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Industry Efficiency and Plant Turnover in the Canadian Manufacturing Sector

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INDUSTRY EFFICIENCY AND PLANT TURNOVER IN THE CANADIAN MANUFACTURING SECTOR

by

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INTRODUCTION

Most studies of industry performance ignore the existence and diversity of the productivity of firms within an industry. For example, productivity growth is generally measured at the industry level with almost complete disregard for the underlying production entities. This habit is probably the result of the widespread acceptance of the concept of a representative or average firm. As Reid (1987) has pointed out, in industrial organization, the Vinerian concept of the representative firm has dominated the more complex notion of the diversity of firm performance stressed by Marshall. As a result, the mainstream of industrial organization has had trouble in coming to grips with the reality of firm heterogeneity.

One of the few strands of applied industrial economics to face the existence of firm heterogeneity is the X-inefficiency literature. On the one hand, are those like Leibenstein (1966) who argued, from observation, that this phenomenon deserved attention. On the other are economists like Stigler (1976) who argued that profit maximization made it unlikely that inefficiency could exist for long, and that observation of the phenomenon had to be based on incorrect measurement.

Despite this existential debate, econometricians who were working on the estimation of frontier production functions, began to investigate how the error structure of these production functions could be used to characterize the degree of efficiency in an industry. The resulting literature has now developed an impressive body of empirical evidence on the nature and correlates of efficiency.[1]

Many articles have focused on methodology. Empirical applications have often been limited to a small number of industries, until the recent work of Caves and Barton (1990) that looked at a broad cross-section of U.S. manufacturing industries in the 1970s. But until now, there have been few studies that would allow an assessment of how fleeting the phenomenon is--thereby answering one of Stigler's criticisms--or the causes of changes in the level of efficiency over time that result from more efficient firms replacing the less efficient. This study uses a longitudinal panel of Canadian manufacturing firms in the 1970s to investigate both issues.

The first section of this paper outlines the methodology to be used to measure industry efficiency in this study. The second section examines certain characteristics of the measure. The third section investigates the extent to which this measure is related to the same industry characteristics that were found to be important determinants of efficiency in the U.S. study. The fourth section explores the dynamics of industry change, focusing on the role of turnover with respect to changes in efficiency. The fifth section uses regression analysis to examine the industry determinants of the forces that reduce turnover and examines the commonalities between the determinants of cross-industry variability in efficiency levels and the forces that lead these levels to change over time.

THE MEASUREMENT OF EFFICIENCY

Measures of efficiency have typically been divided into two categories--those dealing with technical and those dealing with allocative efficiency. Technical efficiency arises when a firm makes the best use of its inputs. Allocative efficiency occurs when a firm employs its inputs in the correct proportions. Like the majority of previous studies, this paper focuses on allocative efficiency. Inefficiency implies that the same amount of resources if reallocated from the least productive to the most productive plants could increase output.

Recent work in measuring efficiency has estimated production functions from plant and firm data. This approach attempts to correct for differences in output that are caused by the use of different input combinations and differences in the size of the production unit. The residuals are then utilized to produce an "average" measure of efficiency.

The same notion of efficiency is adopted here as elsewhere but a simpler measurement technique is adopted. Efficiency is measured as the ratio of actual output to potential output. Potential output is calculated as the efficient level of output per person multiplied by the level of employment in each establishment, summed over all producing establishments. The efficient level of output per person is defined as the sum of output divided by the sum of all employment in the most productive establishments accounting for a specified percentage of total output--10, 20, 30, or 40 per cent.

This method is more direct but perhaps less elegant than those which estimate efficiency from the residuals derived from a production function. It may be the most efficient research strategy for several reasons. First, it is not obvious that the production function is the correct strategy to follow. Estimating the average level of efficiency from a production function presumes that it is appropriate to correct for differences in productivity that result from differing establishment sizes or from different factor proportions. But if the cause of inefficiency is the existence of suboptimal-sized plant, then part of the estimated inefficiency is being eliminated by the use of a production function. Similarly, if a firm is unable to produce an efficient level of output for a given workforce because of inadequate capital investment, correcting for differences in capital-labour intensity by estimating a production function will understate the level of inefficiency.

The measure employed here will avoid both of these problems. By focusing directly on output per worker, it presumes that our goal should be to maximize product per worker and that those firms that set the lead in this area can and should be emulated. Whether this is justified depends on the extent to which intra-industry differences in factor proportions and plant sizes are efficient. It might be argued that different factor proportions within an industry are justifiable in terms of different factor prices. If differences in capital-labour ratios are optimal because of different factor costs, or because of different vintage effects, inefficiency as measured here will be overstated. It also might be argued that small inefficient firms provide externalities that compensate for their inefficiencies and make their existence desirable--that these firms provide external discipline on large firms, and that it is this group that provides the next generation of large efficient firms.

These views are very much akin to the view that the concept of efficiency is misplaced. Stigler (1976) voiced the opinion that the search for optimum techniques that leads to firm dispersions in efficiency is costly--just like the search for the best price or the most suitable occupation; but these costs are as legitimate costs as costs associated with the use of factor inputs like labour and capital. As such the term inefficiency is a misnomer.

This is not the place to try to resolve the issue. But the parallel to input costs can be used to justify our interest in the dispersion of relative productivity across plants within an industry--irrespective of the term applied to the phenomenon. Materials inputs are a cost and the economics profession has increasingly come to recognize that productivity improvements can also be had by economizing on these inputs. Similarly, to the extent that the productivity levels in less productive plants can be brought up to levels in the most productive plants, productivity gains will ensue. How this occurs and the process that generates it has been poorly documented and warrants further investigation.[2]

This study then makes no apologies for the topic pursued. It is more modest about the efficiency measure adopted--since the use of production functions to estimate efficiency measures has become widespread. As a practical matter, none of the potential problems in the use of the specific measure adopted here--failure to correct for differing factor proportions or firm size--may be very important if the measure used closely correlates with others. Unfortunately, there are no studies that allow us to infer whether this is the case by examining how closely our measure is related to others. But there is an increasing body of evidence to suggest that alternate measures of efficiency in general are highly correlated (Caves and Barton) and that the use of different measures has a relatively minor effect on isolating the determinants of efficiency (Caves and Barton). In this respect, it has been observed that skewness measures of efficiency--from which the measure used here is derived--are closely correlated to other efficiency measures derived from the residuals of production functions.

There are several additional reasons to adopt the measure used here. First, its inter-industry variance is relatively unaffected by the choice of industry sample that is used to define optimal output-per-person ratios. The measure is not greatly affected by outliers and is less likely to be affected by the number of observations used to estimate it than are most measures that are determined from the production function approach. Secondly, as a subsequent section demonstrates, it is correlated with many of the variables found in previous studies to be correlated with alternative inefficiency measures. Its inter-industry variability, therefore, appears to be closely related to the more complex and more costly measures of efficiency that are derived from production functions.

II) EFFICIENCY IN THE CANADIAN MANUFACTURING SECTOR

a) Choice of Sample

When industry efficiency is defined using output per person of the most productive plants, as it is here, the choice of the subset to define maximum potential productivity must be determined. If the inter-industry variability is sensitive to the sample chosen, then choice of the subset becomes critical. In order to examine this issue, different cutoff points based on the percentage of the market were used to define the plants considered to be efficient, output per person was calculated using each of these cutoff points, and the correlations between the various efficiency estimates associated with each cutoff were calculated. The sample chosen for the exercise was the 4-digit level of the Canadian manufacturing sector. The years chosen were 1970 and 1979. Data on all plants available from the Canadian Census of Manufactures were used. Output per person was defined alternately as shipments per worker and as value-added per worker.

The cutoff points were chosen so as to successively include an increasing percentage of output in each industry. In the first case, the efficient output per person was defined as the sum of output over the sum of labour input of the most productive plants that accounted for 10 per cent of output. Subsequently, levels of 20, 30, and 40 per cent of industry output were also used. The efficiency measures corresponding to each will be called EFF1, EFF2, EFF3, and EFF4, respectively.

