Small Manufacturing Firms and Canadian Industrial Development: Empirical and Theoretical Perspectives*

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Recent work on Canadian industrial development suggests an economic synergy among market-linked networks of small and large manufacturing firms, government research units, and professional consultants (Britton 1988, 1989; MacPherson 1988a; ORF 1987). A prominent theme in this literature is that quick access to external knowledge is an important factor in successful product innovation. A related theme is that innovative industrial firms have the potential to induce major upthrusts in regional employment, even over the short run (Oakey et al. 1987). Particular attention has focused on the industrial export opportunities afforded by small manufacturing firms (SMFs), especially those with an interest in new-product development (Ong and Pearson 1982; Rothwell 1987; Steed 1982). While large enterprises remain at the heart of Canadian technology production, employment, and foreign trade (Ontario 1988), evidence from a variety of sources suggests a growing role for SMFs in industrial job creation (DRIE 1986, 1987; Ontario 1987a). In addition, ongoing work on technological change reveals an increasingly dynamic role for small firms that serve "demanding" customers (Rothwell 1986, 1987; Rothwell and Bessant 1987).

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Evidence of this sort has stimulated a fresh bout of policy interest in the SMF sector, leading to a spread of support programmes across all of Canada's major provinces (Ontario 1988). For technological optimists, a major hope is that interlinked clusters of innovative SMFs will eventually recharge Canada's export capability (Steed 1982). A more modest hope is that sustained industrial growth at the SMF level will partially offset ongoing employment losses among larger firms (Ontario 1987a, 1987b). While there is still a good deal of debate about the overall importance of the small business sector, particularly in North America (see Case 1989), few analysts would deny that small industrial firms have become a distinctive component of secondary manufacturing.

Set against this context, this paper seeks to establish an empirical framework to guide future industrial research on the economic potential of Canadian SMFs. Using Toronto as a geographic focus, it will describe key sets of interfirm linkages that give rise to improved growth prospects among small firms of different types. Three main questions are posed in the analysis: First, how important is the small-business segment of Canadian manufacturing? Second, in which sectors has SMF expansion been the fastest? And third, what kinds of interfirm linkages support SMF entry, survival, and growth?

In suggesting answers to these questions, this paper will give special attention to the role of corporate fragmentation (vertical and horizontal disintegration), service-to-manufacturing linkages (intersectoral information trade), and new manufacturing technology (flexible production methods). Prior to an examination of these issues, however, it is pertinent to consider the general empirical context of the small-firm growth phenomenon in Canada. How important are small firms?

SMFs and the Canadian Economy: An Overview

Table 1 summarizes recent employment change (1976-1984) across firms of different size in 10 major sectors of the Canadian economy.[1] A striking feature of these data is that they closely resemble Birch's (1979) findings on the contribution of small firms to U.S. employment over the 1970s. Indeed, an implication that can be gleaned from Table 1

[1]A recurring source of confusion in the published data on manufacturing employment is that job counts are typically recorded (explicitly or implicitly) at the establishment level (Tables 1-3). Because individual establishments can be either single-plant firms, branches of multilocational firms, or even parent units (headquarter plants), it is by no means clear whether the recent employment contribution of "small firms" has been as high as the available establishment data suggest. Thus, in this paper Tables 1-3 should be interpreted with caution.

Table 1

PERCENT DISTRIBUTION OF THE NET CHANGE IN EMPLOYMENT, DISAGGREGATED BY INDUSTRY AND FIRM SIZE, CANADA, 1976-1984

	Size Class						
Industry	0-19	20-49	50-99	100-199	200-499	500+	All
Agriculture	2.3	0.1	—	-0.1	-0.1	0.2	2.3
Forestry	0.5	-0.2	-0.1	-0.3	0.1	0.4	0.4
Fishing	0.4	—	—	—	-0.1	-0.1	0.2
Mining	1.8	0.2	0.2	0.1	0.2	2.1	4.6
Manufacturing	15.5	1.5	-4.1	-10.1	-13.4	-1.6	-12.3
Construction	3.0	-4.9	-4.4	-4.8	-2.3	-1.6	-15.0
Transport	5.0	0.1	-0.3	-1.1	-0.1	9.6	13.1
Trade	21.6	-0.5	-3.1	-4.2	-1.9	9.1	21.0
Finance	5.8	1.6	0.5	-0.4	-0.5	2.8	9.8
Services	31.4	9.2	5.4	3.3	1.0	25.3	75.7
Total	87.3	7.2	-5.9	-17.6	-17.1	46.2	100.0

Source: DRIE (Department of Regional Industrial Expansion). 1986. *A Study of Job-Creation in Canada, 1974-1982*. Toronto: DRIE.

