Measuring relative efficiency of manufacturing industries across regions in Canada - a method,

by

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MEASURING RELATIVE EFFICIENCY OF MANUFACTURING INDUSTRIES ACROSS REGIONS IN CANADA -- A METHOD

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INTRODUCTION

The purpose of this paper is to propose first a method by which interregional differences in the costs of production of SIC 3-digit manufacturing industries[1] can be computed over a period of 1961-1968 in a number of regions[2] of Canada and second a procedure suggested by which we can have numerical measures of comparative advantage of different regions from the cost side as well as the demand side. Despite the fact that the need for quantitative measures of this kind had been urgently felt for a long time in Canada for regional development and planning purposes, attempts to meet this need have failed so far partly due to:

a. Lack of availability of data at the regional level[3].

b. Absence of developments in selected methodologies when constraints on data become severe.

One particular example to overcome (b) is the share-shift analysis which tries to capture some of the missing links with the minimum data. But we all know the limitations of the share-shift technique and we all desire to have much more information on the costs of inputs (both primary and intermediate) as well as demands for products in the regions which

1. For as many industries as are possible by the existing data availability.

2. In the beginning we can have seven regions, namely, Atlantic Provinces (total), Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia. In case of extreme data deficiency, we may have to collapse the three provinces in the Prairies into one region.

3. Confidentiality of data at the region level is the most crucial reason for this defunct state of affairs.

the share-shift technique does not offer[1]. It is submitted that the measures we shall seek to arrive at are restricted in terms of coverage but are better than any other measures so far constructed and applied to the regions in Canada since we deliberately look for the profiles of cost and demand over time. We resist from pronouncing policy judgments on industrial location interregionally since policy matters may involve criteria other than interregional cost and demand efficiency which is what we are after. The procedures of calculations of cost and demand efficiency are described in the following Sections 1 and 2 whereas Section 3 describes some analytical aspects of interrelations between the two measures. Finally Section 4 will deal with the statistical aspects of the problems in implementing the various measures proposed.

1. Cost Efficiency Measures

1.1 Over-all Efficiency

We formulate the following measures of overall efficiency of an industry per unit of time, t, in each region R:

$$g^{*R}_{it} = \frac{S^R_{it} - (C^R_{1i,t} + C^R_{2i,t} + C^R_{3i,t} + W^R_{i,t})}{QS^R_{it}} \qquad (1)$$

= average annual gross realized profit (before taxes) per unit of gross value of output produced in Region R by industry i, in time t.

1. See D.B. Houston: The Shift and Share Analysis of Regional Growth - A Critique, Southern Economic Journal, April 1967.

$$\bar{g}^{*R}_{it} = \frac{QS^R_{it} - (C^R_{1i,t} + C^R_{2i,t} + C^R_{3i,t} + W^R_{i,t})}{QS^R_{it}} \quad (2)$$

= average annual accounting gross profit (before taxes) per unit of gross value of output produced in R region by industry i in time, t.

where $QS^R_{it} = S^R_{it} + \Delta I^R_{it}$ (3)

$$\Delta I^R_{it} = I^R_{it} - I^R_{i,t-1} \quad (4)$$

$$I^R_{it} = IG^R_{it} + IF^R_{i,t} \quad (5)$$

$$C^R_{3i,t} = K^R_{it} \quad (d^R_{it} + \gamma_t) \quad (6)$$

$$K^R_{i,t} = b^R_{it} \quad QS^R_{it} \quad (7)$$

with, $R = 1,2,.....j$

$i = 1,2,.....n$

$t = 1961, 1962, ...1968$

(For a description of the variables please see Appendix A and for some of the data sources Appendix B).

The preceding equations perhaps would require a little clarification. In the first place, the distinction between equation (1) and equation (2) arises from the fact that in equation (1) ΔI^R_{it} is not included whereas in equation (2) it is included in the numerator of the R.H.S. Obviously g^{*R}_{it} can be negative but $\bar{g}^{*R}_{it}$ cannot be. The purpose why we have introduced equation (1) as a measure is to find out actual economic performance as distinguished from the accounting concept of gross profit calculation although it is conceded that equation (1) penalises perhaps too much for inventory accumulations. To correct for this bias we introduce the following procedure:

$$\text{Call} \quad C^R_{it} = C^R_{1it} + C^R_{2it} + C^R_{3it} + W^R_{it} \tag{8}$$

$$\text{then} \quad g^{*R}_{it} = \frac{S^R_{it} - C^R_{it}}{QS^R_{it}} \tag{9}$$

$$\bar{g}^{*R}_{it} = \frac{QS^R_{it} - C^R_{it}}{QS^R_{it}} \tag{10}$$

$$\text{and,} \quad \sum_{t=1}^{T} (\bar{g}^{*R}_{it} - g^{*R}_{it}) = \sum_{t=1}^{T} \frac{\Delta I^R_{it}}{QS^R_{it}} = \frac{I^R_{i0} + I^R_{it}}{\sum_{t=1}^{T} QS^R_{it}} \tag{11}$$

$$\text{or} \quad \bar{g}^{*R}_{i} - g^{*R}_{i} = \frac{I^R_{i0}}{T \sum_{t=1}^{T} QS^R_{it}} + \frac{I^R_{iT}}{T \sum_{t=1}^{T} QS^R_{it}} \tag{12}$$

$$\text{where} \quad \bar{g}^{*R}_{i} = \frac{\sum_{t=1}^{T} \bar{g}^{*R}_{it}}{T} \tag{13}$$

$$g^{*R}_{i} = \frac{\sum_{t=1}^{T} g^{*R}_{it}}{T} \tag{14}$$

Equation (12) brings out clearly the divergence between economic and accounting gross profit rates over time (when they are averaged out) with two components of inventories at only two time periods, namely when $t = o$ i.e., when t is counted from the range $t = 0, 1, 2, \cdots T$; and when $t = T$. Since inventories at $t = T$ cannot be adjusted to arrive at expected economic profits in the future i.e., one can never say when this is likely to be sold, whereas inventories at $t = 0$ are more likely to be sold out during the time period[1], we shall rationalize the over-all efficiency over time by the following modification:

$$\bar{g}_i^R = g_i^{*R} + \frac{I_{i0}^R}{T \sum_{t=1}^{T} QS_{it}^R} \quad (15)$$

$$= \bar{g}_i^{*R} - \frac{I_{iT}^R}{T \sum_{t=1}^{T} QS_{it}^R} \quad (16)$$

Thus we have included the initial inventory in the calculation of economic profits whereas we have ignored the final inventories for the profitability estimates. At this stage it is important to introduce the other equations namely, equation (6) and equation (7) to highlight the statistical limitations of data on capital costs at the regional level.

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1. This is likely to be so when t is large whether or not one follows the FIFO or LIFO system.

The first approximation as to capital stocks regionally has been proposed by the capital-output ratio (b^R_{it}) vide equation (7) failing which we have got to surrender the direct estimates of capital cost through equation (6). In actual fact we can never measure C^R_{3i} precisely because regional data on b^R_i, d^R_i do not exist. One particular way to overcome this deficiency partially would be to introduce national capital costs by industries as substitutes for regional capital costs estimates. We may examine the impact of this hypothesis now.