The level of efficiency on average differs substantially for the different cutoff points. Figure 1 plots the mean value of efficiency for each cutoff point, as well as its upper and lower bounds for 1970 using value-added as the output measure. When the most productive plants that account for ten per cent of value-added are used to define maximum potential output per person, production is only 47 per cent of potential. This increases to 55, 61, and 66 per cent when the top most productive plants accounting for 20, 30, and 40 per cent of value-added, respectively, are used for the cutoff. Comparable measures using shipments per worker are 44, 52, 57, and 63 per cent. Since there is little difference in the value-added and the shipments-based measures, only the former are subsequently reported herein.[3]

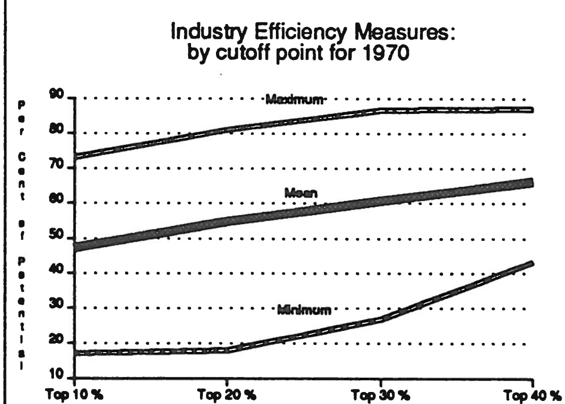

Figure 1

In light of the number of different methodologies for measuring efficiency and a lack of agreement on the most appropriate one, comparisons among countries of the level of inefficiency are hazardous. Nevertheless, they are made. Caves and Barton (1990) summarize several studies that all use the stochastic production function technique and that find efficiency estimates ranging upward from 50 to 90 per cent for such disparate countries as Columbia, Indonesia and France. Caves and Barton themselves report mean values for efficiency in the U.S. manufacturing sector as different as 27 and 91 per cent using the stochastic production frontier approach, but two different techniques. The differences in these values indicates the degree to which estimates of levels of efficiency are sensitive to the technique used.

While extreme differences in the level of efficiency are generated for the United States in the Caves and Barton study, the cross-industry variability of the two main estimates is quite similar. The partial correlation coefficient of the two main measures is .69 and the regressions that examine the relationship between an industry's efficiency and its characteristics using each of these measures tell the same story.

This is also the case for the measures of efficiency that are derived here for the Canadian manufacturing sector. While the mean value of the efficiency measures differs for the four cutoff points used, the inter-industry variability of the measures is closely related. The correlation matrix for the four 1970 measures derived using the 10, 20, 30 and 40 percent cutoff points is presented in Table 1. The correlations are all high and for adjacent cutoff points are about .90. Since it is the nature of cross-industry variability and changes therein that are of greatest interest, this suggests that the choice of cutoff will not be critical for this study. This supposition was tested and confirmed by using several values of the efficiency measure at subsequent stages of the analysis. The conclusions were generally the same, irrespective of the cutoff chosen to generate the inefficiency measure. The measure that uses value-added and that corresponds to the 40 per cent cutoff point will be used subsequently in this paper.

b) Characteristics of the Efficiency Measure

There is considerable variation in the efficiency estimates across the 167 industry sample as the upper and lower bounds attached to the mean value in Figure 1 indicate. In order to better describe the inter-industry variation in efficiency, Figure 2 plots the mean value of efficiency for decile groups along with the upper and lower bounds for each decile group. The mean efficiency value is 53 per cent at the tenth percentile and increases to 77 per cent at the ninetieth decile. The preferred efficiency measure in the Caves and Barton study ranged from 11 per cent at the tenth percentile to 51 per cent at the ninetieth percentile.

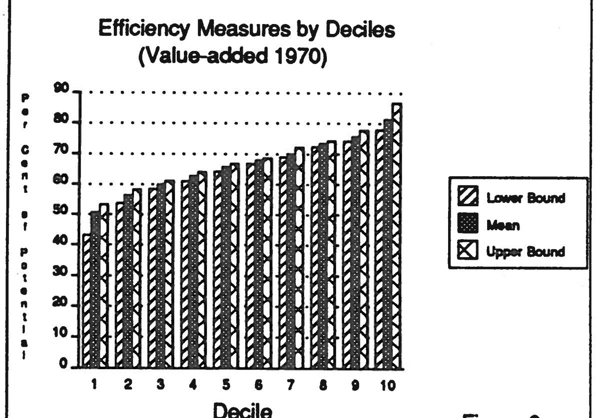

Figure 2

The inter-industry differences in efficiency change over time. The last column of Table 1 contains the estimates of the correlation of the efficiency estimates in 1970 and 1979. Correlations between .5 and .6 indicate that, while patterns of cross-industry efficiency differentials persist, they are not immutable. Figure 3 plots the mean value of both the 1970 and the 1979 efficiency estimates based on the decile ranking of the 1970 estimates. There is a certain tendency for

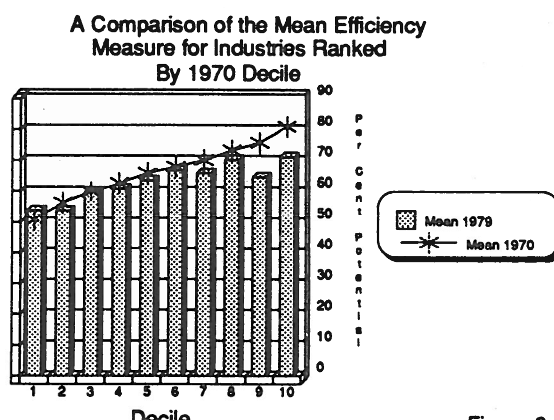

Figure 3

industries to regress towards the mean--or at least for those with high efficiency values in 1970 to decrease over the decade.

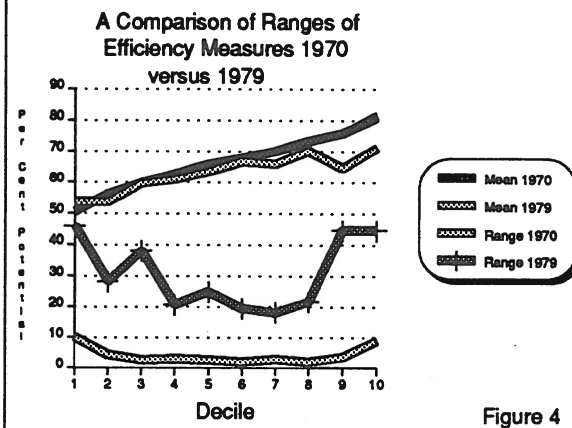

Figure 4

What is most striking is the dramatic increase in the range of efficiency estimates. In 1970, the range of estimates for each decile is relatively small as the bottom line in Figure 4 indicates. Figure 4 shows that the range in 1979 for each of the industries in a particular 1970 decile is much greater than for the same industries in 1970. The increase in variability is particularly large for the industries that were most efficient in 1970. The world does not stand still. Industries where most firms have moved close to the maximum potential output are those where new technology is likely to result in some firms gaining an advantage over others in the future.

III) INDUSTRY CHARACTERISTICS ASSOCIATED WITH INEFFICIENCY

The industry characteristics associated with efficiency are of importance not only because they shed light on the reasons for inter-industry differences in efficiency, but also because they provide independent information on the usefulness of the efficiency measure adopted herein. Because this measure is not identical to others, it is important to ask whether it is related in much the same way to industry characteristics found to be important determinants of efficiency in other countries.

In order to provide this comparison, the taxonomy developed by Caves and Barton for their extensive U.S. study is used. Industry characteristics are divided into six broad groups. In the first group are competitive conditions like concentration and trade exposure that are posited to produce centripetal pressures that reduce firm heterogeneity. The second group consists of product differentiation characteristics that are used to control for the likelihood that there is measurement error in the efficiency measures. These measures are generally based on value of shipments or value-added--variables that combine both output and price. It is normally assumed that prices are reasonably similar across firms. If there are differences in the prices buyers pay, some of the measured differences in efficiency will actually be differences in rents accruing to firms. Product differentiation variables are used to control for this possibility. The third group of variables captures the occurrence of change and, therefore, the centrifugal forces that might allow for diversity of productivity to develop. The fourth group encompasses characteristics of geographic market heterogeneity that permit greater heterogeneity. The fifth group includes organizational influences that are postulated to exert pressures on management--the extent of diversification, of multiplant operation, of large plant size, and certain labour characteristics like the degree of unionization and the use of full as opposed to part-time workers. Finally, there are a group of variables that are used to control for other omitted variables. Some of these variables, like the vintage of capital or the variation in capital/labour ratios, proxy factors that have been missed in estimating a simplified production function. Other variables, like the number of observations on which the production function was based, are used to account for the bias that arises because of a purely statistical factor. Technical efficiency, as defined in most studies, inversely depends on the highest observed value of a distribution. The theory of order statistics suggests that the larger the number of observations drawn (i.e., plants in an industry), the greater the range will be, and thus the lower will be measured efficiency.

