SOME ASPECTS OF THE IMPACT OF OIL ON THE SHETLAND ECONOMY

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ABSTRACT

This study analyses the impact of oil-related developments on output, incomes and employment in Shetland. An Input-Output approach is adopted based on a Shetland transactions table constructed by the author. Using this, the pre-oil Shetland economy is analysed as base for assessing oil impact. Three major oil activities are identified and their local effects estimated: Supply Bases, the Sullom Voe Tanker Terminal, and Oil-related Construction. Estimates of the impact of these on local activity are given in aggregate and on an individual industry basis. Appropriate oil sector 'multipliers' are derived. Attempts are made to modify the basic estimates by allowing for 'negative multiplier' effects, induced investment and other elements of impact excluded in the basic model. Finally, the possibility of oil-induced changes in local technology is considered and its implications for the preceding impact estimates discussed. In the conclusions the results of the previous analysis are drawn together and some policy implications suggested by them are considered briefly.

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CONTENTS

INTRODUCTION

The impact of a new industry on a regional economy will depend on the technological and economic characteristics of both the industry and the region. This is especially striking in the case of North Sea Oil and Shetland, where the geographical position of the North Sea fields, and the difficult weather conditions found there, ensure that fairly sophisticated industries related to the former will be situated in the semi-industrialised economy of the latter. This study attempts to analyse and measure the effects of local oil-related activities on the economy of Shetland, particularly on the changes induced in local outputs, incomes, and employment.

The study is based primarily on an empirical implementation of the Input-Output methodology. This latter framework is particularly useful in the present context, for not only does it provide detailed estimates of the impact of new industrial developments within a region, but is sufficiently flexible to permit considerable variation in the assumptions and variables included and excluded in the analysis. The latter attribute is particularly useful in the present context where the local impact of oil is likely to be large in magnitude and wide-ranging in effect. Furthermore, an Input-Output table reveals much of the industrial structure which is essentially technological in nature, and hence provides a framework for analysing economic repercussions of technological change; the latter being another possible result of local oil developments.

Chapter One describes the structures of the Shetland economy and population immediately pre-oil, and the development of these in the preceding decade. A final section briefly updates some of the more important figures as far as possible. Chapter Two develops the basic theoretical framework used in the subsequent analysis. No attempt is made to provide a comprehensive survey of Input-Output literature; rather aspects of the model, such as multiplier derivation and impact analysis, relevant to the present study are emphasised. Chapter 3 describes the 1971 Input-Output table constructed for Shetland and the conventions employed in its construction. Detailed empirical study of the structure of the local economy follows, including the derivation of a number of 'multiplier'-type relationships for each local industry. Chapter 4 uses the Input-Output table derived in Chapter 3 to analyse the local impact of oil-related developments. Three major areas of oil activity in Shetland are identified: Oil Supply Bases, the Sullom Voe Terminal, and Oil-Related Construction, and the impact of each in <u>isolation</u> on local output, income, and employment, estimated. Subsequently, the impact of oil in 1982 is forecast to provide an idea of the magnitude of impact when all three activites described above are in operation <u>simultaneously</u> in the local economy. Chapter 5 discusses, largely qualitatively, some other considerations which may affect the empirical magnitude of oil impact. The areas specifically examined are: 'negative multiplier' effects, effects on non-oil Final Demand, and local Supply constraints. Since phenomena of this type generally involved departures from the standard Input-Output assumptions, they have been discussed infrequently, and at best, cursorily, in previous Input-Output studies. As the analysis of this chapter indicates, their importance may have been underestimated hitherto. Chapter 6 attempts to analyse the possibilities of oil-induced technological change in local industries <u>ex ante</u>, and to begin to translate any such predicted changes into Input-Output form. In this way technological change can be transformed into economic variables, and the economic implications of the change readily assessed. This chapter represents a radical departure from previous Input-Output work, and as such required new model development for its implementation. In the chapter, a simple framework for analysing and classifying processes of induced technological change is developed, and the potentiality for oil-induced technical changes in Shetland examined within this framework. Chapter 7 presents the conclusions derived from the preceding analysis, and discusses some policy implications suggested by them. Appendix I discusses the methodology used to derive the migration flows discussed in Chapter I. Appendix II describes, industry-by-industry, the methods of data collection and processing employed in the construction of the Input-Output Table. Appendix III discusses the derivation of the oil industry expenditure data used in the basic measurements of oil local impact. Finally, Appendix IV gives some examples of the questionnaires employed throughout the study to generate the empirical data base.