Consider that:

$$\left.\begin{aligned} b^R_{it} &= b_{it} \\ d^R_{it} &= d_{it} \end{aligned}\right) \qquad (17)$$

Then it can be shown that:

$$g^{*R}_{it} = \bar{g}^R_{it} - b_{it}(d_{it} + \gamma_t) \qquad (18)$$

$$\text{where} \quad \bar{g}^R_{it} = \frac{S^R_{it} - (C^R_{1i,t} + C^R_{2i,t} + W^R_{it})}{QS^R_{it}} \qquad (19)$$

And similarly:

$$\bar{g}^{*R}_{it} = \bar{\bar{g}}^R_{it} - b_{it}\,(d_{it} + \gamma_t) \qquad (20)$$

$$\text{where} \quad \bar{\bar{g}}^R_{it} = 1 - \frac{(C^R_{1it} + C^R_{2it} + W^R_{it})}{QS^R_{it}} \qquad (21)$$

It is clear that under the assumption of equation (17) ranking of industries by over-all efficiency in each time unit will be invariant whether one follows method (18) or method (19) since there is only a constant term $b_{it}\ (d_{it} + \gamma_t)$ which is being deducted from (19). The same principle follows for choice between (20) and (21). It is reiterated here that $\bar{g}^R_{it}$ and $\bar{\bar{g}}^R_{it}$ are the economic and accounting counterparts of gross profit ratios to output (as described before) without having the capital costs deducted. At this stage it is interesting to note a particular example we have worked out following equations (19) and (21). This example relates to Breweries' industry in seven regions and has been computed for 1965 and given in the following table.

TABLE I

Values of $\bar{g}^R_{it}$ and $\bar{\bar{g}}^R_{it}$ coefficients and ranking by Seven Regions in Canada: 'Breweries' Industry 1965.

Regions (1)	$\bar{g}^R_{it}$ (2)	Rank (3)	$\bar{\bar{g}}^R_{it}$ (4)	Rank (5)	Difference between Col. (2) and Col.(4) is due to: (6)
Atlantic	0.443	7	0.448	7	$S < QS$
Quebec	0.624	2	0.623	2	$S > QS$
Ontario	0.658	1	0.652	1	$S > QS$
Manitoba	0.610	4	0.610	4	$S = QS$
Saskatchewan	0.561	6	0.564	6	$S < QS$
Alberta	0.570	5	0.577	5	$S < QS$
B.C.	0.611	3	0.614	3	$S < QS$
Nation	0.617	-	0.615	-	

Source: 1. DBS Cat. No. 32-205, August 1967.
2. To calculate output we had to use the additional inventories and thus covered data for 1964 too.

Table I reveals the following:

a. Under assumptions of capital costs being ignored, Ontario is performing the best and the Atlantic Provinces the worst in terms of efficiency of production as well as sales at the average establishment level of manufacturing production in Breweries in 1965.

b. The rank correlation between the two methods $\bar{g}^{R}_{it}$ and $\bar{\bar{g}}^{R}_{it}$ is unity. This is just a coincidence for a particular example here taken and can be explained by the fact that the differences between value of shipments(S) and value of gross output (QS) have not been very large. If the difference between S and QS would have been very large, i.e., either very high inventory accumulation or decumulation, then the ranks by the two methods would have been different. Col.(6) exhibits this property of inventory accumulation (when $S < QS$) and decumulation (when $S > QS$).

The propriety of choice between $\bar{g}^{R}_{it}$ and $\bar{\bar{g}}^{R}_{it}$ can now be taken up on similar lines as we have done before for g^{*R}_{it} and $\bar{g}^{*R}_{it}$ vide equations (11) through (16). It can be shown that when we ignore capital costs we have the over-all efficiency of industry i over time in any region R as given by:

$$g_i^R = \bar{g}_i^R + \frac{I_{io}^R}{T \sum_{t=1}^{T} QS_{it}^R} \quad (22)$$

$$= \bar{\bar{g}}_i^R - \frac{I_{it}^R}{T \sum_{t=1}^{T} QS_{it}^R} \quad (23)$$

where $$\bar{g}_i^R = \frac{\sum_{t=1}^{T} \bar{g}_{it}^R}{T} \quad (24)$$

$$\bar{\bar{g}}_i^R = \frac{\sum_{t=1}^{T} \bar{\bar{g}}_{it}^R}{T} \quad (25)$$

From the long-term point of view it is g_i^R that is interesting to us for a measure[1] of over-all efficiency when capital costs are ignored. For the example cited in Table I we have not worked out g_i^R in Breweries by regions in Canada although this should not be difficult if we could get around data for the whole time period 1961-68.

One final point needs to be made with respect to computing comparative level of capital costs for any Region in order to be competitive with any other Region or the nation when the latter is given in terms of capital costs for any specific industry. This calculation is only indicative of the

This is critical for efficiency measure.

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1. To be more exact we should also get a dispersion measure around the mean value $\bar{g}_i^R$ or $\bar{\bar{g}}_i^R$ which can be measured by

$$\mathrm{Var}\left(\bar{g}_i^R\right) = \frac{\sum_{t=1}^{T}\left(\bar{g}_{it}^R - \bar{g}_i^R\right)^2}{T} \quad (24a)$$

and $$\mathrm{Var}(\bar{\bar{g}}_i^R) = \frac{\sum_{t=1}^{T}\left(\bar{\bar{g}}_{it}^R - \bar{\bar{g}}_i^R\right)^2}{T} \quad (25a)$$

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extent of differential capital costs which can be permitted for any interregional comparisons based on a treatment of equal rates of return. Thus if Ontario cost of capital is 15% per unit of value of capital good in Breweries with:

a. heterogeneity between structure, and machinery and equipment being collapsed into one category;

b. depreciation rate being 9% and long-term bond yield rate being 6%;

then capital cost per unit of gross value of output is 15% x 1.5 = 0.225 when gross capital-output ratio of Ontario Breweries is taken to be equal to 1.5. This gives the net $g^{*R}_{it} = .658 - .225 = .433$ for Ontario. Then in order that Atlantic Provinces are competitive with Ontario the average capital cost per unit value of output should not exceed .010 (i.e. .443-.433) which seems untenable under usual market conditions. The usual conclusion follows that the Atlantic Provinces do not compete at all with Ontario unless capital costs are subsidized in this particular example. The mathematical formulation of equilibrium interregional capital costs for equal rate of return per unit value of gross output can therefore be given by the following:

$$\left.\begin{array}{l} \text{when } g^{*A}_{it} = g^{*B}_{it} \\ \text{and } \bar{g}^{A}_{it} < \bar{g}^{B}_{it} \end{array}\right) \qquad (26)$$

then $$b^A_{it}\left(d^A_{it}+\gamma_t\right) = b^B_{it}\left(d^B_{it}+\gamma_t\right) - \left(\bar{g}^B_{it} - \bar{g}^A_{it}\right) \quad (27)$$

(cf. equations (1), (6), (7), (18) and (19)).
A similar form can be established having variables $\bar{\bar{g}}^A_{it}$ and $\bar{\bar{g}}^B_{it}$.

The R.H.S. of (27) constitutes a value of 0.010 when applied to the preceding example where the supscripts A and B may now be taken to stand for Atlantic Provinces and Ontario respectively. Even assuming implausible value for b^A_{it} 0.5, we then obtain through equation (27) that $d^A_{it} = -0.08 = -8\%$. If the actual depreciation rate in A is taken to be 9%, then 17% must be the rate of subsidy on depreciation costs for Atlantic Provinces in order that the latter is perfectly competitive with Ontario. It follows then one can simulate differential subsidies for any other regions on capital costs when at least capital cost estimates for one region or the nation is given. This task can be easily fulfilled by following through equation (27).

The above scheme so far referred to one time period and it is evident that a time shape of the differential capital costs for any region together with its dispersion and mean value should not be difficult to construct as we have done a similar exercise for the over-all efficiency through time vide equations (24), (24a), (25) and (25a). A final point may be reiterated here: to compute the differential capital costs of any specific region, say A, it is not at all necessary that capital costs of another region, say B, must be given; one can compute straight away the differentials with respect to the national capital costs for which much data exist substantially for preliminary estimates (See DBS Cat. 61-207 for Corporation Financial Statistics, 1968).

