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NATIONAL IMPACTS OF A REGIONAL PRIMARY INDUSTRY

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This paper demonstrates a method whereby the national multiplier effects of a given regional industry (or group of industries) can be calculated. The method obviates the need to assume that national input-output coefficients will be duplicated in each regional case, and further does not necessitate the estimation of a complete regional input-output model. An example, utilizing some data originally collected for a regional input-output model of Central Queensland, is included.

Introduction

Regional input-output models and economic base models have long been used by economists to quantify the impacts of changes in economic activity within regions. It can be difficult to interpret the net effects of such changes at the national level through the use of such models and yet, from the viewpoint of decision makers who are concerned with some aspect of national resource allocation, it would be highly desirable to be able to do so. One option, which has been explored by Haveman and Krutilla [6], is to link regional input-output models to a national input-output model so that the impact of a given regional change can be quantified at both the regional and the national level. Such a method is theoretically highly attractive but in practice requires either that appropriate regional models exist and have been functionally linked to the national model, or that there are sufficient research resources available for this situation to be brought about. Neither of these two conditions seemingly prevails in Australia.

Another approach would be assume simply that the regional industry or industries of interest have sufficiently similar input-output coefficients to their national 'parent' sectors for the national model to be used directly for multiplier calculation. Intuitively, this is not a convincing assumption and the multiplier results given in this paper will provide one counter example.

A compromise between these two extremes forms the basis of this paper. The method relies on imputation of specific regional industry input-output data into a national input-output model. This method avoids the need to construct a full regional input-output model and also avoids the need to use the highly restrictive assumption that the input-output coefficients of the regional industry of interest match those of its national parent sector. It *does* rely on an assumption that the industries with which the industry under examination deals will have similar coefficients to their national counterparts. This assumption is more acceptable, since it excludes the highly significant direct factor in the mutiplier expressions. In any event, the

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method allows regional sector information to be imputed into the national model, which allows observed regional coefficients for those industries most closely related to the one under examination to be included in the model, if this was thought necessary. Note that the objective of this approach is to calculate the effects of a regional industry on national exogenous inputs—i.e. national value added components.

Method

Consider the case of regional industry k, for which it is desired to calculate impacts on the national economy. In most cases, it will be a relatively simple matter to assess the inputs into, and outputs from, industry k, in terms of the industry classification implicit in the national input-output model (or some aggregation of that model, if necessary). A series of inputs and outputs for industry k will result and these can be appended to the national input-output flow matrix as an additional sector (with appropriate correction of the inter-industry flows in the parent (national) sector of regional industry k). A Leontief inverse is derived from this enlarged flow matrix, and multipliers for industry k can then be calculated accordingly. Thus, if the enlarged flow matrix is of dimension n, the input-output system will be solved by the standard Leontief relationship:

$$(1) \qquad [I—A]^{-1}Y = X$$

where

I is an identity matrix of dimension n,
A is a matrix of input coefficients of dimension n,
Y is a vector of final demands of dimension n, and
X is a vector of total outputs of dimension n.

Douglas [4] has argued that, for certain primary industries, it is more useful for purposes of comparing the total impacts of such industries on the economy to use an expression which reflects not only the effects generated by the necessity to supply inputs to the industry but also those resulting from its output to other industries. This is a departure from the standard Miernyk [8] 'Type I' mutiplier expression and as such requires careful interpretation.

Consider the case where separate inputs and outputs for regional industry k have been assessed; the separate sector has been appended to the national transactions matrix (with appropriate corrections to the flows for the national counterpart sector to industry k); and the Leontief inverse has been obtained. If the resulting system is of dimension n, define:

$$(2) \qquad m_{kp} = \Big(\sum_{\substack{j=1 \\ j\neq k}}^{n} z_{jk}p_j + z_{kk}p_k + \sum_{\substack{j=1 \\ j\neq k}}^{n} z_{kj}p_j\, x_{jd}\Big)/z_{kk}p_k$$

where

m_{kp} = modified multiplier[1] expressing the ratio of total usage of exogenous input p generated by inputs into, and

[1] This definition is based on acceptance of Bradley and Gander's [1] argument that the leading diagonal element of the $(I—A)^{-1}$ matrix for a given sector is the actual amount by which that sector would need to increase its output in order to deliver one unit of product to final demand and that therefore it is this amount that should be included in multipliers as direct effect.

outputs from, regional industry k to the direct usage of input p in regional industry k;

z_{jk} = interdependence coefficient expressing the necessary input from industry j into industry k to allow industry k to deliver one unit of output to final demand;

z_{kk} = interdependence coefficient expressing the input necessary from industry k into itself to allow it to deliver one unit of output to final demand;

z_{kj} = interdependence coefficient expressing the necessary input from industry k into industry j to allow industry j to deliver one unit of output to final demand;

p_j = amount of exogenous input p used in industry j, expressed as a fraction of the total output of industry j;

p_k = amount of exogenous input p used in industry k, expressed as a fraction of the total output of industry k;

x_{jd} = amount of output of industry j delivered direct to final demand, expressed as a fraction of the total output of industry j.

