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Multiplier Values for the Fishing and Fish Processing Industries in the UK and in Scotland:

An Input - Output Analysis

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Summary

This paper presents multiplier values (Type I) for the fish catching and fish processing industries in the United Kingdom and in Scotland. The values have been obtained by use of input-output analysis.

- The output multipliers in the UK for the catching and processing sectors were found to be 1.82 and 2.14 respectively. The equivalent values for Scotland were 1.65 and 2.26.

- The income multipliers in the UK for the catching and processing sectors were found to be 1.76 and 3.90 respectively. The equivalent values for Scotland were 1.67 and 4.52.

- The employment multipliers in the UK for the catching and processing sectors were found to be 1.44 and 2.72 respectively. The equivalent values for Scotland were 1.50 and 2.64.

Introduction

This paper presents multiplier values for 1994 for the fishing and fish processing industries in the UK as a whole and in Scotland. The last attempt to compute such values was, as far as the author is aware, made several years ago. The present paper attempts to update and extend previous work.

Multiplier values are a useful tool for demonstrating the interdependence of different sectors of the economy. A multiplier measures the total change in output, income or employment in an economy resulting from a direct change in final demand in a particular industry. For example, an increase in the final demand for a given commodity may result in increased output both directly, because the immediate supplier must increase output, and indirectly, because the immediate supplier may purchase additional input from the same and other industries to produce that extra output.

As far as the fisheries sector is concerned, multipliers are particularly useful in socio-economic studies, which assess the degree of fisheries dependence in regions and evaluate the implications of any changes in supply or demand.

Multiplier values can be obtained by using input-output models, which is the methodology chosen for this study. An input-output table records the flows of products in the economy for a certain year, illustrating the relationship between producers and consumers on the one hand, and the interdependence of industries on the other. It gives a comprehensive overview of an economy and thus enables an articulate analysis.

1. Methodology

Multiplier values can be obtained by using Leontief Input-Output models[1]. The rationale for the term input-output analysis is that the output of any industry, say the fish processing industry, is needed as an input in several other industries, or even for that industry itself. In turn, the output of other industries will enter into the fish processing industry as inputs.

Since an input-output model normally encompasses a large number of industries, matters are simplified by the following assumptions:

The produce of each industry is regarded as one commodity;
Each industry uses a fixed input ratio (or factor combination) for the production of its output;
Production in every industry is subject to constant returns to scale, so that a k-fold change in every input will result in an exactly k-fold change in the output.

In addition to the industry sector, there is the consuming sector or the final use sector. The final use sector also provides input to the industries, in the form of primary input, labour for example. The two sectors make up the Transactions Matrix.

Table 1. Transactions Matrix

Producing Sector – Input	Purchasing Sector – Output				
	Industry I	Industry II	Industry n	Final Use	Total Use = Total Output
Industry I	x_{11}	x_{12}	x_{1n}	d_1	x_1
Industry II	x_{21}	x_{22}	x_{2n}	d_2	x_2
Industry n	x_{n1}	x_{n2}	x_{nn}	d_n	x_n
Primary input	y_1	y_2	y_n		
Total Input = Total Output	x_1	x_2	x_n		

From the assumptions made above, it can be seen that, in order to produce each unit of the j^{th} commodity, the input need for the i^{th} commodity must be a fixed amount, which shall be denoted by a_{ij}. Specifically, the production of each unit of the j^{th} commodity will require a_{1j} (amount) of the first commodity, a_{2j} of the second

[1] Wassily W. Leontief: The Structure of American Economy 1919-1939, 2d ed., Oxford University Press, Fair Lawn, N.J., 1951

commodity, and so on up to a_{nj} of the n^{th} commodity. The a_{ij} symbol is referred to as an *input coefficient*.

For an n-industry economy, the input coefficients can be arranged into a matrix $A=[a_{ij}]$ as in table 2, in which each column specifies the input requirements for the production of one unit of the output of a particular industry. This makes up the input coefficient matrix, or the technology matrix.

