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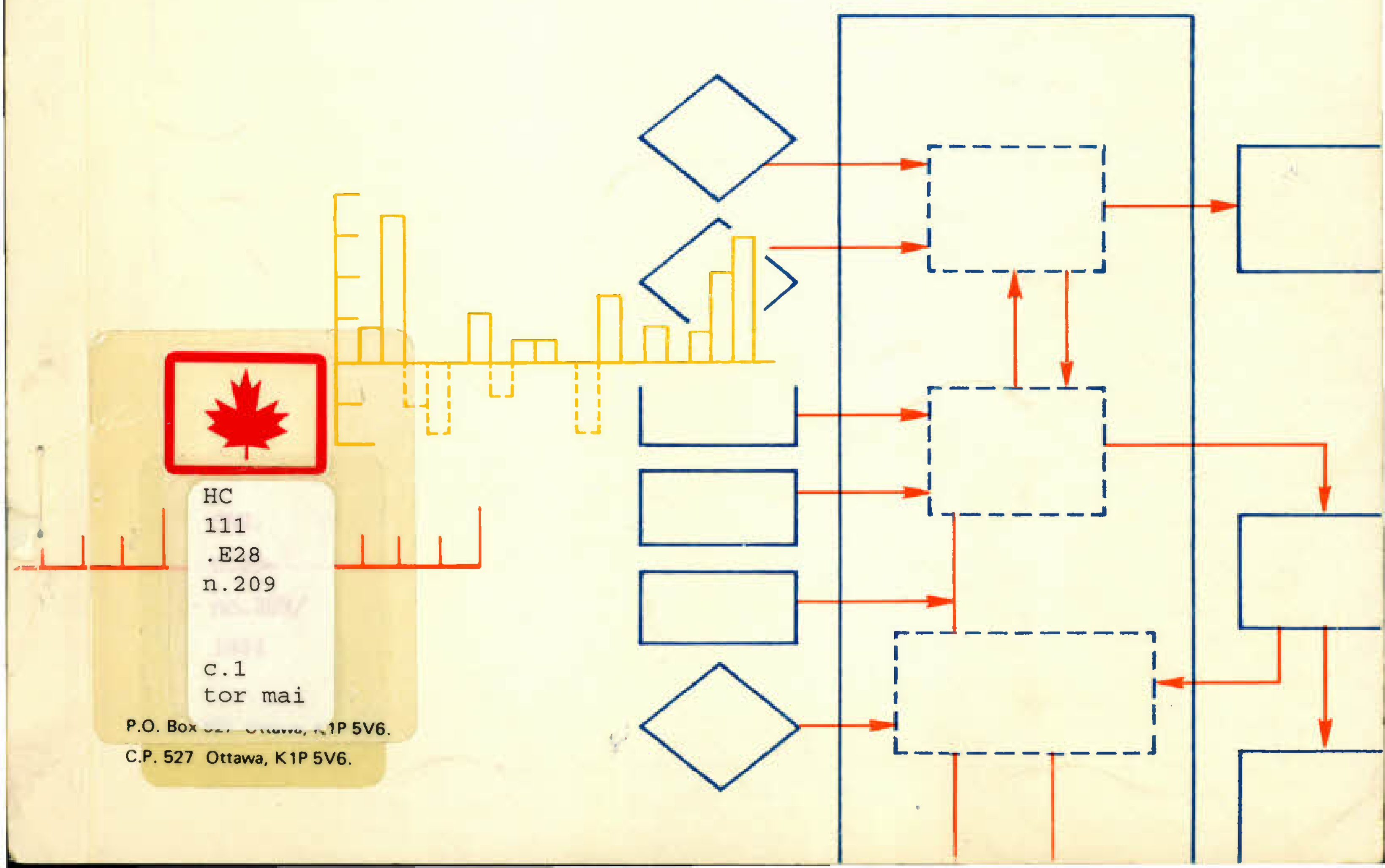

P.O. Box 527 Ottawa, K1P 5V6.
C.P. 527 Ottawa, K1P 5V6.

DISCUSSION PAPER NO. 209

Innovation and Export Performance in Canadian Manufacturing

by Petr Hanel and
Kristian Palda*

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Council Secretary
Economic Council of Canada
Post Office Box 527
Ottawa, Ontario
K1P 5V6

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Résumé

Dans le cadre du programme de recherche sur les changements technologiques, le Conseil Economique du Canada et le Ministère de l'Industrie et du Commerce ont organisé une enquête auprès des dirigeants d'entreprises manufacturières en vue de recueillir de l'information sur leurs activités d'innovation.

C'est ainsi que nous avons pu avoir accès aux données fournies par 153 entreprises qui produisent le matériel de télécommunications et pièces, le matériel électrique industriel, les matières plastiques, les résines synthétiques, la fonte et l'affinage de métaux non ferreux. Nous avons tenté de voir s'il y a une relation entre l'effort à innover et la propension à exporter de ces entreprises.

Notre hypothèse, dont nous avons examiné plusieurs variantes, propose un lien de causalité entre la proportion de ressources consacrées par l'entreprise à l'innovation et la proportion des revenus qu'elle tire de l'exportation. Nous avons examiné la relation entre les dépenses de la R & D (exprimées en pourcentage de ventes) et l'exportation (en pourcentage de ventes) au niveau de l'entreprise et aussi au niveau de la catégorie SIC de son activité principale. Les données disponibles nous ont également permis de vérifier notre hypothèse dans le cas des principales innovations pour lesquelles nous disposions, en plus des coûts de la R & D, d'une information supplémentaire sur les coûts de la mise en production et de la mise en marché. Le lien de causalité allant de la dépense de la R & D (mais non des autres dépenses reliées à l'innovation) à la propension à exporter a été vérifié à trois niveaux d'analyse.

Bien que ces résultats ne soient pas surprenants puisque d'autres études ont déjà montré la performance à l'exportation des industries orientées vers la production de produits innovateurs, cette étude semble être la première à démontrer rigoureusement, au niveau de l'entreprise et de sa principale activité, que la recherche favorise l'exportation.

Parmi les autres conclusions auxquelles nous sommes arrivés, il faut noter premièrement que la plupart des déterminants potentiels de la propension à l'exportation diffère de façon significative d'une industrie à l'autre. Deuxièmement, il semble qu'il existe une taille minimale pour que l'entreprise puisse songer à exporter. Et enfin, les entreprises canadiennes ont tendance à exporter une plus grande partie de leur production que celles qui sont contrôlées de l'étranger. Cette tendance semble vouloir s'atténuer si l'on introduit des variables plus "immédiates", telles que "l'idée d'une innovation vient de la mainson mère" ou "l'innovation fabriquée sous licence", c'est-à-dire des variables qui montrent encore davantage le degré de dépendance technologique des filiales.

Les données se contredisent quant au lien (ou co-variation) qui existe entre l'aide gouvernementale et la propension à exporter une innovation. C'est pour cette raison que nous hésitons à conclure qu'une aide directe de la part du gouvernement à la R & D industrielle contribuerait nécessairement à améliorer la situation du commerce extérieur.

EXECUTIVE SUMMARY

In the course of its research program concerning technological change the Economic Council of Canada and the Department of Industry, Trade and Commerce sponsored a questionnaire survey of manufacturing firms to collect information regarding their innovative activities and other characteristics. We availed ourselves of access to data from 153 firms (in the telecommunications equipment and components, electrical equipment, plastic compounds and resins, and non-ferrous metal smelting and refining industries) in order to examine the relationship between innovation-directed effort and export propensity among these enterprises.

The basic hypothesis, upon which many variations were attempted, proposed a causal link between the proportion of resources devoted to innovation by the firm and the proportion of revenues derived from exports. Employing the multivariate statistical methodologies of chi-square, discriminant and regression analyses we investigated the relationship between exports (as proportion of sales) and R&D outlays (as proportion of sales) at the level of the whole firm and also of its main (SIC) activity category. Fairly abundant data allowed us to test the proposition also on the level of the firm's major product innovation, at which we had additional information on manufacturing and marketing start-up costs in addition to R&D outlays. The expected causal connection between research (but not the other innovation-connected costs) and export intensities emerged consistently on all three levels. While perhaps not surprising

in light of previous investigations of the export success of technologically oriented industries or innovative products, this study appears to be the first one which documents rigorously the research-leads-to-exports proposition as far as the firm or its divisions is concerned.

Among the other findings which appear of considerable interest we note the following. There are significant inter-industry differences with respect to the influence of most of the potential determinants of export intensity; the telecommunications and electrical industrial equipment firms appear to have more in common than the firms in the other two industries. There appears to be a sales threshold for exportation. Firms under Canadian control have a tendency to export more of their sales than their counterparts under foreign control; this tendency weakens and appears to be pre-empted by the more "immediate" variables of "idea for innovation came from parent firm" or "innovation undertaken under licence", that is, by variables which express better the degree of a subsidiary's technological dependence.

Our data yield contradictory evidence on the influence of (or covariation between) government funding of the innovation and the innovation's export intensity. We would therefore hesitate to conclude that direct government support to industrial R&D would necessarily contribute to the strength of the trade balance.

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Introduction and Overview

In the course of its research program concerning technological change, productivity and growth the Economic Council of Canada undertook a mail questionnaire survey of a large sample of manufacturing firms to collect information regarding their innovative activities and the characteristics which may be associated with such. The survey results were summarized and cross-tabulated, but not analyzed along formal statistical lines, in the Council's discussion paper No. 176 of October 1980, authored by De Melto, McMullen and Wills. Several academic economists were subsequently offered the opportunity of testing innovation-related economic hypotheses with the help of the survey data, suitably disguised and stored on tape. The present writers welcomed the offer trusting that the Council's information bank would yield interesting insights and some possibility of generalization about the relationship between innovation effort and export propensity in Canadian manufacturing.

It is, however, proper at this point to alert the reader that the survey-derived data base has a special aspect and is also somewhat lopsided. The special aspect is the fact that the firms included are all "innovators" and thus possibly a-typical of the five Canadian manufacturing industries covered: only those companies were retained which reported creating or adopting a major innovation affecting their profits over the last twenty years of sold. (A small sample of firms, 12 in all, did not report an innovation but filled out the part of the questionnaire concerning the firm. Of these firms only 4 export more than one percent of total sales and only 2 more than ten percent). The lopsidedness comes about from the survey's emphasis on innovationconnected information, at the inevitable cost of some neglect of company-related statistics. Naturally, as in all surveys, some questions were answered more frequently than others and this makes for samples of varying sizes as different variables are selected for cross-tabulation and statistical analysis.

The basic focus of our analysis is the investigation of the relationship between innovative activities, or innovation characteristics, and export performance. We believe, with some reservations, that causation runs from the former to the latter. And so the principal methodological thread in our work is the endeavour to hold the influence of other factors on exportation constant, the better to see if there is an association or indeed causal connection between the two types of variables of interest.

The paper's five sections are organized as follows. The first one is devoted to associative (cross-tabulation) and regression analyses of the export propensity of the innovating firm, after some necessary data description valid for the whole of the subsequent tasks is gone through. The firm's 1978 export-to-sales ratio, overall or only in the industrial category to which the innovation pertains, is related to R&D expenditures and to other non-innovational factors in 1978 deemed to stimulate or inhibit exporting. Also tested for is the direction of causality between research and exports.

Subsequent sections are concerned but with exports of the product innovations upon which the surveyed companies reported--process innovations are excluded from consideration as it is difficult to assign export ratios to products flowing from new processes. Section 2 serves to provide acquaintance with the multifarious potential determinants of the export propensity of product innovations. In the absence of well formulated theory it tries its hand, by means of statistical cross-tabulation, at detecting important or interesting relationships between export intensity and two groups of variables. The first set of potential covariates or determinants of export intensity, whether innovation- or firm-connected, tends to exercise its influence from the outside environment or markets. The second relates largely to the costs incurred in bringing the innovation to the launch pad.

The third section builds and estimates regression models focusing on "market-related" factors, the fourth on innovation-cost factors. In the following section, we raise, but hardly make any progress with the issue as to whether the profitability of a product innovation depends on its export intensity. If yes this would imply that innovation activity itself may get its boost from prospective exports. The penultimate section attempts to provide a crude check on the preceding results by running a linear discriminant analysis on exported and non-exported innovations, using some of the previously employed export determinants as discriminatory variables. The last section, by tradition, carries tentative conclusions.

1. Export Intensity of Innovating Firms: Its Covariates and Determinants

1.1 Brief data description

Before proceeding with the theoretical and statistical portions of this paper it is necessary to give an overview of the data upon which this study relies. Naturally we shall provide more of the pertinent details alongside the individual statistical results as we go on. The basic and detailed reference on the nature and collection of the data is of course the De Melto et al. discussion paper. Almost any question with regard to the nature of the data collected (rather than with respect to numerical values) can be obtained by the study of the survey questionnaire of which a copy is enclosed in the appendix.

Neither the questionnaire nor the discussion paper dwell on the semantics of the definition of the word "innovation:"

> This is part of a study of innovations - major new/improved products and production processes - and of the ability of Canadian firms to generate, rapidly adopt, and commercialize them. We are interested in the innovations, created by your firm or adopted from elsewhere during the 1960-1978 period, which have most contributed to your firm's profitability in the (relevant industry) field.

This introduction to the questionnaire defines implicitly as innovation any technological change in the firm's major industrial sector, be it product or process, which turned out to be profitable, i.e., which of necessity was "put to work." And this, indeed, is the accepted meaning of innovation as an invention or technological change which reaches the commercial (production or market) stage.

Note also that the questionnaire, sent out in 1979, covers almost 20 years of the firm's collective memory span. The replies are bound to be affected by forgetting.

The Council's survey gathered usable information from questionnaires returned by 170 firms in 5 industries, reporting on 283 major innovations of which 201 were product and 82 were process innovations. We eliminated from our data the petroleum industry subsample on the premise that exports in this sector are strongly shaped by government intervention rather than by market forces; the influence of the former factor being rather more difficult to assess. The remaining 153 firms in our sample came, in decreasing order of abundance, from the telecommunications equipment and components industry, from electrical industrial equipment, plastic compounds and resins, and from non-ferrous smelting and refining.