1.2 Input-Efficiency

It is sometimes maintained that the over-all efficiency of any form that may be computable either at a point of time or over time may not catch the respective efficiency of different inputs which go into production. It seems logical then to isolate the different inputs in the production of industry i over regions and over time. The procedure we shall follow in this regard can be described below.

Recall equations (2) and (21) in which the former includes the capital costs whereas the latter does not. Following equation (2) we get the following five measures of input efficiency, namely:

a. $\bar{g}^{*R}_{it}$ = profit efficiency (gross) (cf eqn 2).

b. $a^{R}_{lit} = \dfrac{C^{R}_{lit}}{QS^{R}_{it}}$ = material efficiency. (28)

c. $a^R_{2it} = \frac{C^R_{2it}}{QS^R_{it}}$ = fuel efficiency. (29)

d. $a^R_{3it} = \frac{W^R_{it}}{QS^R_{it}}$ = labour efficiency. (30)

e. $a^R_{4it} = \frac{C^R_{3it}}{QS^R_{it}}$ = capital cost efficiency. (31)

Obviously, $\bar{g}^{*R}_{it} + a^R_{1it} + a^R_{2it} + a^R_{3it} + a^R_{4it} = 1$ (32)

A similar treatment can be made of equation (21) which can be decomposed into the following four components on the L.H.S. of (33) :

$$\bar{\bar{g}}^R_{it} + a^R_{1it} + a^R_{2it} + a^R_{3it} = 1 \quad (33)$$

where $\bar{\bar{g}}^R_{it} = \bar{g}^{*R}_{it} + a^R_{4it}$ = residual efficiency (34)

We maintain the term 'residual' for $\bar{\bar{g}}^R_{it}$ because it includes both gross profits and capital costs expressed as a ratio to the total value of output. It should be clear to the reader that a treatment involving equation (1) and equation (19) similar to (32) and (33) cannot be done as in that case we shall not have the accounting identity of the type like equations (32) or (33). We know that g^{*R}_{it} (cf eqn. (1)) and $\bar{g}^R_{it}$ (cf eqn (19)) can be negative and it is

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difficult to handle problems of relative input efficiency if either the value of shipments (S) enter in the numerator or the same thing enters in the denominator without any reference to the value of output for both. Thus for relevant input efficiency measures the appropriate measures should follow the condition expressed by equation (32) or failing capital costs data, should follow equation (33). At this stage it is important to note some prevalent practices to deal with 'value added'. In our scheme value added (V^R_{it}) is given by:

$$V^R_{it} = QS^R_{it} - (C^R_{1it} + C^R_{2it}) \qquad (35)$$

which when combined with equations (28), (29), (32), (33), and (34) can be written as:

$$\frac{V^R_{it}}{QS^R_{it}} = 1 - (a^R_{1it} + a^R_{2it}) \qquad (36a)$$

$$= \bar{g}^{*R}_{it} + a^R_{3it} + a^R_{4it} \qquad (36b)$$

$$= \bar{\bar{g}}^R_{it} + a^R_{3it} \qquad (36c)$$

Whereas it is true that value added expressed as a ratio to output has some important implications in planning for industries which can generate maximum incomes i.e., the higher this ratio, the larger is the income potential, it is no longer certain that industries which are presumably guided by profitability should be satisfied with such a maxim. In other words it is conceivable that one may have large spectrum of industries having higher value added - output ratios with very low $\bar{g}^{*R}_{it}$ or $\bar{\bar{g}}^{R}_{it}$. This is because one underestimates the role of capital costs or labour costs in profitability (cf. eqns. (36b) and (36c)). Hence it is desirable not to tamper with value added ratios[1] whenever one has an opportunity to decipher other components, namely, a^{R}_{3it} and/or a^{R}_{4it}.

Our next step from equation (32) or (33) would be to trace the developments of the coefficients a_1, a_2, a_3, a_4 and $\bar{g}^{*}$ or $\bar{\bar{g}}$ for each industry over regions and over time. A preliminary guess-work of this sort of procedure can be best understood in a simple static diagram with two factors of production (say labour and materials) operating on non-constant returns to production scale in three different regions, A, B, and C. This diagram is exhibited below:

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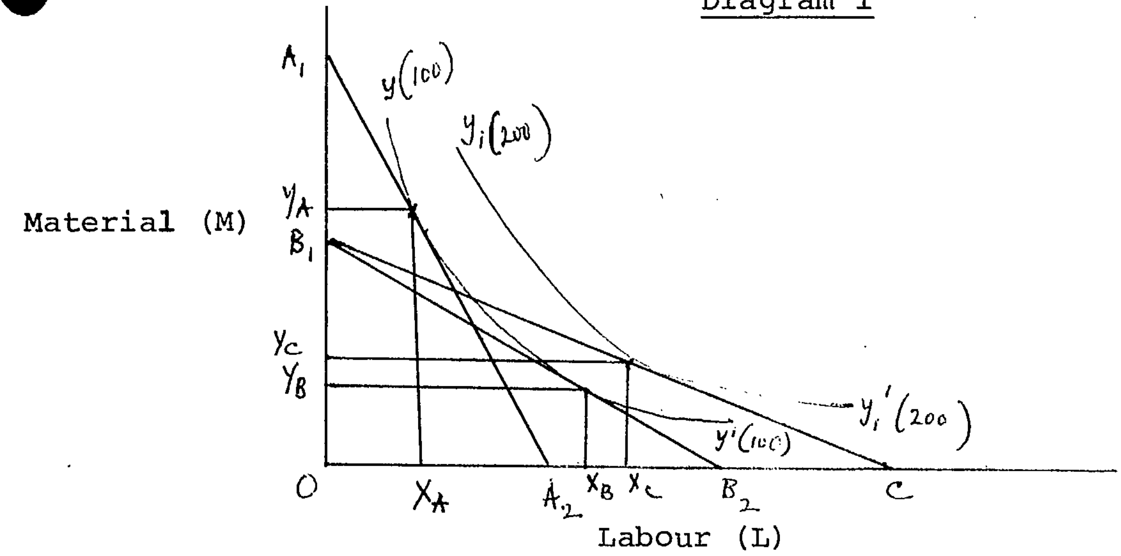
1. Sometimes one comes across far more curious measures like $\frac{V_t}{S_t} = \frac{\text{Value added}}{\text{Value of Shipments}}$ which is, of course, meaningless because in a certain time, t, one can get very well $S_t < V_t$ i.e., shipments are relatively low. Any ranking procedure with regard to industries based on this is definitely thoughtless unless at least one gets a measure of this over time.

Diagram 1



For a given industry with two continuous production contours yy^1 and $y_1y_1^1$ both being available to regions A, B and C and with budget lines A_1 A_2 (for A), B_1 B_2 (for B) and B_1C (for C) we get the following equilibrium values of labour and material in the three regions.