Table 2. Technology matrix

Input	Output				
	I	II	III	…	N
I	a_{11}	a_{12}	a_{13}	…	a_{1n}
II	a_{21}	a_{22}	a_{23}	…	a_{2n}
III	a_{31}	a_{32}	a_{33}	…	a_{3n}
…	…	…	…		…
N	a_{n1}	a_{n2}	a_{n3}	…	a_{nn}

Our model will be an open model, including an “open” sector, which exogenously determines a final demand (non-input demand) for the product of each industry and which supplies a primary input (labour service) not produced by the n industries themselves. In view of the presence of an open sector, the sum of the elements in each column of the technology matrix, A, must be less than 1. The amount by which the column sum falls short of 1 must represent the payment to the primary input of the open sector. If industry I is to produce an output just sufficient to meet the input requirements of the *n* industries as well as the final demand of the open sector, its output level x_1 must satisfy the following equation:

$$(1 – a_{11})x_1 - a_{12}x_2 - \ldots - a_{1n}x_n = d_1$$

For a set of *n* industries, the output levels can be written as:

$$(I – A)x = d$$

The matrix (I – A) is the technology matrix and it may be denoted by T. Thus it can also be written as

$Tx = d$

As long as T is nonsingular, it is possible to find its inverse $T^{-1}d$, and obtain the unique solution of the system from the equation

$$\bar{X} = T^{-1}d = (I - A)^{-1} d$$

The Output Multiplier

The column sums of the matrix $(I - A)^{-1}$ describe the total effect on gross output in the economy given a unit change in final demand for the i^{th} commodity. This is called the *output multiplier* and shows the degree of domestic interdependence of each industry. The multiplier is the number of times a direct change in output must be multiplied to obtain the total change in output. With the help of the output multiplier, it is then possible to calculate income and employment multipliers.

The Income Multiplier

An income multiplier measures the total change in income resulting from a unit change in final demand. This, again, can be calculated from the inverse matrix $(I - A)^{-1}$. For industry j, total income change is defined as

$$\sum_i b_{ij} h_i$$

where

$b_{ij,}$ = the total output of the i^{th} industry required to produce one unit of j, and
h_i = the i^{th} industry's household row coefficient (income from employment/total input).

The income multiplier is the total income change divided by the direct income change for the industry in question. This can be denoted as:

$$\mu_i = \frac{\sum_i b_{ij} h_i}{h_j}$$

The Employment Multiplier

The employment multiplier measures the total increase in employment in an economy as a whole which result from an increase in final demand great enough to create one additional full time job in that industry.

In order to calculate the employment multiplier, the employment coefficients must first be computed. These represent the relationship between the number of people employed in an industry and its output, that is the total full-time equivalent (fte) employment in a certain industry divided by the gross output of that industry. It is thus an 'employment per unit output' coefficient.

The employment multiplier, analogous to the income multiplier above, is then calculated as the ratio of the direct and indirect employment changes to the direct employment change:

$$\mu_e = \frac{\sum_i b_{ij}\,\alpha_i}{\alpha_j\, b_{jj}}$$

where

b_{ij} = the total output in sector i required per unit of output of sector j
α_i = the employment coefficient of sector i
α_j = the employment coefficient of sector j, and
b_{jj} = the total output in sector j required per unit of output of sector j

2. Results and Conclusions

Each given sector of an economy generates output, employment and household incomes. It does so both directly through employment within the sector itself and

indirectly through the output and employment generated in sectors, which supply goods and services to that sector. These direct and indirect effects are denoted Type I multipliers. Type II multipliers also take account of changes in consumption and, therefore, effects arising from changes in personal income (induced effects). A Type II multiplier thus has a higher value than a Type I. This paper is concerned with Type I multipliers only.

Output, income and employment multipliers for 1994 have been computed in this paper for the UK as a whole, and for Scotland.

The Output Multiplier

The value of the multiplier is the number of times a direct change in output must be multiplied to obtain the total change in output. For example, a (Type I) output multiplier of 1.5 means that for each unit of additional final demand from this industry, there will be a total increase in output of the entire economy of 1.5 units, allowing for the direct and indirect effects.

The output multipliers in themselves are of no particular interest in a socio-economic study, since they merely show the degree of inter-dependence between each industry and the rest of the economy. A lower value indicates greater leakages from an economy. In general, the less self-sufficient an economy in terms of being able to provide its required intermediate outputs, the lower the output multipliers.

The output multipliers were found to be:

Table 3. Output Multipliers

Sector / Region	UK	Scotland
Catching sector	1.82	1.65
Processing sector	2.14	2.26

From the above figures it can be concluded that the processing sector generally shows a greater dependence on the rest of the domestic economy than does the catching sector. This can most certainly be explained by the fact that the processing sector purchases a large share of its input from another intermediate sector, the catches, while the catching sector is not traditionally dependent on any other sector of the economy for its main source of supply, fish.