CHAPTER 1 : Population and Employment Structure of Shetland

This chapter provides an introduction, and background, to the detailed economic analysis of Chapter 3. In particular, the Input-Output table for 1971 described in that chapter is complemented by the discussion of this chapter, which, using rather more accessible data, is able to examine some of the historical trends which led to the particular structure which emerged in 1971. Section 1 analyses pre-1971 developments in the population of Shetland and Section 2 examines Shetland employment statistics over a similar period. Shetland's Gross Regional Product, Personal Income and Trading pattern, will be discussed in Chapter 3.

1. The Population Structure of Shetland

a) The Shetland population over time

Table 1.1 shows the total population decenially since 1911, as well as inter-censal changes over the same period.

Table 1.1: Total Population of Shetland 1911-71 and inter-censal changes[1]

	Total Population	Change per period
1911	27,911	-
1921	25,520	-2391
1931	21,421	-4099
*1939	19,868	-1553
1951	19,352	-516
1961	17,812	-1540
1971	17,327	-485

* mid-year estimate.

As Table 1.1 clearly demonstrates, while the absolute magnitude of decline varied substantially between period-to-period, the population of Shetland has declined continuously over the period as a whole.[2] The total reduction in population during this sixty years was very substantial:

1. Source: Census of Population; Zetland County Report 1971, Table 1.
2. 'Continuously' only over the point measurements given in Table 1.1. It is quite possible that in some shorter period, population may have increased before a subsequent greater decline, or indeed may have declined further than indicated in Table 1.1 before being subsequently partially offset by a later rise. An important instance of the latter will be considered in the text.

the population in Shetland in 1971 was only 62% of that in 1911. Changes in total population, such as those indicated in Table 1.1, can be caused either by differing rates of birth and death or by net migration, or by some combination of both. Each of these possibilities is considered in turn: firstly, the birth and death rates in Shetland at five year intervals from 1911 to 1970 are given in Figure 1.1.[3] As these graphs show, the death rate has been considerably greater than the birth rate for most of the period, indicating that at least part of the population decrease over the sixty years is as a result of an excess of deaths over births. However, as Figure 1.2 indicates, over the most recent decade 1961-71, the birth rate has generally been above the death rate, indicating a 'natural' increase in population during the period.

Figure 1.1. also gives the Scottish birth and death rates over the equivalent period. Comparison of the respective rates indicates that the birth rate is significantly lower in Shetland while the death rate is significantly higher. It should be borne in mind however that the birth and death rates in Figure 1.1 are 'crude' i.e. not corrected for age and sex differences in the structures of the respective populations.[4] As will be discussed in the following section, the proportion of older persons in Shetland is considerably greater than that in Scotland as a whole. Since the death rate among old persons is relatively high, this fact alone will tend to raise the proportion of population dying in Shetland above the Scottish figure. Furthermore, the proportion of population 'at risk'[5] in Shetland is smaller, so that identical fertility rates in Shetland and Scotland would imply a lower birth rate in the former. The Registrar General provides birth and death

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3. All figures are at the end of the chapter.

4. The figures are however adjusted for normal residence.

5. Defined to be the proportion of the population who are women aged 15-49. In 1971, this proportion was 0.39 and 0.43 in Shetland and Scotland respectively.

rates for Shetland and Scotland which are standardised to a common age and sex structure. While it would be tedious to give series of these here, it is worth pointing out that during the decade 1961-71, the standardised birth and death rates for Shetland are respectively higher and lower than those for Scotland, indicating that differences in the crude rates are significantly influenced by differences in the age and sex structures of the two populations.

b) The age/sex structure of the Shetland Population

Table 1.2 shows the breakdown of the Shetland population by major age groups, both male and female. Equivalent figures for Scotland and the Rest of the Highlands[6] are included for comparative purposes. As the Table shows, the proportion of the total population accounted for by males is very similar in all three cases, being 48.8%, 49.4%, and 48.8% for Shetland, Scotland, and the Rest of the Highlands respectively. Hence there is nothing unusual in the sex structure of the Shetland population, but Table 1.2 also shows that there are significant differences in the male and female

Table 1.2: Age Structure Comparisons[7]