To say that we had at all times access to a sample of 153 companies would, however, exaggerate the degrees-of-freedom ease conferred by such large cohorts. As the number of variables that we employ in the subsequent cross-tabulation and regression analyses increases, the smaller is the sample likely to be on account of unanswered survey questions and so of missing data. It is very difficult to state what, if any, bias this sample shrinkage introduces into our results. We make sure always to include sample size information in them.

As can be seen on the last page of the survey instrument, devoted to "firm information," two streams of data were asked for. Within each stream run two parallel strands. In the first stream a distinction is made between the sales, exports, employment and R&D of the firm as a whole and the same indices of activity within the firm's - and the innovation's - chief standard industrial classification category. The two parallel strands of information in the second stream concern the same activity indices, but this time during the year 1978 and during the year of the commercial launch of the innovation, which may be as early as 1960. The bulk of our analysis in this section pertains to 1978, but attention is almost equally divided between TOTAL firm activities (exports, sales, employment, R&D) and SIC-connected activities.

Apart from the already mentioned relative scarcity of information with regard to firm activities or characteristics, the main other drawback of this data bank is the absence of any information on what "happened" between the year the innovation was launched - as early as 1960, as late as 1978 - and the "now year" of 1978. These and other aspects will be brought up as necessary in what follows.

1.2 Some covariates of export intensity in the innovating firm

The number of activities or characteristics about which information on the firm level, as opposed to the innovation level, is available is limited. Any theory-based approach to the analysis of the survey data on the firm level is thus circumscribed by what might be called circumstances beyond our control. It is, nevertheless, of considerable interest to examine export intensity relationships at this level since much of the empirical investigations of export performance reported in the literature took place at this level of aggregation. It should also be added that the De Melto et al. paper confined itself, as far as exports go, to the more disaggregate export-of-innovation level.

Table 1.2 lists the variables employed in this section's analysis. Exporting activity is expressed as export intensity (ratio of 1978 total exports to 1978 total sales of firms, or ratio of exports in the main - which is also the innovation-pertinent - SIC category to sales in that category in 1978) and research outlays are similarly transformed into research intensity. Our two main variables of interest are thus at all times - even in subsequent sections - dimensionless and heteroskedasticity

- proof in regressions.

Table 1.2 about here

We are now ready for the cross-tabulation analysis which, at this stage, may be considered as a procedure that facilitates our understanding of the survey's results. We start with the T - or total - firm version of the export, research and employment variables; the second batch of cross-tabs deals with the S - or SIC versions.

1.2.1 Two-variable cross classification (T) export (intensity) by research (intensity) in 1978

As expected, a significant (.03) association emerged, judged by a chi-square test from the SPSS armoury (sample size = 127) between a five-step index of research intensity (RDSALEI) and a six-step index of export intensity (EXPXT78Q). The research index steps were defined as

RDSALEI = 0 if		RDSALE = 0
" = 1	0.00 ≤	" < 0.01
" = 2	0.01 ≤	" < 0.03
" = 3	0.03 ≤	" < 0.08
" = 4	0.08 ≤	" .

In a similar vein the export intensity index was defined as follows:

EXPXT78Q = 0 if		EXPXT78 = 0
" = 1	0.0 ≤	" < 0.1
" = 2	0.1 ≤	" < 0.25

TABLE 1.2

Variables Used in Analysis of Firm-Level

Export Intensity During 1978

Variable \ Level	Firm (T)	SIC (S)
Exports/Sales	EXPT78	EXPS78
RD/Sales	RDSALE	RDSSALE
Employees	EMPXT78	EMPXS78
Diversification = EMPXS78/EMPXT78	DIV	
Country of control Cdn = 1, US = 2, Other=3	PAYSC	
Operations abroad no = 0, yes = 1	NOPX	
Industry D1 = Telecommunications D2 = Plastics D3 = Smelting D4 = Electrical	D1, D2, D3, D4	D1, D2, D3, D4

"	= 3	$0.25 \leq$	"	< 0.50
"	= 4	$0.50 \leq$	"	< 0.75
"	= 5	$0.75 \leq$	"	.

In the cross-tabulations shown or discussed here it was always our endeavour to break the variables down into as many levels as possible subject to making the number of observations in each cell as equal as possible.

The cross-classification detail is reproduced in the appendix table table 1.2.1a. Other tables will be adduced when their evidence appears enlightening. They all are the offspring of SPSS programming.

Exports by country of control, by diversification

Here the association does not prove of significance, even in the case where US and other ownership are merged into one category only. Similarly, no association is evident between exports and diversification defined as the ratio of SIC to firm employment, where the latter is indexed into four categories (0 to 25 percent, 25 to 50, 50 to 75, and above).

Exports by size of firm as measured by employment

The hypothesis of association between export intensity and an index of the firm's employment (0 for less than 50 employees, 1 for 51 to 100, 2 for 101 to 200, 3 for 201 to 500, 4 for more than that) is accepted by the chi-square test at the 0.001 level, as can be seen in appendix table 1.2.1b.

Exports by operations abroad

A very highly significant association here between export intensity and the presence of either sales offices or R&D, production or assembly units abroad.

Exports by industry

Finally, an unsurprising association between export intensity and the four industry types was confirmed at the 0.000 level of significance. The number of cases (i.e., firms) in the six instances above ranged from a low of 105 to a high of 139.

1.2.2 Cross-classification of T-level export and research intensities, controlling for other variables

The initial exploratory results provided by the bi-variate contingency tables may be modified when additional variables are controlled for or held constant at predetermined levels. Here attention is confined to the "main" relationship between exports and research (in the "total" T category), and we control for some other factors.

Controlling by country of control

As can be seen in appendix table 1.2.2a, the previously significant relationship between research and exports vanishes when all the (63) sample firms are Canadian; similarly, the relationship disappears in the other two subsamples as well (US - 46 firms, Others - 18 firms).

By employment

Using total firm employment as a controlling variable keeps the export-research association significant in the three middle employment categories covering 51 to 500 employees.

By country-of-control and by employment

To reduce the chance that national control or ownership is related to the firm's size and that it is the latter which muddies the waters, we also control for the employment categories described previously. The sample sizes of the five employment classes under Canadian control are, from the smallest to the highest, 27, 9, 11, 5 and 11; only in the median class with 11 observations does a significant (.04 level) - negative - relationship surface between exports and research. No signs of relationships in the US and other - control samples.

By country-of-control and by industry

Only two firm samples are sufficiently large to allow a look at the relation between exports and research unclouded by nationality of control and nature of industry; telecommunications (N=56) and electrical equipment (N=42). Only faint signs of a positive export-research relationship survive this double control, in the Canadian-owned (N=32) and the other-controlled (N=7) telecommunications firms.

When NOPX, the presence of firm activity abroad, was added to the two previous controlling variables, no evidence of a relationship between exports and research remained, even in the largest (N=14) of the samples.

By this point, of course, the degrees-of-freedom limits of the cross-tabulation method are reached and the loss of information incurred by the grouping of individual observations makes itself painfully felt.

1.2.3 Cross-tabulation on the SIC Level

Let us then, keeping the reservations just expressed in mind, go quickly through the results surrounding the hypothesized relationship between exports and research intensity in the firm's SIC category which is also the category within which the innovation took place.

We note, first, that this relationship is stronger on the S than on the T level: appendix table 1.2.3a shows positive association at the 0.01 level (N=121) between EXPXS78Q and RDSSALEI, while the corresponding T-level table showed it at the 0.03 level. (Incidentally, there is also positive covariation at the 0.06 level between SIC exports and the total research intensity of the firm.) When the SIC export intensity is cross-tabulated with the four industrial categories it is even more evident in the main SIC activity than at the T-level of aggregation that the two factors are not independent. These two results yield some _prima facie_ evidence that tighter and "truer" relationships might hold _within_ the SIC category and that, at the minimum, this level of disaggregation cannot be omitted from consideration.

As with the T-level, there appears no relationship between export intensity and country-of-control or diversification; and there is a positive significant one with the presence of operations units abroad. Also paralleling the earlier results, there is a strongly significant positive export association with employment in the main SIC category as well as some relationship with T-level employment.

Given the strong covariation between S-exports and S-research on one hand, and the employment size of the firm's main division on the other, we also controlled the exports-by-research table by S-employment to see whether their positive relationship is not due to this effect of size. But no: for the three lowest employment sizes (N=42 - see appendix table 1.2.3b, N=18, N=23) a 5-percent positive level association persists and faint traces of it remain in the two highest employment sizes (N=20, N=17).

Unlike the T-level of comparison, when country-of-control is held constant, a marked (0.04) degree of positive association between exports and research remains in the 70-strong Canadian sample. When both size and country of control are held constant, exports in the smallest Canadian companies (N=38) rise with research intensity (0.10 level). Given the experience with the T-level samples where three- or four-way classifications led rapidly to dwarf-size samples and empty cells, no other controls were imposed here.

Can any interpretation survive this swarm of numbers? Possibly, but not without some modest theory.

1.2.4 Interpretive reflections

Looking back at the cross-tabulation results we see that simple associations of export intensity--on the total and on the SIC levels--are found with research intensity, employment, the presence of activity points abroad and industry type. As a preliminary evidence this would indicate that in innovative firms research is helpful in creating sales abroad, that economies of firm and of scale are favourable to exporting, that some industries have more of an international trade advantage than others and that "antennae" abroad may confer informational benefits in exporting. This interpretation is based on the working assumption that causation runs from all of these variables to export intensity.

The other two variables available in or from our survey, country of control and an index of diversification, do not exhibit significant association with exports. At first look, it does not seem as if subsidiaries were hindered in their export propensity by their foreign parents. Nor does it appear that diversification, if it stands for fragmentation of product offering and short production runs behind tariff protection, depresses exports.

The export-research relationship which is of primary interest in this study tends to persist with one additional variable imposed as control, namely employment, and in the case of the 70 firm Canadian-controlled sample. A plausible interpretation would state that export intensity tends to grow on the whole significantly with research intensity and employment size, and with research intensity in the 70 Canadian companies of the 153-member sample analyzed, regardless of employment size. While only an iceberg tip of the contingency table evidence is brought up, the general observation can be made that the export-research relationship does not survive the imposition of other second-layer controls such as industry type or activity points abroad and is necessarily undetectable with third-layer controls.

These results are sufficient to whet the appetite for further inquiry but they hardly carry conviction. Their quality may indicate that the relationship between export and research intensities is quite weak, but it may also be due to the loss of information incurred when data are grouped, of necessity arbitrarily, for statistical cross-classification analysis. In any case it is perfectly clear that a more powerful multivariate technique must be applied to the data.

1.3 Determinants of export intensity in the innovating firm

It is with some hesitation that the expression "determinant" is resorted to, for sound a priori reasons must be proffered to justify recourse to the regression model that is the concomitant of that expression. This calls first for a brief look at the hypotheses which purport to explain the export stance of firms.

1.3.1 Some export propensity theory

We remind ourselves first of the constraints imposed on our analysis by the survey's parameters: all firms are "innovators" though not necessarily engaging in research; information is available for the firm as a whole, and for its main SIC class, at 1978 and at innovation-launch year on export and research intensities, employment, diversification, national control and, of course, type of industry. As we have seen, the type of industry in which the firm is situated does make a difference in export intensity and this difference will show up in the subsequent regression analysis. We are, however, not interested in the pursuit of the obvious which is discernible in less costly sectoral macrodata. We shall control for industry sector by the use of dummy variables or by employing one-industry samples and concentrate on intra-industry firm differences in export intensity.

At this stage of firm or SIC level of aggregation the fullest structural model that could be tested with the available data is

(1.3.1.1) Export intensity_{ij} = f (Research intensity_{ij}, Employees_{ij}, Country of control_{ij}, $\text{Diversification}_{ij}$, Activity points abroad_{ij}).

where the subscript _i_ refers to the innovating firm and _j_ to one of the four industries. (It was already pointed out that the peculiarity of our sample is that all firms are actual "innovators" though not necessarily "researchers"). As written, the relationship naturally presupposes a flow of causation from right to left; in general, we would expect that firms with higher research intensity - as measured by the proportion of total sales revenues devoted to that activity - would also be able to derive a larger proportion of their total sales revenues from exports.

As McGuiness and Little (1981) point out in their excellent scan of the literature, both of the major competing theories of international trade assign a causative influence to R&D. The neofactors theory of trade views research as a manifestation of technological, capitalized human skills - a factor of production - that may confer upon the firm a trade advantage (Baldwin 1971). The product life cycle theory focuses upon individual products and postulates that technological activity creates new products with advantages sufficient to make them competitive beyond domestic markets

(Gruber and Vernon 1970). Yet a third, though not rival, theory of international production (i.e., production financed by foreign investment) utilizes research--called an "ownership specific" factor to distinguish it from country-specific--as an element determining export competitiveness (Dunning 1979).

There is substantial evidence in favour of a positive influence of research on exports, but almost all of it comes from inter-industry analysis, no matter which theory in the background (Dunning and Buckley 1977, Hanel 1976). This could make for what political scientists call the ecological fallacy: hypotheses designed to explain phenomena at one level of aggregation (the voter, the firm) are tested on a higher one (the electoral district, the industry). It may be too difficult to aggregate successfully information with regard to an important variable to a higher level.