The correlation matrix between industry characteristics for 1970 and the measure of efficiency for the same year is reported in Table 3.[4] Correlation rather than regression analysis was used because our objective was, in the first instance, to depict the relationship between each characteristic and efficiency; it was not to sort out the relative importance of each. The variables that were used are listed below in Table 2. They are defined as carefully as possible to resemble those used in the U.S. study.[5]

The correlations between efficiency and industry characteristics produce a story similar to that reported by Caves and Barton for the United States. Several of what were classified as core variables in the U.S. analysis have high correlations with the Canadian efficiency measure. As was the case for the U.S., the higher the proportion of an industry's sales that are controlled by firms with their main interests elsewhere (COVE), the lower is efficiency. Similarly, the greater the diversity of the inputs available to work with labour--SD(M/L)--the lower is efficiency. In the Canadian case, several other variables that capture the heterogeneity in the industry--variables that reflect the mechanism that might cause variations in productivity and thus lower efficiency levels--were also employed. The number of products classified to the industry (N5D), the variation in the level of plant specialization (SD[HERF]), and the standard deviation in the plant specialization ratio (SD[SPEC]) were all included. None of these was significantly correlated with efficiency at the 5 per cent level. Also included in the core set of U.S. explanatory variables was a labour conditions variable--the importance of full-time workers (FULL). Like the U.S. results, Canadian efficiency was positively related to the use of part-time workers.

In the U.S. case, the importance of competitive conditions proved difficult to discern. By itself, concentration was not significant--but when entered in a non-linear fashion, an effect was found. Efficiency first rose and then fell as concentration increased. In Canada, the concentration ratio is negatively correlated with efficiency. This is not inconsistent with the U.S. finding since the level of concentration in most Canadian industries is higher than for the U.S. As was the case for the U.S. study, export and import intensity in Canada were not closely related to industry efficiency. Nominal and effective tariff variables were also included, but they too proved insignificant.

Other similarities between the Canadian and U.S. results extend into the set of relationships outside the core variables. In both cases, the geographic market heterogeneity did not have a robust effect, product differentiation was strongly correlated with lower efficiency, and the labour market variable (UNION) had a weakly negative effect on efficiency.

An attempt was made to ascertain whether the strongly negative effect of concentration might be related to economies of plant scale, as opposed to multiplant operation. To this end, the average plant size of the top four firms divided by market size was included (RPSIZE), as well as the excess concentration variable (XC). The former proxies the concentration effect due to plant scale economies and the latter the concentration effect due to multiplant activity. The former was not significant, while the latter was negatively correlated with efficiency. It was the multiplant aspect of concentration that was most harmful. Additional variables that captured the multiplant nature of the industry (MULT1 and MULT2) also exhibited negative correlations with industry efficiency. Diversification across industries had a negative effect on efficiency; so too did horizontal expansion within an industry by multiplant operations.

While the two analyses contain many similar results, there are two important differences. First, the number of observations is inversely related to efficiency in the U.S. study because of the "order" effect. This was posited to be less of a problem with the measure used for the Canadian study and was found to be so. The number of observations was not significantly correlated with efficiency.

Secondly, the U.S. study found that research and development intensity was significantly correlated with efficiency. This was not the case for Canada. One of the reasons for the difference may be the truncated nature of research and development in Canada. In order to test for this, a variable that consisted of technology payments made abroad divided by sales was used both alone and in conjunction with domestic expenditures on R&D divided by sales. The latter, like the employee-based measure that was used above, continued to be insignificantly correlated with efficiency; the former was positively correlated with efficiency, but only marginally significant.

The industry characteristics were also regressed against industry efficiency, where the latter was expressed in log odds form. The results of the regression are reported in equation #1. Only the most significant coefficients are reported

1) EFF4 = 2.61 - 4.77 ADS - 0.378 XC - 0.001 N5D

t=	(2.74)	(2.98)	(2.18)
probt =	(.004)	(.031)	(.085)

-0.768 FULL -.0001 UNION-0.005 SD(M/L).

(1.75)	(1.70)	(1.80)
(.092)	(.023)	(.074)

$R2 = .16$ d.f.= 143 Prob f=.0001

Simultaneous consideration of industry characteristics once more confirms the importance of the core set of U.S. variables. Product differentiation (ADS), labour market conditions (FULL, UNION), and variability of the factor input ratio (SD[M/L]) all decrease efficiency. Concentration due to multiplant activity (XC) and the number of products produced in industry (N5D) do so as well.

Consideration of the various industry characteristics jointly in a regression may run afoul of multicollinearity. This problem is compounded here by the fact that some of the variables measure industry characteristics--like competitive conditions--that are hypothesized to affect efficiency, while others capture the mechanism by which inefficiency may develop--like the degree of suboptimal capacity or the degree of diversity within an industry. The latter also beg explanation and may themselves be related to basic industry characteristics like product differentiation, research and development activity, the state of industry competition and organizational traits.

In order to sort out the relative importance of the "determinants" of inter-industry efficiency levels, a principal component analysis was performed on the set of industry characteristics and the components were used in the regression. Principal component analysis permits us to characterize the joint effects of the industry characteristics, since each of the components generated by the analysis is constructed as a weighted average of the original variables. By examining which of the original variables are heavily weighted in a component that significantly affects industry efficiency, we can better appreciate how various industry characteristics tend to work together. Table 4 contains the weights of the original variables on the components.

2)EFF4=0.70	- 0.098 VAR2	+ 0.061 VAR3	- 0.056 VAR4
t=	(2.75)	(1.94)	(1.82)
prob t =	(0.01)	(0.05)	(0.07)
-0.061 VAR5	-0.079 VAR9	+ 0.060 VAR10	- 0.079 VAR18
(1.82)	(2.57)	(1.97)	(2.52)
(0.07)	(0.01)	(0.05)	(0.01)

$R2 = .166$ d.f.='143

Each of the significant components contains one of the variables that was previously found to be important; but there are other variables that come into play. The addition of these variables considerably enriches the interpretation of the process at work. The first component has a positive though insignificant effect on efficiency. It is the plant scale portion of concentration--weighting both the four-firm concentration ratio (CONC) and the relative plant size (RPSIZE) positively. The second component has a negative effect on efficiency that is significant. It represents the multiplant nature of the industry with XC, MULT1, and MULT2 heavily weighted. Relative plant size (RPSIZE) is negatively weighted and the regional variable is positively weighted in this component. Thus inefficiency here is associated with multiplant ownership where plants are small relative to the market and where production is distributed regionally.

The third component has a positive effect on efficiency; it positively weights both comparative advantage (COMP) and export intensity (XS), but negatively weights advertising intensity. This component can be interpreted as representing the resource-based industries that do little advertising. The fourth component has a negative effect on efficiency: import intensity (MS), advertising (ADS) and number of products (N5D) are included in this component with positive weights. In addition, suboptimal capacity (SUBOPT) has a positive weight. This component represents import competing industries with a large number of products that are intensively advertised. The signs and significance of the coefficients of both these components indicate that trade matters--a conclusion that the earlier partial analysis missed. Export industries are relatively efficient; import competing industries are less efficient.

The fifth component has a negative effect on efficiency: it combines a negative weight on export intensity, a positive weight on the use of full-time employees, and on multiplant activity. Here as elsewhere, it is a combination of factors that contributes to inefficiency.

The ninth and tenth components both represent regional industries, but have opposite effects on efficiency. In both, the effect of advertising intensity and the use of full-time workers is to decrease productivity. The ninth component, which has a negative effect on efficiency, represents regional industries with intensive advertising, suboptimal capacity, high unionization, and few part-time workers. The tenth component represents regional industries with little advertising and more part- time workers. The difference between the two components lies primarily in the existence of suboptimal capacity in the component that has a negative effect on efficiency.

The use of principal components of the industry characteristics confirms and extends the picture drawn by the simple correlation analysis and regression analysis. Advertising is deleterious not so much because it is found on it own and, therefore, may capture rent effects but when it is found in conjunction with high import intensity, suboptimal capacity, and a large number of products. Export and import intensity both matter. Labour conditions both matter, but primarily in regional industries.

IV) TURNOVER AND INDUSTRY EFFICIENCY

Most empirical studies of industry efficiency have used single period cross-sectional regressions as was done in the first section. This methodology can miss the manner in which efficiency changes. Changes in relative efficiency levels are important as the evidence on the correlation between the estimates for 1970 and 1979 presented in Table 1 indicated. This section briefly outlines the forces that cause this. The next section investigates the determinants of the strength of these forces and relates them to the same industry characteristics that were found to be important in the cross-sectional analysis.

a) The Nature of Turnover and its Relationship to Productivity Growth

Changes in efficiency will occur as the productivity of individual establishments and their market shares change. With market shares held constant, changes in the level of industry efficiency will be a function of the extent to which productivity growth is spread evenly across establishments. The value of the efficiency measure does not change if productivity gains are spread equally across all establishments. Efficiency can increase if those firms that are less productive make greater productivity gains over the period. Efficiency will decrease if the most productive plants make the greatest productivity gains.

