings by continuing foreign firms was 129%, plant closings, 87%. Thus, the gain in productivity from foreign plant turnover was only substantial for the plant creation and destruction process in foreign continuing firms. Foreign greenfield entry and closedown exit in high technology industries once more show quite different patterns from all other categories--probably because exits are greater than entrants.

The same exercise was conducted for other industries. A similar result was recorded in that the replacement process in both the foreign and domestic sectors led to improvements in productivity. However, there was one exception. In contrast to the results for the high technology industries, the foreign greenfield entry and closedown exit process led to a substantial increase in productivity for other industries. This is consistent with the result in Table 9, which shows that foreign firms were reducing market share in high technology industries with closedown exits exceeding greenfield entrants, while the reverse occurred for domestic firms in the same categories. The failure of the turnover process to replace exiting foreign firms with new foreign entrants in high technology industries meant that the entry and exit process contributed less to productivity growth in this sector than elsewhere.

Nationality and the Impact of Ownership Change

High technology industries attract more foreign than domestic firms and the acquisition process reflects this. A larger proportion of acquisitions and divestitures involve foreign than domestic firms. Mergers in this sector do relatively better than elsewhere. The relevant question for policy purposes must be: Do foreign firm acquisitions exhibit superior performance?

The impact of nationality on the success of acquisitions and divestitures was examined by dividing divestitures into those originating in foreign as opposed to domestic firms and those being acquired by domestic as opposed to foreign firms. Four categories were distinguished:

FF= a foreign-owned firm acquires a plant from a foreign firm;
DF= a foreign-owned firm acquires a plant from a domestic firm;
DD= a domestically owned firm acquires a plant from a domestic firm; and
FD= a domestically owned firm acquires a plant from a foreign firm.

The labour productivity of plants in the acquisition/divestiture category, for high technology and other industries, was once again expressed relative to the labour productivity of all non-merged continuing plants, in high technology and other industries, respectively. The relative productivity ratios were estimated for 1970, prior to the merger, and for 1979, after the merger. The results are presented in Figure 1.

The divestiture and acquisition process in other manufacturing industries had a small impact on the productivity of plants that changed ownership, irrespective of the nationality of the buyer and seller. Productivity increased by a small amount in all cases relative to non-merged continuing plant. In contrast, the productivity of merged plant in high technology industries increased substantially in all categories.[55]

In conclusion, the distinguishing feature of the high technology sector is the size of the productivity gains associated with the merger process. These gains are in marked contrast to those found in other industries. Moreover, they are not confined to firms of just one nationality.

CONCLUSION

Several issues have been addressed in this paper. These include the following:

1) Are high technology industries different from other industries? Do they have characteristics that are considered desirable?

Relative Productivity of Acquisitions by Nationality for High Technology and Other Industries.