Ecological fallacy is of course but one possible contribution to the threat of mis-specification which hangs over the model (1.3.1.1). Concentrating on the export-research connection it is quite likely that a variable affecting both is omitted: management's entrepreneurial drive or simply the quality of management. Writing

(1.3.1.2) EXP/S = f (R&D, MGT)

we see that omission of MGT will bias upward R&D's coefficient. Of course, the structure may be more complex:

```
EXP/S <------------------ R&D <----------------- MGT
  ^                                                |
  |________________________________________________|
```

McGuiness and Little are quite worried about this aspect; de Woot and

Heyvaert (1979), using the firm's rate of return rather than exports as dependent variable, document it empirically. Finally, Kirpalani and Macintosh (1980) on the basis of their multivariate analysis of a sample of 34 small manufacturers in Canada opine that management practices are more critical for successful international marketing than situational (e.g., government assistance), marketing, product, and manufacturing policies. Nothing in our data allows us to specify a "management quality" variable.

While on the gloomy side we might as well raise the issue of causality. If export markets are important to Canadian firms and if they can be entered more successfully by firms that are technologically oriented, we would expect the prospect of exports to stimulate research expenditures. If research and export intensities can only be indexed by the same year, simultaneity will invalidate the regression results. Fortunately, our data have two time indices, 1978 and the (varying) year of innovation launch, to allow us to detect danger signs in this respect.

Let us now discuss the role and meaning of the other variables in the (1.3.1.1) structure, starting with the number of employees which we conceive of as a representation of firm size. It is not clear whether total firm employment (EMPT) or employment in the main SIC category (EMPS) represent better the effects of scale relevant to exports. While "orthodox" scale economies which lower total unit costs are related to plant size, perhaps more closely approximated by employment in the SIC category, certain authors favour with regard to exports the hypothesis of firm-size economies, approximated here by total employment (Horst 1972), while others cannot make a distinction with their data (Glejser, Jacquemin, Petit 1980). Certainly the cost of access to exporting agents or of sharing market and documentary information would seem to be spread more naturally in non-giant enterprises across the whole firm (Bilkey 1978). We shall use both versions of the employment variable.

It cannot be said that there is unanimity as to the presence of economies of scale in exporting. McFetridge and Weatherley (1977) do not find theoretical justification for them (indivisibility is thwarted by a well-established market in export management services), nor empirical evidence from the multiple regression analysis of two large samples of firms in which they use sales revenue as the factor of size. Poynter, Kerrigan and Sarjeant (1980) find some indication of such economies, as measured both by employment and sales.

More convincing, however, is a recent analysis of Glejser et al. (1980) based on a sample of 1446 Belgian exporters. They point out that a positive corrrelation can be expected between domestic sales (and a fortiori total sales) and exports, since entry into the foreign market raises the quantity sold at home through a reduction in average cost. However, if exporting were entered into essentially to achieve economies of scale, a negative relationship would be found between domestic sales and the ratio of exports to domestic sales since the larger the domestic sales, the higher the chance of getting the benefits of large-scale output without incurring the extra costs that typically go with exporting. Their conjectures are borne out, the relationship between export sales and domestic sales is significantly positive, that between exports as a percentage of domestic sales and domestic sales is negative.

We cannot follow the Belgians because the dependent variable's specification as exports/domestic sales would not fit that of our main determinant, research/total sales. It should be noted that on their argument and results with respect to the negative correlation true causation actually runs from expected cost reductions via exports to larger domestic sales--a possibility which may also be present in our case.

Locus or country of control is an ancient, controversial, probably Canadian-invented variable, discussed at length in Safarian (1973) among others. The Science Council of Canada (Gilmour and Britton 1978) would argue that there is a negative correlation between foreign ownership and research activity in the firm; thus less export intensiveness in such firms. Other authors point out the obvious: foreign firms in resource-rich sectors may be more export-oriented since they entered these sectors primarily to satisfy home-country or world demand. Foreign firms in sectors not possessing special endowments, say others, may not export much since they came in merely to circumvent high tariff walls and are in Canada to exploit the domestic market (Daly 1979, Globerman 1978, Safarian 1979).

Diversification, proxied of necessity by the ratio EMPS/EMPT, is typically considered a determinant of research outlay as it may be the beneficiary of serendipity (Grabowski 1967). There is some, but not excessive first-order correlation in our data between the two factors. But the chief expectation would be of a direct, negative influence of diversification on export intensity. As stated already, the explanation runs from tariff-sheltered fragmented markets to excessive product diversification, to short product runs (approximated by low EMPS/EMPT ratios) to low competitiveness abroad.

Finally, activity points abroad seem co-terminous with enhanced knowledge of foreign markets. Its influence on exporting (unilateral?) is documented elsewhere (Glejser et al. 1980).

1.3.2 "Orthodox" regression results

The outcomes of regression analyses are discussed in the following order, due more to convenience of grouping than to some iron inner logic: we first look at the total sample results, whether on the T or SIC levels, next we examine industry subsample-based regressions, after which we interpret the results of our attempt at "hierarchical ordering"; we close with a look at the possibility of two-way causality in our data. We also add, at this point only, that we are in possession and have used an as yet unmentioned continuous variable - the year of the firm's incorporation. We have no theory for it, except to believe intuitively that the younger the firm (INCORPYR close to 1978), the livelier and export-intensive it might be.

Total Sample, T or S Aggregation Levels

The flavour of the results based on the total sample is revealed in table 1.3.2A which gives two regression outcomes for the firm level of aggregation and one for the SIC level. A first glance will show that the diversification and "points of activity abroad" variables are not in the regressions. Diversification early on (just as in the cross-tabs) did not show any influence on export intensity and was eliminated from further analysis. NOPX, points

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Table 1.3.2A about here

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abroad, a 0-1 dummy variable was dropped from the regression analysis with some regrets. Internal analysis of the data at the Council showed the information provided under this rubric to be quite inaccurate; acceptable to us in preliminary cross-classification analysis, but not in a more serious one.

The results indicate, first of all, the export intensity differences among industrial sectors (D1 = Telecommunications, D2 = Plastics, D4 = Electrical, D3 = Smelting and others in intercept). They show (total employment) size to influence export intensity positively; experimentation with EMPSX78 and a squared term of employment to push scale analysis further was unsuccessful. Youth appeared to give {lan to exporting in the T-category, but its influence was not detectable in the SIC grouping (the higher the value of the year of incorporation, the younger the firm, the more intensive export activity). Canadian ownership (C1) when added, showed all the effects of high intercorrelation with research intensity (r=0.39): it weakened R&D's influence on exports and lost its statistical power when research intensity was added to the equation (phenomenon not shown in table). It is definitely a factor to contend with in our analysis. Finally, and most importantly, research intensity "did much better" here than in the cross-tabulations and showed up stronger in the

TABLE 1.3.2A

Total Sample Regressions

Dependent Variable	EXPT78		EXPS78	
Constant	.275	.275	.490	
D1 (t-ratio)	-.172 (3.0)	-.175 (2.0)	-.230 (2.4)	
D2	-.339 (3.2)	-.352 (3.5)	-.493 (4.6)	
D4	-.298 (3.0)	-.303 (3.4)	-.421 (4.4)	
RDSALE	.754 (1.9)	.588 (1.4)	.765 (2.1)	RDSSALE
EMPXT78	.00003 (2.4)	.00003 (2.3)	.00002 (2.0)	
C1		.0599 (1.22)	.578 (1.1)	
INCORPYR	.00277 (1.9)	.00246 (1.7)		
$\bar{R}^2$	0.24	0.24	0.34	
N	122	122	115	
$\overline{EXPT78}$	.276		.285	$\overline{EXPS78}$
$\overline{RDSALE}$	0.05		0.06	$\overline{RDSSALE}$

SIC grouping than on the firm level. The R^2 adjusted for degrees of freedom equally improved to 0.34 from the not disrespectable 0.24 result-given the size and diversity of the sample - when the focus of analysis shifted to the S group.

To give the reader some feel for the tendencies toward multicollinearity in the data, correlation tables for the whole-sample T and S categories are included in the appendix (A1.3.2a and A1.3.2b).

Industry Samples, T or S Aggregation Levels

The largest two industry subsamples available come from the telecommunications (N>50) and electrical equipment (N>40) industries, followed by plastics (N>15) and smelting and others (N>12). Export and research intensities differ among these industries, but no systematic variation is detectable between these factors when T and S levels are considered.

The results at the industry level fall surprisingly short of expectations. Only the telecommunications group yields significant relations, shown in table 1.3.2B. The T and S samples are somewhat different, as shown in the last three lines of the table. Only the "best fit" results are shown out of a number of regressions: we see research intensity holding its own here. In the S results declining returns to research intensity are showing up and a U-shaped relation between employment and exports. The latter gives a hint of agreement with the Glejser et al. (1980) results.

Table 1.3.2B about here

No significant results whatever could be coaxed out of the largish electrical industry sample or from smelting. In the plastics industry, on the T-level, research and squared research (negative sign), as well as the (negative) influence of diversification seep through the significance barrier (0.05) of the 16-strong sample.

1.3.3 A Hierarchical Order?

> The most common strategy used in testing regression coefficients involves (sic!) a decomposition of the explained sum of squares into components attributable to each independent variable in the equation. There are two basic methods of decomposition... In the standard regression method each variable is treated as if it had been added to the regression equation in a separate step after all the other variables had been included... In the hierarchial method variables are added ... in an order predetermined by the researcher ... and the increment in R^2 at each step is taken as the component of variation attributable to the particular variable added on that step... The researcher should make the choice between these two strategies. The crucial criterion is whether the researcher considers the correlation among the independent variables to be causal relations ... Then the hierarchial strategy is in order (Nie et al., SPSS 1975).

Believing that there could be some hierarchial (thus causal) ordering to be discovered among the data, we tried a few experiments. Using the total sample (N=126) of firms at the T-level, we imagined the following structure:

Industry ------------> Control ------------> R&D ------------> EXP/S

Table 1.3.2B

Telecommunications Sample Regression

Dependent Variable	EXPXT78	EXPXS78	
Constant	-.098	.231	
RDSALE (t-ratio)	.886 (1.7)	3.62 (1.9)	RDSSALE
		-9.445 (1.8)	$RDSSALE^2$
		-.00065 (2.1)	EMPXT 78
		0.000 (2.4)	$EMPXT\ 78^2$
INCORPYR	.006 (2.0)		
$\bar{R}^2$	0.15	0.20	
N	53	51	
$\overline{EXPXT78}$	.335	.378	$\overline{EXPXS78}$
$\overline{RDSALE}$	0.08	0.10	$\overline{RDSSALE}$

We predetermined the order of entry of the variables as indicated from left to right, and used the method of testing by F the increments to R^2 for each variable, as recommended in the SPSS manual (pp. 334-40). The F-tests showed (at the 10 percent level at least) that all the independent variables were significant. The industry dummies accounted for 19 percent of the variation in export intensity; not only through their direct influence on it, but also through indirect influence via control and R&D. In turn, country-of-control was responsible for 2.5 percent of the total variation, both directly and through its influence on R&D, while R&D itself accounted for a further 1.9 percent.

A similar, but more ambitious, scheme which inserted employment size between control and R&D and could be directly compared to the S results in the last column of table 1.3.2A failed to show significant results. At this point it was decided to revert to "standard" regression strategy and tests.

1.3.4 Checks on direction of causal flows

There seems to be general agreement in recent writings (see, for instance, McFetridge and Weatherly 1977) that issues of causality cannot be satisfactorily resolved with "one-shot" cross-sectional data. The Council's survey elicited, fortunately, both 1978 and "year-of-innovation-launch" time anchors which allow to test the issue of causality with some confidence. The question before us is, then, whether - all other things held constant - an increase in research intensity will result in higher export intensity, or whether the lure of foreign markets stimulates technological effort.

We restrict our sample to 78 observations by excluding those firms which had zero SIC sales in either the innovation launch year or in the year 1978 and concentrate on export intensity in the main S category. Where necessary, variables are in constant 1971 (GNE implicit price index deflated) dollars.

Is there any prima facie indication of research intensity following export opportunity? Negative answers are provided by two regressions which are based on the two versions of:

(1.3.4A) RDSSALEI = f(EXPSI, SALESI71\$, D1, D2, D4, C1, INCORPYR),
or
EMPXTI plus EMPXSI

where RDSSALEI is the S-research intensity in the innovation year, where EXPSI stands for export intensity in the year of innovation and SALESI71\$ are constant 1971 dollar S category sales in that year. Neither regression's R^2 passed a significance test.

As the next step we undertake a 2SLS estimation using the (N=78) sample's 1978 labelled data. RDSSALE is made a function of industry type, control (C1), SIC sales, total employment and year of incorporation. Its predicted value is then used in the second stage:

$$\text{(1.3.4B) EXPS78} = -.049 + \underset{(2.5)}{3.417}\ \widehat{\text{RDSSALE}} + -.00005\ \underset{(3.0)}{\text{EMPXT78}} + \text{C1 (N.S.)}$$

D2 (N.S.)
INCORPYR (N.S.)

(Here control, industry type and age of firm were not significant; just one industry dummy - for plastics - was used as previous regression runs indicated it to be the only discriminating one.)

It would seem that even after taking possible simultaneity into account, research influences strongly export propensity.

Finally, we made use of the different dating of our data and regressed export intensity (S) in the year 1978 on research in the innovation year. The result confirms strongly and without ambiguity the preceding findings:

(1.3.4C)

$$EXPS78 = .124 - \underset{(-3.2)}{.330\ D2} - \underset{(-2.9)}{.208\ D4} + \underset{(0.6)}{.039\ C1} + \underset{(2.6)}{.0643\ RDSSALEI} + \underset{(3.1)}{.00004\ EMPXT78}$$

$\bar{R}^2 = 0.31$ $\qquad$ $N = 78$

1.3.5 Interpretive Remarks

The foregoing regression analysis appears to us to have documented a statistically significant causal influence of research intensity on export intensity in a multi-variate context. Its presence is felt most strongly in data based on the total sample of firms, with export and research intensities defined on main (SIC) activity levels. The influence can be detected less strongly in the T-level total sample data and even less so in the telecommunications and plastics group data; it fades away in the other two industry subsamples.

