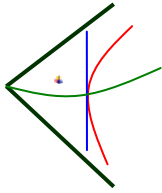


The Importance for the Fish Processing and Merchanting Sector of Landings of Fish from the waters of the Pentland Firth and Orkney to the Local and Scottish Economies



ERINSHORE ECONOMICS LIMITED

**THE IMPORTANCE FOR THE FISH PROCESSING AND MERCHANTING SECTOR
OF LANDINGS OF FISH FROM THE WATERS OF THE PENTLAND FIRTH AND
ORKNEY TO THE LOCAL AND SCOTTISH ECONOMIES**

Prepared for

Marine Scotland

by

ERINSHORE ECONOMICS LIMITED

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THE IMPORTANCE FOR THE FISH PROCESSING AND MERCHANTING SECTOR OF LANDINGS OF FISH FROM THE WATERS OF THE PENTLAND FIRTH AND ORKNEY TO THE LOCAL AND SCOTTISH ECONOMIES

Executive Summary

- The objective of this study is to assist ongoing work at Marine Scotland which seeks to examine the importance of the fish processing and distribution industries in the Pentland Firth and Orkney waters relative to alternative uses of the local waters.
- The specific objective is to estimate the contribution of the fish and shellfish processing industry and the fish merchants in providing returns on landings from the waters of the Pentland Firth and Orkney area, first to the local economy, and secondly, to the Scottish economy.
- The contribution is measured in terms of output, income and employment from the fish processing industry and fish merchants in the North Highland region and the Orkney Islands based on landings from the Pentland Firth and Orkney waters.
- The method used is that of calculating Leontief demand-driven upstream multipliers for output, income and employment from Input-Output Tables and applying them to activities of the Pentland Firth and Orkney waters fish processing industry and fish merchants in the context of both the local and the Scottish economies.
- The Ghosh supply-driven downstream multipliers are set out in Annex 1 for completeness.
- The results for the Scottish economy exclude the impact of the oil production industry, for which no allowance for its contribution has been made at the request of the client.
- The concept of the multiplier, an explanation of Input-Output Tables, and the methodology for calculating the multipliers are set out in the Appendix.
- To protect commercially sensitive information, given the small number of larger firms in the fish and shellfish processing industry around in the Pentland Firth and Orkney area, the Consolidated Transactions Matrices both for the local economy and for the Scottish economy are not shown but the Technology Matrices derived from them are shown in the Appendices.
- Unless otherwise stated the comments in this report relate to the product of the Pentland Firth and Orkney waters.

The Local Economy of North Highland and Orkney

- More than £40m of fish and shellfish is landed annually to ports in the waters of the Pentland Firth off Northern Scotland and around the Orkney Islands. Of this some £7.4m comes from within those waters themselves.
- The waters are particularly productive of crustaceans, mainly crabs, whose value exceeded £4.7m in 2011.
- The product of the fish and shellfish processors and merchants, especially crab, enjoys a widely-recognised reputation. Some produce finds its way as far afield as the Far East.
- In 2011, the output of the fish and shellfish processing and merchants sector of product from Pentland Firth and Orkney waters was worth nearly £6m and crustaceans accounted for nearly 90% of sales.
- This is achieved from the official figures for input of raw material from Pentland Firth and Orkney waters set out by value for 2011 in Table E1 below.

Table E1: Input of Raw Material from Pentland Firth and Orkney Waters to the Fish Processing and Merchanting Sector, 2011

2011, £	Crustaceans	Non-Crustaceans
North Highland	474,000	241,000
Orkney	1,706,000	106,000

- The results suggest that £18m of output in the local economy depends on the initial £6m of output. £5.7m of income depends on the £1.4m direct income. 243¹ full-time equivalent jobs depend on the 112 jobs estimated to exist in the industry.
- Output in the local economy resulting from the initial output in the shellfish segments (including the initial output) is as set out in Table E2 below:
- Income in the local economy resulting from the initial output in the shellfish segments (including the initial output) is as set out in Table E3 below.
- The number of jobs in the local economy resulting from the initial jobs in the shellfish sectors (including the initial jobs) is as set out below in Table E4.
- In most cases, the multipliers² for the segments of the industry are close to but generally above those for other businesses in the local economy.

¹ The slight difference from the apparent total of 244 in Table E4 is due to rounding.

² The different types of multiplier, their derivation and general implications are set out in Annex 2.

Table E2: North Highland and Orkney Output Dependent on the North Highland and Orkney Fish and Shellfish Processing Sector Use of Pentland Firth and Orkney Landings, 2011.

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, (£m)	£0.39	£7.12	£0.90	£1.99
Direct, Indirect and Induced Effects, Type II, (£m)	£0.67	£12.74	£1.44	£3.55

Table E3: North Highland and Orkney Income Dependent on the North Highland and Orkney Fish and Shellfish Processing Sector Use of Pentland Firth and Orkney Landings, 2011.

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, (£m)	£0.10	£2.04	£0.20	£0.57
Direct, Indirect and Induced Effects, Type II, (£m)	£0.20	£3.99	£0.39	£1.11

- The multipliers imply that the productivity of the fish processors and merchants is greater than that for the average of the economy. This conclusion is to be expected in an area where there are relatively few large businesses and where the fish and shellfish processors are among the larger operations.
- The bulk of the product is exported directly from the processors and merchants. It is estimated that more than 90% of output is exported from the locality.

Table E4: North Highland and Orkney Employment Dependent on the North Highland and Orkney Fish and Shellfish Processing Sector Use of Pentland Firth and Orkney Landings, 2011.

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, FTE Jobs	6	112	10	31
Direct, Indirect and Induced Effects, Type II, FTE Jobs	9	171	16	48

The Scottish Economy

- The results suggest that £12m of output in the Scottish economy depends directly and indirectly on the initial £6m of output. £6.3m of income depends on the £1.4m direct income.
- 261 full-time equivalent jobs depend on the 112 jobs estimated to exist in the industry.
- Output in the Scottish economy resulting from the initial jobs in the North Highland and Orkney fish and shellfish processors and merchants (including the initial output) is as set out below in Table E5. The inputs are the same as those for the local economy set out above in Table E1.