When market shares are allowed to change, the effect of changing relative productivity is more complex. If the continuing establishments that become relatively more productive gain sufficient market share and displace less productive plants, efficiency improves. The productivity gain and the market share gain in these firms have opposite effects on the measure of industry efficiency. The larger the gain in market share, the greater the likelihood of gains in efficiency.

The nature of the relationship between turnover and relative productivity performance is, therefore, of crucial importance. Turnover in the Canadian manufacturing sector for the period 1970-79 has been detailed elsewhere by Baldwin and Gorecki (1989, 1990a) using a longitudinal panel that links plants to firms and tracks both over time. Market share gains and losses, based on comparisons of 1970 and 1979 plant shipments, were calculated for the categories that are listed in Table 5. More than one category was used because of the heterogeneity of the underlying plant population and the belief that there were differences--both in size and productivity--in the various categories.

Turnover, as measured by market share changes within 4 digit industries, between 1970 and 1979 was substantial. The average market share per 4-digit industry that was transferred by turnover and the components of this turnover are summarized in Figure 5. In 1970, plants that were to close by 1979 accounted for 22.7 per cent of total shipments on average. Most of this--some 18 per cent--was in plants that were owned by firms that were to exit the industry (SHARE34). Some 4.6 per cent of 1970 shipments were in plants that were to be closed by 1979 by firms that would continue production in some other facility (SHARE14). The third category--losers that continued over the decade (SHARED)--lost some 14 per cent of their market share.

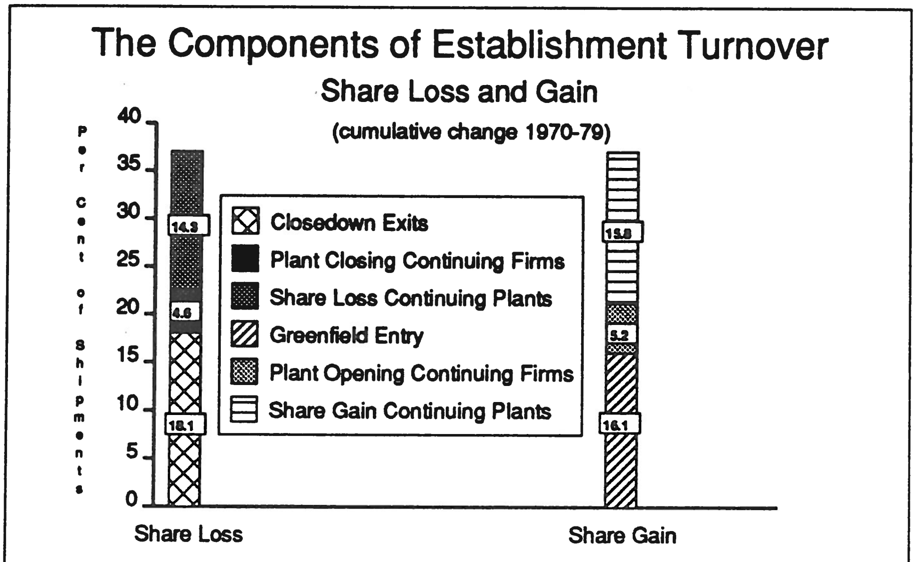

Figure 5

Greenfield entrants accounted for some 16.1 per cent of market share in 1979 (SHARE23); new plants of continuing firms, some 5.2 per cent (SHAR13). The division of plant openings between new and continuing firms is similar to that between exiting and continuing firms. Finally, gaining continuing plants acquired some 15.8 per cent of share (SHAREU) over the period.

All of this indicates that a considerable portion of market share was transferred over the decade of the 1970s as a result of plant entry and exit, growth and expansion. In total, some 37 per cent of market share was lost due to plant closedown and decline.

Market share turnover was accompanied by substantial changes in relative productivity, defined in terms of output per worker.[7] In 1970, the mean ratio of the productivity of plants that were subsequently to gain market share to those which were subsequently to lose share was .98, not significantly different from one. By 1979, the mean relative productivity of gainers to losers was 1.34 (s.e. of mean=.09). Gains in market share and changes in relative productivity then went hand in hand in such a way that the transfer of market share among continuing firms contributed substantially to productivity growth.

A similar conclusion holds true for entrants and exits. Figure 6 depicts the productivity of plant exits relative to continuing plants as of 1970 and of entrants relative to continuing plants in 1979. Plant entrants and exits are divided on the basis of whether they belonged to continuing firms or to entering/exiting firms. Closedown exits are some 79 per cent as efficient as all continuing plants in 1970. Greenfield entrants are some 4 per cent more productive than all continuing plants in 1979. The closed plant of continuing firms is 96 per cent as productive as the continuing population in 1970, but new plant of continuing firms is 16 per cent more productive in 1979.[8]

Productivity of Plant Openings and Plant Closings Relative to Continuing Plants

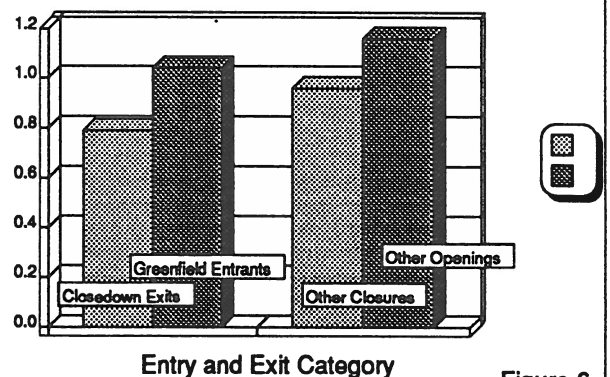

Figure 6

b) Turnover and Changes in Efficiency

The pattern of market share turnover was also associated with changes in efficiency. The efficiency of each of the turnover categories is reported in Table 6.[9] Plant closedowns by exiting firms were the least efficient category in 1970--at 57 per cent of potential. Plant births associated with the entry of new firms were relatively more efficient as of 1979--at 62 per cent. Plants closed by continuing firms, at 67 per cent efficiency, were about the mean in terms of efficiency in 1970; but, in 1979, new plants opened by continuing firms were more efficient--at 71 per cent.

In 1970, the continuing plants that were to gain market share differed very little in terms of efficiency from those about to lose market share over the subsequent decade and from the industry average. The mean efficiency of the gainers was 67 per cent and of losers 69 per cent. But this situation had changed dramatically by 1979. Market share losers had dropped to only 57 per cent efficiency while the gainers were about the same absolute level--68 per cent--but had moved above the mean level.

The contribution to the change in efficiency made by each of the new plant categories and of the continuing plants that gained market share will depend upon the pattern of replacement. Each percentage point of market share gained by one of the categories "a" to "c" in Table 5 comes at the expense of one or other category of losers "d" to "f". The contribution made to efficiency change by each of the gainers will depend upon how much share is given up by each category displaced and the difference in efficiency between the two classes. Figure 7 contains a bar chart that shows the percentage of each of the gainers that come from each of the losers. Greenfield entrants primarily replaced closedown exits, but took about one third of their gains from declining plants. Continuing plants that gained market share took most of their gain from closedown exits. New plants of continuing firms obtained most of their market share from declining firms and the remainder from plants that they themselves closed.

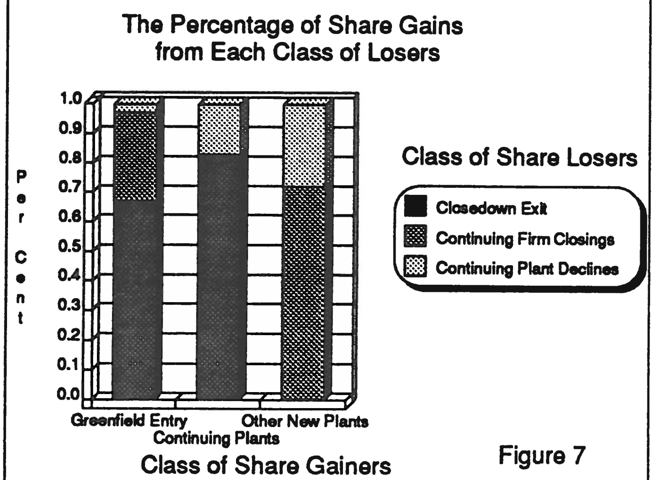

Figure 7

The turnover process clearly contributes to changes in efficiency. Greenfield entrants were more efficient than both categories that they replaced--closedown exits and declining plants. In 1979, they were some 5 percentage points more efficient than closedown exits were in 1970; they were also about 5 percentage points more efficient in 1979 than the remaining incumbent plants that had lost market share since 1970. The same pattern holds for the replacement process accompanied by the opening of new plants by continuing firms--which replaced closed plant in 1970 (about 5 percentage points less efficient) and continuing plants (in 1979, about 15 percentage points less efficient). Finally, the turnover associated with the replacement of declining continuing plant by those continuing plants that gained market share would also have increased efficiency.

