a model for industrial development

A MODEL FOR INDUSTRIAL DEVELOPMENT

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August, 1971

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MEMORANDUM **NOTE DE SERVICE**

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FROM / DE

D.J. McEachran,
Director,
Industrial Development Branch.

TO / À

See Attached List

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DATE

October 1, 1971.

SUBJECT / SUJET

A Model for Industrial Development

The enclosed paper outlines a methodology for identifying industries which appear best suited for development in designated regions. It has been prepared to stimulate discussion on the development of practical processes to facilitate a selective approach to industrial development. The study attempts to provide a framework for the determination of those industries which are best suited to a particular region in terms of their desirability, their attractability and their capacity for long run viability.

This analysis is obviously only one of many possible methods and thus we would appreciate your comments concerning both this approach and alternative methods for identifying industries with high development potential.

Mr. Barrows of the Intelligence Section can be contacted at 2-0238.

D.J. McEachran.

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FOREWORD

Economic growth depends, in large measure, upon identifying and developing viable manufacturing industries. This study presents a methodology for industrial identification based on research conducted for a number of areas.

Statistics Canada publishes data on over one hundred and fifty secondary manufacturing industries. Mr. Barrows' study attempts to eliminate those industries which do not appear viable, permitting more detailed attention to be given to those industries best suited to the area. The analysis represents the first, but important, stage in the process of determining those industries with the greatest potential for long term viability.

The original article, on which this study is based, was published in the October-December, 1970 issue of the Indian Economic Journal. This paper, which represents a revision and elaboration of the original article, will be published in the February, 1972 issue of the Journal of Economic Affairs.

We wish to thank the editors of the Indian Economic Journal and the Journal of Economic Affairs for their permission to publish this paper. Observations and conclusions reached in the study are those of the author and do not necessarily reflect the opinion of the Department of Regional Economic Expansion.

A MODEL FOR INDUSTRIAL IDENTIFICATION [1]

BY D.S. BARROWS, A.K. DATTA, R. MASKILL

In recent years governments have embarked upon a policy of encouraging industrial development in stagnant regions by offering incentives. Obviously any incentive plan must be selective as to which industries should receive aid. Difficulties arise in choosing appropriate industries whose development is most desirable. The very fact that the regional economy is underdeveloped suggests that limitations may exist as to the types of industries which may be successfully developed.

There is no single or simple criterion by which the task of selecting proper industries can be accomplished. However, a list of priorities for industries can be established which provides a guideline as to which industries should be selected for encouragement and development. Examining over 400 manufacturing industries at the four digit Standard Industrial Classification level we employed a composite criteria to determine the most desirable industries. From this list of desirable industries we then selected those industries most likely to be attracted to the region. Finally, the list was further narrowed by determining those industries that appeared most feasible in the region.

Methodology

A. Desirability

In formulating a desirability index we have taken the following factors into account: diversification of the region's industrial base, growth, value added to total factor cost, labour intensity and the intensity of forward and backward linkages.

We then attached weights, representing the relative importance of each of the six criteria,[2] and calculated values for all possible industries. The values obtained were summed to obtain a composite desirability index for each industry. The industries were then ranked in descending order and a cut off point was established.

(1) Diversification

As Isard has noted, the presence of growth industries and the diversity of the industrial structure (among other factors) are important in assessing a region's growth potential and the regional impact of business cycles.[3] We employ the location quotient to determine whether a region has its proportionate share of a particular industry. A location quotient less than unity indicates that the region has less than its proportionate share of that industry, and suggests that the industrial base could be broadened by attracting this industry to the region.