Table E5: Scottish Output Dependent on the North Highland and Orkney Fish and Shellfish Processing Sector Use of Pentland Firth and Orkney Landings, 2011.

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, (£m)	£0.44	£7.98	£1.01	£2.24
Direct, Indirect and Induced Effects, Type II, (£m)	£0.74	£13.81	£1.61	£3.87

- Income in the Scottish economy resulting from the initial income in the North Highland and Orkney fish and shellfish processors and merchants (including the initial income) is as set out below in Table E6.

- The number of full-time equivalent jobs in the Scottish economy resulting from the initial jobs in the North Highland and Orkney fish and shellfish processors and merchants (including the initial jobs) is as set out below in Table E7.

Table E6: Scottish Income Dependent on the North Highland and Orkney Fish and Shellfish Processing Sector Use of Pentland Firth and Orkney Landings, 2011.

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, (£m)	£0.12	£2.34	£0.24	£0.65
Direct, Indirect and Induced Effects, Type II, (£m)	£0.22	£4.36	£0.45	£1.22

Table E7: Scottish Employment Dependent on the North Highland and Orkney Fish and Shellfish Processing Sector Use of Pentland Firth and Orkney Landings, 2011.

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, FTE Jobs	6	121	11	34
Direct, Indirect and Induced Effects, Type II, FTE Jobs	9	183	18	51

THE IMPORTANCE FOR THE FISH PROCESSING AND MERCHANTING SECTOR OF LANDINGS OF FISH FROM THE WATERS OF THE PENTLAND FIRTH AND ORKNEY TO THE LOCAL AND SCOTTISH ECONOMIES

1. Introduction

More than £40m of fish and shellfish is landed annually to ports in the waters of the Pentland Firth off Northern Scotland and around the Orkney Islands. Of this over £7m comes from within those waters themselves. The waters are particularly productive of crustaceans, mainly crabs, whose value exceeded £4m in 2011.

This activity provides the opportunity to fish processors and fish merchants to add value to the raw material as it progresses through the supply chain to local consumers and consumers in the remainder of Scotland and elsewhere. The product, especially crab, enjoys a widely-recognised reputation. Some produce finds its way as far afield as the Far East.

Adding value provides income and employment in the locality and further afield through so-called multiplier effects which create additional income and employment based on supplying inputs to processing and marketing.

1.1 Objective

The objective of this study is to assist ongoing work at Marine Scotland which seeks to examine the importance of the fish processing and distribution industries in the Pentland Firth and Orkney waters relative to alternative uses of the local waters.

The specific objective is therefore to estimate the contribution of the fish processing industry and the fish merchants in providing returns on landings from the waters of the Pentland Firth and Orkney area, first to the local economy, and secondly, to the Scottish economy.

The contribution is measured in terms of output, income and employment from the fish processing industry and fish merchants in the North Highland region and the Orkney Islands based on landings from the Pentland Firth and Orkney waters.

The method used is that of calculating Leontief demand-driven upstream multipliers, from Input-Output Tables, for output, income and employment for firms in or supplying the Pentland Firth and Orkney waters fish processing industry and fish merchants. This exercise is undertaken in the context of both the local and the Scottish economies.

For completeness, the Ghosh supply-driven downstream multipliers which relate output, income and employment in firms dependent on purchases from the Pentland Firth and Orkney waters fish processing industry and fish merchants for both the local and the Scottish economies are given in Annex 1.

The concept of the multiplier, an explanation of Input-Output Tables, and the methodology for calculating the multipliers are set out in Annex 2.

In order to protect commercially sensitive information from the small number of larger firms characterising the fish processing industry in the Pentland Firth and Orkney area, the Consolidated Transactions Matrices both for the local economy and for the Scottish economy are not shown. However, the Technology Matrices derived from the Consolidated Transactions Matrices for the both economies are able to be presented along with the results because the magnitude of the turnover is disguised by the conversion to percentages.

At the request of the client, and in conformity with common practice in Scottish Government statistics, no provision has been made for including a proportionate share of the output of the oil production industry.

1.2 Data

General economic data for Scotland and for the North Highland and Orkney areas have been obtained from the websites of the Office for National Statistics and the Scottish Government. Data on the sources and purchasers of fish and shellfish have been provided by Marine Scotland. Other information and data have been provided in telephone interviews with industry participants in the locality.

1.3 Raw Material Input from the Waters of the Pentland Firth and Orkney Areas

Official figures for input of raw material from Pentland Firth and Orkney waters set out by value for 2011 in Table 1 below.

Table 1: Input of Raw Material from Pentland Firth and Orkney Waters to the Fish Processing and Merchanting Sector, 2011

2011, £	Crustaceans	Non-Crustaceans
North Highland	474,000	241,000
Orkney	1,706,000	106,000

2. The Importance of Fish Processing and Marketing of Landings of Fish from the Pentland Firth and Orkney Waters to the Local Economy

The multipliers estimated in this study for the impact of fish and shellfish processors and merchants in North Highland and Orkney on the local economy are set out in Table 2 and are given for comparison against the multipliers estimated from the model for other businesses in North Highland and Orkney. North Highland is defined as the local authority areas of Caithness, Sutherland, Scrabster and Wick.

Table 2: Multipliers for the Activity of Pentland Firth and Orkney Waters Fish Processing Industry and Fish Merchants on the Local Economy, 2011.

Type I	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans	Other Businesses
Output	1.76	1.74	1.77	1.75	1.41
Income	2.20	2.04	2.63	2.04	1.41
Employment	1.50	1.40	1.69	1.43	1.41
Type II					
Output	3.03	3.11	2.85	3.12	2.75
Income	4.29	3.98	5.13	3.98	2.75
Employment	2.29	2.14	2.65	2.17	2.75

The Leontief Technology Matrix for Type I demand-driven multipliers for the North Highland and Orkney economy derived from the Type I Consolidated Transactions Matrix is set out as Table A2.1 in the Appendix to Section 2. That for the Type II multipliers is given in Table A2.2.