Note: In this paper tabulations based on DRIE (1986, 1987) data may not correspond with the aggregate data now becoming available from Statistics Canada for 1984/1985 and 1986. Because the DRIE statistics were drawn from Dun and Bradstreet credit files, Tables 1 and 3 pertain only to those firms for which credit information was sought during the period in question. The DRIE data are included in this paper because of their uniquely disaggregated nature.

is that small firms have been outperforming their larger counterparts across all of Canada's major sectors, including manufacturing. Whether this represents a secular shift toward a small-firm economy is a moot point. Of interest here is the fact that small firms have become increasingly active in secondary production, especially in Ontario, Canada's largest industrial province. In 1984, for example, rates of new-business formation in Ontario's manufacturing sector outpaced the average for the provincial economy as a whole (Figure 1), suggesting a stronger level of entrepreneurial interest in goods production than one might normally suspect. Interestingly, moreover, evidence from the Department of Regional Industrial Expansion (DRIE 1986, 1987) suggests that recent volatility within manufacturing has been generated primarily by the decline or closure of large- and medium-sized firms. Time-series data from the same source indicate that manufacturing outperformed all other sectors (1976-1984) in terms of relative employment growth among surviving small firms. Thus, Canada's largest "problem sector" may also be the country's most prolific source of fast-growing companies (Ontario 1987a).

To put this in perspective, however, it is important to note that recent SMF growth rates have not been matched by commensurate

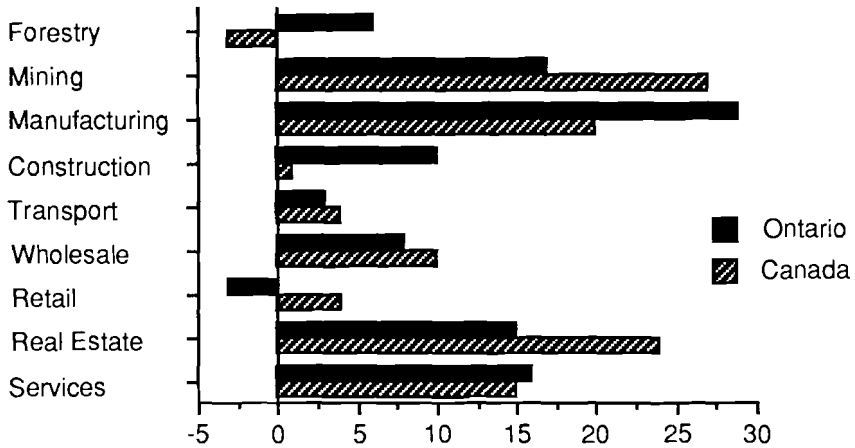


Figure 1

PERCENT CHANGE IN THE NUMBER OF SMALL BUSINESSES (THOSE HAVING ANNUAL SALES OF BETWEEN $10,000 AND $2 MILLION) BY INDUSTRY, CANADA AND ONTARIO, 1984 (Source: Statistics Canada. 1988. *Employment, Earnings, and Hours.* Cat. No. 31-401.)

shifts in the distribution of employment and output shares across firms of different size. Table 2 indicates that manufacturing establishments with fewer than 200 workers increased their shares of total employment and value added over 1978-1984 by a mere 3.6 per cent and 3.4 per cent, respectively. Table 2 also implies superior productivity among larger firms, especially those in the 500+ employment class. While these data convey a less prominent role for small enterprises than many would have us believe, the fact that SMFs marginally increased their share of manufacturing activity over 1978-1984 is encouraging. Moreover, because this period was marked by two economic downswings that dampened the performance of all of Canada's major sectors, modest gains on the part of the SMF population should not be dismissed as unimportant.

Tables 1-3 in fact suggest two major trends that merit attention. First, recent employment decay among large- and medium-sized manufacturers has been partially cushioned by the entry and expansion of SMFs in the 0-19 category. Second, high levels of SMF activity can be discerned across all segments of manufacturing (Table 3). Despite two spells of recession in the late 1970s and early 1980s, almost all sectors of manufacturing experienced substantial SMF growth over 1976-1984. Interestingly, some of the fastest growth rates occurred among small firms in such traditional activities as metal fabricating, knitting, rubber, and clothing. These industries do not produce high-technology goods, nor do they produce goods for which

Table 2

EMPLOYMENT AND VALUE-ADDED SHARES IN CANADA'S MANUFACTURING SECTOR, DISAGGREGATED BY ESTABLISHMENT SIZE, 1978 AND 1984

	% Share of Value Added			% Share of Employment		
Size Class	1978	1984	% Change	1978	1984	% Change
0-19	4.96	6.07	22.37	7.36	9.09	23.36
20-49	8.62	9.24	7.19	11.38	11.79	3.60
50-99	10.50	11.35	8.09	12.21	13.00	6.47
100-199	16.42	14.76	-10.65	17.22	16.04	-6.85
200-499	21.42	23.15	8.07	20.77	22.02	6.01
500 +	38.04	35.40	-6.94	31.03	28.05	-9.60
All	100.00	100.00	—	100.00	100.00	—

Source: Statistics Canada. 1978, 1984. Cat. No. 31-209.
Note: Columns may not sum to 100 per cent due to rounding.

long-run income elasticities of demand are strong (Science Council of Canada 1981). The question thus arises: What factors might explain the polarized distribution of new employment growth across the size range of manufacturing firms? And, why have high rates of SMF development occurred in traditional or import-impacted industries?