Despite the replacement of the less efficient with the more efficient, the mean level of efficiency fell over the period. Continuing plants gaining share retained about the same level of efficiency, while those losing share declined substantially. Amongst other things, it was the failure of the gainers to make greater efficiency gains as a group and to take away even more market share from the losers that was one force contributing to the decline in average efficiency levels.

Nevertheless, the fundamental conclusion is that the process of market share turnover associated with the competitive process contributed substantially to efficiency gains. Without this turnover, there would have been even greater declines in efficiency. With certain information, an estimate of the joint impact of all the turnover categories on efficiency can be made. The first requirement for this estimate is knowledge of the replacement pattern. This was provided above. The second requirement is a knowledge of the level of efficiency as of 1979 that would have existed for plants in the two exit categories--"d" and "e" in Table

5--had they not been replaced. It will be assumed that the efficiency of each of the plant exit categories would have been the same in 1979 as it was in 1970 relative to continuing plants that lost market share over the decade. This is a conservative assumption since exiting plants fared even worse than declining plants over the decade. The latter just lost market share; the former had to close down.

Then the contribution that one of the entry or growth categories "i" made to efficiency by displacing category "j" $(DEFF)_{ij}$ is calculated by:

#3) $DEFF_{ij} = SHARE_i * P_{ij} * (EFF_i - EFF_j)$ where

$SHARE_i$ = the increase in market share of the i'th entry or growth category,

P_{ij} = the proportion of the i'th entry or growth category to come from the j'th exit or decline category, and

EFF_i, EFF_j = the efficiency of the i'th entry or growth category or the j'th exit or decline category in 1979.

The total effect of each entry or growth category is the sum of its effects across all exit and decline categories "d" to "f" in Table 5. The effect of all entry categories is then the sum of the effects of the categories "a" to "c". The importance of each of these categories is expressed as a proportion of the total and reported in Table 7. Without turnover, efficiency levels would have been 58.7 per cent rather than 62.8 per cent. Greenfield entry contributed almost 34 per cent of this; other plant births some 15 per cent and gains in market shares of the most efficient group contributed 51 per cent. The split is depicted Figure 8.[10]

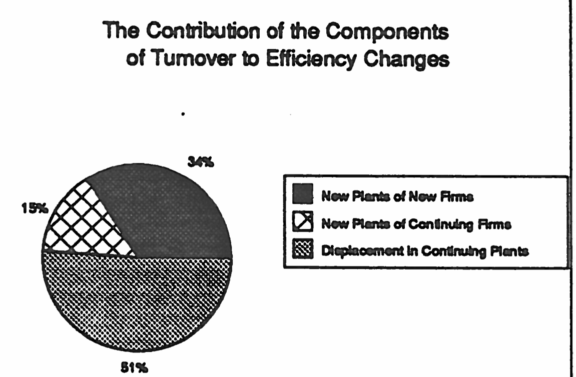

Figure 8

V) THE DETERMINANTS OF TURNOVER

Efficiency then is affected amongst other things by plant turnover--by the process by which the efficient replace the inefficient. Ultimately, it is the determinants of that process that should have an effect on the level of industry efficiency. The greater the extent to which entrants displace less efficient exits, the higher will be industry efficiency.

Connecting the relationship between the intensity of turnover and the level of efficiency is difficult because there are opposing forces at work. The rate of technical progress and the extent to which some plants are capable of adopting that process faster than others will determine the rate at which others fall behind. The rate of turnover will then determine the extent to which the latter are eliminated and efficiency is maintained in equilibrium.

In a world where efficiency does not vary, the two forces will be in balance. But there is no reason to presume that equilibrium always prevails. Exogenous shocks may come in coordinated waves that cause efficiency levels across a wide variety of industries to change. In turn, the turnover process may increase in intensity for a period of time as efficiency is restored to its previous levels. The intensity of turnover in the latter case affects the speed of adjustment to exogenous shocks.

This tendency was at work in Canada during the decade of the 1970s. Caves and Barton postulated that growth in productivity would produce a disequilibrating force yielding lower levels of efficiency. There is support for this proposition in the experience of Canada. Between 1970 and 1979, the change in efficiency across 4-digit industries was negatively correlated with growth in real output per worker (-.25; prob value=.10). This suggests that some changes in efficiency are brought about by the external shocks that lead to growth spurts. Just as revealing is the fact that the change in industry efficiency and the change brought about by market share turnover reported in Table 7 were negatively and significantly correlated (-.24:prob value=.002). Similarly, greenfield entry share was significantly negatively correlated with efficiency change. Thus, where efficiency was falling, turnover was larger than elsewhere and productivity gains were higher. This suggests that turnover is part of an equilibrating process associated with rapid technological change.

Since the intensity of the turnover process affects both the level of efficiency and its adjustment path, it follows that the determinants of turnover may be expected to affect both and that these determinants may vary somewhat from the determinants of industry efficiency at a point in time.

a) Modelling the Turnover Process

There are several problems that must be resolved in modelling the determinants of the turnover process. First, there is more than one component to the process--three on the expansion and three on the contraction side, respectively. The resulting system of equations produces a large number of coefficients that have to be evaluated in order to estimate the net effect of the various determinants of efficiency. This problem is handled here by estimating an overall turnover equation--the sum of the various entry and growth categories (GAIN). In order to recognize that the turnover categories do not each have the same effect on changes in efficiency, weights were applied to each category. These weights reflected the contribution that a one percent gain in that category had on changes in efficiency. They were calculated using the same assumptions employed for the estimates reported in Table 7.

The determinants of the turnover process are broken into three separate groups. The first set are those variables that have already been outlined to affect the industry efficiency level. This set includes some variables that engender change and others that tend to dampen that change. Caves and Porter (1978) have stressed these two groups as the determinants of share change in incumbent firms. It is of interest here to discover the extent to which the various forces that affect efficiency also influence the turnover process.

The second set of variables are those traditionally used in entry and exit studies and that have not been captured in the original set of variables used to explain efficiency.[11] These variables, with the exception of foreign ownership, can be classified as well-being variables that attract entry or which reduce exit. They are:

- GROW = the real rate of growth between 1970 and 1979.
- VAR = the variability of output around the trend growth line.
- PROF = the rate of profitability of the industry in 1970 and 1979.
- PROFG = the rate of growth of profitability, 1970-79.
- FOR = the intensity of foreign ownership in 1979.

The third set of determinants contains relative productivity variables. It has been demonstrated that the turnover process replaces the less efficient with the more efficient, the less productive with the more productive. The differences in productivity between the various categories is taken here to represent the technological opportunities available to new participants. These variables are taken to proxy basic technological conditions that favour one or other form of turnover. For example, the amount of entry is postulated to be a function of the productivity advantage that entrants possess relative to exits, and to their competitors--continuing plants that are growing and new plants of continuing firms.

Several measures are required to represent the various factors at work. The first captures the extent to which the 1979 productivity of continuing plants that gained market share was higher than those losing market share.

- RLUD79 = Productivity of continuing plants in 1979 that gained market share between 1970 and 1979 divided by the productivity in 1979 of continuing plants that lost market share over the decade.

Another set of variables measure the 1979 productivity of the two entrant categories relative to the continuing plant of gainers and losers.

- RLGU = Productivity of greenfield entrants in 1979 relative to continuing plants that gained market share.
- RLGD = Productivity of greenfield entrants in 1979 relative to continuing plants that lost market share.
- RLNU = Productivity of other new plants--those of continuing firms relative to the continuing plants that gained market share.
- RLND = Productivity of other new plants--those of continuing firms relative to the continuing plants that lost market share.

The next three measures provide a similar standard for 1970--for the gainers, and the two plant closing categories--relative to the continuing plants that lost market share over the decade. These are:

- RLUD70 = Productivity of continuing plants in 1970 that gained market share between 1970 and 1979 divided by the productivity in 1970 of continuing plants that lost market share over the decade.
- RLCD= Productivity of closedown exits in 1970 divided by the productivity in 1970 of the continuing plants that were to lose market share over the decade.
- RLDD = Productivity in 1970 of other plant exits--those of continuing firms over the decade--divided by the 1970 productivity of the continuing plants that were to lose market share over the decade.

Finally, there are three variables that represent the progress that was made as a result of the replacement of closedown exits by greenfield entrants, other exits by other births, and declining but continuing plants with gaining, continuing plants.[12]

- RLUDDIF = RLUD79-RLUD70 = The growth in productivity of gainers relative to losers over the decade.
- RLGDDIF= the productivity of greenfield entrants in 1979 relative to continuing plant market share losers in 1979 minus the productivity of closedown exits in 1970 relative to market share losers in 1970
- RLODIF= the productivity of other plant births in 1979 relative to continuing plant market share losers in 1979 minus the productivity of other plant deaths in 1970 relative to market share losers in 1970.