For the purposes of this paper, it is more useful to express the total amount of usage of input p generated by industry k as a fraction of the total output of industry k. This expression facilitates comparisons between industries or between regional sub-sectors of a nationally defined industry in the cases where differing proportions of input p are required by each. Hence, define:

$$F_{kp} = m_{kp} \cdot p_k. \tag{3}$$

The figures given in Table 3 are calculated using this expression (both for regional industry k, and its national 'parent' sector).

Before proceeding to the case study based on this technique, it should be emphasized that there is no theoretical reason why this procedure could not be used to impute coefficients for more than one regional industry into the national matrix.

A Case Study

Data

A research group at the University of Queensland has constructed a regional input-output model of the Central Queensland region (Jensen [7]). This region includes the Rockhampton, Central and Far Western statistical divisions, covers an area of some 540 000 km^2 and has a population of 145 000. Data from this study are used to demonstrate the imputation method. The regional industry selected for imputation is forestry and the data for this industry originated from the Queensland Department of Forestry. The original data were based on the year 1965/66 and were collected for use in a 16-sector classification of the Central Queensland economy. The forestry sector is defined as including all activities associated with the management and protection of forests (the timber growing activities) and with the harvesting and transportation of logs.

The National Model

The basic input-output model used in this case was the Monash University 1967/68 RAS updating (Evans *et al.* [5]) of the Commonwealth Bureau of Census and Statistics 1962/63 model [2]. A problem arose in that data collected for the Queensland study were based on the 16-sector classification, whereas the national input-output model has 105 sectors. It would be useful to be able to aggregate the 105-sector model to 16 sectors. However, this is not feasible in practice, due to the large distortion that would result from such heavy aggregation.[2]

A 51-sector aggregation[3] of the Monash model has been developed by the authors which has as its aims the preservation of forestry repercussions and multiplier effects to within 5 per cent of disaggregated levels, and the preservation of these effects in other important sectors to within 10 per cent of the disaggregated levels.[4]

Reclassification and Imputation of the Regional Data

The sector definition in the central Queensland regional model follows closely the A.S.I.C. [3] classification of industries. To some extent this simplified reclassification into the 51 national input-output sectors since there is some information in the Appendix to the preliminary Input-Output Tables as to how input-output and A.S.I.C. sector classifications are related. However, some areas of doubt still existed in the transfer, and these are noted and discussed in Table 2.

Other assumptions which were necessary to allow imputation are as follows:

(a) The entries entitled 'State Government Taxes' and 'Commonwealth Government Taxes' in the Queensland model were assumed to be equivalent in total to 'Commodity Taxes' and 'Indirect Taxes' in the 51-sector national model. Once the total was thus decided, the partitioning into the indirect and commodity components was made in the same proportion as for the national average for forestry.

(b) In the absence of detailed trade data, it was assumed that the imports and exports in the Queensland model would be in the same proportion as in the national model. The direct national imports and exports pertaining to the forestry industry play a relatively small role in the multiplied import and export effects (which are the effects of interest in this case), hence this assumption is reasonable, so long as expression F_{kp} is used. Provided the direct forestry import and export figures are relatively small (as they are in this case) then erroneous measurement of them will not distort F_{kp} greatly. This is because this expression has total output of the industry concerned as its denominator (this follows from the definition of p_k above), whereas standard input-output multiplier

[2] The authors have empirical evidence to support this claim, at least so far as multiplier effects are concerned. Rather than undertake a long discussion as to how this evidence was adduced, the authors offer the evidence to any interested readers.

[3] The Appendix contains details of the aggregation.

[4] The first constraint was tested by comparing multipliers for the forestry sector calculated from the aggregated matrix with those equivalent from the disaggregated matrix. The second constraint was tested by carrying out the same procedure for a number of important sectors selected at random from the primary, secondary and tertiary sectors.

expressions would have the direct import or export figures as denominators.

(c) Personal consumption was assumed to be in the same ratio to total output as in the national case. It is obvious that personal consumption of wood direct from the forest will be fairly insignificant (as in the national case) so this assumption should not affect the results unduly.

(d) Data on the distribution of outputs were not sufficiently detailed to allow an accurate accounting for all of them. The total inputs figure was assumed to be sufficiently accurate to use as the balancing figure, and total outputs were therefore assumed to be equal to total inputs. The balancing item of $178 520 which appears in the output column is therefore the amount required to equalize outputs with inputs, given the measured intermediate output figure, and the assumed values for exports and personal consumption. It is probable that this figure is largely a result of transfers of public funds into forestry operations in the area. Such transfers are reasonably common, where forests are in an early stage of development or where there are other reasons why the raw material is not being sold in volumes and/or at prices sufficient to cover operating costs. So long as assumptions (a), (b) and (c) above are considered reasonable, and it is accepted that the measurement of total inputs given is also reasonable, it is not necessary to attempt a more detailed specification of this item.

Using the above assumptions and the data originally provided for the regional input-output study, the summary shown in Table 1 of the inputs and outputs of the forestry industry in the Central Queensland region can be made.

The figure for intermediate output is, in fact, predominantly deliveries to sawmills, and this simplifies the analysis considerably.