1. $Dit = a_1 \left(\frac{1}{LQit} \right)$

Dit = Weighted diversification of industry i in time t

a_1 = Weight assigned to the relative importance of diversification

$LQit$ = Location Quotient of industry i in period t

(2) Growth

We have chosen growth as one of our desirability criteria as it represents one measure of an industry's future viability. The planner wishes to ensure that after the initial incentive the firm will be able to compete effectively and to expand with the general increase in business activity.

$$2.\ Git = a_2 \left(\sum_{j=i}^{n} b^j \quad \frac{Sij - Sij-1}{Sij - 1} \right)$$

Git = Weighted growth of industry i in time period t

a_2 = Weight assigned to the relative importance of growth

Sij = Sales of company i in time period j

$b < 1$

(3) Efficiency

We view the ratio of value added to total factor input cost as a measure of efficiency. For a given cost input the firm with the greater value added is assumed the more efficient.

$$3.\ Eit = a_3 \left(\sum_{j=1}^{n} c^j \quad \frac{Vij - Vij-1}{Vij - 1} \right)$$

Eit = Weighted efficiency of industry i in time t

a_3 = Weight assigned to the relative importance of efficiency

Vij = Value added divided by the materials, supplies, fuel and power cost of industry i in time period j

$c < 1$

(4) Labour Intensity

Because many underdeveloped regions suffer from a lack of adequate job opportunities we view labour intensity as a desirable characteristic.[4, 5]

$$4.\ LIit = a_4 \left(\frac{Pit}{Sit} \right)$$

LIit = Weighted labour intensity in industry i in period t

a_4 = Weight assigned to the relative importance of labour intensity

Pit = Payroll costs of industry i in time t

Sit = Sales of industry i in period t

(5) Linkage effects

The development of an industry with strong forward and backward linkages is highly desirable. The location of such an industry within an underdeveloped region may provide a stimulus to firms already located in the area that supply inputs to this newly developed industry and to firms which use as an input the product of this particular industry. In addition the location of an industry with strong linkages within the region may serve as a further incentive for user and supplier industries to locate there.[6] It is possible that the resultant economies derived from the spatial association of closely linked groups of industries may be more important to the region than the economies associated with the location of the original firm.[7]

$$5.\ LKit = a_5 \ (Bit + Fit)$$ where,

$$Bit = a'5 \left[\frac{\sum_{j=1}^{n} (Gjt + Ejt + LIjt)}{(Git + Eit + LIit)} \right]$$

$$Fit = a''5 \left[\frac{\sum_{j=1}^{n} (Gjt + Ejt + LIjt)}{(Git + Eit + LIit)} \right]$$

LKit = Weighted linkage effects of industry i in period t

a5 = Weight assigned linkages (in total)

Bit = Backward linkages of industry i in time t

Fit = Forward linkages of industry in time t

a'5 = Weight assigned to the relative importance of backward linkages

Gjt, Ejt & Ijt = Weighted growth, efficiency and labour intensity of industry j in time period t; computed as described above for industry i.

a"5 = Weight assigned to the relative importance of forward linkages.

The linked industries and an indication of the key linkages were found through the use of a national Input-Output table.

(6) Composite Desirability Index

$$6.\ Ait = Dit + Git + Eit + LIit + LKit$$

Ait = Total composite desirability index for the i^{th} industry in time period t

Industries are then ranked in descending order of Ait. All industries above the designated cut off value of Ait are then subjected to an analysis based on the region's ability to attract these particular industries.

B. Attractability

Optimal plant location is in large measure determined by economic variables with non economic considerations of undetermined importance.[8]

We view the attraction of footloose industries as a function of comparative labour cost, comparative processing cost, comparative labour efficiency and the degree of concentration in the industry.

A composite attractability index is developed using the same methodology employed in the development of the desirability index.

(1) Localization Coefficient

We employ the localization coefficient to indicate whether an industry tends to concentrate regionally or disperse geographically over all regions.[9] The lower the localization coefficient the more dispersed, or footloose, the industry tends to be and, ceteris paribus, the probability of attracting the industry to the region is greater.

1. $LCit = d_1 \left(\frac{1}{Cit}\right)$

$LCit$ = Weighted localization coefficient for industry i in time period t

d_1 = Weight assigned to the relative importance of the localization coefficient

Cit = Localization coefficient of industry i in time t

(2) Concentration ratio

The concentration ratio indicates the extent to which an industry is dominated by large numbers of small firms or by a relatively few large firms. Previous studies have shown that most footloose firms tend to be found in industries dominated by a large number of small firms.[10] It has also been shown that industries dominated by large scale firms tend to be more footloose than those dominated by medium size firms.