The Type II multipliers are greater than those of Type I as a consequence of their definitions, since besides the direct and indirect effects of Type I, the Type II multipliers include also the induced effects on the broader local economy.

The levels of the multipliers are generally plausible. Determining the levels of some of the figures to be included in the Consolidated Transactions Matrices arising from trade among the merchants and processors has necessitated closing the Matrices.

The effect of this is to assume that leakages and injections to the local economy are in balance and therefore that the circular flow of income in the locality is in balance. Both these indicate an economy which is in a stable equilibrium.

The output, income and employment (in full-time equivalent jobs) in North Highland and Orkney dependent on the presence of the fish and shellfish processors and merchants are set out in detail in Tables 3, 4 and 5.

Table 3: Dependency of the Local Economy on the Pentland Firth and Orkney Waters Fish Processing Industry and Fish Merchants for Output

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, (£m)	£0.39	£7.12	£0.90	£1.99
Direct, Indirect and Induced Effects, Type II, (£m)	£0.67	£12.74	£1.44	£3.55

The results suggest that £10m of direct and indirect effects rests on the initial £6m output of the fish and shellfish processors and merchants. When induced effects are added the dependency rises to £18m.

They also indicate that £2.9m of direct and indirect effects rests on the initial £1.4m income of the sector rising to £5.7m when induced effects are included.

Table 4: Dependency of the Local Economy on the Pentland Firth and Orkney Waters Fish Processing Industry and Fish Merchants for Income

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, (£m)	£0.10	£2.04	£0.20	£0.57
Direct, Indirect and Induced Effects, Type II, (£m)	£0.20	£3.99	£0.39	£1.11

It has been difficult to determine precisely the number of people employed in the sector. A significant proportion of the employees of both the processors and the fish merchants works part-time. Their hours vary between person and between season.

In addition, among the smallest operations there is a degree of contribution from family members which is frequently unpaid and flexible in the extreme.

Nevertheless it has been calculated that there are the full-time equivalent of 112 people working in the sector in North Highland and Orkney on the product of the

Pentland Firth and Orkney waters. These divide as to 10 working on demersal and pelagic fish (the pelagic segment is minute) and molluscs, and 102 on crustaceans.

Table 5: Dependency of the Local Economy on the Pentland Firth and Orkney Waters Fish Processing Industry and Fish Merchants for Employment

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, FTE Jobs	6	112	10	31
Direct, Indirect and Induced Effects, Type II, FTE Jobs	9	171	16	48

160 jobs in the North Highland and Orkney economy are estimated to depend directly and indirectly on the 112 people estimated to be working in the sector in North Highland and Orkney and when induced effects within the locality are added the figure rises to 243³.

³ The slight difference from the apparent total of 244 in Table 5 is due to rounding.

Appendix to Section 2

Closed Input-Output Table Derivatives for the Local Economy to produce Type I Multipliers

Table A1.1: Technology Matrix for Leontief Demand-Driven Type I Multipliers for the Local Economy, 2011 (Closed)

%	2011	Purchaser				
		Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans	Other Businesses
Producer	Processors and Merchants: Orkney Landings of Non-Crustaceans	0.075	0.000	0.000	0.000	0.000
	Processors and Merchants: Orkney Landings of Crustaceans	0.000	0.020	0.000	0.000	0.000
	Processors and Merchants: North Highland Landings of Non-Crustaceans	0.000	0.000	0.100	0.000	0.000
	Processors and Merchants: North Highland Landings of Crustaceans	0.000	0.000	0.000	0.050	0.000
	Other Businesses	0.445	0.500	0.420	0.470	0.291
	Total Primary Inputs	0.520	0.520	0.520	0.520	0.291
	Households	0.210	0.245	0.150	0.245	0.346
	Indirect Taxes & Profits	0.270	0.235	0.330	0.235	0.363
	Total Inputs	1.000	1.000	1.000	1.000	1.000

Note: Some columns and rows may not exactly add-up owing to rounding.

Closed Input-Output Table Derivatives for the Local Economy to produce Type II Multipliers

Table A1.2: Technology Matrix for Leontief Demand-Driven Type II Multipliers for the Local Economy, 2011, (Closed)

%	2011	Purchaser					
		Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans	Other Businesses	Households
Producer	Processors and Merchants: Orkney Landings of Non-Crustaceans	0.075	0.000	0.000	0.000	0.000	0.000
	Processors and Merchants: Orkney Landings of Crustaceans	0.000	0.020	0.000	0.000	0.000	0.000
	Processors and Merchants: North Highland Landings of Non-Crustaceans	0.000	0.000	0.100	0.000	0.000	0.000
	Processors and Merchants: North Highland Landings of Crustaceans	0.000	0.000	0.000	0.050	0.000	0.000
	Other Businesses	0.445	0.500	0.420	0.470	0.291	1.000
	Households	0.210	0.245	0.150	0.245	0.346	0.000
	Total Primary Inputs	0.730	0.765	0.670	0.765	0.637	1.000
	Taxes, Subsidies, Imports and Profit	0.270	0.235	0.330	0.235	0.363	0.000
	Total Inputs	1.000	1.000	1.000	1.000	1.000	1.000

Note: Some columns and rows may not exactly add-up owing to rounding.

3. Inferences and Conclusions Concerning the Importance of Processing Landings from Pentland Firth and Orkneys Waters for the Local Economy

In general the estimations have offered plausible results, though this may in part be due to the fact that some view has had to be taken of income levels in the sector, especially for the merchants, though these can be directly compared with those for the processors from whom it has been possible to obtain reliable figures.

The Fraser of Allander Institute (2007) reported demand-driven Type II multipliers of 4.81 and 6.21 for output and income multipliers for the UK shellfish catching sector. These are quite high results but are generally mirrored here.

Earlier Gibbs (1990) reported Type I output and employment multipliers of 2.24 and 3.76, also for the UK, noticeably higher than those reported here. Greig (2000) found Type II multipliers for fish processing in the UK for output and employment of 3.34 and 4.53. Higher multipliers would suggest low wages compared to other industries and high productivity.