The more detailed breakdown of the inter-industry inputs is as given in Table 2.

Imputation of the New Sector

The regional sector of forestry in Central Queensland can now be 'split-off' from the national forestry sector, and multipliers calculated. This was done using the inputs and outputs discussed above. Multipliers

TABLE 1

Summary of Inputs and Outputs in the Forestry Industry of Central Queensland

Input	Value ($)	Output	Value ($)
Intermediate	364 070	Intermediate	889 100
Wages and salaries	524 000	Personal consumption	79 000
Taxes	22 000	Balancing item	179 470
Other value added	240 000	Exports less imports	2 500
Total	1 150 070	Total	1 150 070

TABLE 2

Intermediate Inputs for the Forestry Industry in Central Queensland

	Sector	Amount ($)
6.[a]	Metallic minerals, non-metallic minerals, etc.	100
26.	Petroleum products	59 100
27.	Glass, clay, etc.	2 100
32.	Cutlery, hand tools, etc.[b]	6 400
37.	Other industrial machinery and equipment[b]	83 000
39.	Rubber products[b]	5 000
41.	Electricity, gas, water	1 300
43.	Other building and construction	800
46.	Motor vehicle repairs and service[c]	68 000
47.	Transport and storage	116 123
48.	Communication	7 989
49.	Defence, education, welfare	5 000
50.	Services, landlords, etc.	756
51.	Business expenses	8 402
		364 070

[a] The numbers preceding the sector names are the sector numbers in the 51 sector classification.

[b] These sectors contain all the input from the sector given in the Queensland model as 'Other Manufacturing', in the proportions 8:84:8 respectively. The proportions are based on the national average but are weighted slightly to allow for local differences.

[c] All amounts entered under 'Conveyances' in the Queensland model are included in this sector, since it most closely approximates the definition given for conveyances.

TABLE 3

Forestry Multipliers Calculated from Central Queensland and National Data

Multipliers	Central Queensland	National
Wage income	1·102	0·663
Commodity taxes	0·008	0·046
Indirect taxes	0·026	0·057
Imports	0·203	0·108
Exports	0·121	0·093

based on equation (3) were calculated for the Central Queensland case and, for comparison, for the national case and are presented in Table 3.

Discussion

This paper is primarily a demonstration of the imputation technique. Accordingly, it is not the intention to include a detailed interpretation of the multiplier results from the viewpoint of economic policy. Some of the results have methodological implications, however. In general, the order of difference between equivalent multipliers for the regional and national parent sectors suggests that the use of national average coefficients to calculate the multiplier effects of regional industries would be misleading. For example, the higher wage income multiplier in Central Queensland is partly due to the higher indirect wage generation per dollar of output caused by this industry than in the national average case. This can be confirmed by comparing the indirect wage payments generated per dollar of industry output in the regional and national cases; a comparison which shows the regional figure to be higher. Wage income multipliers can be taken as a reasonable proxy for the general economic stimulative capacity of the industry concerned (see Douglas [4] for an explanation of this assertion) and hence can yield important information as to the full effects of a change in the activity level of the industry concerned.

Further developments using this technique would seem to lie along two separate paths. Firstly, as is usual in cases where input-output models are used, the usefulness of the multiplier information which can be derived will be a function of model quality (a subject which has been discussed at length in the literature) and of the number and nature of exogenous vectors attached to the model, or at least the number which can be derived for it from existing data. It is likely that future national input-output models for Australia will be constructed on the basis of A.S.I.C. This should allow more exogenous vectors to be derived from information collected on the basis of A.S.I.C. for other purposes. It should be possible, for example, to include vectors of company taxation, various forms of government assistance to industry (tariff protection for example), employment by occupation classes, and so on.

The second way in which this technique might be developed is in quantifying the regional effects of economic activity, without the necessity of constructing whole regional inter-industry models. It should be possible to determine empirically how much of the activity of sectors closely related to the industry of interest actually occurs within the defined regions, or to use some other approach to 'regionalize' the coefficients of the industry. Once this is done, the coefficients in the national model could be adjusted by a procedure analogous to the imputation process described in this paper, and multipliers could then be calculated accordingly.

References

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APPENDIX

51-Sector Aggregation of the 1967/68 RAS Updated Input-Output Model[a]

New sector no.	Original sector no.	NS	OS	NS	OS
1	1	20	40	39	79
2	2, 3, 7	21	41	40	80–82
3	4	22	42	41	83–85
4	5, 6, 9	23	43	42	86
5	8	24	44–46	43	87
6	10, 12, 13	25	47–50	44	88
7	11	26	51	45	89
8	14	27	52–55	46	90
9	15	28	56	47	91
10	16–24	29	57	48	92–95
11	25, 26	30	58–60	49	96–100
12	27, 28	31	61–63	50	101–104
13	29–33	32	64–66	51	105
14	34	33	67		
15	35	34	68–70, 75		
16	36	35	71–73		
17	37	36	74		
18	38	37	76		
19	39	38	77, 78		

[a] The table shows the sector numbers, as given in the original model presented by Evans *et al.* [5], that were aggregated to produce the 51-sector model used in this paper.