2. $CRit = d_2$

$CRit$ = Weighted concentration ratio in period t for industry i

d_2 = Weight assigned to the value of the concentration ratio.

Weights may be established as follows. The concentration ratio assumes values between 0% to 100%. d_2 is given a high value for those ratios in the lower range, a smaller value for those ratios in the highest range with the lowest value for those concentration ratios in the middle range. In our empirical work we employed the following distribution.

d_2 =	5 points :	0%	$\leq$	concentration ratio	$\leq$	20%
	4 points :	21%	$\leq$	"	$\leq$	40%
	3 points :	81%	$\leq$	"	$\leq$	100%
	2 points :	61%	$\leq$	"	$\leq$	80%
	1 point :	41%	$\leq$	"	$\leq$	60%

(3) Comparative Labour Cost

A region demonstrating a comparative labour cost advantage, in a given industry, over the most industrially advanced region in the country has a positive advantage in the attraction of that industry. As labour costs are more important to labour intensive industries we have weighted the comparative cost ratio by the labour

intensity of the industry.

3. $CLCit = d_3 \left[\left(\frac{W_{Bit}}{W_{Ait}} \right) \cdot \left(\frac{Pit}{Sit} \right) \right]$

$CLCit$ = Weighted comparative labour cost for industry i in time t

d_3 = Weight assigned to the relative importance of comparative labour cost

W_{Bit} = Wages per employee in industry i, in region B the most industrially advanced region in the country, in time t[11]

W_{Ait} = Wages per employee in industry i, in Region A the region under consideration, in time t

(4) Comparative Processing Cost

The logic for using this measure is analogous to the comparative labour cost argument. We have weighted this ratio by the importance of processing costs to the industry, as lower processing cost are of greater concern to industries that are relatively materials oriented.

4. $CPCit = d_4 \left[\left(\frac{YBit}{YAit} \right) \cdot \left(\frac{Mit}{Sit} \right) \right]$

$CPCit$ = Weighted comparative processing cost of industry i in time t

$d4$ = Weight assigned to the relative importance of CPCit

$YBit$ = The cost of materials, supplies, fuel, and power per employee for industry i, in region B the most industrially advanced region, in time t[12]

$YAit$ = The cost of materials, supplies, fuel and power per employee for industry i in region A, the region under consideration, in time t.

Mit = The cost of materials, supplies, fuel and power in industry i, in time t.

(5) Comparative Labour Efficiency

Our measure of comparative labour efficiency is defined as the ratio of incremental output per employee in the two region.

$$5.\ CLEit = d_5 \left(\frac{JAit}{JBit} \right)$$

CLEit = Weighted comparative labour efficiency for industry i in time t

d_5 = Weight assigned to CLEit

JAit = Value added per employee in industry i, in region A the region under consideration, in time period t

JBit = Value added per employee in industry i in region B, the most industrially advanced region, in time period t[13]

(6) Composite Attractability Index

$$6.\ Xit = LCit + CRit + CLCit + CPCit + CLEit$$

Xit = Composite Attractability Index of industry i, in time t

Industries are ranked in descending order of Xit and a cut off value specified such that all values of Xit below this value are dropped from further consideration. The remaining industries are then subjected to a feasibility analysis.

C. Feasibility

We consider an industry would be feasible if the possibility exists for import substitution, the industry can successfully compete in interregional trade, the industry exhibits high profit rates, the industry obtains many of its material inputs regionally, professional and skilled labour are available regionally and the industry can operate on a profitable scale within the region.[14]

(1) Import Substitution

We view the potential for at least some import substitution as a necessary condition for industrial feasibility. Establishing a profitable firm which sold no output in the region appears to us to be an almost impossible task. Of course, exceptions are always possible but we are attempting to establish broad criteria.

In calculating this index we have included transportation costs for imports into the region in determining the possibilities for import substitution.