However, with fixed quotas being allocated to fishing vessels, track records have acquired a value. The catching sector is thus in a sense starting to pay for its raw material. If a skipper leases his track record from a domestic source, it is expected to be treated as a variable cost and would appear as an intermediate input in the input-output table, thus increasing the value of the output multiplier. If, on the other hand, the track record is bought it would enter the accounts as a capital asset. Since the value of track records is increasing rather than decreasing, however, it would not give rise to depreciation costs.

As for a comparison between the UK and Scotland, the higher value for the Scottish processing sector indicates a higher dependence on domestic (Scottish) intermediate resources than is the case for the UK sector. On the other hand, the Scottish catching sector is more dependent on the non-domestic economy than is the UK one.

The Income Multiplier

Of more interest from a socio-economic point of view, is the degree to which variations in final demand will affect the levels of household incomes. This information can be obtained by calculating income multipliers.

The starting point in calculating the income multiplier is the total income effect. The total income effect shows the direct and indirect income from employment generated in an economy as a whole as a result of a unit increase in final demand for a specific industry's output. The total income effect on the economy can then be divided by the direct income effect on that industry alone to produce the income multiplier. This shows the increase in income from employment in an economy as a whole resulting when there is sufficient increase in final demand for a particular industry to create one unit of additional income from employment in that industry.
The income multipliers are outlined below.

Table 4. Income Multipliers

Sector / Region	UK	Scotland
Catching sector	1.76	1.67
Processing sector	3.90	4.52

The values for the processing sector are substantially higher than those for the catching sector. This can be attributed to two factors. First, there is a higher indirect income effect for the processing sector due to its higher inter-industry dependence (transferred from the value of the output multiplier). Second, expenditure on wages and salaries – household income – is relatively much lower in the processing sector (just over 11%) than in the catching sector (32%); this results in a higher income multiplier, since its value is obtained by dividing the total income effect by labour costs' share of total expenditure – a division with a lower denominator gives a higher value.

Because of the way the labour costs have been calculated for the purpose of this paper, the relationship between the four values above remain the same as for the output multipliers. (Labour cost percentages computed from the Fishermen's Handbook and the UK Survey of the Sea Fish Processing Industry have been applied to both the UK and the Scottish catching and processing sectors respectively.)

The Employment Multiplier

For socio-economic purposes, the employment multiplier is probably the most interesting. The employment multiplier, analogous to the (Type I) income multiplier above, is defined as the ratio of the direct plus indirect employment change to the direct employment change. It should, however, be pointed out that this relationship is by no means exact, since as output increases employers may simply utilise their existing labour resources more intensively so that output may change significantly without employment, measured in the number of people employed, varying at all (McNicoll, 1976, p. 33). The method used for calculating employment multipliers in this paper, consequently tends to overestimate their value.

The total employment effect shows the total increase in employment in an economy, as a whole, which results from a unit increase in final demand for the output of a particular industry. Using the employment effect for a particular industry, it is possible to determine the employment multipliers, which show the total increase in employment in an economy as a whole which result from an increase in final demand sufficient to create one additional full time equivalent (fte) job in that industry.

Example: A multiplier of 2.12 implies that for every 100 jobs directly created in an industry as a result of an increase in final demand, a further 112 jobs would be created indirectly in supplying industries.

The employment multipliers were found to be:

Table 5. Employment Multipliers

Sector / Region	UK	Scotland
Catching sector	1.44	1.50
Processing sector	2.72	2.64

Again, the values for the processing sector are substantially higher than are those for the catching sector. The reason for this is twofold. First, as was the case with the income multiplier, because of its higher inter-dependency with other sectors, a change in the processing sector has a larger impact on intermediate demand from other sectors, thus increasing output in those sectors. Second, because the processing industry, in relation to the value of its output, is not as labour intensive as the fishing industry, the additional output required to create one additional job within the processing sector is relatively larger than for the catching sector.

The value for the UK processing sector being higher than the Scottish value indicates a lower employment coefficient for the UK as a whole (less labour intensive). Consequently, a larger increase in output is necessary to trigger an increase of one fte job in that industry, implying a larger impact on intermediate industries. This outweighs the fact that the UK processing industry is less dependent on the domestic (UK) intermediate economy than is the Scottish industry on its local (Scottish) intermediate economy (the value of the output multiplier).

Comparisons with Previous Work

Comparisons with other studies should be made with caution, since the results vary with the character of the input-output tables and other assumptions made.