Toward an Explanation of SMF Development

One possible explanation for the relative success of the SMF sector is that versatile production technology has become available to a growing size range of establishments. Many small- and medium-sized producers are now in a position to capture new market opportunities based on flexible specialization, customized output, and innovation (Ontario 1987a, 1988). The abundant technical literature available indicates that flexible manufacturing systems (FMS) are sufficiently divisible to overcome the main production inefficiencies normally associated with limited plant scale (OCAM 1987; ORF 1987). In fact, for many small firms it is now technically and economically feasible to manufacture a wider range of items using short production runs. This represents a technological breakthrough because volume of output may no longer be the single most critical influence on industrial productivity (OCAM 1987). Thus, internal economies of scale stemming from long production runs may gradually become less important to firms that have installed the latest and most divisible capital equipment (Britton and Gertler 1986). External economies, such as good access to specialized business services, may soon become more crucial to plant efficiency. This argument need not be confined to modern or high-technology industries. Indeed, as shall be demonstrated later, small

Table 3

NET CHANGE IN MANUFACTURING EMPLOYMENT AS A PERCENT OF 1976 EMPLOYMENT BASE, BY INDUSTRY AND ESTABLISHMENT SIZE, CANADA, 1976-1984

	Size Class						
Industry	0-19	20-49	50-99	100-199	200-499	500+	All
Food	32.1	9.1	-1.9	-13.6	-16.1	2.5	0.3
Tobacco	33.3	-47.9	-100.0	-100.0	-75.9	64.4	25.7
Rubber	77.1	33.9	18.7	-26.0	-6.7	-34.1	-9.9
Leather	59.0	-7.4	-4.1	-35.0	-42.4	-47.2	-26.4
Textiles	40.8	11.8	-20.6	-25.4	-32.4	-20.1	-16.2
Knitting	64.7	-4.1	-12.9	-17.5	-36.6	-16.3	-17.4
Clothing	60.5	5.0	-16.5	-34.4	-32.9	-31.6	-18.3
Wood	30.7	-8.3	-15.8	-15.3	-27.6	-12.8	-2.5
Furniture	52.5	-0.9	-20.9	-26.4	-30.1	-29.2	-10.1
Paper	100.1	20.4	-0.5	-23.3	-7.2	-1.9	-1.6
Printing	31.9	5.0	0.0	-21.2	-25.2	-34.2	11.4
Primary met.	46.9	10.6	-14.8	-7.8	-16.4	12.2	8.3
Metal fab.	47.2	5.4	-15.4	-30.6	-24.0	-15.0	-7.5
Machinery	70.7	-2.7	-0.7	-24.6	-19.2	-19.9	-8.7
Transport	23.1	-4.2	-20.0	-19.2	-19.2	12.8	5.3
Electric	95.1	26.7	-6.0	-18.9	-22.9	-0.4	0.6
Non-met. mins.	17.3	-13.2	-23.0	-13.8	-38.1	-9.9	-11.2
Petroleum	71.2	15.8	-6.4	-55.0	3.5	-6.8	-4.8
Chemicals	33.2	15.5	-10.8	-8.0	17.4	1.0	5.1
Miscellaneous	36.3	-2.3	-19.6	-27.3	-25.6	11.1	-1.4
Total	42.1	4.1	-11.2	-23.3	-22.2	-1.0	-3.3

Source: DRIE (Department of Regional Industrial Expansion). 1987. *A Study of Job-Creation in Canada, 1976-1984*. Toronto: DRIE.

firms in traditional product markets can also use flexible manufacturing methods.

A second possible explanation for the success of the SMF sector is that recent employment growth in the producer services has created an expanding reservoir of technical expertise which can be exploited by small manufacturers on a task-specific basis. For example, small firms with a limited in-house research capability can subcontract dedicated technical work to a growing variety of private and public R&D consultants. Similarly, SMFs that want product market information to support strategic decision making can delegate some of their needs to private data-base firms. The important point is that high-order producer services have become increasingly visible, prevalent, and accessible, particularly in large metropolitan centres (Beyers and Hull 1988; Coffey 1987). Moreover, evidence from a number of international studies suggests a growing technological link between innovative SMFs and specialized strands of the service sector (Rothwell 1977, 1987; Stockman and Docter 1987). A central message in this work is that fast access to external information is a crucial requirement for competitive success. High-quality technological information is essential for the

development of new products and processes (Beije 1987; Design Council 1983), while external market information can support sales expansion (Czinkota and Johnston 1983; Kleinschmidt and Ross 1984). Canada's fast-growing producer services, in fact, consist primarily of firms that either create, process, or distribute information—business information, in particular (Hepworth 1986). By 1981, approximately 10 per cent of Canada's labour force was employed in the producer services, compared to only 6 per cent in 1971. Estimates for 1987 place this figure at roughly 13 per cent (Statistics Canada 1988). Clearly then, the potential for knowledge-based interaction between SMFs and producer services has grown substantially over the last few years. As Rothwell (1987) points out, moreover, much of this interaction can support the types of innovative activity necessary for successful SMF development.

A third possible explanation for the vitality of the SMF sector is that some of its growth can be attributed to a process of industrial fragmentation within manufacturing (Shutt and Whittington 1987). Management and engineering personnel with previous industrial experience have become increasingly active initiators of new small enterprises (Dermer 1984; Ralphs 1987), sometimes through forced spin-offs (redundancies), but more often as part of an opportunistic thrust based on individual initiative (Ontario 1988). While good data on spin-offs are hard to find, a testable proposition is that small-business owners with prior industrial training are more likely to generate successful enterprises than their counterparts with no track record in manufacturing.