Despite some collinearity with S-level research (r=-0.15, N=115), firm size proxied by total firm employees was the other consistently detectable influence on export propensity. (Of course, the type of industry from which the firm came from was also in that league when the total sample was analyzed, but this is not a finding of overwhelming interest.) Occasionally, the country of control and the age of the firm exerted some effect, while diversification had a negative effect in the plastics industry only.

Our kind of sample and our results bear some resemblance to those discussed in the recent McGuiness and Little (1981) article; M-L's focus was on the export intensity of product innovations which will be ours as well in the next section. Nevertheless, it is of interest to note that in their 82-product sample, the firm's technological character (defined as upper or lower half of the sample's values of the firm technological intensity) was in strongly positive association with export intensity. Firm size, defined by total sales, had no detectable influence and neither did foreign ownership.

In our results there is thus a measure of agreement with M-L as regards research intensity; and no contradictions with respect to size and country-of-control. As far as we are aware there are no other regression studies, here or abroad, taking the firm or the firm's product as unit of observation, to which a further comparison could be made.

2. Export Intensity of Product Innovations: Some Covariates

2.1 Background and data

Here the attention shifts to the export intensity of the firm's major product innovation and to the product-specific covariates some of which, for want of a better word, are called market-related. Others can be thought of as cost-connected and yet a third category finds no label. These distinctions are infused with clearer meaning in the regression models of Sections 3 and 4 and are not of great importance at this stage, devoted to data description and statistical cross-tabulations. These are undertaken in the absence of explicit theory--and in the face of survey questions not uniquely related to export intensity of innovations--in order to give us an impression of the strongest or most interesting relationships to innovation export intensity. While we look here mostly at innovation - specific potential covariates, it should be mentioned that in the subsequent regression analyses we shall not omit the influences of the wider context at the firm level.

As already mentioned, the De Melto paper and the M-L (1981) study examined relationships at this level of disaggregation, which presents advantages as well as drawbacks. New products--and we deal here with new products that are major to the reporting firms--are often important enough to the enterprise to constitute a nexus of economic decisions which receive separate and intensive attention from management. They are, in short, the outcome of investment analysis and so a legitimate target of the scholar's and policy maker's interest. Yet their investment, rather than a more permanent profit-centre, character makes them less susceptible to a full cost allocation as well as to routine record keeping. The Council survey questions, probing as far back as 1960, are fragile indeed: some of them asking for dollar figures, others for what are really opinions held at the time of the decision.

The variables constructed from the survey data at the product innovation level are more numerous than those pertinent to the firm as a whole and a good part of them is of the "yes-no" categorical variety. Their nature can best be understood by direct reference to the survey questionnaire included in the appendix. Almost 160 product innovations are available for analysis since four or five firms reported on more than one.

2.2 Some covariates of product innovation export intensity-general remarks

Four kinds of questions that could be put to the data seemed to us worthy of particular attention. First of course, as throughout this study, the relationship between research and other innovation-connected costs and export propensity. Second, we would like to know if there is a threshold for exporting and whether there are economies of scale for exports, as measured against the innovation's or firm's total sales. Third, we continue to pay attention to the control or ownership of the firm, not only because nationality is a perennial issue in this country but also because foreign ownership could be a proxy for a number of "ownership-specific" advantages (such as of technology and access to capital markets) or could affect the "classical" trade patterns (Dunning 1979, Helleiner and Lavergne 1979). Fourth, it would be interesting from a policy point of view to learn something about the influence of government subsidies to innovation upon the latter's subsequent exports. Our quest for possible generalizations will, however, be weakened by the persistently strong differences between the four industrial sectors from which our data came. We start by looking at the relationship between export intensity and innovation cost.

2.3 Cross-tabs of innovation export intensity and the cost of innovation

Here we cross-classify the product innovation's export intensity in the year 1978 and the total costs--as well as its three components--of getting the innovation commercialized, deflated to 1971 constant dollars. Deflation will alleviate but not eliminate the fact that the product may have been launched anywhere between 1960 and 1978--some innovations may be at the beginning, others at the end of their useful lives.

TOT71($) represents the sum of R&D (basic and applied research, development), manufacturing and marketing start-up costs relevant to the product innovation. De Melto _et al_. (p. 26) indicate that of the total cost of product innovation (N=234), 54.1 percent went to R&D, 40.8 to manufacturing start-up and 5.2 percent to marketing start-up. The proportions in our ever-changing samples conform roughly to the same pattern.

Categories of the intensity of exports of the product innovation were defined as:

EXPXI78Q = 0 if export intensity = 0
= 1   0 <   "   < 0.25
.   .   .
:   :   :
= 4   0.75 ≤   "   .

The five TOT71 categories, and those of its components, were defined as between zero and $100,000, to $500,000, to $1 million, to $5 million, and above.

TOT71($) is related significantly and positively to the innovation's export intensity in 1978 (0.03, N=148). When the relationship is controlled for ownership and for type of industry, it remains in evidence, though somewhat less significantly. (The exception is the Canadian telecommunications sample; for smelting the number of observations is too small to permit judgment.) Appendix table A2.3a shows the pattern in the foreign-controlled firms of the telecommunications industry (N=38, 0.01).

The influence of RD71($) persists in three out of the six meaningful cross-tabs when control and industrial sectors are held constant. An illustration is provided of the foreign-controlled electrical firms (N=27, 0.05) in appendix table A2.3b. There is barely a relation between the propensity to export and the manufacturing start-up costs (N=148, 0.16) and none discernible with marketing start-up outlays.

2.4 Cross-tabs of export intensity with innovation and firm sales

Sales of the firm, of the firm's main activity (SIC) category, and of the innovation--all of them as of 1978--were cross-tabulated against the innovation's export intensity in 1978. The sales were broken down into six categories, zero to $50,000, to $100,000, to $500,000, to $1 million, to $10 million, and above. Neither total firm sales (N=155) nor SIC sales (N=158) exhibited a significant relationship with exports, while innovation sales did so beyond the 0.01 level (N=156). The covariation between SALEI78Q, the index of innovation sales, and export intensity was significant at the same strong level when country of control was held constant. It still showed up very strongly among both types of control in the telecommunications and electrical industries ($18<N<42$) and gave credence to the hypothesis that there are innovation-specific economies of scale for exporting, or alternatively, to the premise that exportation helps in achieving larger sales because it contributes to scale economies. An illustration of our results is in appendix table A2.4.a pertaining to Canadian-controlled telecommunications firms (N=41, 0.00).

2.5 Export intensity and sources of funding

We use two somewhat complementary measures of sources of funding which went into the commercialization of the innovation (i.e., into TOTCOST). One is percentage of government funding, with five categories (0-20%, ..., 80-100%), and the other is percentage internally funded, with seven categories (0, 0-20%, ..., 80-99%, 100%). The cross-tab results tend to reinforce each other.

There is positive association of a very strong kind between the innovation's export intensity and the degree of government financing (N=156, 0.00), though 103 innovations received no support. This association persists in foreign firms (N=89, .00), but fades in domestic firms (N=78, 0.16). It survives among the foreign-controlled firms in the telecommunications industry (N=40, 0.05) and in the electrical equipment sector (N=28, 0.00).

When firms finance out of internal funds, as opposed to government assistance, parental contributions, bank loans, etc., they have very much less of a tendency to export (N=155, -0.00). Holding control constant, the negative relationship is still strong (C1, N=76, 0.08; C2, N=90, 0.03) and carries over in two instances into domestic telecommunications (N=39, 0.05) and foreign-owned electricals (N=14, 0.02). At the same time a look at financing by parents, banks, venture companies reveals no association with export intensity.

The presumption therefore appears plausible that internally financed innovations are destined primarily to domestic markets, possibly because these appear more profitable. This is corroborated by the tentative finding, to be discussed in Section 5, of an inverse relationship between the profitability of an innovation and its export intensity. Government-supported innovations tend quite possibly to be those which, because of export promise, receive assistance from the public sector. More informed judgment must await the results in Section 4.

2.6 Export intensity and other factors

Most product innovations were not developed under licence (113 out of 159). Those which were did not export as well (-.03), a finding similar to that of M-L (1981). This is corroborated by the finding that innovations whose primary source was the firm's own research were exported more intensively than those originating outside the company (N=159, 0.05). When the primary source of technology was Canadian, the innovation had a better chance of being exported (N=64, 0.00). The influence of the source of outside technology, whether domestic or foreign, did not survive control by type of industry.

Many of the other cross-tab results are compatible with those given in De Melto et al. We add, however, the dimension of statistical significance. Thus, for instance, innovations commercialized in response to foreign competition were more export intensive (N=159, 0.00), while those developed to counter domestic competition were significantly less export-intensive (N=159, 0.04). Taking advantage of new technological capabilities had no discernible effect, somewhat in accord with M-L's finding that products based on newer technology sold less well abroad.

Of all the other influences listed among the three most significant factors which contributed to the development of the innovation, only deteriorating profit margins were significantly--and negatively--associated with subsequent export intensity (N=159, 0.00). Of all the main sources of ideas which helped develop the innovation only a very few were associated one way or another with exports; when the idea came from the parent, it tended to result in a product with low export intensity (N=159, 0.00), a finding which we keep encountering in a highly significant fashion in subsequent regression and discriminant analyses.

2.7 Interpretive remarks

Our contingency table analysis found fairly strong associations between the export intensity of product innovations and the innovation's total sales, total innovation costs (and its most important component, R&D) and government financing of technology. Nationality of control (Canadian vs. foreign) was only employed as a cross-tab control and did frequently make a difference. Other potential influences on export intensity occasionally showed up in a significant pattern, such as that where the idea for the innovation came from the parent and where the source of technology was not Canadian, the chances of exporting the innovation were not bright. These results give encouragement to probe further with more powerful methods.

3. Market-related Determinants of Innovation Export Intensity

In this section we suggest and estimate a regression model designed to uncover possible export scale or threshold phenomena connected with the total sales of the innovation or of the firm. (We recall that the influence of the sales of the innovation product came through various levels of control in the preceding cross-tab analysis). Sales may be a more appropriate measure of the scale of operations with regard to exporting since, in this survey data at least, they can be attributed directly to the product and because they are likely to be in strong inverse relationship with general market information costs: as the number of sales contacts increases, additional ones are more easily managed.

We pitch the statistical analysis to the (most reliably reported) 1978 exports and sales and write the model's basic structure, with the corresponding estimating form below, as:

(3.A)

$$EXPI = b_1 SI + bo + b_2 SI^2 + b_3 SF + b_4 D_i . SI + b_5 Cl . SI + b_6 Cl . SI^2 + b_7 TM$$

(3.B)

$$\frac{EXPI}{SI} = b_1 + b_o \frac{1}{SI} + b_2 SI + b_3 \frac{SF}{SI} + b_4 D_i + b_5 Cl + b_6 Cl . SI + b_7 TM$$

where

EXPI = exports of innovation in 1978

SI = total sales of innovation in 1978

SF = total sales of firm in 1978

D_i = industry dummy Cl = Canadian control

TM = 80/Launch year less 1900

It is apparent that beyond sales scale and threshold we also wish to see what difference ownership makes, expressed in both intercept and slope dummy variable form. Since the product innovations have various birthdates (i.e., launch times) from which to make their mark, this element deserves to be held constant. The estimated equation is weighted by 1/SI; SI and SI^2 were tried out as weights but were not as successful in keeping heteroskedasticity at bay.

Table 3 presents the principal results of several stages of our regression analysis. A notable omission is that of the results of the telecommunications (N=65) and electrical equipment (N=47) individual samples: no results there approached significance. The total sample of innovations (N=129) with which we work here does not include the "smelting and others" sample which has only nine "usable" innovations.

Table 3 about here

Looking at the total sample results it appears that the plastics industry intercept dummy (D2) is strongly significant with a negative sign, indicating that this industry's innovation average export intensity (N=17) is much lower than that of the telecommunications and electrical equipment industries. In fact, it is marginally above zero when Canadian firms are being considered: the average export intensity in TELE and ELECT is (b_1 + b_5=) 46 percent and from this is deducted (b_4) 43 percent. When foreign-owned firms are in question the average propensity to export is zero ($b_1 - b_4 = -.07$). A look at the plastics industry data confirms the

TABLE 3

Coefficients from Export-Sales Regressions

Structural Coefficient	Estimating Variable	Total Sample	Telecommunications and Electrical	
b_0 (t-ratio)	1/SI	-1.733 (-1.68)	-2.150 (-2.0)	-2.199 (-2.1)
b_1	Constant	.356 (6.3)	.276 (4.7)	1.370 (2.8)
b_2	SI	-.00003 (-.5)	-.00025 (-1.78)	-.00002 (1.4)
b_3	SF/SI	-.00063 (1.3)	.00362 (3.2)	.353 (3.2)
b_4	D2	-.427 (-3.9)		
b_5	Cl	.099 (1.4)	.175 (2.33)	.112 (1.4)
b_6	Cl.SI	.00001 (.1)		
b_7	TM			-.712 (-1.75)
b_8	DECD			-.297 (-1.9)
	$\bar{R}^2$	.103	.094	.134
	F	3.45	3.88	3.85
	N	129	112	112

general impression. Only six firms export, none of them more than 10 percent. It was therefore decided to concentrate on telecommunications and electrical equipment in order to get a clearer picture of those two industries rich in innovations and exports.

Apart from the variables in the structural equation (3.A) two others, generated by the survey, seemed strongly market-related and were experimented with. When the innovation's idea originated from within the sales force or marketing department (question No. 9 in survey), a dummy variable was activated. It did not turn out to be significant. When the decision to innovate was influenced by interactions with customers, or to gain a larger market share or because of a perceived gap in existing markets, a dummy coded DECD was given the value of one. As is evident from the third column of table 3, innovations affected by these sorts of influences tend to be significantly less export oriented, possibly due to stronger domestic demand.