The Type I and Type II multipliers for the fish processing industries and fish merchants in North Highland and Orkney based on landings from Pentland Firth and Orkney waters vary above and below the level of the multipliers for other businesses in the local economy. In general those for Orkney are lower, perhaps reflecting the higher costs of production in an island economy supplying mainland markets.

The Impact of a 10% Decline in Supply on the North Highland and Orkney Economy

Table 6 below sets out the losses to the North Highland and Orkney economy that might be expected to occur should there be a 10% reduction in the value of landings from the waters of the Pentland Firth and Orkney area.

Table 6: The Impact of a 10% Decline in Supply on the North Highland and Orkney Economy

Type II	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Output (£m)	£0.07	£1.27	£0.14	£0.36
Income (£m)	£0.02	£0.40	£0.04	£0.11
Employment (Units)	1	17	2	5

It is estimated that a 10% decline in the value (and volume) of landings would result in a fall in output of £1.8m, of £0.6m of income, and 25 jobs in the economy of North Highland and Orkney.

Since the model is linear the impact of other percentage changes may be calculated as simple multiples of 10%, but because of the linearity the reader should be aware that the reliability of such estimates declines as the percentage change considered increases.

4. The Importance of Fish Processing and Marketing of Landings of Fish and Shellfish from the Pentland Firth and Orkney Waters to the Scottish Economy

The multipliers estimated in this study for the impact of fish and shellfish processors and merchants in North Highland and Orkney on the Scottish economy as a whole are set out in Table 7 and are given for comparison against the multipliers estimated from the model for other businesses in Scotland.

Table 7: Multipliers for the Activity of Pentland Firth and Orkney Waters Fish and Shellfish Processing Industry and Merchants on the Scottish Economy, 2011.

Type I	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans	Other Businesses
Output	1.98	1.95	2.00	1.97	1.34
Income	2.57	2.33	3.17	2.35	1.34
Employment	1.64	1.52	1.90	1.55	1.34
Type II					
Output	3.33	3.37	3.19	3.40	2.49
Income	4.79	4.35	5.91	4.37	2.49
Employment	2.48	2.28	2.95	2.32	2.49

The output, income and employment (in full-time equivalent jobs) in Scotland dependent on the presence of the fish and shellfish processors and merchants in North Highland and Orkney are set out in detail in Tables 8, 9 and 10 below.

Again, the Type II multipliers are higher than those for Type I because they include the induced effects on the broader economy as well as the direct and indirect effects.

The results suggest that £12m of direct and indirect effects rests on the initial £6m output of the fish and shellfish processors and merchants. When induced effects are added the dependency rises to £20m.

They also indicate that £3.4m of direct and indirect effects in the Scottish economy rests on the initial £1.4m income of the sector rising to £6.3m when induced effects are included.

Table 8: Dependency of the Scottish Economy on the Pentland Firth and Orkney Waters Fish and Shellfish Processing Industry and Merchants for Output

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, (£m)	£0.44	£7.98	£1.01	£2.24
Direct, Indirect and Induced Effects, Type II, (£m)	£0.74	£13.81	£1.61	£3.87

Table 9: Dependency of the Scottish Economy on the Pentland Firth and Orkney Waters Fish and Shellfish Processing Industry and Merchants for Income

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, (£m)	£0.12	£2.34	£0.24	£0.65
Direct, Indirect and Induced Effects, Type II, (£m)	£0.22	£4.36	£0.45	£1.22

The difficulty in determining precisely the number of people employed in the sector identified in Section 2 for the local North Highland and Orkney Consolidated Transactions Matrices applies also to those for Scotland, and the reasons - the proportion of part-time employees and the contribution of unpaid family members – are similar.

173⁴ jobs in the Scottish economy are estimated to depend directly and indirectly on the 112 people estimated to be working in the sector in North Highland and Orkney and when induced effects are added the figure rises to 261.

⁴ The slight difference from the apparent total of 172 in Table 10 is due to rounding.

Table 10: Dependency of the Scottish Economy on the Pentland Firth and Orkney Waters Fish and Shellfish Processing Industry and Merchants for Employment

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, FTE Jobs	6	121	11	34
Direct, Indirect and Induced Effects, Type II, FTE Jobs	9	183	18	51

Appendix to Section 4

Closed Input-Output Table Derivatives for the Scottish Economy to produce Type I Multipliers

Table A2.1: Technology Matrix for Leontief Demand-Driven Type I Multipliers for the Scottish Economy, 2011 (Closed)

%	2011	Purchaser				
		Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans	Other Businesses
Producer	Processors and Merchants: Orkney Landings of Non-Crustaceans	0.075	0.000	0.000	0.000	0.000
	Processors and Merchants: Orkney Landings of Crustaceans	0.000	0.020	0.000	0.000	0.000
	Processors and Merchants: North Highland Landings of Non-Crustaceans	0.000	0.000	0.100	0.000	0.000
	Processors and Merchants: North Highland Landings of Crustaceans	0.000	0.000	0.000	0.050	0.000
	Other Businesses	0.625	0.680	0.600	0.650	0.252
	Total Primary Inputs	0.700	0.700	0.700	0.700	0.252
	Households	0.210	0.245	0.150	0.245	0.347
	Indirect Taxes & Profits	0.090	0.055	0.150	0.055	0.401
	Total Inputs	1.000	1.000	1.000	1.000	1.000

Note: Some columns and rows may not exactly add-up owing to rounding.

