A NOTE ON THE USE OF A MODIFIED INPUT-OUTPUT MULTIPLIER FOR LAND USE EVALUATION*

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The modified input-output multiplier is proposed. Some limitations of the multiplier and the results of its application to four major land use industries are discussed.

Method

The input-output labour multiplier for an $m \times m$ matrix of industries that will be used in this note is given in equation 1:

$$(1) \qquad M_i^1 = (\sum_{j=1,\, j\neq i}^{m} [z_{ji}\, {}^{l}_{j}] + {}^{l}_{i} + \sum_{j=1,\, j\neq i}^{m} [z_{ij}\, {}^{l}_{j}\, x_{jd}])/{}^{l}_{i}$$

where, M_i^1 = the modified labour multiplier for industry i.
l_j = the labour coefficient of industry j (i.e. labour cost in industry j/ total output of industry j).
l_i = the labour coefficient of industry i.
z_{ji} = the interdependence coefficient expressing output from industry j into industry i.
z_{ij} = the interdependence coefficient expressing output from industry i into industry j.
x_{jd} = the amount of output from industry j that goes directly to final demand/total output of industry j

This expression differs from conventional input-output multipliers in that it includes the labour performed in the processing industries attributable (on a per dollar of output basis) to input industry ij. Conceptually, the expression is similar to the basic-derivative employment mutliplier presented by Olson and Fischer [12]. Billings [9] has shown the mathematical identity of input-output and economic base multipliers in general.

In addition to the multiplier itself, a policy-maker may also want to know the types of labour generated directly and indirectly by a given industry. If $g_{j1}, g_{j2} \ldots g_{jn}$ are coefficients that express the proportions of skill groups l_1 to n that comprise the work force of industry j, then:

$$(2) \quad G_{is} = (\sum_{j=1,j\neq i}^{m} [z_{ji} L_j g_{js}] + L_i g_s + \sum_{j=1,j\neq i}^{m} [z_{ij} l_j x_{jd} g_{js}])/L_i M_i^1$$

where G_{is} = the proportion of total labour generated by industry i that is classified as skill group s.

L_i, L_j = total labour used in industries i, j (in \$)

(All other terms as defined previously).

If the labour multiplier is to be used as an indicator of the economic stimulation caused by industry i, then the effect of the magnitude of labour coefficients on the labour multiplier has to be determined. One method of isolating this coefficient magnitude effect is by calculating the weighted average of labour coefficients of all industries, where the

* The author gratefully acknowledges the assistance of Mr E. D. Parkes, Department of Forestry, A.N.U., in the preparation of this paper.

weighting used is the significance[1] of each industry to the one being examined.

Let,

$$S = \sum_{j=1, j\neq s}^{m} [z_{ji}L_j]$$
$$P = \sum_{j=1, j\neq i}^{m} [z_{ij}l_j x_{jd}]$$

Now,

$$(3)\quad ML_i = \{(S.\sum_{j=1, j\neq i}^{m} [z_{ji}l_j])/\sum_{j=1, j\neq i}^{m} [z_{ji}] + (P.\sum_{j=1, j\neq i}^{m} [z_{ij}l_j]/ \sum_{j=1, j\neq i}^{m} [z_{ij}])\}/(S + P)$$

where ML_i = the average of labour coefficients weighted by their significance to industry i.

(All other terms as defined previously)

Results and Conclusions

The processes outlined above were used to analyse the labour effects of four Australian land use industries; wool, wheat, meat cattle and forestry. In this analysis, the industry definitions are the same as those used in the 1962-63 Input-Output Tables [4]. The inter-industry coefficients used were those derived from the 1967-68 RAS updating [10] of the 1962-63 tables.

The labour coefficients of the three agricultural industries derived from the input-output table required some adjustment, because the table included owner-operator labour in gross operating surplus, rather than wages and salaries. To make the labour components of these industries comparable with that of forestry (which has virtually no owner-operator labour), owner-operator labour was transferred to wages and salaries. A major problem was encountered during transfer because the supplementary data sources, such as the BAE bulletins and Census and Statistics publications classified the agricultural industries differently to the input-output table. Where more than one commodity is produced on a single farm, the problem is intensified because the input-output table is set out on an industry/commodity basis, and therefore allows only one commodity to be produced by one industry. Thus, when BAE data for multiple-product farms were imputed into the input-output table, it was necessary firstly to sort the data into single commodity groups. The labour inputs were then calculated by allocating labour from the multiple product farm figures to the relevant commodity groups on a pro rata basis. Labour coefficients calculated in this way are given in column 2 of Table 1.

The labour multipliers calculated from equation 1 are given in column 3.

A better figure for comparison and planning is obtained by multiplying the labour coefficient by the labour multiplier. The result will give the labour generated, directly and indirectly, per dollar of input into the industry being examined. These labour/output figures are shown in column 4 of Table 1.

Column 5 of Table 1 gives the weighted average labour coefficients (equation 3) for the four industries.

[1] The significance, in this case, is taken to be in the order of inter-industry linkages between the industry in question, and all other industries. These can be read direct from the $(1 - A)^{-1}$ matrix.