For A,

$\left.\begin{array}{l}\text{Labour} = OX_A \\ \text{Material} = OY_A\end{array}\right\}$ the budget line being A_1A_2

For B, $\left.\begin{array}{l}\text{Labour} = OX_B \\ \text{Material} = OY_B\end{array}\right)$ the budget line being B_1B_2

For C, $\left.\begin{array}{l}\text{Labour} = OX_C \\ \text{Material} = OY_C\end{array}\right)$ the budget line being B_1C

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It is evident that in a situation described in Diagram 1 the two regions A and B are using different amounts of labour and materials to attain the same output (shown by the iso-quant yy^1 representing 100 units of a given commodity) and this depends on both the prices of inputs (here in our case only prices of labour and materials as shown by the slopes of the budget lines A_1A_2 and B_1B_2) as well as by the resources of the representative firms (which are shown by the intercepts of the specific budget lines on the two axes). Both the firms are equally efficient in terms of cost minimization with respect to production of a given quantity of output. The same is true when the firm in C happens to have a budget line B_1C which indicates a cheaper price of labour as shown by the flatter slope than B_1B_2. The firm in Region C is at the same time reaching proportionately greater output (200 units of the same commodity) than either of the firms in A or B. Under the assumptions involved in the construction of our diagram we, therefore, find the following:

a. $\frac{OX_A}{100} < \frac{OX_B}{100}$; b. $\frac{OY_A}{100} > \frac{OY_B}{100}$

c. $\frac{OX_A}{100} < \frac{OX_C}{200}$; d. $\frac{OY_A}{100} > \frac{OY_C}{200}$

e. $\frac{OX_B}{100} > \frac{OX_C}{200}$; f. $\frac{OY_B}{100} > \frac{OY_C}{200}$

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The above can be written in a much simpler form which is given by:

1. $\frac{OX_A}{100} < \frac{OX_C}{200} < \frac{OX_B}{100}$; i.e., labour shares in the total outputs in Regions A, B and C.

2. $\frac{OY_A}{100} > \frac{OY_B}{100} > \frac{OY_C}{200}$; i.e., materials' share in the total outputs in Regions A, B and C.

By further assumptions of our construction we see that:

3. $p_L^A > p_L^B > p_L^C$

4. $p_M^A < p_M^B = p_M^C$

or 5. $\frac{p_L^A}{p_M^A} > \frac{p_L^B}{p_M^B} > \frac{p_L^C}{p_M^C}$

where, p_L^A denotes price of labour in Region A, p_M^B denotes price of materials in Region B and similarly for others.

One conclusion which is universal in the neo-classical theory of cost minimization under constant returns to scale is that if (3) and (4) or (5) above should hold then we must have:

6. $\frac{OX_A}{100} < \frac{OX_B}{100} < \frac{OX_C}{200}$

7. $\frac{OY_A}{100} > \frac{OY_B}{100} > \frac{OY_C}{200}$

It is evident that conditions (6) and (7) do not tally with those of (1) and (2) precisely because of the non-constant returns to scale. In our case the non-constant returns assume increasing returns to scale for the firm in Region C. More particularly the violation of the rule (under constant returns to scale) emerges with respect to labour shares in outputs of the two Regions, B and C. Thus if it is possible to get hold of relative prices or factor and material inputs by regions (cf condition (5)) then it should be possible[1] to also measure the extent of non-constant returns to scale for particular regions provided the prices of final outputs do not vary significantly except by transport margins. It is however difficult to get hold of any regional data on relative prices based on factor and/or intermediate inputs as well as data on final prices by regions in Canada. This makes a tremendous difficulty in locating real efficiency of inputs when returns to scale are assumed not to be constant. On the other hand, it seems inappropriate to leave the matter as such only because of data difficulty even though we may not succeed in discovering returns to scale precisely. A rough catalogue of causes leading to different shares of inputs (intermediate and primary) in the total outputs of a given industry over regions can be classified thus:

1. The procedure here is first to make an ordering of the relative prices of inputs over regions as in condition (5) and then to correlate them with ratios of actual input shares in the outputs of the regions for each type of product. Thus to give an example, if in two regions $p_L^A / p_M^A > p_L^B / p_M^B$ then we should have $OX_A / OY_A < OX_B / OY_B$. For constant returns the correlation should be equal to minus 1 (-1). Any deviation from this value would be considered to be a violation of the neoclassical rule of constant returns and the deviation then should be attributed to the existence of non-constant returns to scale. As for the pairs of observations for correlation studies, we can show, for example, that there will be 24 pairs of observations relating to relative prices and ratios of input shares for three inputs and four regions.

a. input prices are different over regions even though production functions are the same i.e., constant returns to scale;

b. production functions over regions are different and do not obey constant returns to scale and furthermore may be guided by indivisibilities;

c. product prices are different interregionally (after allowing for transport costs) and thus invoke oligopolistic market behaviour even though differentiation of products is ruled out.

The existing input shares interregionally, therefore, for any specific industry can be attributed to either of the above causes or a combination of them. Sometimes under-utilization of capacity is described as an additional cause, but this is not right. Under-utilization is a result of cost minimization schemes under existing demand conditions. The forces behind cost minimization which forms the supply side alone fall, to be more precise, in the categories (a) and (b) and not even in (c) since this is governed partly by demand conditions despite oligopolistic supply considerations. However to cut the story short, we cannot afford to dismantle the above three causes due particularly to the data difficulty. We, therefore, have to rationalize the explanation of the

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existing input shares interregionally mainly in terms of the factors (a), (b) and (c) above and conjecture that if the supply side as governed by (a) and (b) are predominant, then particularly there is hardly any clue to decide, for example, that labour in one region is more efficient than labour in any other region. The only thing that one can say in that case is that labour is more expensive in one region vis-a-vis another, and similarly for other inputs. The word 'efficiency', therefore, is used only in a particular sense, namely, the relative expensiveness of one input as against another and it is purged of any connotation regarding whether a particular input is being used to the maximum effective utilization or not.

Given the above reservations, we proceed again to sort out the profiles of a_1, a_2, a_3 and $\bar{\bar{g}}$ as in equation (33) over time. Equation (32) cannot be handled properly because many a time we cannot get hold of a_4 because of lack of data availability on capital costs. Thus consider the following hypothetical example of an industry i for four regions, A, B, C and D over time, $t = 1, 2, 3$.

TABLE II

An Hypothetical Example of Input Shares by Regions Over Time

Input Shares \ Regions by time		Regions (t = 1) A	B	C	D	Regions (t = 2) A	B	C	D	Regions (t = 3) A	B	C	D
Material's Share:	a_1	.20	.25	.20	.20	.15	.20	.20	.20	.20	.20	.10	.20
Fuel Share:	a_2	.10	.20	.30	.25	.20	.20	.20	.25	.20	.10	.20	.25
Labour Share:	a_3	.40	.40	.20	.20	.30	.40	.30	.20	.40	.40	.35	.20
Residual Share:	$\bar{\bar{g}}$	.30	.15	.30	.35	.35	.20	.30	.35	.20	.30	.35	.35
		1	1	1	1	1	1	1	1	1	1	1	1

What inferences can be drawn about the stability of input shares in this example? The standard procedure is to work out in the first place the standard deviations of a_1, a_2, a_3 and $\bar{\bar{g}}$ over time. The results together with the means of the input shares are given in the following Table III.

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TABLE III

Representative Input Shares of the Regions (Mean Input Shares) in Industry i and Their Dispersion Over Time

Input Shares \ Regions	A		B		C		D	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
a_1	.183	.098	.217	.191	.167	.191	.200	.000
a_2	.167	.387*	.166	.196	.233	.387*	.250	.000
a_3	.367	.191	.400	.000	.283	.479*	.200	.000
$\bar{\bar{\bar{g}}}$	.283	.098	.217	.387*	.317	.098	.350	.000
	1		1		1		1	

NB: * signs refer to special cases to be explained below.

One can notice clearly from Table III that the most marked changes in the stability of input shares are those areas where values of S.D. are the highest which are characterized by an asterisk (*) sign. Thus the fluctuations are discernible in the following cases:

1. In Region A, a_2 has changed rapidly i.e., from a low value in the initial period it has taken a larger value in the two other periods although variations in the residual share $\bar{\bar{\bar{g}}}$ have been small due to compensating variations in a_1 and a_3.

2. In Region B, $\bar{\bar{\bar{g}}}$ has received the largest impact in variations although we can see this is mainly a result of the variations in a_1 and a_2.