1. $ISit = e_1 \left[\left(\frac{Iit}{RDit} \right) \cdot \left(\frac{WTUit}{VTUit} + MTCit \right) \right]$

$ISit$ = Weighted import substitution for industry i in time period t

e_1 = Weight assigned to ISit

Iit = Total imports of products (or the main product) competing with the product(s) of industry i, in time t

$RDit$ = Total regional demand for the product(s) of industry i, in time t[15]

$WTUit$ = The weight of a transport unit of the product(s) of industry i, in time t

$VTUit$ = F.O.B. value of a transport unit of product(s) of industry i in time t

$MTCit = \sum_{j=1}^{n} \frac{MTCjt}{n}$ where,

MTC_{jt} = Minimum transport cost for a transport unit of the competing product(s) from the j^{th} production site exporting the competing product into the region, in time t.[16]

n = Total number of production sites outside the region exporting products competing with the products of industry i in the region.

(2) Interregional Market

Export base theory has long been an integral part of Regional Economic Theory and forms a part of the newer growth center theories.[17] We have measured export potential as the growth of sales in external markets weighted by the transportation characteristics of the product.

$$2.\ EX_{it} = e_2 \left[\left(\sum_{j=1}^{n} b^j \ \frac{(S - RD)_{ij} - (S - RD)_{ij-1}}{(S - RD)_{ij-1}} \right) \cdot \left(\frac{VTU_{it}}{WTU_{it}} + \frac{1}{TC_{it}} \right) \right]$$

EX_{it} = Weighted inter-regional market of industry i, in time t

e_2 = Weight assigned to the relative importance of EX_{it}

$(S-RD)_{ij}$ = Total national sales minus total regional sales of industry i in time period j

$b < 1$

$$TC_{it} = \sum_{g=1}^{n} \frac{TC_{gt}}{n} \quad \text{where,}$$

TC_{gt} = Minimum transport cost per transport unit of product(s) of industry i from the region to the g^{th} market site

n = Number of main market sites for the product(s) of the i^{th} industry external to the region.

(3) Rate of Return

The rate of return on investment is an important criteria determining an industry's feasibility. This is particularly true in underdeveloped regions where the very fact that the region is lagging suggests difficulties may exist in establishing viable industries.

$$3.\quad Rit = e_3 \left(\frac{TARit - TACit}{TCIit} \right)$$

Rit = Weighted rate of return in the i^{th} industry, in time period t

e_3 = Weight assigned to the relative importance of Rit

TARit = Total annual revenue of industry i in time period t

TACit = Total annual cost of industry i in time t

TCIit = Total capital invested in industry i, in time t

(4) Material Input

The availability of required materials within the region is an important determinant of feasibility. Costs are lowered, there are potential inventory savings and fewer delays in production due to input shortages.

$$4.\quad MIit = e_4 \left[1 - \left(\frac{MRit - MAit}{MRit} \right) \right]$$

MIit = Weighted material input of industry i, in time t

e_4 = Weight assigned to MIit

MRit = The dollar value of the main inputs required by the i^{th} industry in time period t

MAit = The dollar value of the main inputs available to industry i, within the region, in time t

(5) Labour Input

A shortage of professional and/or skilled labour within the region could be a serious constraint on the potential feasibility of an industry.[18]

$$5.\quad LIit = e_5 \left[1 - (LRit - LAit) \right]$$

LIit = Weighted labour input of industry i, in time t

e_5 = Weight assigned to LIit

LRit = The proportion of professional and skilled labour (to total employment) required by the i^{th} industry, in time t.

LAit = The proportion of professional and skilled labour (to total employment) available in the region, in time t.[19]

(6) Plant Scale

An industry may not be feasible if the regional demand is insufficient to support the normal scale of operation of that industry.

Firms within particular industries tend to operate within a prevalent size range. The number of total employees was used to determine the median size firm within the industry. Regional demand was then compared with the output of the median size firm to access market size against the normal scale of plant operation.

$$6.\quad PSit = e_6 \left(\frac{RDit}{Omit} \right)$$

PSit = Weighted plant scale industry i in time t

e_6 = Weight assigned to PSit

OMit = Output of the median size firm of industry i, in time t

(7) Composite Feasibility Index

$$7.\quad FIit = ISit + EXit + Rit + MIit + LIit + PSit$$

FIit = Composite feasibility index of industry i in time t

Industries are ranked in descending order of FIit and the planner selects a cut off value. Those industries above the cut off point should then be examined in detailed feasibility studies.[20]

Conclusion

In this paper we have attempted to answer a very practical question. Specifically, what industries should a region attempt to attract? Essentially an industry should be desirable, attractable and feasible.