TABLE 1
Labour Effects of Four Land Use Industries

Industry (1)	Labour Coefficients (2)	Labour Multiplier (3)	Labour/ output (2) x (3) (4)	Weighted average of Labour Coeff. (5)
Sheep	0·32	1·53	0·49	0·24
Wheat	0·16	2·25	0·36	0·25
Meat Cattle	0·31	1·87	0·58	0·25
Forestry	0·30	2·20	0·66	0·26

Table 2 gives the proportions of each of five skill groups employed directly in land-use industries in Australia.

TABLE 2
Skill Group Coefficients for the Major Australian Land Use Industries

Industry	Skill Groups				
	I	II	III	IV	V
Sheep	0·00	0·69	0·31	0·00	0·00
Wheat	0·00	0·78	0·22	0·00	0·00
Other Grains	0·00	0·66	0·33	0·01	0·00
Meat Cattle	0·00	0·61	0·39	0·00	0·00
Milk, Cattle & Pigs	0·00	0·71	0·29	0·00	0·00
Poultry	0·00	0·58	0·42	0·00	0·00
Other Crops	0·00	0·66	0·34	0·00	0·00
Forestry	0·03	0·37	0·59	0·01	0·00

Classification problems were again apparent in compiling these figures. The skill group classification used (see Appendix 1) was the one provided by the Tariff Board [14]. This classification is compatible with the input-output table in the secondary and tertiary divisions, but groups all the rural industries under the single heading, Agriculture. To rectify this, it was ncessary to inspect detailed records of occupational employment in rural industries held by the Bureau of Census and Statistics. The figures were then adjusted to conform with the input-output model using the procedure outlined above for derivation of labour inputs.

Table 3 gives the direct and indirect effects of the four industries on skill groups (equation 2).

TABLE 3
Direct and Indirect Effects of Four Land Use Industries on Skill Groups

Industry	Skill Groups				
	I	II	III	IV	V
Sheep	0·0096	0·5594	0·3805	0·0503	0·0001
Wheat	0·0235	0·4345	0·4144	0·1273	0·0003
Meat Cattle	0·0218	0·3928	0·4642	0·1209	0·0002
Forestry	0·0313	0·2348	0·6134	0·1203	0·0002

Before progressing to conclusions, some of the limitations of this analysis need to be discussed. Firstly, there is the general limitation of all input-output models; the exclusive use of linear functions. Many of the assumptions implicit in the relationships described above depend on this fact. Changes in technology, diminishing and increasing returns to scale and similar factors are ignored. For this reason, it is important that any analyses using this method should be based on recent data, and that any large-scale changes predicted by the model be verified by other means where possible.

The second limitation is more specific to the particular inter-industry system used in this analysis, and is a result of the aggregate nature of the figures. All data used are in national average terms and therefore should not be used for specific project evaluations. The findings should be regarded only as indicators of the nature and order of indirect effects that pertain to the industries examined.

Within the range of these limitations, some conclusions can, however, be drawn from the above results.

The most obvious feature is the marked difference in ranking that results from assessing total, as against only direct effects. This difference is clearly shown by comparing the figures from columns 2 and 3 of Table 1. It is paralleled by the disparity in equivalent skill group coefficients between Table 2 and Table 3. The order and nature of indirect effects is significant in the industries examined, and this fact has quite profound implications for decisions on land use being taken at the state or federal levels.

In terms of employment generation, the high labour/output figure for forestry and, to a lesser extent, meat cattle, indicates that these industries have a greater influence per dollar of output on the labour market than do the other industries. This argument can, in this case, be extended to suggesting that forestry and meat cattle also stimulate a higher degree of economic activity in the rest of the economy. The reason this inference can be drawn is that the weighted average labour coefficients (column 5, Table 1) for the four industries do not vary over a great range, while the labour/output figures do.

There is a wide range in the effects that the four industries exercise over the composition of the work force. It can be seen from Table 3 that forestry, for example, tends to cause a somewhat higher demand for sales workers, and a lower demand for clerical workers than do the other industries. Such facts as this are of interest to the planner, and are able to be compiled in Australia due to the availability of good data on occupation distribution and industry requirements.

Whether employment is regarded as a constraint or a factor to be maximized, it will usually exercise some influence over decisions being taken at governmental level. There would seem to be little point in nominating upper and/or lower limits to such a variable if there is no investigation of whether the limits can be met, both directly and indirectly. In the above analysis, only labour effects were considered. There seems to be no reason why the full effects of any decision on taxation and subsidy flows, import and export generation, population location and so on cannot be similarly investigated. Hopefully the results presented here will demonstrate that total, rather than only direct

effects can be assessed, and that where large scale decisions are involved, should be assessed.

APPENDIX 1

Skill Group Classification

1. Professional, technical and related workers. Includes government administration and executive officials, some employers and workers on own account, pilots, flight engineers, etc.
2. Clerical and related workers. Includes draughtsmen and designers, precision instrument makers, etc., artists, etc.
3. Sales workers. Includes transport and communication workers, most production process workers, farm, mining and forestry workers.
4. Unskilled workers.
5. Unclassified.

The five major groups given here are the ones used in the Tariff Board skill group classification. A more detailed listing, including occupation codes from the Classification and Classified List of Occupations (7), is available from the Board.

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