3. In Region C both a_2 and a_3 have shifted considerably although variations in $\bar{\bar{g}}$ have been minimized by the opposite directions of a_2 and a_3 (which are not shown by the S.D. but can be obtained from absolute deviations that we have seen separately).

4. In Region D, all input shares are perfectly stable.

As we said earlier it is not possible to fully account[1] for any given instability of the share coefficients by decomposition into (a) input price changes and (b) shifts in returns to scale i.e., jumping to non-constant returns to scale as production keeps changing. All that needs to be meticulously observed is the direction of the changes in input shares by regions. Unless there are marked changes in technology in a particular industry as given by known production functions, location decisions of a particular industry cannot avoid the use of average measures of input shares by regions as well as by their stability as shown in Table III. Of course, the more the input shares are unstable, the less we are clear as regards locational planning even though sometimes the residual share ($\bar{\bar{g}}$) may have minimum variance. However, if risk aversion can be taken as a valid criterion in planning apart from gross profitability (although capital costs are not fully dismantled) criteria, Region D stands out as a clear candidate for choice

1. Here we are considering only the supply side of production after plant and equipment have been installed.

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of industry i location (cf Table III). In our example this choice is easier because of the clear-cut situation of Region D having no variance for each input share. In the more complicated cases a premium for risk as measured by variance or S.D. of input shares has to be imposed in order to make a choice.

2. Demand Efficiency Measures

As is well known a consistent measure of cost efficiency in production by inputs (both intermediate and primary) is not a sufficient condition for viability; goods produced must be sold either for the region's own market or for exports. It is quite conceivable that a region may be endowed with all sorts of inputs whose prices are lower than other regions, yet it may be uneconomical to produce a product whose demand does not exist. Obviously at a specific time unit there may be production but no sales. For a firm or establishment which faces such a situation it is logical to expect that there will be very little production in the next period since already inventories have been accumulated. This is not the case when some specific signs are discernible for a very sharp rise in demand in future for which it pays the firm to avoid the potential customers being frustrated. The usual rule of measuring potential demand involves the sum of two components, namely:

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a. pre-determined demand as given by orders of customers today for shipments at a later date;

b. demands as anticipated by the firm or the industry through various indirect routes such as rise in income, previous years' sales, withdrawal of tariffs or quotas in international trade and so on.

Pre-determined demands as reflected in orders are easy by virtue of definition and leave nothing for explanation and some industrial demands in the manufacturing sector are particularly specific to this type[1]. However, regional industrial data on an order-basis are well-nigh impossible although very likely the national behaviour of industries which are order-oriented[2], e.g., heavy transportation, machinery, construction and even some durable consumer goods, would be repeated at the regional level. In any case it is useful to consider total demands for regional products as if they are all anticipated or expected. The demand projections at the regional level have then to be also, needless to say, aggregated i.e., one cannot go into a breakdown of them by final demand categories, namely, con-

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1. See for example, T.J. Courchene: Inventory Behaviour and the Stock-Order Distinction -- An Analysis by Industry and Stage of Fabrication with Empirical Application to the Canadian Manufacturing Sector, Canadian Journal of Economics and Political Science, August 1967.

2. Ibid, p.330.

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sumption, Government demand, investment, exports to the rest of Canada and exports to the rest of the world. This is particularly severe due to data difficulty although for some specific regions in Canada, namely, Ontario and Quebec such problems can be reasonably overcome. Even in the final demand projections one comes across a further feature in model construction, namely, the phenomenon of "conditional projections" i.e., if Government demand for a certain industrial product is such and such, the total demand would be so and so etc. This then goes through a whole set of chain reactions through induced impacts on factors and products that call for an elaborate specification of a model at the regional level. At the present stage of our knowledge with respect to the data situation this task should better be left out. The only hunch that we shall employ in demand projections at the regional level is a different variant of conditional projections, i.e., if the conditions of the past prevail in future what demands for regional products can be expected. In pursuance of this objective we shall also assume that if demand exists for a product of region, supply or production in the region follows. The latter hypothesis can be easily tested with production data in time, t, being regressed on sales data in previous years and by some other means of an adjustment index of sales and production. In the following we shall also consider such an index of production planning for each industry in each region. However, the first thing that comes in our analysis is the task of demand projections. One final comment seems in order. The word 'efficiency' used in this Section should be interpreted to mean the extent or the speed at which the demands keep rising of falling in different regions, i.e., higher the speed the more efficient is the demand for a regional product.

2.1 Regional Demand Projections -- A Simple Time Series Device

In the first place we shall hypothesise the following linear form for each region's value of shipments (S) over time:

$$S^R_{it} = S^R_{io} \quad (1 + \beta^R_i t) + \varepsilon^R_{it} \qquad (37)^*$$

where $R = 1, 2, 3, \ldots j$

$t = 0, 1, 2, \ldots T$

$i = 1, 2, 3, \ldots n$

The data of S^R_{it} fitting the regression equation (37) refer to ex-post data and will include one cumbersome element of price-changes which needs to be eliminated. However regional industrial price deflators do not exist in the current publishable data inventory. Far more difficult is to get access to quantity data by shipments with the additional

* ε^R_{it} stands for the usual error term which is additive in our form.

problem of aggregation i.e., it is not possible to aggregate different types of product under one industrial classification in quantity terms. Our approach then is to conform to value of shipments in nominal terms since other alternatives to improve the situation do not become accessible. However it is to be borne in mind that to the extent the price deflators do not exist regionally our results are bound to be biased, upward or downward, and interregionally. Another point which is particularly important to remember is that data of value of shipments are ex-post data not only in the demand sense but also in the supply sense. The ex-post demand is ex-post not only because demand existed before but also supply was high enough to get the demand materialized. The latter condition will be violated if and only if inventories were of zero order[1] in which case demand will not be truly "revealed". However, it is from these equilibrium demand/supply shipments value that effective demand[2] estimates may be partially syphoned through time. The procedure may now be followed thus:

1. One can get, however, a curious situation when an industry is classified in such a way that there are two types of products X and Y under one industry and the nature of demand is such that X is all sold out i.e. zero inventories in X, but Y is not. In such a case total inventory in the industry is not zero, but this would not prove that the demand is revealed.

2. We recognize the identification problem here but since we consider not the potential demand but the equilibrium demand this problem is somehow overcome ab initio.

From equation (37) we obtain a reduced form given by:

$$\frac{S_{it}^{R}}{S_{io}^{R}} = \bar{S}_{it}^{R} = 1 + \beta_i^R t + \frac{\varepsilon_{it}^{R}}{S_{io}^{R}} \qquad (38)$$

The term $\varepsilon_{it}^R / S_{io}^R$ now represents the error component which follows through time. Assuming a normal distribution of the error components in time, it can be shown that the fitted regression equation for (38) can be expressed as:

$$\frac{\hat{S}_{it}^{R}}{S_{io}^{R}} = \hat{\bar{S}}_{it}^{R} = 1 + \hat{\beta}_i^R t \qquad (39)$$

Where the variables with ˆsign symbolize estimated values of the respective variables. The usual presumption in such a case is that $\varepsilon_{it}^R / S_{io}^R$ are not serially correlated which we may assume for the time being. Thus the projected average values of $\hat{S}_{it}^R$ can be estimated as:

$$\hat{S}_{it}^{R} = S_{io}^{R} \quad (1 + \hat{\beta}_i^R t) \qquad (39a)$$

It can also be shown that when total national values of shipments (actual and estimated) are given by:

$$S_{it} = \sum_{R=1}^{j} S_{it}^{R} \qquad (40a)$$

$$\hat{S}_{it} = \sum_{R=1}^{j} \hat{S}_{it}^{R} \qquad (40b)$$

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then

$$\hat{\beta}_i = \sum_{R=1}^{j} \hat{\beta}_i^R \frac{S_{io}^R}{S_{io}} \quad (41)$$