Closed Input-Output Table Derivatives for the Scottish Economy to produce Type II Multipliers

Table A2.2: Technology Matrix for Leontief Demand-Driven Type II Multipliers for the Scottish Economy, 2011, (Closed)

%	2011	Purchaser					
		Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans	Other Businesses	Households
Producer	Processors and Merchants: Orkney Landings of Non-Crustaceans	0.075	0.000	0.000	0.000	0.000	0.000
	Processors and Merchants: Orkney Landings of Crustaceans	0.000	0.020	0.000	0.000	0.000	0.000
	Processors and Merchants: North Highland Landings of Non-Crustaceans	0.000	0.000	0.100	0.000	0.000	0.000
	Processors and Merchants: North Highland Landings of Crustaceans	0.000	0.000	0.000	0.050	0.000	0.000
	Other Businesses	0.625	0.680	0.600	0.650	0.252	1.000
	Households	0.210	0.245	0.150	0.245	0.347	0.000
	Total Primary Inputs	0.910	0.945	0.850	0.945	0.599	1.000
	Taxes, Subsidies, Imports and Profit	0.090	0.055	0.150	0.055	0.401	0.000
	Total Inputs	1.000	1.000	1.000	1.000	1.000	1.000

Note: Some columns and rows may not exactly add-up owing to rounding

5. Inferences and Conclusions Concerning the Importance of Processing Landings from Pentland Firth and Orkneys Waters for the Scottish Economy

The estimations have offered plausible results, though again this may in part be due to the fact that some view has had to be taken of income levels in the sector, especially for the merchants. As with the development of the Consolidated Transactions Matrix for the North Highland and Orkney local economy these can be directly compared with those for the processors from whom it has been possible to obtain reliable figures.

The results found here show that the wage levels are generally lower than those found throughout Scotland, a conclusion to be expected for a peripheral area of the UK dependent on primary production.

The Type II multipliers vary around those for other businesses in Scotland. Less of the output is exported from the Scottish economy, 56% from Scotland compared to 89% from the locality. This is because the merchants tend to supply processors in Peterhead, especially with demersal fish.

The higher values of the multipliers indicate that the sector has high labour productivity levels but that the mark-up is lower especially for crab processing.

The Impact of a 10% Decline in Supply on the Scottish Economy

Table 11 below sets out the losses to the Scottish economy that might be expected to occur should there be a 10% reduction in the value of landings from the waters of the Pentland Firth and Orkney area.

Table 11: The Impact of a 10% Decline in Supply on the Scottish Economy

Type II	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Output (£m)	£0.07	£1.38	£0.16	£0.39
Income (£m)	£0.02	£0.44	£0.04	£0.12
Employment (Units)	0.9	18.3	1.8	5.1

It is estimated that a 10% decline in the value (and volume) of landings would result in a fall in output of £2m, of £0.63m of income, and 26 jobs in the Scottish economy.

Since the model is linear the impact of other percentage changes may be calculated as simple multiples of 10%, but because of the linearity the reader should be aware that the reliability of such estimates declines as the percentage change considered increases.

ANNEX 1: Ghosh Supply-Driven Downstream Multipliers

A1.1 The Importance of Fish Processing and Marketing of Landings of Fish and Shellfish from the Pentland Firth and Orkney Waters to the Local Economy

The Ghosh, supply-driven, or downstream multipliers estimated in this study for the impact of fish and shellfish processors and merchants in North Highland and Orkney on the local economy are set out in Table B1 and are given for comparison against the multipliers estimated from the model for other businesses in North Highland and Orkney.

Table B1: Ghosh Multipliers for the Activity of Pentland Firth and Orkney Waters Fish Processing Industry and Fish Merchants on the Local Economy, 2011.

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans	Other Businesses
Type I					
Output	1.12	1.06	1.19	1.05	1.41
Income	1.14	1.08	1.29	1.05	1.41
Employment	1.10	1.04	1.18	1.05	1.41
Type II					
Output	1.16	1.10	1.26	1.05	2.76
Income	1.20	1.14	1.46	1.05	2.75
Employment	1.13	1.07	1.25	1.05	2.76

The Ghosh Technology Matrix for Type I supply-driven multipliers for the North Highland and Orkney economy derived from the Type I Consolidated Transactions Matrix are set out as Tables B1.1 and B1.2 in the Appendix to Annex 1.

The levels of the multipliers are generally plausible but a noticeable feature is the similarity of both the Type I and Type II supply multipliers across output, income and employment. Likewise the effects are small, as is to be expected. Purchasers could obtain supplies from elsewhere were North Highland and Orkney supplies to dry up, though the increased demand on the alternative sources would raise supply prices and therefore cost some output and jobs.

The output, income and employment (in full-time equivalent jobs) in North Highland and Orkney dependent downstream among purchasers on the presence of the fish and shellfish processors and merchants are set out in detail in Tables B2, B3 and B4.

The results suggest that £6.4m of direct and indirect effects rests on the initial £6m output of the fish and shellfish processors and merchants. When induced effects are added the dependency rises only slightly, to £6.6m.

Table B2: Downstream Dependency of the Local Economy on the Pentland Firth and Orkney Waters Fish Processing Industry and Fish Merchants for Output

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, (£m)	£0.25	£4.35	£0.60	£1.20
Direct, Indirect and Induced Effects, Type II, (£m)	£0.26	£4.52	£0.64	£1.20

Table B3: Downstream Dependency of the Local Economy on the Pentland Firth and Orkney Waters Fish Processing Industry and Fish Merchants for Income

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, (£m)	£0.05	£1.08	£0.10	£0.29
Direct, Indirect and Induced Effects, Type II, (£m)	£0.06	£1.14	£0.11	£0.29

Table B4: Downstream Dependency of the Local Economy on the Pentland Firth and Orkney Waters Fish Processing Industry and Fish Merchants for Employment

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, FTE Jobs	4	83	7	23
Direct, Indirect and Induced Effects, Type II, FTE Jobs	4	85	7	23

They also intimate that £1.5m of direct and indirect effects rests on the initial £1.4m income of the sector rising to £1.6m when induced effects are included.

118⁵ jobs in the North Highland and Orkney economy are estimated to depend directly and indirectly on the 112 people estimated to be working in the sector in North Highland and Orkney and when induced effects within the locality are added the figure rises to 120⁶.

The Type II Ghosh multipliers are noticeably lower than the Leontief multipliers. These low supply-driven multipliers indicate that the bulk of the product is exported directly from the processors and merchants. It is estimated that more than 90% of output is exported from the locality.

⁵ The slight difference from the apparent total of 117 in Table B4 is due to rounding.