Age Group	Percentage of total population 1971					
	Shetland		Scotland		Other Highlands	
	M	F	M	F	M	F
0-15	11.8	11.2	13.3	12.6	12.8	12.1
15-65 (M) 60 (F)	30.2	26.4	30.4	28.5	30.0	26.4
65 (60)+	6.8	13.8	4.7	10.6	6.0	12.7

age structures among the three populations. Firstly, the proportion of the population of working age is lower in Shetland than in Scotland as a

6. The 'Rest of Highland' counties are Argyll, Caithness, Inverness, Ross and Cromarty, Sutherland, and Orkney.

7. Sources: Shetland and Highlands: Respective 1971 Census Reports Table 8. Scotland: 1971 Census, Table N2.1.

as a whole, almost entirely because of a lower female component in this age group. The percentages of the population of working age in Shetland and the rest of the Highlands are almost identical, however. The implications of this are that, ceteris paribus, less labour will be available locally in Shetland than in Scotland, and that the labour force that does exist will have a higher dependent population to support. Secondly, the proportion of the population over retirement age is considerably greater in Shetland at 20.6% than either Scotland (15.3%) or the rest of the Highlands (18.7%).

Closer inspection of the Shetland and Scotland age structures demonstrates that in most ten-year age groups for both sexes the proportion of the population is less in Shetland than in Scotland up to about 40-50 years and thereafter greater. A summary measure of the 'oldness' of the population is the age index[8] which in 1971 was 41.1 for Shetland, 39.0 for the rest of the Highlands and 35.2 for Scotland.

c) Changes in the Age/sex Structure over time

Section (a) discussed the changes in the total population over the sixty years 1911-71 while section (b) examined the age and sex structure at one point in time: 1971. In this section, these two facets of population analysis will be brought together to analyse the way in which population changes over the preceding decade shaped the structure which emerged in 1971. Table 1.3 shows for five year age groups, both male and female, the net changes in each age group over the decade 1961-71. The changes in table 1.3 are, of course, only the end result of the processes of births, deaths, ageing, and migration over the period but are of some interest in themselves. Firstly, the table makes it apparent that

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8. The age index of a population is defined to be the percentage of that population over the age of forty-five. While the cut-off age is arbitrary, it is conventional.

Table 1.3 : Incensal changes in Population by sex and age groups 1961-71

Age group	Males 61	Males 71	Δ	Females 61	Females 71	Δ 1
0-4	640	710	+70	620	680	+60
5-9	712	715	+3	636	680	+44
10-14	739	620	-119	667	595	-72
15-19	572	585	+13	585	550	-35
20-24	498	610	+112	452	515	+63
25-29	478	565	+87	495	530	+35
30-34	521	505	-16	482	470	-12
35-39	582	480	-102	535	465	-70
40-44	474	475	+1	603	515	-88
45-49	583	565	-18	603	515	-88
50-54	587	405	-182	688	495	-193
55-59	568	530	-38	668	555	-113
60-64	491	490	-1	588	610	+22
65+	1065	1170	+105	1752	1782	+30
Total			-85			-405

Sources: Census 1961, Table 6; 1971, Table 8.

the overall decline in the population of Shetland was not spread evenly either between the sexes or among the various age groups in both sexes. The fall in the female population was over 80% of the total fall in population over this decade. This had the effect of raising the male/female ratio from 1.06:1 in 1961 to 1.15:1 in 1971. Furthermore, the overall decline in Shetland's population conceals the fact that in certain age groups, for both men and women, the population actually increased over the period. Notable in this respect are the increases for both sexes in the age groups 0-4, 20-29, and 65+. These increases are, of course, more than offset by declines in other age groups especially 35-39 and 50-59.

d) Migration

Migration is a population variable of particular importance in small regions because substantial migration can radically alter the size and structure of the population in a very short space of time, swamping changes brought about by 'natural' causes (i.e. births and deaths). Unfortunately it is virtually impossible to estimate gross migration flows at the regional level, but a method of estimating net migration by age and sex is described in Appendix I.

While, for reasons explained in the Appendix, the detailed breakdown of net migration figures cannot be regarded as completely accurate,[9] the details in Tables 1.4 and 1.5 are very interesting. It should be pointed out that 1966 was also a full Census year for Shetland so that migration estimates for five year periods can also be derived.