Equation (41) shows that national estimated linear time trend coefficient $\hat{\beta}_i$ is a sum of weighted estimated regional coefficients. Similarly it can be shown that when regional shipments are not intercorrelated, national variance of shipments of a given industry over time can be given as a simple sum of regional variances of shipments of the same industry over time. Thus:

$$\text{National Variance:} (\sigma_i)^2 = \sum_{R=1}^{j} (\sigma_i^R)^2 \quad (42)$$

$$\text{National Variance:} (\sigma_i)^2 = \sum_{t=1}^{T} \frac{(S_{it} - \hat{S}_{it})^2}{T} \quad (43)$$

$$\text{Regional Variance:} (\sigma_i^R)^2 = \sum_{t=1}^{T} (S_{it}^R - \hat{S}_{it}^R)^2 \quad (44)$$

Under assumptions of equilibrium demand path in a linear form the two most important things to be noticed now are the simple versions of national-regional decomposition formulae -- one given by equation (41) and another by equation (42). This has a very important bearing on the present discussions[1] regarding national-regional interrelations of growth dynamics

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1. Take, for instance, the CANDIDE Model in which DREE intends to participate. The national growth in a given industry output needs to be decomposed into a regional breakdown. The formula (41) gives immediately the clue to consistency if output grows in a linear way with respect to time. Of course, we need to have then some particular regional estimates over and above the national estimate to check for consistency.

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and can throw light in the first instance on the consistency of those interrelations. It may be mentioned here that share-shift analysis impinges on the same routine in an indirect way but it cannot take care of the simple principle of consistency we have noted now. Finally it is important to note that we have only given the linear versions of equilibrium demand path and it is conceivable that many other forms, both linear and non-linear, may be pertinent. Consequently aggregation or decomposition formulae will then change and perhaps become more complicated.

2.1 Shipments - Production Planning: An Adjustment Measure

This section deals with the testing of the hypothesis that production/supply follows demand. The usual clue to this objective is to see how the behaviour of inventories varies with the value of shipments (Sales) and the value of output (production) over time, prices being ignored. The organization of this procedure rests on the estimates of output and inventoriesonly in terms of finished goods rather than goods in process or raw materials, since shipments are only for finished goods. In our scheme we have derived no particular methods to identify ex-ante production or sales or inventories so that excess demand or excess supply can be measured first and thereafter adjustment for time lags studied. On the contrary, inventory accumulation or decumulation is supposed to sort out the adjustment itself, not in a particular time unit but over two or more consecutive time units. We are particularly aware of the ex-ante types of exercises involving inventory behaviour and the dangers therein[1] whether one follows a production-smoothing position or demand-smoothing position. (These are related to what is called 'flexible accelerator' approach to inventories whereby accelerator takes care of stock adjustment). However, at the present state of knowledge we consider these exercises mainly speculative.

The procedure that we suggest for an adjustment index is explained below.

Write

$$QF^{R}_{it} = S^{R}_{it} + \Delta IF^{R}_{it} \qquad (45)$$

$$\Delta QF^{R}_{it} = \Delta S^{R}_{it} + \Delta^{2}\, IF^{R}_{it}$$

$$= \Delta S^{R}_{it} + \Delta IF^{R}_{it} - \Delta IF^{R}_{it-1} \qquad (46)$$

(Equation (46) follows from equation (45)).

$$\Delta QF^{R}_{it} = QF^{R}_{it} - QF^{R}_{i,t-1} \qquad (47)$$

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1. One notable exception is Belsey's study which follows a general equilibrium optimization approach. See D.A. Belsey: Industry Production Behaviour, North Holland, 1970.

$$\Delta S^R_{it} = S^R_{it} - S^R_{i,t-1} \qquad (48)$$

$$\Delta IF^R_{it} = IF^R_{it} - IF^R_{i,\ t-1} \qquad (49)$$

$$gQ^R_{i,t} = \frac{\Delta QF^R_{it}}{QF^R_{i,t-1}} \qquad (50)$$

$$gS^R_{it} = \frac{\Delta S^R_{it}}{S^R_{i,t-1}} \qquad (51)$$

$$gI^R_{it} = \frac{\Delta^2 IF^R_{it}}{\Delta IF^R_{i,t-1}} \qquad (52)$$

then consider the following adjustment index or measure

as given by:

$$e^R_{it} = \left(\frac{1 + gS^R_{it}}{1 + gI^R_{it}} + \frac{1 + gQ^R_{it}}{1 + gI^R_{it}} \right) \Big/ 2 \qquad (53)$$

$$= \frac{2 + gS^R_{it} + gQ^R_{it}}{2\ (1 + gI^R_{it})} \qquad (53a)$$

The properties[1] of the above scheme reveal the following:

$$\left.\begin{array}{ll} \text{If,} & gQ^R_{it} > gS^R_{it} \\ \text{then,} & gI^R_{it} > gS^R_{it} \end{array}\right\} \qquad (54)$$

$$\left.\begin{array}{ll} \text{If,} & gQ^R_{it} < gS^R_{it} \\ \text{then,} & gI^R_{it} < gS^R_{it} \end{array}\right\} \qquad (55)$$

1. These properties are derived from the use of equations (45) through (52) where particularly the identity equation (45) plays the most important role. We have not shown the proofs of these properties here. These may be obtained from the author on request.

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The conditions (54) and (55) reveal inventory accumulation and inventory decumulation respectively and would be featured by what may be called unbalanced growth. However it should be mentioned that in the long run the situation (55) cannot be maintained since we have to satisfy also the condition that at any time inventories in finished goods cannot assume zero values i.e., $IF^R_{it} > 0$. The balanced growth situation is given by:

$$gQ^R_{it} = gS^R_{it} = gI^R_{it} \quad (56)$$

which when applied to (53) gives

$$e^R_{it} = 1 \quad (57)$$

From (53) and (55) it further follows that

$$e^R_{it} > 1 \quad (58)$$

whereas from (53) and (54) it can be shown that

$$e^R_{it} < 1 \quad (59)$$

Now in regard to two consecutive time periods the situations as described by (58) and (59) are both conceivable where we see clearly that:

(a) in the case of (58) growth in effective demand as shown by gS outstrips that in production as shown by gQ and;

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(b) in the case of (59) the reverse position applies. However this disequilibrium between production and effective demand is confined to a short period only and some adjustment must take place in the long run. A convenient and simple procedure to catch this adjustment is to take note of the path of e_{it}^R over time with particular reference to its dispersion rather than to its mean value. In other words our procedure may simply be defined by computing the following measure:

$$e_i^R = \frac{\sum_{t=1}^{T} (e_{it}^R - 1)^2}{T} \qquad (60)$$

The interpretation of (60) is that when e_i^R is higher in one region than in another the adjustment lag is higher. Correspondingly the ranking of the regions for a particular industry with respect to their adjustment to a balanced growth situation becomes clear. However, this final measure points up to production management with respect to effective demands only i.e., sales management is ruled out.

3. Interrelations Between Cost and Demand Efficiency Measures

A complete list of causal variables affecting the measures proposed in Sections 1 and 2 which takes care of simultaneity would call for a complete model with identified

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equations. Even when a specification of such a model can be theoretically managed we shall inevitably face the severe data difficulties to implement such a model. Two particular examples of the data situation should suffice to illustrate this point. These are price deflators of the final products of the regions and the capital costs of the industries in the regions. Neither of these exist in the available publishable data inventory and as we know that both are vitally important even in partial models of efficiency estimates. The situation has, therefore, been made to conform to ratios and measures of nominal values and that too without taking care of capital costs. It is conceded that a large part of our exercise is devoted to the historical directions of change, rather than to the particular processes by which changes have been brought into being. With this reservation we shall note now some cases of interaction between demand and cost measures in Sections 1 and 2.