⁶ The slight difference from the apparent total of 119 in Table B4 is due to rounding.

Appendix to Section A1.1

Closed Input-Output Table Derivatives for the Local Economy to produce Type I Multipliers

Table B1.1: Technology Matrix for Ghosh Supply-Driven Type I Multipliers for the Local Economy, 2011, (Closed)

%	2011	Purchaser									
		Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans	Other Businesses	Total	Households	Misc Final Demand	Exports	Total Output
Producer	Processors and Merchants: Orkney Landings of Non-Crustaceans	0.075	0.000	0.000	0.000	0.025	0.100	0.000	0.000	0.900	1.000
	Processors and Merchants: Orkney Landings of Crustaceans	0.000	0.020	0.000	0.000	0.030	0.050	0.000	0.000	0.950	1.000
	Processors and Merchants: North Highland Landings of Non-Crustaceans	0.000	0.000	0.100	0.000	0.050	0.150	0.000	0.000	0.850	1.000
	Processors and Merchants: North Highland Landings of Crustaceans	0.000	0.000	0.000	0.050	0.000	0.050	0.000	0.000	0.950	1.000
	Other Businesses	0.000	0.000	0.000	0.000	0.291	0.291	0.346	0.098	0.264	1.000

Note: Some columns and rows may not exactly add-up owing to rounding.

Closed Input-Output Table Derivatives for the Local Economy to produce Type II Multipliers

Table B1.2: Technology Matrix for Ghosh Supply-Driven Type II Multipliers for the Local Economy, 2011, (Closed)

%	2011	Purchaser									
		Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans	Other Businesses	Households	Total	Misc Final Demand	Exports	Total Output
Producer	Processors and Merchants: Orkney Landings of Non-Crustaceans	0.075	0.000	0.000	0.000	0.025	0.000	0.100	0.000	0.900	1.000
	Processors and Merchants: Orkney Landings of Crustaceans	0.000	0.020	0.000	0.000	0.030	0.000	0.050	0.000	0.950	1.000
	Processors and Merchants: North Highland Landings of Non-Crustaceans	0.000	0.000	0.100	0.000	0.050	0.000	0.150	0.000	0.850	1.000
	Processors and Merchants: North Highland Landings of Crustaceans	0.000	0.000	0.000	0.050	0.000	0.000	0.050	0.000	0.950	1.000
	Other Businesses	0.000	0.000	0.000	0.000	0.291	0.346	0.638	0.098	0.264	1.000
	Households	0.000	0.001	0.000	0.000	0.999	0.000	1.000	0.000	0.000	1.000

Note: Some columns and rows may not exactly add-up owing to rounding.

A1.2 The Importance of Fish Processing and Marketing of Landings of Fish and Shellfish from the Pentland Firth and Orkney Waters to the Scottish Economy

The multipliers estimated in this study for the impact of fish and shellfish processors and merchants in North Highland and Orkney on the Scottish economy as a whole are set out in Table B5 and are given for comparison against the multipliers estimated from the model for other businesses in Scotland.

Table B5: Ghosh Multipliers for the Activity of Pentland Firth and Orkney Waters Fish and Shellfish Processing Industry and Merchants on the Scottish Economy, 2011.

Type I	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans	Other Businesses
Output	1.70	1.68	1.14	1.26	1.34
Income	2.10	1.95	1.18	1.35	1.34
Employment	1.46	1.37	1.14	1.17	1.34
Type II					
Output	2.23	2.24	1.17	1.45	2.49
Income	2.97	2.75	1.24	1.61	2.49
Employment	1.79	1.67	1.16	1.27	2.49

The Ghosh Technology Matrix for Type I supply-driven multipliers derived from the Type I Consolidated Transactions Matrix for Scotland is set out as Table B2.1 in the Appendix to Section A1.2. That for the Type II multipliers is set out in Table B2.2.

The output, income and employment (in full-time equivalent jobs) in Scotland dependent on the presence of the fish and shellfish processors and merchants in North Highland and Orkney are set out in detail in Tables B6, B7 and B8 below.

Again, the Type II multipliers are higher than those for Type I because they include the induced effects on the broader economy as well as the direct and indirect effects.

The results suggest that £9m of direct and indirect effects rests on the initial £6m output of the fish and shellfish processors and merchants. When induced effects are added the dependency rises to £12m.

They also indicate that £2.5m of direct and indirect effects in the Scottish economy rests on the initial £1.4m income of the sector rising to £3.4m when induced effects are included.

Table N6: Downstream Dependency of the Scottish Economy on the Pentland Firth and Orkney Waters Fish and Shellfish Processing Industry and Merchants for Output

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, (£m)	£0.38	£6.86	£0.58	£1.44
Direct, Indirect and Induced Effects, Type II, (£m)	£0.50	£9.18	£0.59	£1.65

Table N7: Downstream Dependency of the Scottish Economy on the Pentland Firth and Orkney Waters Fish and Shellfish Processing Industry and Merchants for Income

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, (£m)	£0.10	£1.95	£0.09	£0.38
Direct, Indirect and Induced Effects, Type II, (£m)	£0.14	£2.76	£0.09	£0.45

Table N8: Downstream Dependency of the Scottish Economy on the Pentland Firth and Orkney Waters Fish and Shellfish Processing Industry and Merchants for Employment

	Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans
Direct and Indirect Effects, Type I, FTE Jobs	5	110	7	26
Direct, Indirect and Induced Effects, Type II, FTE Jobs	7	134	7	28

The difficulty in determining precisely the number of people employed in the sector identified in Section 2 for the local North Highland and Orkney Consolidated Transactions Matrices applies also to those for Scotland, and the reasons - the proportion of part-time employees and the contribution of unpaid family members – are similar.

148 jobs in the Scottish economy are estimated to depend directly and indirectly on the 112 people estimated to be working in the sector in North Highland and Orkney and when induced effects are added the figure rises to 176.