The negative and almost significant coefficient of the "time since launch" variable, defined as the ratio (19)80/(19)YY, means that older innovations are less likely to be exported in the year 1978. Thus more recent product-embodied technology seems to have a competitive edge in foreign markets; in accord with the consensus of the literature but not with M-L (1981) who find little evidence of foreign sales success of "newest technology". This interpretation is subject to the reservation that there is no reason why all products should age at the same rhythm.

We now come to the question of primary interest in this section, namely that of threshold and of economies of scale. We refer to the results yielded by the telecommunications and electrical equipment sample in the second column of table 3 as we consider them less contaminated by the disparate units of measurement which constitute the TM and DECD variables.

The statistically significant and negative value of the structural coefficient b_o shows that the intercept in the export non-ratio function is negative. This implies that, on average, there is a threshold size of innovation sales which must be attained before exports start. The threshold is situated around the \$78,000 level of 1978 innovation sales, given that

$\$EXPI = 0 = -2.15 + 0.276SI \quad SI = \$77,899$

and that sales are measured in tens of thousands of dollars.

The positive and significant values of b_1 and b_3 show that exports do, on the average, increase with the total sales of the innovation and of the firm as a whole. Put differently, the b_3 coefficient also indicates that larger firms tend to export a higher proportion of their innovation sales.

A second, squared, term of innovation sales, SI^2, exhibits a negative coefficient (b_2) hovering on the edge of significance and gives evidence of diseconomies beyond a certain level of sales. But a squared term of firm sales, SF^2, did not prove to be significant in other regression runs.

Neither did the coefficient b_6, testing for second-power influences of the (innovation) total sales of Canadian-controlled firms. There appears, nevertheless, a not quite significant confirmation that innovation sales of Canadian firms are more export intensive, through the b_5 coefficient. This is best seen by taking the estimating equation (3.B) perspective, in which b_1 is the intercept of export intensity of non-Canadian firms and b_5 the intercept dummy of Canadian control. Attempts to use slope and intercept dummies for Canadian control of the SF variable in conjunction with those of the SI variable failed due to collinearity.

Our interpretation of size impact is tempered by the reflection that, in the above specification without TM, innovations with greatly different launching dates may have attained or barely commenced attaining their export potential. On the whole, nevertheless, we are satisfied that we did establish a positive association between total sales of the innovation or of the whole firm and the innovation's export intensity, with more than a hint of a better performance of Canadian-controlled firms.

4. Innovation Costs as Determinants of Innovation Export Intensity

Previous cross-tabulation statistics gave indication of a significant association between innovation export intensity and the total, as well as the R&D-related, outlay to commercialize the new product. We now wish to examine the influence of "innocost" in a more rigorous multivariate light.

In the previous section we gained the impression of an association between exports and total sales of an innovation. Let us now posit that the total sales of an innovation in a period t=78 are a function of employment within the firm (ideally, of the personnel working on the supply of the innovation, less rigorously of the personnel with the pertinent SIC division) and of the total cost of innovation (R&D plus manufacturing and marketing start-up) incurred up to the launch year t-1, and of certain other conditioning variables, such as country of control etc. A simple expression of this premise is:

(4.1) $S_t = b_1\ EMPS_t + b_2\ COST_{t-1}$

Our interest lies in export intensity rather than in the explanation of the behaviour of total sales; we decompose total sales into exports, X, and domestic sales (D). We already estimated the X=f(S) relation and know that, grosso modo, X=-a+pS. Since D+X=S, then D=S+a-pS or D=a+S(1-p). Writing:

(4.2) $S_t = X_t + D_t$

and substituting for S_t in (4.1) we get:

(4.3) $X_t = -D_t + b_1\ EMPS_t + b_2\ COST_{t-1}$

or

(4.4) $X_t = -[a + S_t\ (1-p)] + b_1\ EMPS_t + b_2\ COST_{t-1}$

Using S_t, the total sales of the innovation in the year 1978, as weights to insure homoskedasticity, our basic estimating equation is:

(4.5) $(X/S)_t = -a/S_t - (1-p) + b_1\ (EMPS/S)_t + b_2\ (COST_{t-1}/S_t)$

To test for non-linearity, squared terms of "innocost" and of employment can be added, and so can of course other conditioning variables.

A difficult issue, not totally resolved, has already been touched upon and surfaces annoyingly at this stage. It has to do with time labels and weighting. The total cost of innovation has been incurred up to the year of commercialization and the time factor can be partly neutralized by using constant (1971) dollars. However, the sales and exports we selected--in part to ensure unilateral causality--took place in 1978. Clearly no uniform period elapses in our sample from launch to 1978. The alternative solutions are: (a) match launch year exports, sales, and "innocost;" (b) estimate (and use) cumulative sales from launch year to 1978, under the assumption that sales were growing at a constant rate.

Once an option is chosen (1978 sales or launch year sales or cumulative sales), it is used to weigh the right-hand side innocost and employment variables to prevent heteroskedasticity. Another way to alleviate this problem is the taking of logarithms. All four options were tried out but, life being short, attention was mostly focused on the theoretically appealing and statistically fairly safe version of Eq. (4.5).

4.2 Results with the 1978 sales ratio model

Four groups of estimates were generated with the (4.5) model: with total sample data and in the TELE plus ELECT subsample, employing either the total cost of innovation or its three components (R&D, manufacturing and marketing start-up costs) as regressors.

The total cost of the innovation (incurred up to the year of launch designated as t-1 and expressed in 1971 dollars) which is divided by the value of the total sales of the innovation during 1978 expressed in 1971 dollars, TOTCOST71/SI7871, did not prove to have any statistically significant impact upon the export intensity of the innovation, though having a consistently positive sign. This result appeared both in the total and in the TELE + ELECT samples and also when using an additional squared term.

In the third group of estimates based on total sample data (N=117), with the innovation cost decomposed into three variables, the results were not brilliant either. Only the three industry dummies were significant, with the TELE and ELECT intercepts almost identical in value and the plastics dummy notably negative. As in the previous section the decision was then made to concentrate on the TELE + ELECT subsample.

Table 4.2 about here

After some experimentation and considerable reflection, the results shown in the first column of table 4.2 were selected for presentation. Only the R&D squared term is retained in the regression equation. Used singly, the linear term had a positive significant effect on export intensity, but its significance waned when the squared term was added. The manufacturing cost variable is also absent for analogous reasons, while marketing start-up costs exhibit a quadratic influence on exports. Employment in the S category has also been left out; as the correlation table A4.2 in the appendix shows, the correlation coefficient between RD/SI and EMPS/SI is a considerable 0.57. (Other collinearities are present, especially between the innocost components and certain dummy variables). In a similar vein a consistent, strong and <u>negative</u> correlation was found between Canadian control and "idea for innovation coming from parent firms". The fact that IDEAPAR was always more significant than C1 (Canadian control) suggests that the control itself is less important than the technological dependence on foreign parents. Thus only IDEAPAR was retained in the regression.

1/SI is here, as in other regression runs not shown, consistently significant and negative, indicating that there is a threshold size of innovation sales before exporting (and vindicating, incidentally, our

TABLE 4.2

INNOCOST REGRESSIONS

Dependent Variable	EXPI78/SI78	EXPI78/EMPS78	
Constant	.498	.185	
(t-ratio)	(9.2)	(2.5)	
1/SI	-1.375	-2.165	1/EM
	(2.3)	(4.4)	
RD2/SI	.00035	.00222	RD2/EM
	(3.2)	(3.4)	
MKT/SI	.591	.541	MKT/EM
	(2.0)	(2.2)	
MKT2/SI	-.034	- .03915	MKT2/EM
	(2.0)	(7.0)	
IDEAPAR	-.337	- .565	
	(3.8)	(4.6)	
GOVFUND	-.00020	- .00050	
	(1.5)	(2.7)	
		.411	SI/EM
		(8.9)	
$\bar{R}^2$	0.21	.52	
F	5.2	15.5	
N	94	94	

model). The constant C is deemed to show, according to the theoretical specification C = 1-p, the proportion of sales exported. The value of the constant, 0.498, is not quite within two standard deviations (s.d. = 0.06) of the mean value of exports in this sample which is 0.369.

The association of government funding and export intensity is not quite significant at the 5 percent level, but in other runs it is just significant. Its (consistently) negative association with exports is in complete contradiction to our cross-tabulation results. It will be recalled that only about one-third of the innovations received government funding. In other regression experiments no noticeable influence emerged of such other conditioning categorical variables as licensing, new technology, prior use or "idea from own R&D."

Given the high correlation between RDSI and EMPSI it was advisable to check whether RDSI's relatively good showing was not spurious. Instead of sales, 1978 employment in the main SIC category was used as a deflator. The results are set out in the second column of table 4.2. No change of direction but a major increase in significance is in evidence.

Finally, the ratio regressions in logarithmic form gave much poorer fits as could be expected in a situation in which the values of all the variables are very circumscribed in range.

4.3 Results with year-of-launch and cumulative sales models

Matching export intensity and innocost components in the year of the launch (TELE + ELECT, N=83) gave predictably less significant results since at that period much of the export potential is as yet unrealized. The (linear term of) RD/SI appeared to have the most significant impact; licensing also showed up as a strong negative influence.

Various versions of the cumulative sales model did not give any enlightening or significant results. This outcome presents us with the leeway of not mentioning the special biases that are introduced by these versions which attempted to minimize the consequences of disparate product ages, forced upon our analysis by the nature of the survey.

4.4 Results with non-ratio logarithmic regressions

Naturally, the simplest version of a model testing for the influence of innovation pre-launch activity on export intensity would be of a non-ratio form, such as

$$\text{(4.4.1)} \qquad \ln EXPI7871 = f(\ln COST71, \ln EMP78, \ldots).$$

The (natural) logarithms would tend to depress extreme values and fend off heteroskedasticity. How does this version perform? Using a sample of 116 innovations in TELE + ELECT, the results for the total innocost and innocost component versions are, respectively:

(4.4.2)

$$LEXP = -1.051 + \underset{(3.0)}{.331}\ LTOT + \underset{(3.5)}{.408}\ LEMP + \underset{(1.0)}{.363}\ C1 \qquad \bar{R}^2 = 0.27$$

(4.4.3)

$$LEXP = -.0873 + \underset{(1.5)}{.217}\ LRD + \underset{(1.4)}{.211}\ LMFG - \underset{(0)}{.022}\ LMKT + \underset{(3.4)}{.400}\ LEMP + \underset{(1.1)}{.436}\ C1 \qquad \bar{R}^2 = 0.27$$

The correlation table (A4.4 in the appendix) indicates considerable collinearity between the innocost components, as well as between employment and Canadian control (negative sign). This, and an uninvestigated presence of remaining heteroskedasticity, may affect the t-ratio in the "components" regressions.

As a general final comment it is fair to state that throughout our investigation the positive influence of R&D or R&D intensity, at least, on exports or export intensity stands out like a beacon.

5. Profitability and Export Intensity of Product Innovations

> How long did it take for your firm's expenditures on research and development for this innovation to pay off after first commercial launch or first use? Less than 3 years? 3-5 years? More than 5 years?

This question (No. 17) on the Council's survey instrument gave hope that a rough measure of an innovation's profitability could be estimated and regressed on export intensity. If feasible, the expected positive influence of export intensity upon "profitability" would be embedded in and could be estimated from a pattern sketched out in

$$\text{(A)}\ K_i = a_o + a_1\,(EXP/S)_i + a_2\,R_i + a_3\,V_f + u_i$$

(5)

$$\text{(B)}\ (EXP/S)_i = b_o + b_1\,K_i + b_2\,RD/SI + b_3\,V_f + v_i$$

where

K_i = a measure of profitability of innovation i

R_i = revenue from sale of associated technology

V_f = a vector of firm-level variables.

Besides providing yet another check on the causality assumption RD->->EXP, this system's estimates should confirm the reasonable speculation emitted by Mansfield et al. (1979) about the dynamics of research and export markets: while new products or the use of new processes create markets abroad, these markets also furnish revenues without which it would be difficult to undertake R&D. In the event, we could not estimate this system, but the story of our failure is not without interest.

In order to calculate "profitability" we had to make these assumptions:

(a) The rate of growth of sales revenue is constant and can be calculated as:

$$SI7871\$ = SII71\$.R^t$$

where SI7871$ is the sales revenue generated by the innovation during 1978 deflated to 1971 dollars, SII71$ is the revenue in the year of launch in constant dollars, R the rate of growth and t the number of years between launch and 1978;

(b) Production and other costs are a constant proportion of yearly sales:

$$C = cS_t \qquad 0<c<1;$$

(c) Research and development cost is a constant proportion of total innovation launch cost:

$$RD = aTOTCOST \qquad 0<a<1.$$

(This last condition is imposed because the survey question asks about payback with respect to R&D only.)

Then the cumulative "profits" over t years equal

$$Pi = (1-R^t)/(1-R)(1-c)SII71\$ - (RD/a)71\$.$$

When the payback period pb is known, the breakeven condition is

$$(1-R^{pb})/(1-R)(1-c)SII71\$ = (RD/a)71\$.$$

Calling the right hand side term simply TOTCOST we can now derive a measure of profitability as the percentage mark-up, K:

$$K = (1-c)/c = TOTCOST/(h.SII71\$ - TOTCOST)$$

where $h = (1-R^{pb})/(1-R)$. As pb we stipulated 2 when the response indicated yes to "less than 3 years", 4 when it was 3-5 years, and 6 when it was more than 5 years.

Having a payback period of 6 years forced us to abandon innovations launched after 1973, bringing the sample down to 121. Of these, only 44 had all the information we required and of these another 14 had negative "profitability" markups, necessarily due to our formula's sensitivity to measurement error in pb or in R. (Some responses to the question indicated that it was not well understood; for instance, a projection rather than a historical perspective on "payback" was sometimes employed.) Neither of the OLS regressions using 30 or 44 observations gave a significant overall F-signal or a significant t-ratio on the (negative) export intensity coefficient. In that result, at least, we agree with a large-scale investigation of the profitability of U.S. industries, tied by Pagoulatos and Sorensen (1975) to domestic structure and foreign trade variables: their rather successful investigation revealed negative and non-significant association between an industry's export intensity and price-cost margins.