Consider first the measure given by equation (1). The appearance of S in the numerator shows clearly that we have included a demand-oriented variable to measure efficiency which should by our intents and purposes have been only cost-oriented. This demand bias is partly offset in equation (2) and also in other formulations such as equations (15), (21),

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(22), (32), (33) etc. This is because emphasis has been shifted from actual sales to actual output to provide a basis for the supply side. So far about the over-all efficiency aspects of the Section 1.1. As for the input-efficiency aspects of Section 1.2 the only demand impact which is of some importance is the pricing of products which gives us the valuation of output. It is here that it is difficult to isolate demand from supply with the ex-post data as separate data of price deflators do not exist. This brings us to the identification problem which is partly overcome in the demand estimates of Section 2.1 since we deliberately look for historical growth patterns of effective demands only. Thus when we ignore the demand side of inputs the major crucial point of interaction between demand and supply falls on the valuation of output via price formation. It is submitted that this price nexus has been difficult to resolve for the reasons mentioned above.

We may ask a parallel question: Is it not possible that an industry in a given region which maintains a high over-all efficiency as given by Section 1.1 should also face a high effective demand over time as outlined in Section 2.1? Given certain conditions, there is a high apriori conjecture that this should be so. Or, in other words, industries which

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perform best in terms of cost minimization perform so mainly because demand is high enough to ensure so. However, whether it is true or not is mainly an empirical question which can be very easily tested. It is considered not very important to give a separate theoretical measure of this test.

4. Some Notes on Statistical Data

The bulk of data to be used for our efficiency measures depend on the DBS Annual Census of Manufactures by 3-Digit SIC level. One most important thing here to note is the 'Concepts and Definitions' of the terms[1], like 'value of shipments of own manufacture', 'inventories', etc., which are described in the same series in their appendices. The data covers time periods 1961 through 1968 -- 1968 being the year for which the most recent data are available. Data for the individual provinces of the Maritimes being not accessible, we may have to use the Atlantic Provinces as a whole for a single region. Some of the data imperfections in the use of the available data may now be noted. These are:

a. Cost of transport by own carriers is included in the value of shipments of own manufacture.

b. Cost of materials and supplies does not include service charges and hence the gross profitability is overestimated in each industry.

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1. The 'value of shipments of own manufacture' is the most important strategic variable in our exercise of gross output (domestic production) and sales capability. In our demand calculations we have ignored imports since we want first to know whether goods produced domestically are sold or not.

c. Cost of fuel and electricity is not included whenever fuel and electricity is produced by establishments for internal consumption.

d. There is no breakdown of each industry for each region by the size of establishments (except at the national level) and hence estimates remain imprecise to the extent of the size distribution.

e. Data for inventories (both for finished goods and goods in process) refer to opening and closing period only, and, therefore, goods which are relatively less durable (say, for instance, breweries) are under-represented in the inventories.

f. Quantity data being not always available (nor conformable because of the 3-digit level of disaggregation) price impacts cannot be evaluated to calculate demand efficiency at the regional level.

g. Regional price deflators do not exist by industries whereby it becomes difficult to isolate the real value of shipments from the spurious one. Thus the same quantity of shipments can have different values depending on the prices at which shipments are feasible. The same problem arises with inventory depletions.

At the present state of data situation it is impossible to disentangle each of the above errors and it seems a far cry to hope to incorporate them. We have no other alternative than to ignore them. In general, of all the missing links we consider the capital cost and the price deflators as the main villains. In regard to capital costs, of all the regions here again the Atlantic Provinces suffer the most since

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PPI data[1] for the Atlantic Provinces (both in total as well as by provinces) give the total manufacturing only and not by industries. As we saw before the capital cost item contains two essential components -- gross capital stock series by industries and by depreciation rates, assuming uniform bond yield rates (which are national only) being given. Moreover, the 2-digit capital stocks and flows series do not fully answer our requirements since we are asking for the equivalent 3-digit series. Even at the national level this requirement is not lokely to be fulfilled in the immediate future. Hence the only way to bypass all this is to rely on the immediate national capital stock[2] and depreciation series by 2-digit industries, and distribute capital costs equally for each region. Consequently in estimating capital costs at the 3-digit industry level we shall be using capital costs at the 2-digit level only. This anomaly seems to be unavoidable in the present state of affairs except when we use the depreciation rates of the 3-digit SIC industries for a sample of

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1. See the most recent data in Private and Public Investment in Canada, Outlook 1971, Statistics Canada, Cat. 61-205, April 1971.

2. The national capital stock series ending in 1968 is now being published by Statistics Canada shortly whereas GDP at factor cost by 2-digit SIC is already available. This gives the gross capital-output ratios by industries at the national level which can be used to calculate capital costs. See further notes on this in Appendix B. There is however another way in which national capital costs can be obtained partially at the 3-digit level. See Corporation Financial Statistics, 1968, DBS Cat. No. 61-207. It is partial in the sense that data refer to a sample of corporations in each industry group and that data are different from those in years preceding 1965 both in industrial classification as well as in definitions of concepts.

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corporations we have mentioned before in connection with the Corporation Financial Statistics[1].

The role of price deflators has been elaborately explained in the Sections 1.2, 2.1 and 3. At the present stage of compilation of statistical information, this does not exist anywhere (even at the confidential level with the Statistics Canada). We cannot salvage it anyway even by imposing national price deflators since regional prices are special features of the regions and cannot be bargained at any cost. This leads us to maintain a tenuous assumption that price distortions at the regional level are absent and that all regional FOB prices of any industrial product are behaving in a symmetrical way.

Finally, it is to be noted that we are making special efforts to have access to a large set of data that are considered confidential by the Statistics Canada to implement some of the measures proposed in this paper. At the present stage it is difficult to say how far we shall gather from them. But we hope that we shall make some headways as primarily we shall mostly work with ratios or indices, given initial values of some desired variables.

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1. Cf. footnote 2 loc cit, and DBS Cat. 61-207.

List of Variables and Parameters

(Variables/Parameters are characterized by two expressions: 1. Observed or given, and/or arranged; 2. Calculated or computed. The expression 'arranged' means data obtained through special arrangements with the Statistics Canada for release of data which are 'confidential' in certain regions. All variables are measured in terms of current prices and Δ's denote annual changes. Variables/ Parameters without superscript R refer to national categories).

Variables/ Parameters	Given/Arranged/ Computed	Description
S^R_{it}	Given/Arranged	Value of shipments of own manufacture in industry i for region R in year, t.
$C^R_{1i,t}$	Given/Arranged	Total cost of fuel and electricity in industry i for region R in year, t.
$C^R_{2i,t}$	Given/Arranged	Total cost of materials and supplies in industry i for region R in year, t.
$C^R_{3i,t}$	Computed	Total cost of capital in industry i for region R in year, t.
$W^R_{i,t}$	Given/Arranged	Total wages in industry i for region R in year, t.
QS^R_{it}	Computed	Total value of gross domestic output in industry i for region R in year, t, (includes goods in process and finished goods inventories).
QF^R_{it}	Computed	Total value of gross domestic output adjusted for inventories in finished goods only (discard goods in process) in industry i for region R in year, t.