Appendix to Section A1.2

Closed Input-Output Table Derivatives for the Scottish Economy to produce Type I Multipliers

Table B2.1: Technology Matrix for Ghosh Supply-Driven Type I Multipliers for the Scottish Economy, 2011, (Closed)

%	2011	Purchaser									
		Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans	Other Businesses	Total	Households	Misc Final Demand	Exports	Total Output
Producer	Processors and Merchants: Orkney Landings of Non-Crustaceans	0.075	0.000	0.000	0.000	0.425	0.500	0.000	0.000	0.500	1.000
	Processors and Merchants: Orkney Landings of Crustaceans	0.000	0.020	0.000	0.000	0.480	0.500	0.000	0.000	0.500	1.000
	Processors and Merchants: North Highland Landings of Non-Crustaceans	0.000	0.000	0.100	0.000	0.020	0.120	0.000	0.000	0.880	1.000
	Processors and Merchants: North Highland Landings of Crustaceans	0.000	0.000	0.000	0.050	0.150	0.200	0.000	0.000	0.800	1.000
	Other Businesses	0.000	0.000	0.000	0.000	0.252	0.252	0.347	0.109	0.292	1.000

Note: Some columns and rows may not exactly add-up owing to rounding.

Closed Input-Output Table Derivatives for the Scottish Economy to produce Type II Multipliers

Table B2.2: Technology Matrix for Ghosh Supply-Driven Type II Multipliers for the Scottish Economy, 2011, (Closed)

%	2011	Purchaser									
		Processors and Merchants: Orkney Landings of Non-Crustaceans	Processors and Merchants: Orkney Landings of Crustaceans	Processors and Merchants: North Highland Landings of Non-Crustaceans	Processors and Merchants: North Highland Landings of Crustaceans	Other Businesses	Households	Total	Misc Final Demand	Exports	Total Output
Producer	Processors and Merchants: Orkney Landings of Non-Crustaceans	0.075	0.000	0.000	0.000	0.425	0.000	0.500	0.000	0.500	1.000
	Processors and Merchants: Orkney Landings of Crustaceans	0.000	0.020	0.000	0.000	0.480	0.000	0.500	0.000	0.500	1.000
	Processors and Merchants: North Highland Landings of Non-Crustaceans	0.000	0.000	0.100	0.000	0.020	0.000	0.120	0.000	0.880	1.000
	Processors and Merchants: North Highland Landings of Crustaceans	0.000	0.000	0.000	0.050	0.150	0.000	0.200	0.000	0.800	1.000
	Other Businesses	0.000	0.000	0.000	0.000	0.252	0.347	0.599	0.109	0.292	1.000
	Households	0.000	0.000	0.000	0.000	1.000	0.000	1.000	0.000	0.000	1.000

Note: Some columns and rows may not exactly add-up owing to rounding.

ANNEX 2: The Concept of a Multiplier

The Structure of an Economy

While the interdependency of firms within an economy had long been understood, it was not until the 1920s that a Russian émigré, Wassily Leontief (1905-1999), working in the United States on the economics of production, realised that the accounts of firms (or more accurately groups of firms) could be placed side by side to provide a means of examining its precise nature.

It emerged that the sales of primary producers (farming, fishing, forestry, and mining) become the purchases of secondary producers (manufacturers and other processors) in a supply chain that runs downstream through the tertiary sector (broadly; services, retailing and distribution) to the final consumer.

The obverse of this is that the cost structure of the supply chain runs in the opposite direction upstream from the consumer with payments being made at each stage for the raw materials and other factors of production in the supply process.

Hence raw materials enter the supply chain at a high level while finished goods enter close to the end of the chain. Imports enter the supply chain at many different points depending on their state of finish.

Thus, throughout the supply chain, the sales of one firm are the purchases of another until the goods or services are exported or reach the domestic final consumer. However complex the pattern of trade between firms, the basic flow downstream always exists, with value being added at each stage.

The organic interdependency is graphically illustrated when a large company is forced to cease trading. Often upstream suppliers are left unpaid and purchasers downstream lose money paid for unsupplied goods. This is often sufficient to force some of the suppliers or purchasers out of business.

Table N2.1 below shows an abstract Input-Output Table known as the Consolidated Transactions Matrix.

In the real world, it is impossible to include all firms individually because of the dimensions of the table that would be created but Leontief realised that it is possible to group firms into industries or sectors.

A common practice in textbooks is to aggregate activity into the three basic sectors of an economy, primary, secondary and tertiary (see for example, an early contribution, O'Connor and Henry 1975).

The latest Input-Output Tables for Scotland for 2009 (2013) show firms grouped into 104 sectors.

Table N2.1: The Concept of the Sales and Purchases Transactions in the Supply Chain

£m	Year	Purchaser							
		Firm 1	Firm 2	Firm n	Total Intermediate Demand	Households	Misc Final Demand	Exports	Total Output
Producer	Firm 1								
	Firm 2								
	Firm n								
	Total Primary Inputs								
	Households								
	Imports								
	Indirect Taxes & Profits								
	Total Inputs								

This possibility to aggregate makes it possible to isolate a particular segment or firm within an entire economy and from there to determine its contribution to that economy. It is also possible to specify the particular economy to be used, enabling regional impacts to be examined, so long as the basic data are available.

Hence, Input-Output Analysis offers a rigorous means of estimating the contribution of an economic activity to an economy as a whole (Chiang 1984, offers a lucid explanation of the methodology and underlying assumptions).

Multiplier Effects

An increase in demand (or alternatively in supply), known as the direct multiplier effect, creates organic growth within an economy because the firm experiencing the increase will itself need to purchase additional factors of production upstream and supply the additional product downstream in the supply chain.

The suppliers upstream will therefore enjoy additional demand and the purchasers will absorb the additional supply. Both will need additional resources in capital and labour to cope, creating an indirect multiplier effect.

The effects continue within the economy because the profits and wages amount to an increase in income which is spent more generally throughout the economy creating further demand and supply, and further need for capital and labour. These cycles, known as induced effects, would continue to infinity were it not for the fact that on average some income is saved and this acts as a dampener in each successive cycle.