The correlations between these various measures are presented in Table 8. The degree of progress that is made in continuing plants (RLUDDIF) is the basic indicator of technological rivalry--of the potential for rivalrous behaviour without the creation of new plant. It is significantly correlated with RLGDDIF but not with RLODIF. Situations where technological conditions lead some continuous plant to outstrip others are also situations where new plant of entrants is substantially more productive than the closed plant of exits.

The plant replacement process for continuing firms (categories b and d in Table 5) should occur in situations where new technology may not be as adaptable to old plant. This is confirmed since productivity growth associated with the replacement process in continuing firms (RLODIF) is not significantly correlated with productivity differences that arise in continuing plants (RLUD79); but it is significantly correlated with gains associated with the greenfield entry and closedown process (RLGDDIF). This indicates that the latter also partially reflects the need for new technology to be embedded in new plant. Thus large differences in productivity between greenfield entrants and closedown exits occurs both when technological rivalry is manifesting itself in the continuing plant population and when technological improvements are associated with the construction of new plant. Entry is a multi-faceted phenomenon.

There is another indication that similar but not identical technical opportunities are at work across industries. There is a positive correlation between the productivity of greenfield entrants relative to losers (RLGD) and the disparity that develops in the continuing sector (RLUD79). In contrast, there is a negative relationship between the productivity of greenfield entrants relative to the gainers (RLGU) and RLUD79. Thus, when productivity differentials are developing within the continuing sector, entrants do relatively well compared to those being displaced, but poorly, relative to the gainers. When new technology can be embodied very successfully in existing plant, entrants are not excluded from doing well; but they do not do quite as well as continuing plants that are gaining market share.

In order to sort out the way in which the various technological characteristics are combined within industries, the principal components of the relative productivity variables were derived and are reported in Table 9. The first component basically weights all of the variables. The second component represents situations where both RLGU and RLNU are high but RLUD79 is not. This represents industries where new plants for both entrants and continuing firms do relatively well compared to the continuing plants that are gaining share, but where productivity differentials within the continuing sector do not develop. The third component resembles the second but greenfield entrants alone do well. RLGU and RLGDDIF both have positive weights but RLNU and RLODIF have negative weights. This represents situations where technological advantage is related to new plant construction by new firms, but where that technological advantage is not as readily available to all, perhaps because patents matter more. The fourth component represents situations conducive to the adaptation of new technology within existing plants--the productivity differential between continuing plants (RLUD79) is most heavily weighted. The fifth component represents situations where the relative productivity of closedown exits is high (RLCD). This is suggestive of causes of exits other than the productivity disadvantages measured here. The sixth component positively weights internal productivity differences (RLUD79), and the relative success of new plants (RLGU, RLNU). It differs from the first component in that negative weights are attached to the growth in relative productivity of each of the corresponding plant exit and entry categories (RLGDDIF, RLODIF) but a positive weight is given to the development of emerging productivity differences in the continuing plant sector (RLUD79). This component represents situations where there is dramatic change in relative productivity within the continuing plant population, where new plant of both kinds does relatively well, but where exiting plant are not particularly inefficient at the beginning of the period--where turnover would be expected to be more closely related to rapid technical change over the period than to the elimination of those who were laggards in terms of efficiency at the beginning of the period. This, then, is the general technological rivalry variable that is felt in both the continuing and the new sector. The seventh component, like the third, positively weights greenfield entrants' success (RLGU), negatively weights continuing firms' new plant success (RLNU), and disregards productivity differentials that develop in the continuing sector (RLUD79). The primary difference is that RLGDDIF is negatively weighted in the third component while RLODIF is positively weighted in the seventh component. This component represents situations where greenfield entrants are doing well relative to continuing plants that are gaining share and continuing firms are making productivity gains with investment in new plant (RLODIF) but they are still at a disadvantage relative to entrants (RLNU).

Most studies of entry and exit or turnover in the continuing firm population have ignored the exogenous influence of changing technology and the extent to which the turnover process is related to this exogenous force. In order to characterize the process at work, the correlations between the total unweighted share gain (GAIN), the proportion of this total accounted for by each of the components outlined in Table 3 (GAIN23, GAIN13, GAINU, LOSS34, LOSS14, and LOSSD) and the relative productivity components were calculated. Overall, market share change (GAIN) is most closely associated with components two and three. These components represent the two situations where substantial differences in productivity in the continuing plant population do not emerge and where new plant does well relative to continuing plant. The proportion of market share gain taken by greenfield entrants (GAIN23) is primarily related to component six--the pure technological rivalry phenomenon. The proportion taken by gaining continuing plants (GAINU) is negatively correlated with this same component. The proportion taken by new plants of continuing firms (GAIN13) is positively related to the first catchall component but negatively related to the second.

b) The Total Turnover Equation

Because the number of industry characteristics available in the three sets of determinants are considerable, the principal components of each set were derived and used in the subsequent regression analysis. The components of the main set of industry characteristics (VAR1 to VAR18) were presented previously in Table 4 and the productivity components (PROD1 to PROD7) were presented in Table 9. The principal components of the well-being variables (WEL1 to WEL5) are presented in Table 10.

The results of the regression are reported in Table 11. To enable comparison, column one contains the signs of the components of the industry characteristics, mainly those reported to be significant in equation #2. Column 2 contains the main regression results for the weighted turnover regression.

The well-being and the productivity components represent the disequilibrium forces that cause turnover. There are four variables in these two groups that affect turnover. The third well-being component has a positive coefficient and positively weights both average profitability over the decade and variability in demand. The fifth component has a negative coefficient but is less significant; it negatively weights growth and positively weights profitability. The third productivity and sixth productivity components positively affect turnover. Both of these components represent situations where new plant are relatively productive compared to the continuing sector. The sixth was described as the general technological rivalry variable.

There are five components from the industry characteristics components that affect turnover. Concentration associated with larger plant size (component 1) has a negative effect on turnover. Multiplant activity associated with low export intensity but a wide variability in plant diversification across different products (component 5) has a negative effect. Union activity associated with the lack of part-time workers, inward bound diversification and plant suboptimality (component 6) positively affects turnover.

The only component that is found both in the formulation of the turnover equation reported in column 2 and in the efficiency equation and whose coefficient has the same sign is component five. However, this formulation does not allow for interaction effects. It may be that the effect of the industry characteristic was to reduce the effect of the technological conditions represented by the productivity variables. This was examined by entering interaction effects between the relative productivity components three and six and the components that had a negative effect on efficiency--two, four, five, nine, and eighteen. Individual terms entered on their own showed significance, but because of multicollinearity, this was not the case when several were entered simultaneously. In the end, components two, three and five were summed and used interactively with the third productivity component to form the variable INTER. The results with INTER added are reported in column 4. In this formulation, the productivity component itself loses some of its significance but the interaction term is significant and becomes even more so if the productivity component is removed--column 5. The important conclusion is that the multiplant component (#2), the import-advertising-suboptimal capacity component (#3) along with component five serve to reduce the effect of productivity on turnover. These are the same characteristics that are found in industries with lower levels of efficiency.

VI) CONCLUSION

Analysis of turnover process can contribute in important ways to our understanding of the nature of the competitive process. First, it can be used to provide a measure of the intensity of the competitive process. The extent to which market shares are changing provides an alternate and more direct measure of the intensity of the competitive process than do concentration measures. Secondly, an examination of the links between turnover and productivity change serves to emphasize the connection between productivity progress and the extent to which the new supplant the old.

This paper adds another dimension to our understanding of the turnover process. It has shown that turnover directly contributes to reductions in industry efficiency. Moreover, turnover is affected by many of the same set of variables that affect the level of industry efficiency. Thus, this study provides a bridge between two different sets of studies.

Until now, the efficiency literature has relied mainly on cross-sectional studies at one point in time. It was, therefore, difficult to ascertain whether the variables that were found to be related to efficiency were chance correlates. One method of contributing to this debate is to attempt to replicate the results for similar economies. This was done in the first section of this study where it was demonstrated that efficiency in Canadian and U.S. manufacturing industries in the 1970s was related to many of the same industry characteristics.

Even more important is the link between turnover and efficiency that is provided. If the causes of efficiency are to better understood, the forces that cause some firms to move ahead and others to fall behind need examination. When technical change causes this process to occur, efficiency falls if the less efficient are not eliminated. This paper has documented how important this turnover process is in reducing inefficiencies that develop. More importantly, it has demonstrated that the same forces that lead some industries at a point in time to be less efficient are contained in the set of forces that reduce the amount of turnover. That they can also be found to restrain the turnover process that has been demonstrated to reduce the level of inefficiency lends credence to the cross-sectional results.