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Variables/ Parameters	Given/Arranged/ Computed	Description
I^R_{it}	Given/Arranged	Value of inventories (including goods in process and finished goods) in industry i for region R at the end of the year, t.
$IG^R_{i,t}$	Given/Arranged	Value of inventories of 'goods in process' only in industry i for region R at the end of the year, t.
$IF^R_{i,t}$	Given/Arranged	Value of inventories of 'finished goods' of own manufacture in industry i for region R at the end of the year, t.
$K^R_{i,t}$	Computed	Gross capital stock (both a structure and machinery and equipment aggregated) in industry i for region R in year, t.
K_{it}	Given/Arranged	Gross capital stock (structure and machinery and equipment) in industry i in the nation in year, t.
d^R_{it}	Computed	Depreciation rate of capital stock of industryi in the region R in year, t.
d_{it}	Given	Depreciation rate of industry i for the nation in year, t.
γ_t	Given	Corporate bond yield rate for the nation in year, t.
b^R_{it}	Computed	Gross capital-output ratio of industry i in region R in year, t.
b_{it}	Given	Gross capital-output ratio of industry i in the nation in year, t.

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Variables/ Parameters	Given/Arranged/ Computed	Description
g^{*R}_{it}	Computed	Average annual gross realized profit (before corporation taxes) per unit of gross value of output produced in region R by industry i in time, t (it includes retained earnings and dividends and also accounts for capital costs).
$\bar{g}^{*R}_{it}$	Computed	Average annual accounting gross profit (before corporation taxes) per unit of gross value of output produced in region R by industry i in time, t (it accounts for capital costs).
C^{R}_{it}	Computed	Total costs of production of the gross value of output, QS^{R}_{it}, in region R by industry i in time, t.
g^{*R}_{i}	Computed	g^{*R}_{it} averaged over total time, T.
$\bar{g}^{*R}_{i}$	Computed	$\bar{g}^{*R}_{it}$ averaged over total time, T.
$\hat{g}^{R}_{i}$	Computed	Modified average over-all efficiency of industry i in region R over total time, T (when capital costs are accounted for).
$\bar{g}^{R}_{it}$	Computed	Average annual gross realized residual (before corporation taxes) per unit of gross value of output produced in region R by industry i in time, t (it includes retained earnings, dividends and capital costs), cf. g^{*R}_{it}.

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Variables/ Parameters	Given/Arranged/ Computed	Description
$\bar{\bar{g}}_{it}^{R}$	Computed	Average annual gross accounting residual (before corporation taxes) per unit of gross value of output produced in region R by industry i in time, t (it includes capital costs i.e., capital costs are not taken out), cf $\bar{g}_{it}^{*R}$.
$\bar{g}_{i}^{R}$	Computed	$\bar{g}_{it}^{R}$ averaged over total time, T.
$\bar{\bar{g}}_{i}^{R}$	Computed	$\bar{\bar{g}}_{it}^{R}$ averaged over total time, T.
g_{i}^{R}	Computed	Modified average over-all efficiency of industry i in region R over total time, T (when capital costs are not accounted for) cf. $\hat{g}_{i}^{R}$.
a_{1it}^{R}	Computed	Average material efficiency (or share) in the total gross value of output of industry i in region R, in time, t.
a_{2it}^{R}	Computed	Average fuel and electricity efficiency (or share) in the total gross value of output of industry i in region R, in time, t.
a_{3it}^{R}	Computed	Average labour efficiency (or share) in the total gross value of output of industry i in region R, in time, t.
a_{4it}^{R}	Computed	Average capital cost efficiency (or share) in the total gross value of output of industry i in region R in time, t.

Variables/ Parameters	Given/Arranged Computed	Description
V_{it}^{R}	Computed	Value added of industry i in region R in time, t.
β_{i}^{R}	Computed	Coefficient of effective demand with respect to time, t, for industry i in region R.
ε_{it}^{R}	Unknown (but eliminated by regression assumptions).	Error or disturbance term (that is independent of time) but associated with ex-post values of S_{it}^{R}.
$\hat{S}_{it}^{R}$	Computed	Estimated value of shipments of industry i in region R in time, t.
S_{io}^{R}	Given/Arranged	Value of shipments of industry i in region R in the initial period i.e., t = 0.
e_{it}^{R}	Computed	Adjustment index of lags in shipments and production of industry i in region R for two consecutive time periods, t, and t-1.
gS_{it}^{R}	Computed	Growth rate of value of shipments of industry i in region R over two consecutive time periods, t and t-1.
gQ_{it}^{R}	Computed	Growth rate of value of gross finished output of industry i in region R over two consecutive time periods, t and t-1, (inventories in goods in process being excluded).
gI_{it}^{R}	Computed	Growth rate of value of inventories in finished goods in industry i of region R over two consecutive time periods, t and t-1.

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Variables/ Parameters	Given/Arranged/ Computed	Description
e_i^R	Computed	Variance of the adjustment indices, e_{it}^R, with respect to the balanced growth path for industry i in region R over total time, T.
T	Given	Total time period, 1961-68, resulting in T = 8.
t	Given	t = 0, 1, 2, 3, ...7, with 1961 = 0, 1962 = 1, etc.
GDP_{it}	Given	Gross domestic product at factor cost for industry i in the nation in year, t (valued both in current and constant prices). See Appendix B for its use and relevance.

Data Sources for the Variables/Parameters and Notes on Methods Used

(Only the most important ones are considered here)

Variables/ Parameters	Data Source	Methods Used or Comments
1. S^R_{it}, $C^R_{1i,t}$, $C^R_{2i,t}$, W^R_{it}, I^R_{it}, $IF^R_{i,t}$, IG^R_{it}	Annual Census of Manufactures, Statistics Canada from 1961 to 1968 for all relevant 3-digit industries. For industries and regions where data are not publishable by the Statistics Canada because of 'confidentiality' we are making special arrangements with them to organize the use of data. This would then mean that we shall be working with ratios or indices, if the worst situation turns out to be the case.	The same method as used by Statistics, Canada (inventory valuation procedure not being subject to changes).
2. QS^R_{it}	Computed	Equations (3), (4), and (5).
3. QF^R_{it}	Computed	Equations (45) and (49).

Variables/ Parameters	Data Source	Methods Used or Comments
4. γ_t	Data bank Master type, Bank of Canada.	This is the only satisfactory series of corporate bond-yield rates available. It is national in content and serves as a proxy for interest rate. We desisted from using Government of Canada long term bond yield rates since it is felt that it may be less efficient to capture the cost of capital aspects of the corporate business.
5. K_{it}, d_{it}	DBS Cat. Nos. 13-523; 13-522 and 61-207.	1961-68 data at 2-digit SIC Manufacturing level are now being published by Statistics Canada (at the national and not at the regional level), and will be available shortly. Capital stocks, flows and depreciation rates will then be obtained at current and constant prices. Alternatively on a sample basis Corporation Financial Statistics DBS 61-207 can be used for 3-digit SIC industries (at the national level). The coverage here is, however, restricted.

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Variables/ Parameters	Data Source	Methods Used or Comments
6. b_{it}	$b_{it} = \frac{K_{it}}{GDP_{it}}$ GDP_{it} GDP at factor cost in industry i in the nation (absolute values of GDP_i and not indices).	1961-68 data for GDP_i (in absolute values) at 2-digit SIC Manufacturing level can be obtained both at current and constant prices either at the Economic Council or Statistics Canada (National Output and Productivity Division) through special arrangements with them. Data are not officially publishable as yet. The Economic Council has obtained them for uses in the CANDIDE Model. Alternatively b_{it} can be computed at the 3-digit SIC level for only the corporations studies in DBS Cat. 61-207. In that case GDP has to be surrendered and in its place we shall take the sales of the industry concerned.
7. b^R_{it}	-	Use $b^R_{it} = b_{it}$ since nothing else seems very trustworthy.
8. d^R_{it}	-	Use $d^R_{it} = d_{it}$ since nothing else seems very trustworthy.

All other variables/parameters and the methods used to estimate them have been mentioned in the main body of the text.