To date, however, the triad of factors outlined above has received scant empirical attention in the literature on industrial geography, especially in Canada. This is unfortunate because interfirm linkages represent a fundamental entry point for broader geographic work on the evolution of regional production systems. To redress this situation, the following section adds an empirical dimension to ongoing work on SMF development, external market linkages, and industrial fragmentation. The data come from a sample of over 100 small manufacturers in a variety of Toronto industries.

Origins, Behaviour, and Market Linkages of Toronto SMFs

A survey of 109 Toronto SMFs in five local sectors revealed a series of relationships between various measures of SMF business performance (profitability, export intensity, frequency of new-product development) and the presence of backward links to consultants outside manufacturing (MacPherson 1988a, 1988b). The overall purpose of the inquiry, conducted over 1986-1987, was to assess the scale, nature, and

technological effects of service-to-manufacturing linkages. On the services side, attention was restricted to such technical and marketing functions as applied R&D, management consulting, industrial design, and production engineering. On the manufacturing side, attention was restricted to Canadian single-plant firms with 200 or fewer employees.[2] The five industries finally selected for the project were: scientific instruments, electrical industrial equipment, auto parts, fabricated structural metal, and office and household furniture. Each of the five sample industries holds an above-average share of local value added and manufacturing employment; each contains a fast-growing population of small firms; and each faces considerable adjustment difficulties as a result of technological change, import competition, and rising labour costs, among other things.

Two hundred self-administered questionnaires were mailed to the five-sector sample—40 per sector, proportionately stratified by company size (employment)—and a total of 109 valid returns were collected, giving a 54 per cent response rate (Table 4). The survey instrument was designed to capture five main dimensions of variation: (1) innovation and export performance (frequency of successful new-product launches, percentage of sales for export); (2) sources of technological/professional inputs (in-house R&D activity, external consultant linkages, customer inputs); (3) market focus (customer segments, product characteristics); (4) demographic and industry characteristics (age, origins, size, occupational composition, perceived profitability); and (5) technological goals/achievements (product/process innovation, R&D activity).

While only a snapshot of the findings can be presented here, four sets of results merit special mention.[3] First, a majority (60 per cent) of the survey firms introduced computerized numerically controlled (CNC) production equipment over the five-year study period.[4] Second,

[2]Although in the Toronto survey "small manufacturing firms" were defined as single-plant units with 200 or fewer employees, this particular criterion was not based on a rigorous theoretical consideration of what actually constitutes a small firm. The decision to select 200 employees as the cut-off point was based on the Ontario Research Foundation's (ORF) informal "rule of thumb". Whether this cut-off point is too high or too low cannot be answered at this stage, but suffice it to say that all 109 respondents considered themselves in the small-firm category.

[3]Analysis of nonresponse bias at the industry level revealed that the furniture sample was skewed toward the potentially least competitive segment of the population. Among auto parts firms, moreover, statistical tests uncovered a bias toward nonexporting or low-exporting firms. For a more detailed discussion of bias estimation, sample reliability, and survey design, see MacPherson (1988a).

[4]Information on "new technology" adoption (production methods) was based on a mixture of categorical and open-ended survey questions. Respondents were classified as new-technology adopters provided that: (1) the newly acquired equipment significantly improved the firm's manufacturing capability; and (2) the equipment represented a vintage new to the firm.

fully 30 per cent of the survey firms were born as a direct result of industrial spin-off, notably in the 1970s.[5] Third, firms with large industrial clients were found to exhibit superior rates of new-product development.[6] Fourth, firms with links to external consultants were found to exhibit above-average performance with respect to export intensity and frequency of product innovation.[7] These four sets of findings are discussed below.

Adoption of New Technology

A majority (n = 66) of the survey firms significantly improved their manufacturing capabilities over the study period by installing new production equipment (Table 4). Stand-alone CNC machine tools were the single most prevalent additions to fixed capital accross all five industries. Significantly, further deployment of computerized equipment was regarded as an important technical priority among all of the firms in this group. To put this in perspective, however, only one firm indicated a definite interest in coupling multistage process steps via CNC technology.[8] Integrated networks of CNC equipment were not a prominent feature of the innovation thrust. Nevertheless, a majority of the respondents stated that CNC technology provides a flexible and cost-effective means of producing small batches of customized output. This capability is important because many of the sample firms are now in a position to tailor their products to the precise needs of individual customers—without incurring major efficiency losses through low-volume production. Practical applications of the newly acquired equipment ranged from thermoset injection moulding of plastic auto parts to computerized wood cutting, jointing, and finishing; from electric motor coil winding to circuit soldering; and from die-cast

[5]Spin-off firms are defined as firms that enter the market on the basis of production, marketing, or management experience gained directly from former employment in another (usually larger) firm. The spin-off process can be either horizontal (production of a similar product) or vertical (production of a product input). In this sample, all 34 spin-offs received "assistance" from the original parent firm. Assistance varied from formal help (for example, seed money, access to technical resources) to informal help (for example, advice on the preparation of business plans and marketing strategies).