No UK-wide multipliers were computed by the Office for National Statistics in connection with the compilation of the “United Kingdom Input-Output Supply and Use Balances, 1992-96”. There are therefore no multiplier values for recent years to

compare with from this source[2]. The Scottish Office, however, derives input-output tables and multipliers for Scotland on a yearly basis. Since the fish processing sector is merged with the fruit processing sector, no comparison can be made for this sector though. The sea fishing sector, on the other hand, is shown separately. A comparison between the multiplier values from the Scottish Office publication and this study is made below.

Table 6. Comparison of Scottish sea fishing multipliers (Type I)

Multiplier / Source	Scottish Office	Present study
Output	1.73	1.65
Income	1.74	1.67
Employment	2.07	1.50

The values for the output and income multipliers seem to be comparable, although The Scottish Office's figures are slightly higher. This may be due to the fact that the author of the present study has applied percentages from the 1996/97 cost and earning figures to 1994 real earnings figures. Crew share (income from employment) and profit are likely to have constituted a higher share of total earnings in 1996/97 thus transferring higher shares for labour and profit to the 1994 input-output table. This will have reduced the figures for intermediate demand, thus lowering the multiplier value.

There is, however, a relatively large discrepancy between the values of the employment multiplier. This can most likely be explained by the fact that The Scottish Office figures do not take account of the self-employed. The fact that the self-employed are included for the purpose of this study has only a minor impact on the overall employment figure, but a large effect for the sea fishing sector, where a large proportion is self-employed. The employment coefficients thus vary considerably between the two studies.

A comparison could also be made with Gibbs, 1990, who derived multipliers for the UK.

Table 7. Comparison of UK multipliers

[2] The latest values appear to be from 1990; 1995 values will, however, according to the Office for National Statistics, be computed during the course of 1999 or 2000.

Multiplier / Source	Gibbs (1985 figures)		Present study (1994 figures)	
	Catching	Processing	Catching	Processing
Output	2.18	2.24	1.82	2.14
Income	2.32	4.54	1.76	3.90
Employment	1.92	3.76	1.44	2.72

The values in Gibbs' study are higher overall. The reasons behind these discrepancies are not immediately clear to the author but it may be due to both structural changes within the industry during the years between the two studies and differences in the construction of the input-output table.

3. Data Considerations

Below are outlined aggregated input-output tables for the United Kingdom and Scotland for 1994 (£ Million). Information about how the figures have been derived is outlined in separate appendices, not included in this paper. These appendices can be obtained from the author upon request, to enable those who wish to make comments on the construction of the tables to do so. A few remarks, however, are also made in the following.

The tables are household exogenous, that is households are not regarded as an intermediate sector in the economy but as a part of final demand. It can be argued that households should be included in intermediate demand, on the basis that they constitute a part of the local economy (McNicoll, 1976, page 9). This assumption, however, is less valid when the aim is to isolate a specific sector within the economy of a region/country, rather than trying to distinguish the activities of the whole economy of a limited region.

The economies, for the UK and Scotland respectively, have been divided into fish catching, fish processing, and all other sectors of the economy. The fish catching and fish processing sectors only encompass sea fishing products, thus excluding salmon and trout[3].

[3] Only processing units engaged in the processing of shellfish or demersal or pelagic fish are included in the 1995 Survey of the UK Sea Fish Processing Industry. Units engaged solely in the processing of salmon and trout were thus excluded from the scope of the survey.

The assumption has been made that all fish landed goes directly to the processing industry. This implies that wholesalers are defined as primary processors. What little is sold directly to the final consumers on the shore has been disregarded. Fish processors, on the other hand, deliver products both within their own sector (primary processors to secondary processors) and to the rest of the economy (caterers, retailers etc.). A small share of their outlet is also sold directly to consumers (factory gate sales to consumers).

Imports have been placed on an equal footing with expenditure abroad for the catching sector. The best information available to the author about the catching sector's costs and earnings stem from the "Fishermen's Handbook – Cost & Earnings of the United Kingdom Fishing Vessel Fleet 1996/7". The Scottish Office Agriculture, Environment and Fisheries Department has used the Fishermen's Handbook to compute the overall costs and earnings for the Scottish fleet, including its expenditure abroad. The author has applied the percentages from these calculations to the 1994 figures for the UK and Scottish fleets respectively. Consequently, these figures constitute a best estimate. (The calculations for the purpose of this exercise are shown in Appendix iii.)