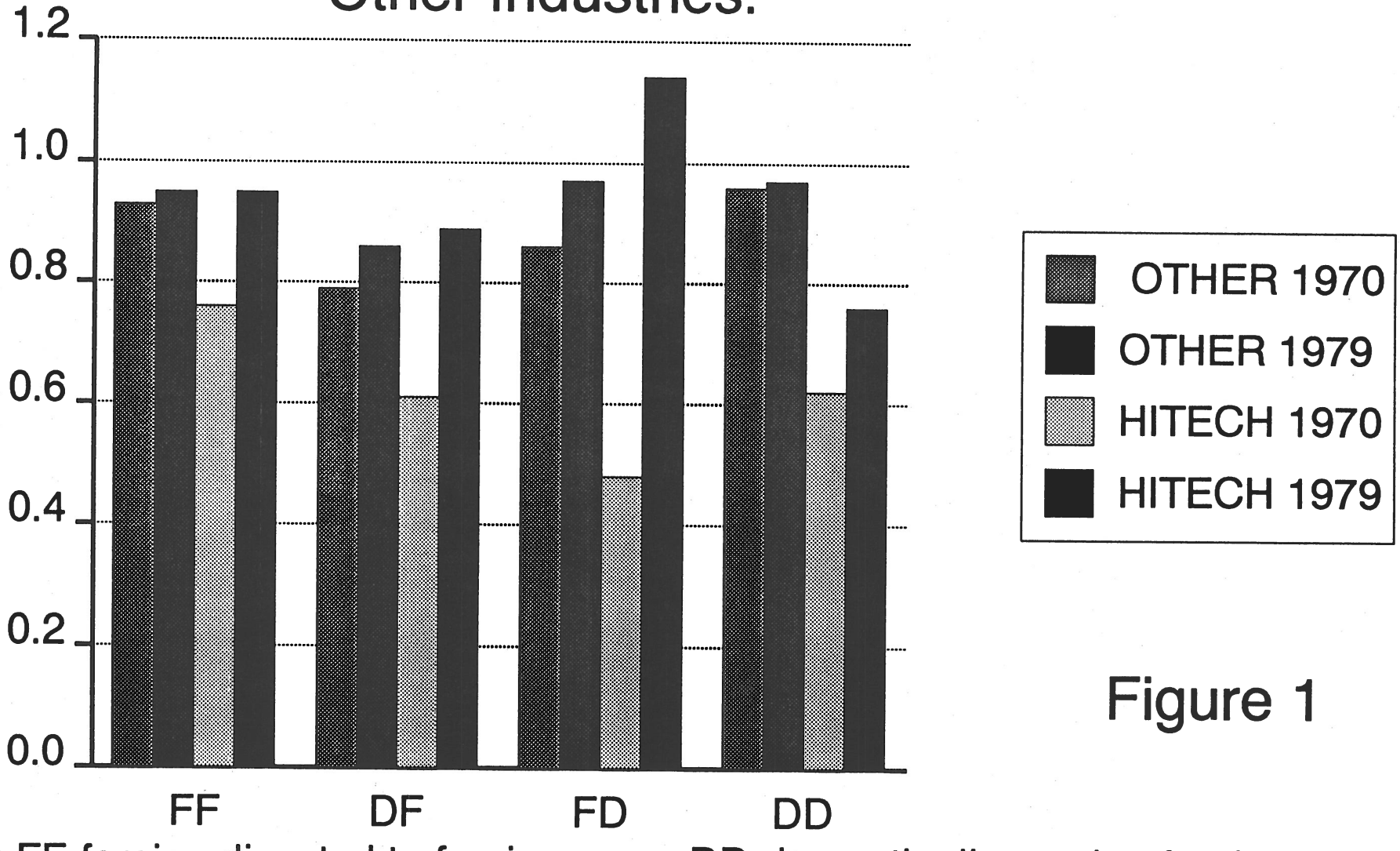

Figure 1

Note: FF-foreign divested to foreign
FD-foreign divested to domestic
DD-domestic divested to foreign
DF-domestic divested to foreign

2) Would one expect foreign direct investment to be particularly important in such industries? Is it important? What have the trends in foreign direct investment been?

3) What is the magnitude of divestiture and acquisition? How important is it in relation to other forms of firm turnover such as plant opening and closing? What is the role of foreign direct investment in this process?

4) What is the impact of the acquisition and merger process on performance variables such as productivity, specialization, wages and salaries? Is the impact of foreign direct investment via acquisition deleterious?

The evidence in this paper suggests that high technology industries do exhibit some of the characteristics that have attracted efforts to promote their development, such as higher R&D and greater openness to trade. Nevertheless, all purported advantages are not present. In particular, growth rates are not particularly high, and the incomes of production and salary workers in high technology industries are much the same as elsewhere in the manufacturing sector. High technology industries would thus not appear to be the engine of high income jobs.

The theory of direct foreign investment predicts that an important cause of foreign investment is technological superiority. Not surprisingly, therefore, in high technology industries, the presence of foreign ownership is substantial. However, it is noteworthy that the importance of foreign ownership is declining in these industries. Indeed, it is declining across all manufacturing industries, but to a greater extent in high technology industries. One of the possible reasons for this is the growing market for high technology, making this a more appropriate method of making a return on technological assets than through direct investment.

Understanding the nature of the firm-turnover process is important because it is at this point that changes in ownership occur and that the policy intervention takes place. This paper has demonstrated that turnover activity in high technology industries is large and important. Although this sector is concentrated and foreign-controlled, there is almost as much turnover here as elsewhere. But contrary to the results found elsewhere, the merger process, irrespective of the nationality of the firms involved, produced large productivity gains. This should not be surprising. It is in high technology industries where the possession of an intangible asset is most likely to mean that the transfer of ownership promises large productivity gains. Mergers here are less likely to involve the churning of assets that leads to little productivity gain.