[6]Product innovation is defined as the introduction and successful commercial development of a new or substantially improved product. Firms were asked to specify the nature and purpose of their innovation, including its current and projected market significance.

[7]Follow-up inquiries revealed that a majority of firms expect to continue using producer service inputs in the future. While both absolute and relative expenditures on these services are low, most respondents indicated that consultant inputs make an important contribution to their product development and marketing efforts.

[8]Data on new technology investment costs were not collected in the Toronto survey. In this paper then, "rates" of new technology adoption do not account for the relative or absolute scale of equipment expenditures.

Table 4

SUMMARY STATISTICS FOR THE SAMPLE OF MANUFACTURERS

	Industry					
	SI	EIE	AP	FSM	OHF	All
Desired no. of responses	40	40	40	40	40	200
Actual no. of responses	28	31	20	14	16	109
Response rate (%)	70	78	50	35	40	54
Innovators[a]	25	21	7	6	3	62
Average size[b]	39	56	76	44	22	49
Exporters[c]	23	23	14	10	3	73
Consultant users[d]	26	22	15	12	5	80
Spin-offs[e]	11	10	4	6	3	34
New technology[f]	15	22	11	9	9	66

Note: SI = scientific instruments; EIE = electrical industrial equipment; AP = auto parts; FSM = fabricated structural metal; OHF = office and household furniture.

[a]Number of firms that introduced new products over 1982-1985.

[b]Average number of full-time employees.

[c]Number of firms with foreign export markets.

[d]Number of firms with backward links to university/college departments or external specialists in R&D, marketing, production engineering, industrial design, management, laboratory testing, database provision, or advertising.

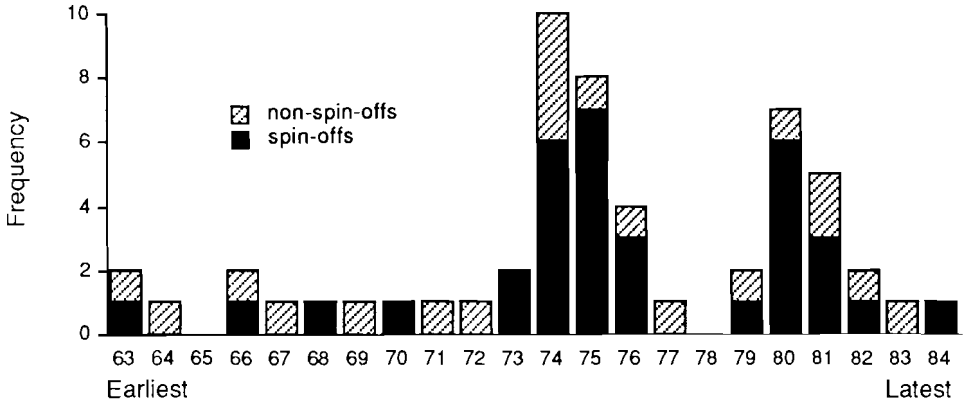
[e]Number of spin-offs from inside the manufacturing sector.

[f]Number of firms that introduced new manufacturing technology.

moulding and stamping to spray painting. In short, local manufacturers have been adopting relatively simple CNC tools for a wide range of labour-saving functions. A key element in the attractiveness of CNC equipment is that "temporarily dedicated" machines can be reprogrammed to perform a wide range of tasks, often with minimal downtime. As several chief executive officers revealed, moreover, CNC machines represent an investment in physical capital that is typically more flexible than fixed (for a good discussion of this point, see Gertler 1988).

Small-Scale Industrial Spin-off

The second package of results concerns the origins of the SMF sample. Fully 30 per cent (n = 34) of these firms were born as a direct result of small-scale industrial spin-off (Table 4). Although the precise impetus behind start-up varied considerably, all 34 spin-off firms were initiated as a result of "opportunistic" motives. In the metal fabricating sector, for example, four of the six spin-offs were formed as a result of declining parent performance. Here, spin-off occurred as part of a pre-emptive strategy for job preservation, and all four of the spin-offs in this group (formed in the late 1970s) survived the last two



Note: Roughly half of the sample firms were born before 1963.

Figure 2
ESTABLISHMENT DATES FOR SPIN-OFF FIRMS, 1963-1984

recessions by specializing in custom work for industrial clients. For SMFs in scientific instruments and electrical equipment, however, spin-off was primarily motivated by a desire to make more money. In the instruments sector, for example, 8 of the 11 spin-offs were formed by professional engineers with ambitious career objectives. Here, the dominant motive appeared to be financial gain.[9] Although the survey instrument was not designed to examine the commercial or non-commercial motives behind spin-off, at least not in a direct fashion, the data indicate that SMFs have indeed been emerging from larger companies over the last few years. Furthermore, when spin-off activity is tracked over time, a clustering of SMF start-up can be discerned for the recession years that immediately followed the two oil price shocks of the 1970s (Figure 2).