Retreating from what was perhaps undue sophistication for simple data, we regressed (N=44) EXPI78 on the payback period (pb = 2, 4 or 6, sic!) assuming profitability to decline in proportion to it, with unmentionable results. Back then to the contingency tables and a mild surprise. Holding constant country of control, we find a strongly significant (N=55, 0.04) and positive association between export intensity and the length of the payback period, which implies a negative association between exporting and profitability. This is confirmed in the U.S.-controlled sample (N=44, 0.07); the "other-controlled" sample (N=24, 0.41) shows no significant association.

We conclude that the data are not rich enough to settle the issue with any degree of confidence. But the inclination lingers to believe that exporting of itself is not necessarily very profitable in the case of innovative products.

6. Factors Discriminating Between Exported and Unexported Innovations

Which elements are likely to be associated with the exportation of product innovations (in 1978)? Knowing the presence and levels of certain elements in the background of a product innovation, can we predict whether it will be exported (in 1978) or not? Is "innocost" or research and development cost among them? Are there other important factors which trace out a "profile" of the exported innovations?

In order to answer these questions, related to but somewhat distinct from those previously centered on export intensity, we had recourse to linear discriminant analysis with a relatively homogeneous sample of 91 "usable" innovations in the telecommunications and electrical industries. Of these, 60 were being exported in 1978 (68%). This compares to the 88 exported innovations out of 145 (61%) reported as operating (and usable) in all of the five industries by De Melto et al. (p. 107).

Our potentially discriminating variables were selected both from among firm-level and innovation-level factors. They are listed, with their respective means and standard deviations, in Table 6. We were to some extent guided by our previous results, but it must be remembered that our "dependent" variable here is a less information-laden binary variable, "exports 1978: yes or no," than export intensity.

Table 6 about here

The stepwise SPSS program was instructed to admit those variables whose inclusion improved the discriminating power of the function at a level of significance of about 0.12, corresponding to an F value of 1, when F is interpreted as a test of differences among group centroids.

As can be seen, 8 out of the 17 variables selected had some significant influence in assigning innovations among exporting and non-exporting groups, led by the total export intensity of the firm, EXPT78, 1978 sales

TABLE 6

DISCRIMINANT VARIABLES

	MEANS Non-exp.	MEANS Export	STD. DEVS. Non-exp.	STD. DEVS. Export	ORDER OF INCLUSION	F to Enter
FIRM LEVEL						
EXPT78 (%)	9.5	39.2	13.9	30.0	(1)	27.3
EMPT78/SI7871	20.1	6.7	53.0	12.0	(5)	1.5
C1 (%)	38.7	51.7	49.5	50.4		
DIV (%)	74.4	81.6	35.1	30.6		
INNOVATION LEVEL						
SI7871 (000)	498	1,086	797	4,030	(2)	6.3
IDEAPAR (%)	35.5	35.0	47.5	32.4	(3)	4.4
DECCOS (%)	0.03	0.07	18.0	25.2	(4)	5.0
LICE (%)	45.1	20.0	50.6	40.3	(6)	1.7
RD/SI7871	0.62	0.98	1.3	2.8	(7)	1.5
TM	1.08	1.10	.063	0.070	(8)	1.1
MFG/SI7871	0.46	0.33				
MKT/SI7871	0.11	0.08				
PATENT3 (%)	25.8	31.7				
DECNT (%)	64.5	63.3				
DECD (%)	100.0	91.7				
IDEARD (%)	61.3	80.0				
IDEA (%)	35.5	35.0				

Wilk's Lambda = 0.60
Eigenvalue = 0.67

revenue of the innovation expressed in constant 1971 dollars, and an affirmative answer to the question as to whether the idea came from the parent firm (this latter factor assigning to the non-exporting groups). The standardized discriminant coefficients which are set out below represent, when their sign is ignored, the relative contribution of that variable to the discriminating function. The negative signs here would incline to placement among non-exporting innovations:

EXPT78	0.074	S17871 = 0.048I
IDEAPAR	-0.037	DECCOS = 0.037
EMPTSI7871	-0.027	LICE = -0.024
RD/SI7871	0.020	TM = 0.018

The remaining significantly discriminating variables are:

DECCOS = 1 if innovation to reduce labour, energy, capital requirements;

LICE = 1 if licence or trade agreement;

EMPT78/SI7871 = total firm employment in 78 divided by sales revenue of innovation in 1978 in constant 1971 dollars;

RD/SI7871 = total R&D cost in 71 dollars divided by ...

TM = time from launch, (19)80/(19)YY.

Among those tried unsuccessfully, the manufacturing and marketing start-up costs are prominent, as well as IDEARD, idea originating in own R&D department. (PATENT 3 means patent taken out; DECNT means innovation undertaken because of new technical capability, DECD means innovation undertaken because of market reasons; IDEA means that the innovation's inspiration came from the marketing department or the sales force).

The eight retained variables were capable of classifying 72 out of the 91 cases (79%) correctly. Attempts to impose other structures upon the data (i.e., by using direct rather than stepwise solution methods) were less successful. A reduced sample of 57, comprising only TELE + ELECT innovations with non-zero innocost components, also yielded inferior results. Naturally, one must recall the inherent upward bias present in discriminant analysis which leads to "better" results when the strict procedure of splitting off confirmatory samples is not adhered to--as it was not here.

Among the results one finds again the (modest) presence of R&D intensity against the (powerful) background influence of the overall export orientation of the firm. The size of the total sales of the innovation in 1978 in constant dollars also discriminates in favour of exporting. Consistent with some previous results we find yet again that when the innovation idea is transferred from the parent abroad, exporting will be less likely -- and this influence appears to preempt the effect of Cl or nationality of control. Finally, the negative classificatory influence of licensing and manpower per dollar of 1978 innovation sales and the positive assigning power to exporting of DECCOS, the decisions governed by cost-reduction considerations, as well as that of time since launch (approximating cumulative output) corroborate in a general way the teachings of the comparative advantage theory.

7. Concluding Remarks

The non-mercantilist's attention to exports is rooted in the belief that they are the sign of competitive vigour of a particular sector of the economy. That a firm's competitive edge can best be honed by the pursuit of technological advantage is the informed judgment of many economists and students of management and the despairingly ardent belief of many high public servants searching for panaceas. Also, it might seem self-evident to all concerned that technological advantage can scarce be attained without the help of research and development. Thus the common-sensical hypothesis that firms which engage actively in R&D will on the whole be competitive and profitable and will reap some of the fruits of their virtue in foreign markets.

Taking advantage of our access to a fairly rich assembly of data generated by a quasi-governmental survey of firms in four industries which reported an important innovation we tried to establish a statistical link between the propensity to export and the research intensity of the responding companies in a predominantly multivariate context. The export propensity we employed as the dependent variable was tied to the exports of the entire firm or of the firm's main activity (SIC) category or, above all, to the exports of the firm's major innovation; the principal explanatory variable focused upon, research intensity, was similarly defined for these three categories. Naturally enough, a swarm of other variables, generated by the survey, was also brought into the analysis. Most of our findings are summarized in the last paragraphs of each topic section and need not be taken up here again in detail.

The one consistent finding which does emerge from our study is the positive significant influence of the firm's research and development expenditures (total firm or SIC or innovation-related); not - be it noted - the influence of other innovation-preparatory costs. This effect has been carefully checked in several ways to assure it has the expected causal direction.

Among the other findings which appear of considerable interest we note the following. There are significant inter-industry differences with respect to the influence of most of the potential determinants of export intensity; the telecommunications and electrical industrial equipment firms appear to have more in common than the firms in the other two industries. There appears to be a sales threshold for exportation. Firms under Canadian control have a tendency to export more of their sales than their counterparts under foreign control; this tendency weakens and appears to be pre-empted by the more "immediate" variables of "idea for innovation came from parent firm" or "innovation undertaken under licence". Our data yield contradictory evidence on the influence of (or covariation between) government funding of the innovation and the innovation's export intensity.

Though there is little doubt in our minds about the causal influence of R&D intensity upon export intensity, it may be that the quality of entrepreneurial direction (one may call it by other names such as "organizational factors" or "managerial leadership") is equally important in establishing the firm's thrust into foreign markets (see Kirpalani and Macintosh 1980). We did not have at our disposal data to test this. But this plausible reservation, coupled with the finding of contradictory evidence on the effects of government funding would make us hesitate to assume that incentives to industrial R&D would necessarily contribute to the strength of the trade balance.

Still, our study is one of the very few to which the opportunity was granted to establish a link between R&D and exports at the disaggregated levels of the firm or the product. The potential drawback of all firms in the sample having an innovation to market turns out to be a rather severe obstacle to finding such a link. Yet the hurdle is overcome by the underlying pattern to the data and gives conviction to this finding.

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APPENDIX

Tables and Survey Questionnaire

LIST CASES AND STAT AND CROSSTABS
FILE INNOVATN (CREATION DATE = 06/03/81)
SUBFILE TELE PLAST SMELT ELECT OTHER

* * * * * * * C R O S S T A B U L A T I O N O F * * * * * * *
EXPXT78Q BY RDSALEI

Table 1.2.1a

EXPXT78Q	COUNT / ROW PCT / COL PCT / TOT PCT	RDSALEI 0.	1.	2.	3.	4.	ROW TOTAL
0.		5 27.8 50.0 3.9	2 11.1 6.9 1.6	7 38.9 20.0 5.5	0 0.0 0.0 0.0	4 22.2 15.4 3.1	18 14.2
1.		4 10.5 40.0 3.1	12 31.6 41.4 9.4	8 21.1 22.9 6.3	8 21.1 29.6 6.3	6 15.8 23.1 4.7	38 29.9
2.		0 0.0 0.0 0.0	7 29.2 24.1 5.5	10 41.7 28.6 7.9	5 20.8 18.5 3.9	2 8.3 7.7 1.6	24 18.9
3.		0 0.0 0.0 0.0	3 17.6 10.3 2.4	2 11.8 5.7 1.6	6 35.3 22.2 4.7	6 35.3 23.1 4.7	17 13.4
4.		0 0.0 0.0 0.0	3 15.8 10.3 2.4	6 31.6 17.1 4.7	5 26.3 18.5 3.9	5 26.3 19.2 3.9	19 15.0
5.		1 9.1 10.0 0.8	2 18.2 6.9 1.6	2 18.2 5.7 1.6	3 27.3 11.1 2.4	3 27.3 11.5 2.4	11 8.7
	COLUMN TOTAL	10 7.9	29 22.8	35 27.6	27 21.3	26 20.5	127 100.0

CHI SQUARE = 33.16316 WITH 20 DEGREES OF FREEDOM SIGNIFICANCE = 0.0324
CRAMER'S V = 0.25550
CONTINGENCY COEFFICIENT = 0.45504
LAMBDA (ASYMMETRIC) = 0.03371 WITH EXPXT78Q DEPENDENT. = 0.09783 WITH RDSALEI DEPENDENT.
LAMBDA (SYMMETRIC) = 0.06630
UNCERTAINTY COEFFICIENT (ASYMMETRIC) = 0.08772 WITH EXPXT78Q DEPENDENT. = 0.09746 WITH RDSALEI DEPENDENT.
UNCERTAINTY COEFFICIENT (SYMMETRIC) = 0.09233
KENDALL'S TAU B = 0.20228 SIGNIFICANCE = 0.0023

LIST CASES AND STAT AND CROSSTABS
FILE INNOVATN (CREATION DATE = 06/03/81)
SUBFILE TELE PLAST SMELT ELECT OTHER

* * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * *
EXPXT78Q BY NEMPXT78
* PAGE 1 OF 1

Table 1.2.1b

EXPXT78Q	COUNT / ROW PCT / COL PCT / TOT PCT	NEMPXT78 1.	2.	3.	4.	5.	ROW TOTAL
0.	COUNT	13	1	4	4	1	23
	ROW PCT	56.5	4.3	17.4	17.4	4.3	16.7
	COL PCT	31.0	8.3	14.3	17.4	3.0	
	TOT PCT	9.4	0.7	2.9	2.9	0.7	
1.	COUNT	11	2	13	10	6	42
	ROW PCT	26.2	4.8	31.0	23.8	14.3	30.4
	COL PCT	26.2	16.7	46.4	43.5	18.2	
	TOT PCT	8.0	1.4	9.4	7.2	4.3	
2.	COUNT	3	1	3	5	12	24
	ROW PCT	12.5	4.2	12.5	20.8	50.0	17.4
	COL PCT	7.1	8.3	10.7	21.7	36.4	
	TOT PCT	2.2	0.7	2.2	3.6	8.7	
3.	COUNT	5	2	3	2	6	18
	ROW PCT	27.8	11.1	16.7	11.1	33.3	13.0
	COL PCT	11.9	16.7	10.7	8.7	18.2	
	TOT PCT	3.6	1.4	2.2	1.4	4.3	
4.	COUNT	5	6	2	2	5	20
	ROW PCT	25.0	30.0	10.0	10.0	25.0	14.5
	COL PCT	11.9	50.0	7.1	8.7	15.2	
	TOT PCT	3.6	4.3	1.4	1.4	3.6	
5.	COUNT	5	0	3	0	3	11
	ROW PCT	45.5	0.0	27.3	0.0	27.3	8.0
	COL PCT	11.9	0.0	10.7	0.0	9.1	
	TOT PCT	3.6	0.0	2.2	0.0	2.2	
COLUMN TOTAL		42	12	28	23	33	138
		30.4	8.7	20.3	16.7	23.9	100.0