This paper has also set the importance of mergers in the context of other changes that were occurring because of the entry and exit of plant. While mergers are a particularly important source of productivity gain in high technology industries, the plant creation and destruction process makes large contributions in both sectors.

NOTES

1. For a discussion of the relationship between technology, R&D, growth, and productivity, see Canada, Royal Commission on the Economic Union and Development Prospects for Canada (1985, 2: 73-107), Economic Council of Canada (1983), and Palda (1984). The meaning and definition of high technology is discussed below. See also Science Council of Canada (1981, Table 1.1, 18).

2. This is discussed further in Economic Council of Canada (1988).

3. For a discussion of these instruments, see Economic Council of Canada (1983, 63-77), Mansfield (1985, 93-94), and Palda (1984, 89-100).

4. For a discussion of the motivation for foreign direct investment, see Caves (1982, 3-15).

5. Canada, Royal Commission on the Economic Union and Development Prospects for Canada (1985, 2: 92-94) and Mansfield (1985, 84-89).

6. See, for example, Britton and Gilmour (1978), Canada (1972), Canada, Royal Commission on Corporate Concentration (1978, ch.8, 181-209), Economic Council of Canada (1983), Levitt (1970), Palda (1984), and Task Force on the Structure of Canadian Industry (1968).

7. See, for example, Canada (1972).

8. See, for example, Canada (1972, 458-469).

9. A more recent concern is that Canada does not have a sufficiently strong base of indigenous multinational firms in knowledge-based industries. Screening foreign investment could provide a method of protecting those Canadian-owned firms that are already in this category from falling into foreign hands. For details of this concern, see Ontario, Premier's Council (1988).

10. Science Council of Canada (1980).

11. For a discussion see, for example, OECD (1986, 58-76) and Canada, Ministry of Science and Technology (1978, 15). This definition of a high technology industry refers to those industries that use R&D as an input in the production process. An alternative approach has been to define high technology industries as those that are heavy users--as opposed to producers--of high technology products and processes. This definition has been used by those interested in the impact of technology on employment growth, occupational structure, and income distribution (Economic Council of Canada, 1987; McMullen, 1986; and Wong, 1990). Interest here centres on the producers rather than users of high technology outputs.

12. An alternative approach to defining high technology industries is to measure technology output, such as patents or major innovations. Such an approach, however, has a number of difficulties. For example, the number of patents filed do not capture all technological outputs, while definitional and measurement problems exist with respect to identifying major innovations. In view of these difficulties, this approach was judged to offer no advantages over the use of R&D intensity measures to define high technology industries.

13. On this, see the discussion in Palda and Pazderka (1982).

14. See, for example, the federal government's willingness to trade off an increase in the R&D-to-sales ratio in the pharmaceutical industry in return for legislation raising the patent protection for drugs. For details, see Canada, Patent Medicine Prices Review Board (1989).

15. Not surprisingly, in view of this, Statistics Canada has no official definition of high technology. Some attempts have been made by the OECD, which are used below. The OECD is presently working to provide a definition that is acceptable to member countries.

16. For example, OECD (1986, 59) uses R&D expenditures to production, while Canada, Ministry of Science and Technology (1978, 15) uses a combination of two indicators of R&D intensity: R&D expenditures to value added and R&D personnel to total employment.

17. On this, see OECD (1987) and, for published Canadian statistics, Statistics Canada (1984). Although for this paper we had access to the unpublished R&D ratios at a more disaggregated level, these rarely were available at the 4-digit SIC level--the level of classification at which the merger and acquisition data were available.

18. The OECD (1986, 58-61) tried to resolve this problem by employing factor analysis to group industries into high, medium, and low technology industries.

19. One way of avoiding this difficulty is to concentrate on high technology products rather than industries. Such products are defined as those which embody significant amounts of leading edge technology. The difficulty with this approach is that process innovations are excluded; moreover, selecting high technology products involves a certain amount of judgement. Nevertheless, much attention has been paid to high technology products, usually in connection with trade concerns. See Abbott et al.(1989), Cardiff (1983), Lodh (1989), Magun and Rao (1989), and Statistics Canada (1989, 97-117; and 1985).