While this pattern also holds true for other modes of new-firm entry (for example, acquisitions, independent start-up), the prevalence of spin-off as a business formation route would seem fairly clear. Moreover, the popularity of the recession years as start-up periods would also seem clear. Whether this pattern reflects the influence of recession-push incentives is a question that cannot be answered here, as the original research effort was not designed to generate detailed information on the inducements behind different modes of new-firm

[9]While the Toronto survey uncovered no evidence of enforced spin-off (for example, strategic disinvestment), this does not mean that spin-off is always based on the efforts of opportunistic individuals who leave their "parents" for financial gain. Indeed, as Shutt and Whittington (1987) point out, spin-off can also take place as part of a deliberate corporate strategy in which production costs and risks (unionized wage rates, uncertainty) are selectively externalized for efficiency purposes.

entry. Having said this, however, an implication that can be gleaned from Figure 2 is that recent patterns of SMF development may partially reflect a broader process of industrial fragmentation. In short, some of the impetus behind the growth of the small-business sector can be traced to the selective disintegration of larger firms, notably during downswings in the business cycle.

Market Segments and Customer Demand

Table 5 suggests that firms with close market ties to larger industrial companies enjoy an innovative advantage over their counterparts that cater mainly to non-industrial markets. For example, 68 per cent of the firms with industrial markets introduced successful new products over the study period, compared to only 46 per cent for firms with non-industrial markets. Interestingly, this relationship also emerged on the export side. There, 88 per cent of the firms with industrial markets produce for export, compared with only 48 per cent for firms that mainly serve non-industrial customers. A logical conjecture here is that whom one serves may be an important factor in how often one innovates. Market focus also may be an important factor in export propensity. While the data are not robust enough to infer causality—at least not in a direct sense—the evidence on hand suggests a general correspondence between new-product development, export involvement, and market focus. Output linkages are influential because certain types of customers are more "demanding" than others.

Table 5

PRODUCT INNOVATION AND EXPORT INVOLVEMENT BY PRINCIPAL MARKET FOCUS

Count ( ) % Row % Column % Total		Product Innovation		Export Involvement		
		Yes	No	Yes	No	Total
Industrial markets[a]	Yes	(35)	(16)	(45)	(6)	(51)
		68.6	31.4	88.2	11.8	100.0
		56.4	34.0	61.6	16.6	46.7
		32.1	14.6	41.2	5.5	46.7
	No	(27)	(31)	(28)	(30)	(58)
		46.5	53.4	48.2	51.8	100.0
		43.5	65.9	38.4	83.4	53.3
		24.7	28.4	25.6	27.5	53.3
Total		(62)	(47)	(73)	(36)	(109)
% of total		56.8	43.2	66.9	33.1	100.0
Chi-square (X)		X = 5.38	p = 0.05	X = 19.47	p = 0.001	

[a]Firms that principally serve other manufacturing firms.

Evidence from Ondrack (1980), Rothwell (1986), Utterback (1974), and Von Hippel (1978), among others, suggests that industrial clients are more likely to transmit innovation initiatives to suppliers than customers outside the manufacturing sector. Rothwell's work, in particular, demonstrates an "innovation-pull effect" in which large technology-producing firms send explicit technical signals to their major suppliers. The latter must then innovate to satisfy customer demand. In this regard, it is worth noting that fully 45 per cent of the survey firms exist primarily to serve larger manufacturers. Moreover, follow-up interviews revealed that a majority of the innovating firms with industrial markets received explicit product suggestions from their clients (for a detailed discussion of this point, see MacPherson 1988a).

Lest the analysis become too simplistic, however, it is important to recognize that SMFs with industrial markets do not constitute a homogeneous group. At the most basic level, it is pertinent to distinguish between firms that produce fully manufactured end-products (for example, industrial lathes) and firms that produce intermediate or semi-finished components (for example, motorshafts). While both groups can and do innovate—often at high levels of excellence—an implication that can be gleaned from Table 6 is that manufacturers of end-products enjoy an innovative edge over their counterparts that cater primarily to intermediate demand. This may explain, in part, why the Ontario Premier's Council (Ontario 1988) recommended special policy support for SMFs that produce original equipment. The logic behind this recommendation is that producers of intermediate goods ride a technological and market curve that reflects the growth or decline of larger firms.[10] While this does not mean that one mode of production is necessarily more desirable than the other, the data on hand suggest that innovation rates are higher among firms that cater to final markets. One possible reason for this contrast is that, on the one hand, suppliers of intermediate goods are more likely to improve their products incrementally on the design side in response to the shifting component needs of customers. End-product manufacturers, on the other hand, enjoy potentially greater scope for the introduction of entirely new products. While the evidence (Table 6) is suggestive rather than conclusive, an implication worth investigating is that prospects for successful SMF development may be

[10]Perhaps a more fundamental motive behind the recommendations of the Ontario Premier's Council is that policy support for manufacturers of original equipment (notably capital goods) may ultimately reduce Ontario's dependence on imported capital equipment. Because capital goods are essential for the production of consumer goods, public efforts to assist producers of innovative equipment may eventually help domestic producers in other industries. For a more detailed outline of this perspective, see the Premier's Council report (Ontario 1988).

brighter in those industrial sectors that supply finished goods to end-users.