CHI SQUARE = 44.01234 WITH 20 DEGREES OF FREEDOM SIGNIFICANCE = 0.0015
CRAMER'S V = 0.28237
CONTINGENCY COEFFICIENT = 0.49174
LAMBDA (ASYMMETRIC) = 0.12500 WITH EXPXT78Q DEPENDENT. = 0.13542 WITH NEMPXT78 DEPENDENT.
LAMBDA (SYMMETRIC) = 0.13021
UNCERTAINTY COEFFICIENT (ASYMMETRIC) = 0.09129 WITH EXPXT78Q DEPENDENT. = 0.10156 WITH NEMPXT78 DEPENDENT.
UNCERTAINTY COEFFICIENT (SYMMETRIC) = 0.09615
KENDALL'S TAU B = 0.11551 SIGNIFICANCE = 0.0461

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LIST CASES AND STAT AND CROSSTABS
FILE INNOVATN (CREATION DATE = 06/03/81)
SUBFILE TELE PLAST SMELT ELECT OTHER

* C R O S S T A B U L A T I O N O F *
EXPXT78Q BY RDSALEI
CONTROLLING FOR..
PAYSC VALUE = 1.
* PAGE 1 OF 1

Table 1.2.2a

EXPXT78Q (RDSALEI →) COUNT / ROW PCT / COL PCT / TOT PCT	0.	1.	2.	3.	4.	ROW TOTAL
0.	2	1	3	0	4	10
	20.0	10.0	30.0	0.0	40.0	15.9
	66.7	16.7	18.8	0.0	20.0	
	3.2	1.6	4.8	0.0	6.3	
1.	1	2	2	5	4	14
	7.1	14.3	14.3	35.7	28.6	22.2
	33.3	33.3	12.5	27.8	20.0	
	1.6	3.2	3.2	7.9	6.3	
2.	0	2	5	4	1	12
	0.0	16.7	41.7	33.3	8.3	19.0
	0.0	33.3	31.3	22.2	5.0	
	0.0	3.2	7.9	6.3	1.6	
3.	0	0	1	2	3	6
	0.0	0.0	16.7	33.3	50.0	9.5
	0.0	0.0	6.3	11.1	15.0	
	0.0	0.0	1.6	3.2	4.8	
4.	0	0	4	5	5	14
	0.0	0.0	28.6	35.7	35.7	22.2
	0.0	0.0	25.0	27.8	25.0	
	0.0	0.0	6.3	7.9	7.9	
5.	0	1	1	2	3	7
	0.0	14.3	14.3	28.6	42.9	11.1
	0.0	16.7	6.3	11.1	15.0	
	0.0	1.6	1.6	3.2	4.8	
COLUMN TOTAL	3	6	16	18	20	63
	4.8	9.5	25.4	28.6	31.7	100.0

CHI SQUARE = 19.34306 WITH 20 DEGREES OF FREEDOM SIGNIFICANCE = 0.4996
CRAMER'S V = 0.27705
CONTINGENCY COEFFICIENT = 0.48467
LAMBDA (ASYMMETRIC) = 0.10204 WITH EXPXT78Q DEPENDENT. = 0.11628 WITH RDSALEI DEPENDENT.
LAMBDA (SYMMETRIC) = 0.10870
UNCERTAINTY COEFFICIENT (ASYMMETRIC) = 0.11040 WITH EXPXT78Q DEPENDENT. = 0.13382 WITH RDSALEI DEPENDENT.
UNCERTAINTY COEFFICIENT (SYMMETRIC) = 0.12098

FILE INNOVATN (CREATION DATE = 06/03/81)
SUBFILE TELE PLAST SMELT ELECT OTHER

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
EXPXS78Q BY RDSSALEI
* PAGE 1 OF 1

Table 1.2.3a

EXPXS78Q (COUNT / ROW PCT / COL PCT / TOT PCT)	RDSSALEI 0.	1.	2.	3.	4.	ROW TOTAL
0.	5 21.7 50.0 4.1	5 21.7 20.0 4.1	8 34.8 23.5 6.6	0 0.0 0.0 0.0	5 21.7 15.6 4.1	23 19.0
1.	4 11.1 40.0 3.3	9 25.0 36.0 7.4	8 22.2 23.5 6.6	8 22.2 40.0 6.6	7 19.4 21.9 5.8	36 29.8
2.	0 0.0 0.0 0.0	3 17.6 12.0 2.5	10 58.8 29.4 8.3	4 23.5 20.0 3.3	0 0.0 0.0 0.0	17 14.0
3.	0 0.0 0.0 0.0	2 15.4 8.0 1.7	3 23.1 8.8 2.5	2 15.4 10.0 1.7	6 46.2 18.8 5.0	13 10.7
4.	0 0.0 0.0 0.0	2 11.8 8.0 1.7	3 17.6 8.8 2.5	5 29.4 25.0 4.1	7 41.2 21.9 5.8	17 14.0
5.	1 6.7 10.0 0.8	4 26.7 16.0 3.3	2 13.3 5.9 1.7	1 6.7 5.0 0.8	7 46.7 21.9 5.8	15 12.4
COLUMN TOTAL	10 8.3	25 20.7	34 28.1	20 16.5	32 26.4	121 100.0

CHI SQUARE = 37.89168 WITH 20 DEGREES OF FREEDOM SIGNIFICANCE = 0.0091
CRAMER'S V = 0.27980
CONTINGENCY COEFFICIENT = 0.48834
LAMBDA (ASYMMETRIC) = 0.03529 WITH EXPXS78Q DEPENDENT. = 0.14943 WITH RDSSALEI DEPENDENT.
LAMBDA (SYMMETRIC) = 0.09302
UNCERTAINTY COEFFICIENT (ASYMMETRIC) = 0.11127 WITH EXPXS78Q DEPENDENT. = 0.12490 WITH RDSSALEI DEPENDENT.
UNCERTAINTY COEFFICIENT (SYMMETRIC) = 0.11769
KENDALL'S TAU B = 0.23440 SIGNIFICANCE = 0.0007

REGRESSIONS ET CROSSTABULATIONS 5/6/81
FILE INNOVATN (CREATION DATE = 06/05/81)
SUBFILE TELE PLAST SMELT ELECT OTHER

* * * * * C R O S S T A B U L A T I O N O F * * * * *
EXPXS78Q BY RDSSALEI
CONTROLLING FOR..
NEMPXS78 VALUE = 1.

Table 1.2.3b

RDSSALEI

EXPXS78Q	COUNT / ROW PCT / COL PCT / TOT PCT	0.	1.	2.	3.	4.	ROW TOTAL
0.	COUNT	5	0	3	0	5	13
	ROW PCT	38.5	0.0	23.1	0.0	38.5	31.0
	COL PCT	62.5	0.0	37.5	0.0	26.3	
	TOT PCT	11.9	0.0	7.1	0.0	11.9	
1.	COUNT	3	1	1	1	4	10
	ROW PCT	30.0	10.0	10.0	10.0	40.0	23.8
	COL PCT	37.5	33.3	12.5	25.0	21.1	
	TOT PCT	7.1	2.4	2.4	2.4	9.5	
2.	COUNT	0	0	3	1	0	4
	ROW PCT	0.0	0.0	75.0	25.0	0.0	9.5
	COL PCT	0.0	0.0	37.5	25.0	0.0	
	TOT PCT	0.0	0.0	7.1	2.4	0.0	
3.	COUNT	0	1	1	1	2	5
	ROW PCT	0.0	20.0	20.0	20.0	40.0	11.9
	COL PCT	0.0	33.3	12.5	25.0	10.5	
	TOT PCT	0.0	2.4	2.4	2.4	4.8	
4.	COUNT	0	1	0	1	2	4
	ROW PCT	0.0	25.0	0.0	25.0	50.0	9.5
	COL PCT	0.0	33.3	0.0	25.0	10.5	
	TOT PCT	0.0	2.4	0.0	2.4	4.8	
5.	COUNT	0	0	0	0	6	6
	ROW PCT	0.0	0.0	0.0	0.0	100.0	14.3
	COL PCT	0.0	0.0	0.0	0.0	31.6	
	TOT PCT	0.0	0.0	0.0	0.0	14.3	
COLUMN TOTAL		8	3	8	4	19	42
		19.0	7.1	19.0	9.5	45.2	100.0

CHI SQUARE = 30.97314 WITH 20 DEGREES OF FREEDOM SIGNIFICANCE = 0.0555
CRAMER'S V = 0.42938
CONTINGENCY COEFFICIENT = 0.65150
LAMBDA (ASYMMETRIC) = 0.10345 WITH EXPXS78Q DEPENDENT. = 0.13043 WITH RDSSALEI DEPENDENT.
LAMBDA (SYMMETRIC) = 0.11538
UNCERTAINTY COEFFICIENT (ASYMMETRIC) = 0.25052 WITH EXPXS78Q DEPENDENT. = 0.30068 WITH RDSSALEI DEPENDE
UNCERTAINTY COEFFICIENT (SYMMETRIC) = 0.27332

REGRESSIONS ET CROSSTABULATIONS 5/6/81
FILE INNOVATN (CREATION DATE = 06/05/81)
SUBFILE TELE PLAST SMELT ELECT OTHER

CORRELATION COEFFICIENTS

A VALUE OF 99.00000 IS PRINTED
IF A COEFFICIENT CANNOT BE COMPUTED.

TABLE A 1.3.2a

	EXPXT78	D1	D2	D4	C1	EMPXT78	RDSALE	DIV	EMPXT782	RDSALE2	INCORPYR
EXPXT78	1.00000	0.18509	-0.21489	-0.25156	0.16494	0.21122	0.25481	0.02364	0.21671	0.21913	0.13750
D1	0.18509	1.00000	-0.34463	-0.60885	0.10931	-0.19033	0.37154	-0.03453	-0.13419	0.24785	0.21531
D2	-0.21489	-0.34463	1.00000	-0.26921	-0.00323	0.08313	-0.23204	-0.29436	-0.01703	-0.15899	-0.17735
D4	-0.25156	-0.60885	-0.26921	1.00000	-0.05875	-0.13004	-0.17687	0.29385	-0.08038	-0.15664	-0.01066
C1	0.16494	0.10931	-0.00323	-0.05875	1.00000	-0.09711	0.38776	0.09459	0.01006	0.31692	0.25480
EMPXT78	0.21122	-0.19033	0.08313	-0.13004	-0.09711	1.00000	-0.17011	-0.17195	0.93135	-0.11276	-0.42849
RDSALE	0.25481	0.37154	-0.23204	-0.17687	0.38776	-0.17011	1.00000	0.22299	-0.09172	0.93940	0.29559
DIV	0.02364	-0.03453	-0.29436	0.29385	0.09459	-0.17195	0.22299	1.00000	-0.03458	0.16640	0.20338
EMPXT782	0.21671	-0.13419	-0.01703	-0.08038	0.01006	0.93135	-0.09172	-0.03458	1.00000	-0.06453	-0.29557
RDSALE2	0.21913	0.24785	-0.15899	-0.15664	0.31692	-0.11276	0.93940	0.16640	-0.06453	1.00000	0.18770
INCORPYR	0.13750	0.21531	-0.17735	-0.01066	0.25480	-0.42849	0.29559	0.20338	-0.29557	0.18770	1.00000

REGRESSIONS ET CROSSTABULATIONS 5/6/81
FILE INNOVATN (CREATION DATE = 06/05/81)
SUBFILE TELE PLAST [illegible] ELECT OTHER

CORRELATION COEFFICIENTS

Table A1.3.2b

A VALUE OF 99.00000 IS PRINTED
IF A COEFFICIENT CANNOT BE COMPUTED.

	EXPXS78	D1	D2	D4	C1	EMPXT78	EMPXS78	DIV	RDSSALE	EMPXS782	EMPXT782	RDSSALE2
EXPXS78	1.00000	0.25902	-0.26596	-0.32905	0.15053	0.22886	0.18006	-0.02040	0.32425	0.16699	0.22232	0.29503
D1	0.25902	1.00000	-0.34573	-0.61482	0.09927	-0.19348	-0.14851	-0.02405	0.41866	-0.10098	-0.14545	0.23270
D2	-0.26596	-0.34573	1.00000	-0.26675	-0.03594	0.09416	-0.05831	-0.29793	-0.23273	-0.04452	0.00710	-0.15344
D4	-0.32905	-0.61482	-0.26675	1.00000	-0.03659	-0.13273	-0.02877	0.26121	-0.23903	-0.04103	-0.08797	-0.19072
C1	0.15053	0.09927	-0.03594	-0.03659	1.00000	-0.12461	0.00138	0.10958	0.38181	0.06922	-0.00598	0.30910
EMPXT78	0.22886	-0.19348	0.09416	-0.13273	-0.12461	1.00000	0.81661	-0.20481	-0.15428	0.74796	0.93325	-0.09245
EMPXS78	0.18006	-0.14851	-0.05831	-0.02877	0.00138	0.81661	1.00000	0.08189	-0.10533	0.95642	0.88021	-0.05310
DIV	-0.02040	-0.02405	-0.29793	0.26121	0.10958	-0.20481	0.08189	1.00000	0.08354	0.06648	-0.06431	0.07803
RDSSALE	0.32425	0.41866	-0.23273	-0.23903	0.38181	-0.15428	-0.10533	0.08354	1.00000	-0.06705	-0.10103	0.91914
EMPXS782	0.16699	-0.10098	-0.04452	-0.04103	0.06922	0.74796	0.95642	0.06648	-0.06705	1.00000	0.88819	-0.04395
EMPXT782	0.22232	-0.14545	0.00710	-0.08797	-0.00598	0.93325	0.88021	-0.06431	-0.10103	0.88819	1.00000	-0.06585
RDSSALE2	0.29503	0.23270	-0.15344	-0.19072	0.30910	-0.09245	-0.05310	0.07803	0.91914	-0.04395	-0.06585	1.00000
INCORPYR	0.11549	0.22046	-0.19731	-0.00200	0.28319	-0.41929	-0.34234	0.22820	0.27108	-0.24338	-0.29115	0.14624

	INCORPYR
EXPXS78	0.11549
D1	0.22046
D2	-0.19731
D4	-0.00200
C1	0.28319
EMPXT78	-0.41929
EMPXS78	-0.34234
DIV	0.22820
RDSSALE	0.27108
EMPXS782	-0.24338
EMPXT782	-0.29115
RDSSALE2	0.14624
INCORPYR	1.00000

TSP

CROSSTABS FOR EXPXI78 CONTROLLED BY PAYSC AND BY INDUSTRY 07/07/81 PAGE 45

FILE INNOVATN (CREATION DATE = 07/06/81)

SUBFILE TELE CRUDE PLAST SMELT ELECT OTHER

F3-2

* C R O S S T A B U L A T I O N O F *

EXPXI78Q BY TOT71

CONTROLLING FOR..