20. This is particularly likely to occur because R&D statistics are collected on a company basis. In contrast, employment and output data are collected at the level of the establishment. If a company changes the industry to which it is located, but all of its research activity is confined to its previous primary industry, than this may cause a change in the set of high technology industries--even though no change has occurred in the location or application of research. See Statistics Canada (1984, 9-10) for further discussion of classification procedures.

21. The ratios were calculated as the weighted average, for each industry, across the eleven reference countries, where the weights were each country's share of total output for all the countries for that particular industry.

22. The more inclusive definition was the sum of the two ratios in Table 2 listed under "R&D Characteristics". The ranking reported here uses the mean of the industry ratio for 1975 and 1979.

23. See, for example, Task Force on the Structure of Canadian Industry (1968).

24. This test presumes each sample comes from a distribution with a different variance. An alternate test would be to treat the high technology industries as coming from a distribution having the same variance as that possessed by the entire other industry sample. With the standard errors of means reported in Table 2, a reader can construct the appropriate confidence intervals.

25. If "invisible" R&D from the foreign parent, that is not paid for, is also included, it is likely that the percentage difference would be even larger. See Palda (1984, 81-83) for further discussion.

26. For details, see Mansfield (1985, 87-89).

27. Shipments in 1970 were used as industry weightings.

28. For production workers, differences in wage rates, defined as total wages divided by hours paid, between high technology and other industries were also compared. The means levels between these two industry groups were not significantly different in either 1970 or 1979.

29. The results concerning the similarity in income levels between high technology and other industries were confirmed using two other sources. The monthly employment, earnings, and hours survey collects information on average weekly earnings of all employees, where earnings is defined as gross pay for the week before any deductions. For 1979, the survey covered firms with 20 or more employees. In addition, the 3-digit 1960, not the 4-digit 1970, SIC was used. This necessitated the combining of 3911, 3912, 3913, and 3914 into a single industry, thus reducing the number of high technology industries to seven. The 1979 mean annual average weekly earnings of all employees, production and salaried, in the manufacturing sector was $311.19; in the high technology industries, somewhat lower--$303.95. (For details of the survey, see Statistics Canada, Employment Earnings and Hours, Cat. No. 72-002, a monthly publication.) The second source was the Labour Market Activity Survey (LMAS), full details of which may be found in Statistics Canada (1988). This is a longitudinal survey of employees for 1986 and 1987. It collects information on wages and salaries before taxes and other deductions. It uses the 3-digit 1980, not the 4-digit 1970 SIC, thus necessitating reducing the number of high technology industries to seven. (1980, SIC = 321, 336, 334, 335, 374, 391, and 337.) The mean hourly rate of production workers in 1986 in high technology industries was $11.53, in other manufacturing industries $11.26. The corresponding hourly rates for salaried employees was $15.40 and $13.39, respectively. The hourly rates were calculated as the mean across employees in the high technology and other industry sectors, using a methodology that weights full and part-time employment to derive average hourly wage rates. The distinction between production and salaried employees follows that based on the blue/white-collar occupational distinction. (See Baldwin and Gorecki, 1990c, Table 2.13, 29, for details.)

30. These are the parent firms of plants in an industry. The firm may or may not be classified to the industry in which the plant is located.

31. Of those differentials in the high technology sector between foreign and domestic plants, only the degree of plant specialization remained significant after size differentials and industry effects were taken into account. Size differentials were captured by the rank of the firm that owned the plant.

32. Full details of the Census of Manufactures may be found in Statistics Canada (1979). Creation of the database used to measure turnover is outlined in Baldwin and Gorecki (1990a).

33. It should be noted that a firm is defined as all plants under common control in the same industry. Thus, if enterprise A acquires enterprise B, which has plants classified to several industries, then more than one firm acquisition would be recorded in the work reported here.

34. For a discussion of the process of entry and exit that relates the short to the long run, see Baldwin and Gorecki (1990c, 33-49; and 1990d). In that study, much more turnover is shown to occur in the short run than the long run. The difference between the short and the long run in high technology as opposed to other industries is not considered here.