Table 6

INNOVATION RATES AMONG MANUFACTURING-LINKED SMFs

Main Product Focus	End-products		Intermediate		Total	
Furniture	1	(1)	0	(0)	1	(1)
Metal fabricating	3	(3)	2	(1)	5	(4)
Auto parts	0	(0)	12	(5)	12	(5)
Electrical equipment	7	(5)	10	(5)	17	(10)
Scientific instruments	13	(12)	3	(3)	16	(15)
All industries	24	(21)	27	(14)	51	(35)

Note: The numbers in parentheses indicate innovators. Chi-square for innovation by product focus = 7.48, p = 0.05.

SMF Innovation and Producer Service Linkages

As mentioned earlier, Rothwell's (1987) evidence suggests a key role for external technological inputs in successful product development, especially at the small-firm level. The Toronto evidence is consistent with Rothwell's view (Table 7), and there are at least two possible reasons for this. First, SMF revenues are rarely sufficient to sustain permanent in-house hiring across a comprehensive mix of scientific, technical, and management occupations. Thus, to resolve specific technical difficulties within a reasonable time-frame (and at reasonable cost), many SMFs have turned toward independent specialists with unique skills. Second, product innovation has become a central ingredient in the competitive success of a growing number of firms (Design Council 1983). More bluntly, small companies that produce mediocre goods typically stay small. These twin thrusts add up to a partial model of innovation in which progressive firms actively seek external knowledge to support in-house efforts. On the supply side, public and private consulting units are available that cater directly to the innovation requirements of local SMFs. In Toronto, for example, semi-public organizations such as Ortech (formerly the Ontario Research Foundation) have long been advocating closer links between SMFs and the province's fast-growing stock of producer services. On the demand side, moreover, the potential market for producer services is substantial, especially in light of recent employment growth at the SMF level. The important point, however, is that many Toronto SMFs have been using consultants for innovation support, indicating a degree of sectoral complementarity that often escapes attention in the literature on services.

Table 7

PRODUCT INNOVATION BY THE INCIDENCE OF BACKWARD LINKS TO EXTERNAL CONSULTANTS

Count ( ) % Row % Column % Total		Product Innovation Yes	 No	 Total
	Yes	(54)	(26)	(80)
		67.5	32.5	100.0
Consultant		87.1	55.3	73.4
linkages		48.5	23.8	73.4
	No	(8)	(21)	(29)
		27.6	72.4	100.0
		12.9	44.7	26.6
		7.3	19.2	26.6
Total		(62)	(47)	(109)
% of total		56.9	43.1	100.0

Note: Chi-square = 13.83, p = 0.01, n = 109.

Discussion

While the empirical results converge with a broad stream of international research, particularly with regard to the innovation-producer service relationship, some of the findings suggest behavioural patterns that were not anticipated during the early days of the study. First, flexible production tools were introduced across the entire industry range. Small firms in the furniture industry appear no less interested in acquiring new production equipment than firms of comparable size in the other sectors. Although the acquisition of equipment was typically confined to stand-alone machines, adoption of even the most basic CNC technology represents a major achievement in terms of potential industrial efficiency. Second, fully 30 per cent of the sample firms were born as a result of small-scale industrial spin-off, notably in the 1970s. A further 35 per cent were started by individuals with previous industrial experience in the large-firm sector. While no significant relationships emerged between spin-off activity and the other major variables, this particular mode of small-firm entry would appear to be fairly durable. Finally, firms with industrial markets emerged as innovative leaders in terms of frequency of new-product development.

While there is little doubt that SMFs can make an important contribution to the economy, rapid small-firm development has by no means been confined to technology-intensive industries. As noted

earlier, some of the fastest rates of SMF growth have occurred in traditional or medium-technology sectors, many of which are exposed to intense foreign competition. From a policy perspective, the logic of market adjustment suggests that firms in import-impacted sectors should not receive prolonged trade protection, investment assistance, or costly subsidies (Economic Council of Canada 1983, 1988). While this is a defensible perspective (depending on one's political/economic persuasion), it does not follow that membership in an import-affected sector implies bleak commercial prospects for all of the firms in that group. Indeed, the emergence of young SMFs in "troubled" sectors implies that adjustment may already be taking place. In this regard, evidence presented earlier suggests a useful role for product innovation, new manufacturing technology, and the intelligent use of external know-how. Curiously, however, innovative SMFs outside the "high-technology" sphere have generated scant policy interest, despite their ability to maintain employment during cyclical downswings in the economy. Data from the sample suggest that small firms of all types are capable of introducing new or substantially improved products for specialized segments of the market. The data also reveal that a wide variety of SMFs have been investing in new technology to achieve improved flexibility. The real growth challenge for many of these firms is to capture multiple-market niches to support sales expansion, particularly through exports. The ultimate challenge, of course, is to move beyond the SMF category altogether. In this regard, greater use of external expertise might conceivably play a helpful role.