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NOTES:

1. See Caves and Barton (1990) for a summary of the literature.

2. See Downie (1958) for one such attempt.

3. The similarities between the measures extended beyond the mean values reported here. Cross-industry correlations of the various measures one with another and with industry characteristics were also very similar.

4. The correlation was performed both on the entire sample for which observations were available and also using a reduced sample that eliminated those industries that provided extreme values of the efficiency measure. Generally, the sign and the significance levels were very similar, suggesting that errors in observation may exist but that they are relatively unimportant. The correlations for the entire sample of 4-digit industries for which there are observations are reported in Table 3.

5. For further discussion of the data base used and the definitions of the variables, see Baldwin and Gorecki (1987).

6. For a description of the methodology used, see Baldwin and Gorecki (1990c).

7. See Baldwin and Gorecki (1990b).

8. See Table 3 in Baldwin and Gorecki (1990b).

9. These efficiency levels use the potential output-per-person ratios derived from the value-added 40 per cent cutoff levels for the entire industry plant distribution.

10. The contribution that each turnover category made to productivity growth can be usefully compared to these estimates. The detailed calculations are described in Baldwin and Gorecki (1990c). Almost half of productivity growth in the 1970s arose from turnover. Some 21 per cent came from the greenfield entry category, some 7 per cent from other new plants, and about 19 per cent from gains in market share of continuing plants.

11. See Geroski and Masson (1987) for a general discussion of such models and Baldwin and Gorecki (1987) for a specific application to the Canadian situation along with more detailed definitions of the variables used here.

12. While these replacement assumptions distort reality slightly,using them makes the description of the ongoing replacement process much simpler.

TABLE 1
CORRELATIONS BETWEEN EFFICIENCY ESTIMATES

	1970 ESTIMATES				1979
	EFF1	EFF2	EFF3	EFF4	
EFF1	1.0	.91	.82	.77	.61
EFF2		1.0	.89	.84	.51
EFF3			1.0	.92	.55
EFF4				1.0	.52

Notes: 1) all correlations are significantly different from zero
2) for definitions of the variables, see text
3) the correlations for 1979 are between the 1970 and 1979 estimate of efficiency that uses the same cutoff point.

TABLE 2
VARIABLE LIST

Competitive Conditions

CONC = percentage of shipments accounted for by the four largest firms, 1970.

XC = the excess concentration ratio defined as CONC minus the share that the largest four firms would have if they each operated one plant equal to MES. MES is defined as the average plant size of those largest plants accounting for the top 50% of shipments.

MS = import intensity--imports divided by domestic disappearance-- domestic production minus exports plus imports, 1970.

XS = export intensity--exports divided by domestic production, 1970.

COMP = comparative advantage--exports less imports over exports plus imports, 1970.

Product Differentiation

ADS = inputs of advertising services divided by value of industry shipments, 1971.

Occurrence of Heterogeneity and Change

R&D = the ratio of research and development personnel to all wage and salary earners, 1975.

SD(M/L) = the standard deviation of the ratio of materials and energy expenses divided by the number of wage and salary workers, 1970.

N5D= the number of 5-digit ICC (Industrial Commodity Classification) commodities per 4-digit SIC industry.

SD(HERF) = the standard deviation of the plant level of product specialization. The latter is defined using a herfindahl index of the proportion of the plant's shipments classified to the Nth 4-digit ICC commodity, 1970.

SD(SIZE) = the standard deviation of average plant size based on salaried and production workers, 1970.

CVTOP8 = the coefficient of variation of the top eight firms, 1970.

SUBOPT = the percentage of industry sales below the average U.S. plant size of those plants accounting for the top 50 per cent of sales, 1970.

KL = the capital labour ratio for the industry, 1970.

Geographic Market Heterogeneity

REG = is a dummy variable for an industry classified as being regional.

Organizational Influences

a) Enterprise Diversification

COVE = sales of plants belonging to enterprises classified to other industries divided by sales by all establishments classified to this industry, 1970.

b) Multiplant Operation

MULT1 = sales by plants belonging to companies that are multiplant operators in this industry divided by sales of all establishments classified to the industry, 1970.

MULT2 = number of plants per enterprise, 1970.

c) Size of Production Units

RPSIZE = Average plant size of the largest plants that account for the top 50 per cent of shipments divided by industry shipments, 1970.

RFSIZE = Average firm size of the largest plants that account for the top 50 per cent of shipments divided by industry shipments, 1970.

d) Labour Relations

UNION = proportion of production workers who were union members, 1971.

FULL = the importance of full-time workers as measured by the number of person-hours worked by production workers divided by the number of production workers, 1970.

e) Other

NOBS = the number of plants on which the efficiency measure was based, 1970.

TABLE 3
CORRELATION MATRIX BETWEEN INDUSTRY CHARACTERISTICS

VARIABLE	CORRELATION	PROBABILITY VALUE
CONC	-.10	.18
XC	-.20	.01
MS	-.04	.60
XS	-.03	.67
COMP	-.08	.27
ADS	-.19	.01
R&D	-.07	.36
SD(M/L)	-.18	.02
N5D	-.12	.14
SD(HERF)	.04	.65
SD(SIZE)	.07	.36
COVTOPS	-.08	.24
SUBOPT	-.08	.28
KL	-.26	.01
REG	-.02	.81
COVE	-.13	.09
MULT1	-.11	.14
MULT2	-.18	.03
RPSIZE	-.04	.59
RFSIZE	-.03	.69
UNION	-.12	.12
FULL	-.18	.02
NOBS	.08	.29

Notes: for definitions of variables, see Table 2.

TABLE 4
PRINCIPAL COMPONENT ANALYSIS
INDUSTRY CHARACTERISTICS

EIGENVECTORS

	VAR1	VAR2	VAR3	VAR4	VAR5	VAR6	VAR7	VAR8	VAR9	VAR10	VAR11
CONC	0.466577	-.085145	-.085638	-.007071	0.115309	-.018576	0.059191	0.047037	-.071110	0.127391	0.036952
ADS	0.020723	-.019391	-.287368	0.204975	-.098219	-.357523	0.433272	0.115407	0.282940	-.404953	0.118040
COMP	0.158702	0.238800	0.322092	-.114804	-.152008	-.089199	0.064392	-.494080	0.037652	-.334204	0.154599
RD	0.184985	-.155619	0.117068	0.304077	-.034730	-.284449	-.145273	0.094589	0.303497	-.028170	0.292386
MULT1	0.281749	0.372757	0.005363	0.143785	0.163453	-.138734	-.047872	-.007268	-.135527	0.147396	-.106126
MULT2	0.285461	0.267869	-.135321	0.101881	0.314718	-.134238	0.043121	-.226033	0.003246	0.035563	0.033445
COVE	0.200795	0.131438	0.162893	-.037196	-.156827	0.349134	-.170832	0.386850	-.232798	-.084422	0.200231
NSD	-.096798	0.007012	0.154364	0.558067	-.002370	-.094786	-.138100	0.090939	0.116673	0.051998	-.547925
REG	-.079283	0.230997	-.042770	-.313855	-.070324	-.245980	-.044714	0.151054	0.373568	0.556433	0.286789
XS	0.186152	0.011291	0.393635	0.161234	-.361111	0.193062	0.131040	-.365605	0.089228	0.124345	0.096775
MS	0.019460	-.331906	-.065118	0.383733	0.049012	0.206034	-.233189	-.230506	0.080644	0.292605	0.227007
CVTOP8	0.441999	-.105454	-.016821	-.040154	0.078280	-.122399	0.059160	0.019158	-.027296	0.216529	-.184899
XC	0.015028	0.479378	-.162945	0.160015	0.132432	0.154514	0.080877	-.060851	-.049230	0.100865	-.025406
NOBS	-.241910	0.192164	0.154244	0.020465	-.221325	-.250098	-.263744	-.072177	0.161061	0.157865	-.051330
FULL	0.128662	0.181821	0.026556	0.059146	0.250180	0.266677	-.412478	0.208663	0.438980	-.356155	0.186903
SUBOPT	-.159207	0.052667	-.195041	0.365883	-.032006	0.272676	0.385764	0.033612	-.077331	0.178413	0.392846
UNION	0.063265	-.103269	-.210871	-.234000	0.067594	0.424117	0.154816	-.244394	0.554003	0.064224	-.321260
RPSIZE	0.304221	-.405653	0.060496	-.120986	-.018296	-.124762	-.018758	0.075962	-.012276	0.012790	0.043409
SDML	0.192552	0.145665	0.242707	0.036787	-.334887	0.150231	0.345795	0.430030	0.194984	0.081404	-.199985
SDHERF	-.157954	-.084679	0.434960	-.019814	0.403437	-.076092	0.274963	0.059448	0.016710	0.109692	0.080293
SDSPEC	-.126513	-.046542	0.421096	-.022792	0.498550	0.062573	0.198783	0.069383	0.089418	-.013254	0.034772