PAYSC VALUE = 2.

BY D VALUE = 1.

* PAGE 1 OF 1

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Table A 2.3a

EXPXI78Q (COUNT / ROW PCT / COL PCT / TOT PCT)	TOT71 1.	2.	3.	4.	5.	ROW TOTAL
0.	10	5	2	1	0	18
	55.6	27.8	11.1	5.6	0.0	47.4
	66.7	55.6	33.3	14.3	0.0	
	26.3	13.2	5.3	2.6	0.0	
1.	2	1	1	2	0	6
	33.3	16.7	16.7	33.3	0.0	15.8
	13.3	11.1	16.7	28.6	0.0	
	5.3	2.6	2.6	5.3	0.0	
2.	0	0	2	0	1	3
	0.0	0.0	66.7	0.0	33.3	7.9
	0.0	0.0	33.3	0.0	100.0	
	0.0	0.0	5.3	0.0	2.6	
3.	0	0	1	0	0	1
	0.0	0.0	100.0	0.0	0.0	2.6
	0.0	0.0	16.7	0.0	0.0	
	0.0	0.0	2.6	0.0	0.0	
4.	3	3	0	4	0	10
	30.0	30.0	0.0	40.0	0.0	26.3
	20.0	33.3	0.0	57.1	0.0	
	7.9	7.9	0.0	10.5	0.0	
COLUMN TOTAL	15	9	6	7	1	38
	39.5	23.7	15.8	18.4	2.6	100.0

CHI SQUARE = 32.92453 WITH 16 DEGREES OF FREEDOM SIGNIFICANCE = 0.0076

CRAMER'S V = 0.46541

CONTINGENCY COEFFICIENT = 0.68134

LAMBDA (ASYMMETRIC) = 0.20000 WITH EXPXI78Q DEPENDENT. = 0.17391 WITH TOT71 DEPENDENT.

LAMBDA (SYMMETRIC) = 0.18605

UNCERTAINTY COEFFICIENT (ASYMMETRIC) = 0.26698 WITH EXPXI78Q DEPENDENT. = 0.24535 WITH TOT71 DEPENDENT.

UNCERTAINTY COEFFICIENT (SYMMETRIC) = 0.25571

KENDALL'S TAU B = 0.31020 SIGNIFICANCE = 0.0132

KENDALL'S TAU C = 0.27181 SIGNIFICANCE = 0.0132

GAMMA = 0.41207

TSP 07/07/81 PAGE

CROSSTABS FOR EXPXI78 CONTROLLED BY PAYSC AND BY INDUSTRY

SOMERS'S D (ASYMMETRIC) = 0.29343 WITH EXPXI78Q DEPENDENT. = 0.32238 WITH TOT71 DEPENDENT.

SOMERS'S D (SYMMETRIC) = 0.30997

ETA = 0.35047 WITH EXPXI78Q DEPENDENT. = 0.43231 WITH TOT71 DEPENDENT.

CROSSTABS FOR EXPXI78 CONTROLLED BY PAYSC AND BY INDUSTRY
FILE INNOVATN (CREATION DATE = 07/06/81)
SUBFILE TELE CRUDE PLAST SMELT ELECT OTHER

F3-38

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F *
EXPXI78Q BY RD71
CONTROLLING FOR..
PAYSC VALUE = 2.
BY C VALUE = 4.
* PAGE 1 OF 1

Table A 2.3b

EXPXI78Q (RD71: COUNT / ROW PCT / COL PCT / TOT PCT)	1.	2.	3.	4.	5.	ROW TOTAL
0.	5	3	1	0	0	9
	55.6	33.3	11.1	0.0	0.0	33.3
	45.5	25.0	100.0	0.0	0.0	
	18.5	11.1	3.7	0.0	0.0	
1.	4	3	0	1	0	8
	50.0	37.5	0.0	12.5	0.0	29.6
	36.4	25.0	0.0	50.0	0.0	
	14.8	11.1	0.0	3.7	0.0	
2.	0	1	0	0	0	1
	0.0	100.0	0.0	0.0	0.0	3.7
	0.0	8.3	0.0	0.0	0.0	
	0.0	3.7	0.0	0.0	0.0	
3.	0	0	0	1	1	2
	0.0	0.0	0.0	50.0	50.0	7.4
	0.0	0.0	0.0	50.0	100.0	
	0.0	0.0	0.0	3.7	3.7	
4.	2	5	0	0	0	7
	28.6	71.4	0.0	0.0	0.0	25.9
	18.2	41.7	0.0	0.0	0.0	
	7.4	18.5	0.0	0.0	0.0	
COLUMN TOTAL	11	12	1	2	1	27
	40.7	44.4	3.7	7.4	3.7	100.0

CHI SQUARE = 26.13428 WITH 16 DEGREES OF FREEDOM SIGNIFICANCE = 0.0522
CRAMER'S V = 0.49132
CONTINGENCY COEFFICIENT = 0.70132
LAMBDA (ASYMMETRIC) = 0.22222 WITH EXPXI78Q DEPENDENT. = 0.26667 WITH RD71 DEPENDENT.
LAMBDA (SYMMETRIC) = 0.24242
UNCERTAINTY COEFFICIENT (ASYMMETRIC) = 0.25565 WITH EXPXI78Q DEPENDENT. = 0.30583 WITH RD71 DEPENDENT.
UNCERTAINTY COEFFICIENT (SYMMETRIC) = 0.27850
KENDALL'S TAU B = 0.20297 SIGNIFICANCE = 0.1170
KENDALL'S TAU C = 0.17147 SIGNIFICANCE = 0.1170
GAMMA = 0.28409

CROSSTABS FOR EXPXI78 CONTROLLED BY PAYSC AND BY INDUSTRY
SOMERS'S D (ASYMMETRIC) = 0.21834 WITH EXPXI78Q DEPENDENT. = 0.18868 WITH RD71 DEPENDENT.
SOMERS'S D (SYMMETRIC) = 0.20243
ETA = 0.38594 WITH EXPXI78Q DEPENDENT. = 0.72375 WITH RD71 DEPENDENT.

NUMBER OF MISSING OBSERVATIONS = 126

CROSSTABS FOR EXPXI78 CONTROLLED BY PAYSC AND BY INDUSTRY
FILE INNOVATN (CREATION DATE = 07/06/81)
SUBFILE TELE CRUDE PLAST SMELT ELECT OTHER

* * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * *
EXPXI78Q BY SALEI78Q
CONTROLLING FOR..
PAYSC VALUE = 1.
BY D VALUE = 1.
* PAGE 1 OF 1

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Table A 2.4a

EXPXI78Q	COUNT / ROW PCT / COL PCT / TOT PCT	SALEI78Q 1.	3.	4.	5.	6.	ROW TOTAL
0.	COUNT	8	7	0	1	0	16
	ROW PCT	50.0	43.8	0.0	6.3	0.0	39.0
	COL PCT	100.0	36.8	0.0	25.0	0.0	
	TOT PCT	19.5	17.1	0.0	2.4	0.0	
1.	COUNT	0	2	3	0	3	8
	ROW PCT	0.0	25.0	37.5	0.0	37.5	19.5
	COL PCT	0.0	10.5	42.9	0.0	100.0	
	TOT PCT	0.0	4.9	7.3	0.0	7.3	
2.	COUNT	0	2	0	0	0	2
	ROW PCT	0.0	100.0	0.0	0.0	0.0	4.9
	COL PCT	0.0	10.5	0.0	0.0	0.0	
	TOT PCT	0.0	4.9	0.0	0.0	0.0	
3.	COUNT	0	1	1	2	0	4
	ROW PCT	0.0	25.0	25.0	50.0	0.0	9.8
	COL PCT	0.0	5.3	14.3	50.0	0.0	
	TOT PCT	0.0	2.4	2.4	4.9	0.0	
4.	COUNT	0	7	3	1	0	11
	ROW PCT	0.0	63.6	27.3	9.1	0.0	26.8
	COL PCT	0.0	36.8	42.9	25.0	0.0	
	TOT PCT	0.0	17.1	7.3	2.4	0.0	
COLUMN TOTAL		8	19	7	4	3	41
		19.5	46.3	17.1	9.8	7.3	100.0

CHI SQUARE = 41.69829 WITH 16 DEGREES OF FREEDOM SIGNIFICANCE = 0.0004
CRAMER'S V = 0.50424
CONTINGENCY COEFFICIENT = 0.71009
LAMBDA (ASYMMETRIC) = 0.23000 WITH EXPXI78Q DEPENDENT. = 0.13636 WITH SALEI78Q DEPENDENT.
LAMBDA (SYMMETRIC) = 0.21277
UNCERTAINTY COEFFICIENT (ASYMMETRIC) = 0.35950 WITH EXPXI78Q DEPENDENT. = 0.36413 WITH SALEI78Q DEPENDENT.
UNCERTAINTY COEFFICIENT (SYMMETRIC) = 0.36180
KENDALL'S TAU B = 0.34309 SIGNIFICANCE = 0.0044
KENDALL'S TAU C = 0.31033 SIGNIFICANCE = 0.0044
GAMMA = 0.45140

CORRELATION MATRIX TELEFELECT (N=94)

	RDSI	MNSI	MKTSI	RD2SI	MKT2SI
RDSI	1.00000	.444034	.417494	.882486	.328244
MNSI	.444034	1.00000	.694186	.202986	.508019
MKTSI	.417494	.694186	1.00000	.197398	.817372
RD2SI	.882486	.202986	.197398	1.00000	.210145
MKT2SI	.328244	.508019	.817372	.210145	1.00000
MN2SI	.438401	.975739	.629700	.207656	.492177
EMPSI	.558128	.290051	.152022	.504414	.133819
IDEARD	-.182851E-01	-.202643	-.104550	.796547E-01	.318063E-01
IDEAPARA	-.242257E-02	.247188E-01	.682216E-01	.150302	.161549
LICE	-.591640E-01	.362273E-01	.163516	-.916886E-01	.204187
DECNT	.473416E-01	-.878143E-01	-.927442E-01	.290537E-01	.505407E-01
FG	.306871E-01	.312220E-02	.348972E-01	.432206E-01	.205456E-01
PU	.208155	.120755	.124934	.157707	.146876
PATENT3	.210953	.165925	.476770E-01	.263081	.294871E-01
	1	2	3	4	5

	EMPSI	IDEARD	IDEAPARA	LICE	DECNT
RDSI	.558128	-.182851E-01	-.242257E-02	-.591640E-01	.473416E-01
MNSI	.290051	-.202643	.247188E-01	.362273E-01	-.878143E-01
MKTSI	.152022	-.104550	.532215E-01	.163516	-.927442E-01
RD2SI	.504414	.796547E-01	.150302	-.916886E-01	.290537E-01
MKT2SI	.133819	.318063E-01	.161549	.204187	.505407E-01
MN2SI	.311390	-.155216	.410317E-01	.150858E-01	-.811681E-01
EMPSI	1.00000	.597453E-01	-.993533E-01	-.146347	.250167E-02
IDEARD	.597453E-01	1.00000	-.202870	-.353517	.746427E-01
IDEAPARA	-.993533E-01	-.202870	1.00000	.467712	-.127797
LICE	-.146347	-.353517	.467712	1.00000	.168498
DECNT	.250167E-02	.746427E-01	-.127797	.168498	1.00000
FG	.210521E-01	-.246315	.334041E-01	.120940	.900336E-02
PU	.671167E-01	.300795	-.300795	-.463249	.568913E-01
PATENT3	.606232E-01	.115827	.997717E-01	.747508E-02	.268416E-01
	7	8	9	10	11

	PU	PATENT3
RDSI	.208155	.210953
MNSI	.120755	.165925
MKTSI	.124934	.476770E-01
RD2SI	.157707	.263081
MKT2SI	.146876	.294871E-01
MN2SI	.116334	.125892
EMPSI	.671167E-01	.606232E-01
IDEARD	.300795	.115827
IDEAPARA	-.300795	.997717E-01
LICE	-.463249	.747508E-02

TABLE A 4.2

FILE INNOVATN (CREATION DATE = 07/14/81)
SUBFILE TELE ELECT

CORRELATION COEFFICIENTS

A VALUE OF 99.00000 IS PRINTED
IF A COEFFICIENT CANNOT BE COMPUTED.

Table A.4.4

	LEXP	LTOT71	LEMP	C1	LSAL	LRD	LMKT	LMN
LEXP	1.00000	0.44938	0.46831	-0.18061	0.66038	0.43628	0.30266	0.39470
LTOT71	0.44938	1.00000	0.51873	-0.28974	0.40885	0.92685	0.69512	0.77787
LEMP	0.46831	0.51873	1.00000	-0.51549	0.50583	0.51762	0.30987	0.42835
C1	-0.18061	-0.28974	-0.51549	1.00000	-0.33063	-0.27044	-0.30532	-0.34121
LSAL	0.66038	0.40885	0.50583	-0.33063	1.00000	0.35111	0.43679	0.47928
LRD	0.43628	0.92685	0.51762	-0.27044	0.35111	1.00000	0.60502	0.61427
LMKT	0.30266	0.69512	0.30987	-0.30532	0.43679	0.60502	1.00000	0.73475
LMN	0.39470	0.77787	0.42835	-0.34121	0.47928	0.61427	0.73475	1.00000