Having said this, however, it is worth noting that the innovation model implied by the service-to-manufacturing relationship may not be well developed in Canada. While over 70 per cent of the survey firms obtained useful producer service inputs over the study period, firm-specific evidence documented elsewhere (MacPherson 1988a) indicates that few SMFs actively acquired external expertise using systematic search procedures. Furthermore, while some of the most innovative and export-intensive firms displayed complex multiple links to a wide mix of consultants, SMFs in this category accounted for less than 20 per cent of the total sample. Impressionistic evidence from a series of personal interviews revealed that some SMFs are less able to obtain high-order consultant inputs than others. Part of the problem may stem from imperfections in the operation of the local information market. On the demand side, for example, some firms appear to lack the in-house skills required for accurate specification of their external input needs. On the supply side, it is possible that some producer service units may not be as "visible" as they should be. While the Toronto survey generated only anecdotal evidence to support these notions, ongoing work by Britton (1988, 1989) suggests that

transactional obstacles to information retrieval can slow the pace of innovation among both large and small manufacturers alike. Many of these obstacles are amenable to government intervention, yet, as Britton points out, efforts to apply a transactions cost framework to Canadian innovation policy have not been attempted. This is unfortunate because evidence from other countries reveals that SMFs with well-articulated informational linkages can reap substantial benefits (Rothwell and Bessant 1987). Significantly, however, these benefits appear to accrue only to those firms that can identify, evaluate, and specify the kinds of external inputs that are needed.

Data presented earlier also suggest that manufacturing may itself function as a potentially major source of new SMFs. In light of Shutt and Whittington's (1987) work on corporate fragmentation, part of the SMF growth phenomenon may be connected to a wider process of industrial restructuring in which new small firms are born as a direct or indirect result of spin-off. Recent work by the Premier's Council (Ontario 1988) suggests that large manufacturing firms can act as major seedbeds for new SMF development. While Bell Northern Research and Northern Telecom are often the only "seedbeds" mentioned in work of this sort, a recent survey by Ralphs (1987) shows that spin-off activity has occurred among large Canadian firms in a variety of sectors. To date, however, little empirical work has been carried out on the relative popularity or durability of this particular mode of new business start-up. At the same time, industrial sectors in which spin-off is most likely to occur have not been systematically identified. It must be recognized, however, that Canada has few large firms from which new SMFs can emerge. Furthermore, as the 1990s unfold, the potential for this kind of SMF start-up may diminish somewhat, if only because many large industrial firms have already pruned their operations in response to both domestic and foreign competition. Suffice it to say that the sectoral and spatio-temporal dynamics of spin-off will remain poorly understood for some time.

Finally, it is worth noting that some of the results presented earlier suggest partial correctives to a number of emerging perspectives on industrial and technological change. On the production side, it appears that small firms have not been investing in full-scale FMS technology. Of course, in view of the tight revenue constraints that confront most small manufacturers, lack of commitment to full-scale FMS production is not surprising. At the same time, however, evidence from Fertey et al. (1986) and the Economic Council of Canada (1988) suggests that larger Canadian firms also have been reluctant to make major FMS investments. This is not to deny that significant technological improvements have been taking place in Canada's manufacturing capability. Nor is it to deny that a number of

innovative firms have benefited substantially from full-scale FMS technology.[11] In realistic terms, however, the evidence suggests a more modest innovation path based on stand-alone CNC machines. While adoption of flexible tools represents a useful starting point, especially for small firms, the current empirical picture is a far cry from the robotized small factories envisaged by industrial futurologists. On the product front, moreover, it should be recognized that innovation has been taking place among progressive SMFs in a wide mix of industries—not just high-technology ones. An implication here, and one that deserves serious policy consideration, is that innovative SMFs in traditional sectors may turn out to be just as important to the Canadian economy as their more visible counterparts in the high-technology arena. Furthermore, if job growth among traditional SMFs continues to match job growth among small high-technology firms, then policy instruments that favour the latter at the expense of the former may have to be reshaped.

Conclusions

While SMFs have become a distinctive component of Canadian manufacturing, it would be inappropriate to view such firms in isolation from their forward and backward linkages to establishments in other sectors, industries, and size groups. Evidence documented earlier suggests that many SMFs are dependent on larger firms for markets, technological initiatives, and product ideas. At the same time, the evidence suggests an important intermediate role for consultants in the producer services. These kinds of interdependencies imply that policy instruments for SMF support should focus more sharply on the input-output relationships that create growth potential among firms in different parts of the economy. More specifically, support systems should acknowledge the technological role of knowledge-based inputs (producer services, R&D), customers (output linkages), and market focus (end-products versus intermediate goods). Furthermore, given that part of the SMF growth phenomenon may be linked to a process of corporate fragmentation, public initiatives to encourage small-scale industrial spin-offs might be worth exploring. Such initiatives, if successful, could hasten Canada's

[11]Use of the term "full-scale FMS technology" is intended to convey a sense of automated process control in which flexibly linked CNC machines are responsible for strategic aspects of the firm's production operation. While Gertler (1988) provides a good description of what is involved here, the distinction between limited FMS adoption and full-scale FMS adoption is at this point a matter of qualitative judgement. As far as this paper is concerned, the distinction is fairly blunt—stand-alone CNC machines versus integrated nests of machines.

adjustment to import competition by encouraging viable specializations in troubled sectors. While there is evidence that adjustment may already be taking place, the need for accelerated adjustment will no doubt intensify in the 1990s. Incremental adoption of the Canada-U.S. free trade agreement will certainly add further impetus to the need for industrial restructuring. Appropriate business responses at the SMF level might usefully include greater recourse to external expertise, greater use of flexible production technology, and a shift toward higher value-added activity. Set against this context, the scope for helpful and commercially legitimate government intervention may be considerable.

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