The methodology adopted is flexible. In determining the weighting system and the cut off points the planner can exercise descretion based upon development objectives and the state of the regional economy.

Detailed feasibility studies cannot be conducted on the over 400 manufacturing industries at the four digit level. By using the composite criteria the planner can eliminate from further consideration those industries that appear inappropriate and concentrate his analysis on those industries which appear to be the most suited to the region.

F O O T N O T E S

1. This paper is the result of studies conducted for the Province of New Brunswick. We are indebted to the New Brunswick Government for allowing us to publish the general methodology. This paper is an extension and revision of a paper by Barrows and Datta published in the October-December 1970 issue of the Indian Economic Journal. We wish to thank Professors Levine, Larsen, Earl and Brander for valuable comments.
2. This can be done by maximizing an objective function as suggested by Leven. See, C. Leven, Establishing Goals for Regional Economic Development, Journal of the American Institute of Planners, Vol. 30.
3. W. Isard, Methods of Regional Analysis: An Introduction to Regional Science, The M.I.T. Press, Cambridge, Mass., 1960.
4. A substantial trade off may exist between criteria 3 and 4. Hence, the values assigned to a3 and a4 by the planner assume greater significance.
5. An alternate equation for determining potential employment, using an input-output table, is:

$$\frac{\sum_{i=1}^{m} \frac{li\ Aij\ Fj}{wi}}{Fj}$$

where, Aij = Elements of the inverse matrix
li = Direct labour coefficients
wi = Sectoral wage rates
Fj = Final demand of the j^{th} sector

see, B. Hazari and J. Krishnamurty, Employment Implications of India's Industrialization: Analysis in an Input-Output Framework, Review of Economics and Statistics, P. 181-186, May, 1970.

6. A. Hirschman, The Strategy of Economic Development, Yale University Press, New Haven and London, Chapter 6, 1958.
7. M. E. Streit, Spatial Associations and Economic Linkages between Industries; Journal of Regional Science, Vol. 9, August 1969.
8. Allan Pred, Behaviour and Location, Lund, Sweden, C.W.K. 1967. M. Logan, Locational Decisions in Industrial Plants in Wisconsin, Land Economics, Vol. 46, August, 1970.
9. For the definition and use of the localization coefficient see Isard, op. cit.
10. J. C. Mills, Industrial Location, unpublished study prepared for the Atlantic Development Board, Ottawa, 1965.
11. The main competitor region to the region under analysis could be used in lieu of the most industrially advanced, if the two are different and the planner believes the other comparison the more useful.
12. See footnote 11
13. See footnote 11

14. We have not included a measurement of capital requirements. The Government of Canada has a generous incentive program (at the time of this writing a maximum of $12 million per plant) for companies locating in a designated region so that capital requirements are not normally a constraint. For those areas where capital requirements do represent a constraint the following equation could be used:

$$KRit = e \left(\frac{VAit}{FKit} \right)$$

KRit = Weighted capital requirement of industry i in time t

e = Weight assigned to the relative importance of KRit

VAit = Value added of industry i in time t

FKit = Fixed capital required by industry i in time t

This is the measure used by Bohr; see, K. A. Bohr, Investment Criteria for Manufacturing Industries in Underdeveloped Countries, The Review of Economics and Statistics, Vol. 36.

15. Sales tax information is one way of initially estimating RDit

16. For the methodology of measuring transport costs see, C. D. Harris, The Market as a Factor in the Localization of Industry in the United States, Annals of the Association of American Geographers, Vol. 44. By transport unit we are referring to a full railroad box car, a full truckload, etc.
17. H. Richardson, Elements of Regional Economics, Penquin Books, P. 106, Baltimore, 1969.
18. This is essentially the measure employed by Bohr, op cit.
19. With labour mobility the non-availability of labour may not be a binding constraint. Nevertheless, we believe a firm would question the desirability of locating in a region that could only supply a small proportion of its professional and/or skilled labour requirements.
20. A methodology for conducting these studies is described in: United Nations, Manual on Economic Development Projects, New York, 1958.