Imports by the processing sector appear in the "1995 Survey of the UK Sea Fish Processing Industry". (Summary information about methods of obtaining supplies, as well as processors' financial results, also compiled from the 1995 Survey, is found in Appendix iv and v respectively.)

Taxes on expenditure are separated from intermediate demand in both the UK Input-Output Supply and Use Balances, and the Input-Output Tables for Scotland. For the purpose of this study, however, taxes on expenditure have not been accounted for as regards the fish catching and fish processing sectors. On the basis that fish is food and consequently does not give rise to any value added taxes, this assumption should not distort the present input-output tables to any greater extent.

For the Scottish input-output table, transactions with the rest of the UK are regarded as exports or imports and thus have a separate row and column.

In order to calculate how much of the catching sector's landings are "exported" to UK processors outwith Scotland, and how much goes to Scottish based processors, a

table has been drawn up on the basis of information from the "1995 Survey of the UK Sea Fish Processing Industry" (Appendix iv). For the purpose of this exercise, fish bought by processors from Scottish auctions has been treated as Scottish landings.

The author began by calculating the proportion of processors' supplies originating from direct imports and UK sources respectively for different parts of the UK. The Scottish share of total supply was then computed, prior to the share of supply from other processors (in the UK) being entered into the table. Having initially excluded imports, the percentages of UK supply coming from UK processors were calculated for each region.

The Scottish shares of total supply were then applied to absolute figures for total supply to processors in each region. The assumption was then made that the share of UK-wide supply being sourced from other processors could be applied for processors in each of the regions. This assumption was necessary due to lack of detailed information on inter-regional flows of supplies. Finally, the remaining share of Scottish supply was attributed to landings into Scotland. Exports by the catching sector to the rest of the UK thus include both landings into England, Wales and Northern Ireland, and landings into Scotland sold on to processors in the rest of the UK.

Sales from the processing sector have been analogously divided into Scottish recipients (processors and others), recipients elsewhere in the UK, and exports abroad.

The figure for the catching sector's expenditure abroad (which can be found in the table based on the Fishermen's Handbook - Appendix iii) is split between expenditure in the rest of the UK and in other countries.

Input -Output Table for the UK – (£ Sterling)

	Intermediate demand			*Total Inter Demand*	*Final demand*		*Total Final Demand*	
	Catching	Processing	Other		Household	Exports		Output
Catching	0.0	454.4	0.0	454.4	0.0	107.0	107.0	561.4
Processing	0.0	94.1	1098.3	1192.4	7.4	305.0	312.4	1504.8
Other	311.7	466.9	409513.6	410292.2	419254.6	178355.0	858946.6	1269238.8
Total interme-diate demand	311.7	1015.4	410611.9	411939.0	419262.0	178767.0	859366.0	1271305.0
Expendit. abroad /Imports	15.0	204.7	183110.3	183330.0				
Taxes on expend.	--	--	71874.0	71874.0				
Labour	177.4	170.6	369611.0	369959.0				
Gross profit (includes deprec. & taxes on production)	57.3	114.1	234031.6	234203.0				
Total Input	561.4	1504.8	1269238.8	1271305.0				
Employment	18,205	19,392	22,283,403	22,321,000				

Input - Output Table for Scotland – (£ Sterling)

	Intermediate Demand			Total Inter Demand	Final Demand			Total Final Demand	
		Scottish				Exports			
	Catching	Processing	Other		Household	Rest of UK	Outwith UK		Output
Catching	0.0	200.1	0.0	200.1	0.0	80.6	29.4	110.0	310.1
Processing	0.0	24.3	73.9	98.2	0.0	236.8	157.6	394.4	492.6
Other	144.9	168.9	27159.6	27473.4	17871.1	16015.0	15904.8	70418.6	97892.0
Total Intermediate Demand	144.9	393.3	27233.5	27771.7	17871.1	16332.4	16091.8	70923.0	98694.7
Expendit. abroad /Imports:									
- Rest of the UK	27.3	5.2	11765.4	11797.9					
- Outside the UK	8.3	4.0	7224.7	7237.0					
Taxes on expend.	--	--	3433.5	3433.5					
Labour	98.0	55.1	31882.7	32035.8					
Gross profit (Incl. taxes on Production & Deprec.	31.6	35.0	16352.2	16418.8					
Total Input	310.1	492.6	97892.0	98694.7					
Employment	7,865	7,484	1,933,651	1,949,000					

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