The direct and indirect effects produce a Type I multiplier. A Type II multiplier includes direct, indirect and induced effects.

Suppose, for example, for each job in a factory a further 0.7 jobs are needed indirectly in the upstream suppliers to support the original job and a further 0.4 jobs are created (induced) in the economy as a whole to support their increased spending. The Type I multiplier is 1.7 (1 direct and 0.7 indirect jobs). The Type II multiplier is 2.1 (1 direct job plus 0.7 indirect jobs plus 0.4 induced jobs).

It can readily be seen that the multipliers have both upstream and downstream effects, and these may be separated in the calculations by treating the data from the point of view of demand or supply.

Assumptions

The multipliers show the size of the part of the economy based on the basic investment. The Technology Matrix and the Consolidated Transactions Matrix from which it is derived are linear. This implies constant returns to scale from any given levels of output, income and employment.

While the linearity is safe for small changes around the existing levels of output, income and employment, increasingly large changes mean that any non-linearity in the technology will not be observed. Hence it does not necessarily follow if the basic investment were removed, that all the employment, for example, based on it would be lost.

It is also assumed that there are supplies of all resources available including labour necessary to meet the needs of any increased investment.

The Problem of Households

A further conceptual problem arises from the question of where to place the household sector in the Input-Output Table. Households have a dual role in the economy.

The first of these roles is as a final consumer, and hence they may be included in the final consumption segment of the Consolidated Transactions Matrix. This places them outside the shaded area of inter-dependent business activity and labour income has to be included in the secondary inputs below the total of primary inputs.

This approach to the position of the household sector offers the possibility of calculating the Type I multipliers showing the direct and indirect effects of the presence of an industry. The Consolidated Transactions Matrix produced is described as Open and the expenditure of households need not equal the income from labour.

An alternative approach is to treat households as businesses which supply labour services and receive payment in return. This approach places the household sector firmly in the central shaded part of the Consolidated Transactions Matrix and offers the Type II multipliers, describing the direct and indirect effects of the Type I multiplier, and also the induced effects. The Consolidated Transactions Matrix is then said to be partially closed.

The Consolidated Transactions Matrix may be constructed so that household expenditure and labour income balance. This Closed matrix arises when savings are treated as a cost to the household business of supplying labour.

Estimation Procedure

In order to calculate, it is necessary to Constructing a Consolidated Transactions Matrix of the form shown in Table N2.1 above enables the Leontief (1951) demand-driven multipliers to be calculated. For illustrative purposes this is reduced further to Table N2.2 below and is shown, by convention, with the household sector excluded from the central core.

Table N2.2: The Consolidated Transactions Matrix

€		Purchases by				
		Processing & Merchants: Orkney	Processing & Merchants: N. Highland	All Other Sectors	Final Demand	Total Output
Producer	Processing & Merchants: Orkney	x_{11}	x_{12}	x_{13}	d_1	x_1
	Processing & Merchants: N Highland	x_{21}	x_{22}	x_{23}	d_2	x_2
	All Other Sectors	x_{31}	x_{32}	x_{33}	d_3	x_3
	Primary Inputs	y_1	y_2	y_3		
	Total Inputs	x_1	x_2	x_3		

Table N2.3: The Technology Matrix

		Purchaser		
		Processing & Merchants: Orkney	Processing & Merchants: N. Highland	All Other Sectors
Producer	Processing & Merchants: Orkney	a_{11}	a_{12}	a_{13}
	Processing & Merchants: N Highland	a_{21}	a_{22}	a_{23}
	All Other Sectors	a_{31}	a_{32}	a_{33}

From the central core (the grey shaded area) of the Consolidated Transactions Matrix, a Technology Matrix, shown above in Table N2.3, is constructed where $i=1$ to n and $j=1$ to n , where n is the number of sectors in the economy.

The elements $a_{i,j}$ are the percentages of Total Input

$$a_{i,j} = \frac{x_{i,j}}{x_j}$$

The Technology Matrix, T , shows, for example, that a unit of production of the fish processing sector requires $a_{1,2}$ units of input from the fishing sector (landed fish), $a_{2,2}$ units from the fish processing sector (e.g. fish traded with another processor) and $a_{3,2}$ units of other products (capital equipment, energy, professional services etc.) from the rest of the businesses in the economy.

Mathematically, the model can be expressed as

$$Tx = d \text{ and } (I - A)x = d$$

where x is the vector of outputs, d is the vector of final demand, I is the Identity Matrix and A is the matrix of input coefficients $a_{i,j}$.

If T is non-singular, the unique solution, \bar{x} , will be

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

The upstream or demand-driven component of the output multiplier is the sum of each column, i , of the matrix $(I - A)^{-1}$ and for industry j is

$$\sum_{i=1}^n b_{i,j}$$

The upstream or demand-driven component of the income multiplier is the total interdependency on income, h , divided by the direct income dependency for industry j and can be expressed as

$$\frac{\sum_{i=1}^n b_{i,j} h_i}{h_j}$$

The upstream or demand-driven component of the employment multiplier is given by

$$\frac{\sum_{i=1}^n b_{i,j} \alpha_i}{\alpha_j}$$

where α is the employment coefficient defined as the employment per unit of output (in other words, the inverse of per capita productivity).

For supply-driven multipliers the elements of the Technology Matrix are the percentages of Total Output in the relevant row (Ghosh 1958) and the same approach to estimating the multipliers may then be followed.

When the household expenditure column and the household income row are included in the intermediate (shaded) sector of the Consolidated Transactions Matrix, then both the Leontief Type II and the Ghosh Type II multipliers may be estimated.

However, in summing the columns of the inverse of the Technology Matrix, $(I - A)^{-1}$, to obtain the output multipliers, the household row must be omitted because the objective is to measure the effect on output in the original industrial sectors.

The multipliers calculated this way may then be applied to the values of output, income and employment to be found in the original Consolidated Transactions Matrix to estimate the levels of output, income and employment dependent on the economic activity of, in this case, the Fish Processing Industry and Fish Merchants of Orkney and the Fish Processing Industry and Fish Merchants of North Highland.

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