35. The exception is the plant acquisition category.

36. However, it could be argued that greenfield entry and closedown exit is inordinately low in high technology industries relative to what might be predicted. High levels of R&D should be associated with dynamic industries, which, when combined with a higher industry

growth rate, should lead to more, not less, turnover in high technology than other industries. There are several difficulties with this line of argument. First, high levels of formal R&D may be associated with a routinized technological regime which is likely to inhibit, not encourage, entry (Audretsch and Acs, 1990). Second, account of other industry characteristics would need to be taken to determine, in a rigorous fashion, whether turnover was high or low in high technology industries compared to what might be predicted. For example, while it is true that industry growth is positively correlated with entry, this applies only to domestic-firm entry via plant opening; foreign-firm entry does not appear to be related to the growth rate of Canadian manufacturing industries (Baldwin and Gorecki, 1987). As shown in Table 6 below, foreign firms dominate the firm-turnover process in high technology industries.

37. See Baldwin and Gorecki (1990c, Table 3-3, 37) for an indication of the variation in firm turnover across manufacturing industries.

38. For this exercise, acquisitions by entering firms and divestitures by exiting firms were not counted as exits or entrants. They were reconstituted as ongoing entities by reassigning to them the enterprise code originally assigned in 1970, and the growth and decline therein was included in line 2 of Table 7.

39. It only approximates the turnover process because, in reality, the replacement process is considerably more complex. The share gained by entrants is partially at the expense of exits and partially at the expense of incumbents that are in decline. See Baldwin and Gorecki (1990b).

40. For this calculation, the entry and exit acquisitions are treated as greenfield entry and closedown exit (row 1), and their growth and decline are omitted from the incumbent growth and decline category of row 2.

41. A different issue is whether turnover is any less in high technology industries than elsewhere, when differences in those industry characteristics that are related to turnover are taken into account. This is not pursed here because the actual level and not the predicted level is of relevance when regulatory burden is being assessed.

42. See Caves (1989).

43. See Eckbo (1986).

44. A large number of issues are ignored herein. For one thing, only the long-run effect of mergers and entrants is considered. No attempt is made here to measure the short-run costs of turnover and compare them to the long-run gains. Productivity is measured as output per worker. It could be measured using total factor productivity. Efficiency rather than productivity could be investigated. The division of gains between shareholders and labour could be more fully outlined. All of these are beyond the scope of this study, but might well provide the agenda for future research.

45. Lichtenberg and Seigel (1987).

46. These characteristics were calculated by summing across all plants in a particular category in an industry. Thus, average productivity of entrants was calculated as total value added divided by total production and salary earners in these firms.

47. Average size of greenfield entrants was calculated as the sum of the shipments of all such plants divided by the number of all such plants.

48. For example, the weighted average output per worker of divested plant in 1970 is less than one, while the unweighted average is about one. This indicates that the least productive plants that were divested were also the largest. While this pattern has some intrinsic interest, it is not pursued here.

49. In order to match plants in 1970 and 1979, all acquisitions and divestitures that involve a horizontal component are excluded. Thus, only plants divested by exiting firms and acquired by entering firms are used. This omits some divestitures made by exiting firms to continuing firms and acquisitions by entrants from continuing firms. A second way to ensure that the plants that are being compared in 1970 and 1979 are the same is to use all divestitures and acquisitions, including those involved in a horizontal merger. If this is done, the results are qualitatively the same.

50. Details of the specialization ratio and plant size are not provided in the tables.

51. See Baldwin and Gorecki (1990b) for a more detailed description of the process.

52. Unweighted averages show that the average productivity of greenfield entrants reaches that of continuing non-merged plants after about a decade. For more detail on the relative productivity of entrants in general, see Baldwin and Gorecki (1990d).

53. An alternate strategy was also used to define high technology industries. The Canadian R&D/Sales levels of the OECD-designated high technology industries were calculated and the lowest level was chosen as a floor. All Canadian industries that exceeded the floor were defined as high technology industries. Many of the industries that were added to the OECD list of high technology industries as a result of this exercise fell into the medium high technology group defined by the OECD. The extended set of industries had the same characteristic reported here--that mergers had a positive effect on productivity. This suggests that an extension of the definition of high technology industries beyond that used here will not affect the conclusion that control changes contribute in an important fashion to productivity improvements.

54. Once again, these relative characteristics were taken by summing across all such plants in high technology industries.

55. An examination of Figure 1 shows that the weighted average relative productivity of merged plant in high technology industries in 1970 was generally below unity; by 1979, it was closer to unity. Unweighted averages are not significantly different from unity in 1970.

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