	VAR12	VAR13	VAR14	VAR15	VAR16	VAR17	VAR18
CONC	-.099559	0.085913	0.057384	0.065571	0.133788	0.237928	0.112456
ADS	0.193584	0.386361	-.105242	0.252428	0.079758	-.016484	-.095508
COMP	0.081090	0.040942	0.245893	-.197139	0.198235	0.263723	0.320423
RD	0.153019	-.649688	0.232052	0.136191	-.157409	-.023982	-.036508
MULT1	-.032280	0.044575	0.098069	0.033482	0.090660	0.030356	-.632491
MULT2	-.028344	0.117676	0.023466	-.208104	-.400268	-.590661	0.260862
COVE	0.439707	0.267070	0.367871	0.206987	-.054761	-.161518	0.038192
NSD	0.231814	0.159354	0.179486	-.350131	0.129708	0.096497	0.088980
REG	0.288862	0.139893	-.067722	-.292883	0.120434	0.081228	0.016006
XS	0.026953	0.069232	-.320399	0.022136	-.055441	-.115321	-.385077
MS	0.112551	0.242684	-.228782	0.188578	0.125844	-.060729	0.247845
CVTOP8	-.122727	0.035840	-.006907	0.207896	0.028119	0.280773	0.165828
XC	0.124457	-.213323	-.154458	0.332579	0.162488	0.193569	0.211619
NOBS	-.427864	0.291446	0.288360	0.456360	-.240581	0.024063	0.079158
FULL	-.346192	0.108738	-.179227	-.141714	0.162204	0.067021	-.069784
SUBOPT	-.315992	0.031737	0.377877	-.259929	-.084374	0.202489	-.048504
UNION	0.122839	-.044590	0.376226	0.135330	-.028071	-.070914	-.126458
RPSIZE	-.157630	0.212951	0.150932	-.197245	-.027643	0.020123	-.077732
SDML	-.231066	-.116483	-.204089	-.048255	-.075113	-.140463	0.279245
SDHERF	-.124411	-.007619	0.171349	0.172228	0.540768	-.368315	0.019736
SDSPEC	0.186375	0.135037	-.129288	0.062628	-.521410	0.375517	-.024879

TABLE 5

CATEGORIES USED TO CALCULATE MARKET SHARE CHANGE BETWEEN 1970 AND 1979

I) Plants that Gained Market Share over the period 1970-79

a) SHARE23 = 1979 share of plants that were opened since 1970 by new firms (greenfield entry).

b) SHARE13 = 1979 share of plants newly constructed since 1970 by firms that continued in the industry between 1970 and 1979 (other births).

c) SHAREU = share gain between 1970 and 1979 of continuing plants--those in existence in 1970 and 1979--that gained market share over the decade (the gainers).

II) Plants that Lost Market Share over the period 1970-79

d) SHARE34 = 1970 share of plants closed by 1979 that were owned by firms exiting the industry (closedown exit).

e) SHARE14 = 1970 share of plants closed by 1979 that were owned by firms that continued in the industry throughout the period (other deaths).

f) SHARED = share loss between 1970 and 1979 of continuing plants that lost market share over the period (the losers).

TABLE 6
THE EFFICIENCY MEASURES OF TURNOVER COMPONENTS
(% of potential)

Plant Category 1970	1970	1979	Plant Category 1979
Closedown Exits	57.6 (1.6)	62.0 (1.5)	Greenfield Births
Other Exits	65.6 (2.2)	71.2 (2.9)	Other Births
Plants Gaining Share 1970-79	66.7 (0.9)	67.7 (0.9)	Plants Gaining Share 1970-79
Plants Losing Share 1970-79	69.0 (0.9)	56.7 (1.2)	Plants Losing Share 1970-79
Mean	66.3	62.8	Mean

Note: These estimates make use of the efficiency estimate used to derive EFF40 and EFF49.

TABLE 7
THE CONTRIBUTION OF TURNOVER TO EFFICIENCY

Mean Industry Efficiency Level 1979	62.8 per cent
Mean Industry Level Without Turnover 1979	58.7 per cent
Contribution of Turnover Category to Difference	
1) Greenfield Births	34 per cent
2) Other Births	15 per cent
3) Continuing Plants Gaining	50 per cent

Note: See text for description of methodology.

TABLE 8
THE CORRELATION BETWEEN THE TECHNICAL PROGRESS VARIABLES

	RLGU	RLGD	RLNU	RLND	RLUD79	RLCD	RLDD	RLUDDIF	RLGDIF	RLODIF
RLGU	1.0	.37 a	.28 a	.37 a	-.14 (.07)	-.01 (.96)	-.05 (.59)	-.10 (.19)	.81 a	.34 a
RLGD		1.0	.12 (.20)	.35 a	.85 a	.05 (.55)	-.04 (.62)	.85 a	.95 a	.44 a
RLNU			1.0	.82 a	-.22 (.01)	.12 (.19)	.14 (.16)	-.18 (.05)	.05 (.55)	.70 a
RLND				1.0	.33 a	.09 (.30)	.10 (.28)	.29 a	.27 a	.85 a
RLUD79					1.0	.02 (.77)	-.05 (.51)	.98 a	.81 a	.33 a
RLCD						1.0	.18 (.05)	-.05 (.51)	-.27 a	-.05 a
RLDD							1.0	-.05 (.60)	-.09 (.30)	-.43 a
RLUDDIF								1.0	.84 a	.38 a
RLODIF									1.0	.84 a

Notes: 1) The prob value is listed below each correlation estimate. The letter "a" represents a value of .001 or less.

TABLE 9
PRINCIPAL COMPONENT ANALYSIS
PRODUCTIVITY VARIABLES

	EIGENVECTORS						
	PROD1	PROD2	PROD3	PROD4	PROD5	PROD6	PROD7
RLGU	0.39	0.40	0.51	-0.24	-0.18	0.44	0.39
RLNU	0.36	0.46	-0.51	0.18	-0.15	0.34	-0.48
RLCD	-0.04	0.48	0.31	0.25	0.74	-0.19	-0.16
RLDD	-0.26	0.30	0.07	0.70	-0.47	-0.19	0.29
RLGDIF	0.53	-0.17	0.42	0.09	-0.28	-0.49	-0.44
RLODIF	0.56	-0.00	-0.42	0.07	0.22	-0.37	0.57
RLUD79	0.24	-0.53	0.13	0.58	0.23	0.50	0.03

TABLE 10
PRINCIPAL COMPONENT ANALYSIS
WELL-BEING VARIABLES

	EIGENVECTORS				
	WEL1	WEL2	WEL3	WEL4	WEL5
GROW	0.70	-0.14	-0.15	-0.08	-0.68
VAR	0.04	0.62	0.53	0.52	-0.25
PROFG	0.18	-0.67	0.23	0.65	0.19
FOR	0.42	0.37	-0.60	0.35	0.44
PROF	0.55	0.06	0.53	-0.41	0.49

TABLE 11
THE DETERMINANTS OF PLANT TURNOVER

	Efficiency	Turnover						
					With Interaction Turns			
	(I) Sign Coefficient	(II) Coefficient	t	probability	(III) coefficient	probability	(IV) coefficient	probability
Wel3		.025	(2.0)	(.048)	.027	(.075)	.023	(.066)
Wel5		-.018	(1.7)	(.097)	-0.25	(.038)	-.021	(.071)
Var1	+	-.025	(2.1)	(.038)	-0.31	(.011)	-.034	(.006)
Var2	-							
Var3	+							
Var4	-							
Var5	-	-.020	(1.8)	(.078)	-.021	(.053)	-.023	(.040)
Var6	+	.046	(4.0)	(.0001)	.048	(.0001)	.050	(.0001)
Var9	-							
Var10	+							
Var11								
Var16	-	-.021	(1.8)	(.063)	-.016	(.156)	-.020	(.078)
Var18	-	.024	(2.0)	(.051)	.019	(.110)	.019	(.109)
Prob3		.021	(1.9)	(.055)	.017	(.098)		
Prob6		.021	(2.0)	(.047)	.022	(.041)	.022	(.033)
Prob7								
Inter					-.011	(.032)	-.012	(.018)
R^{-2}		.41		.435			.42	
Prob>F		.001		.0001			.0001	

Notes: 1) The interpretation of the principal components can be read from tables 4, 9, and 10.