Considering Table 1.4(2) first, the overall net emigration for the decade 1961-71 was 677 persons. This is greater than the actual change in population over the period, which is to be expected since the birth

9. The estimate of total net migration will be accurate, however.

Table 1.4 : Net Migration in Shetland by Age/Sex for 1961-66 and 1961-71

(1)

1961-1966	M Actual*	M Natural	M A-N	F Actual	F Natural	F A-N
0-	712	711	+1	695	684	+11
5-	624	668	-44	593	615	-22
10-	667	704	-37	608	639	-31
15-	1142	1201	-59	1025	1132	-107
25-	973	1042	-69	918	1012	-94
35-	1044	1029	+15	999	1028	-29
45-	990	1097	-107	1094	1184	-94
55-	1013	1086	-73	1279	1252	+28
65-	731	704	+27	982	1033	-51
75-	409	392	+16	747	740	+7
Total			-330			-382

(2)

1961-1971	M Actual**	M Natural	M A-N	F Actual	F Natural	F A-N
0-	710	722	-12	680	703	-23
5-	715	667	+48	680	641	+39
10-	620	677	-57	595	636	-41
15-	1195	1275	-80	1065	1193	-128
25-	1070	1130	-60	1000	1084	-84
35-	955	1042	-87	910	1028	-118
45-	970	1032	-62	1010	1098	-88
55-	1020	1080	-60	1165	1188	-23
65-	785	724	+61	1025	1011	+14
75-	385	340	+45	760	721	+39
Total			-264			-403

Net emigration April 61-April 66: -712
-April 71: -677

* Census 1966 Table 2
** Census 1971 Table 8.

Table 1.5 : Net Migration in Shetland by Age/Sex 1966-71

Formula for Actual population 1971 (A_{71}) = Actual population each age group: 1966 (A_{66}) + Natural change in population from 1966-71 ($N_{61-71} - N_{61-66}$) + net migration.

$\therefore$ Net migration in each age group $= A_{71} - A_{66} - N_{61-71} + N_{61-66}$

$$= (A_{71}-N_{61-71}) - (A_{66}-N_{61-66})$$

Results from Table 2:

Net migration April 1966-April 1971:

	M	F
0-	-13	-34
5-	+92	+61
10-	-20	-10
15-	-21	-21
25-	+9	+10
35-	-102	-89
45-	+45	+6
55-	+13	-51
65-	+34	+65
75-	+29	+32
Total	+66	-31

Net immigration 66-71: +35.

and death rates alone would have implied a 'natural' increase in population. This emigration loss is 3.8% of the 1961 population, a figure which compares favourably with Scotland's net emigration loss over the period (6.2% of 1961 population).[10] Again the net emigration among females is higher than among males, though the difference is less marked than in actual population change. There is generally substantial net emigration for most age groups, the exceptions being 5-10 and over 65 for both sexes where there is net immigration over the decade. The latter is fairly general in rural areas such as Shetland to which older persons retire, but the former is surprising and difficult to interpret on Table 1.4(2) alone.

Tables 1.4(1) and 1.5, which cover net migration in the quinquenniums 1961/66 and 66/71 respectively, shed further light on the migration pattern in Shetland over the decade as a whole. The most significant implication of these tables is that at some point during the decade[11] the pattern changed from one of net emigration to one of net immigration overall, yielding a small but positive net immigration total for the period 1966/71. Noticeably, the net immigration is totally in males, though the net emigration total for females during 1966/71 is substantially less than that for the earlier half of the decade.

Furthermore, while net immigration of older persons took place during both quinquenniums, the net immigration of 5-9 year olds was concentrated solely in the period 1966/71. It is tempting to tie this net immigration of children with the net immigration of 45-55 year old parents since this age group also shows net immigration of both sexes over the period.[12] If this interpretation is accurate, and it is largely confirmed in

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10. Source: A.R.G.S. Table 01.1 (Estimate only).

11. It is of course impossible to identify the precise year from 5-year average figures.

12. The fact that the net immigration figures for men and women in this age group are not equal is, of course, irrelevant since, for example, incoming men may have wives in a younger age group. In fact, Table 1.5 does show that the net emigration of women is less than that of men in the age group 35-45, which lends some support to this proposition.

local sources, it could lead to improved stability in Shetland's population, both in terms of total numbers and in actual identity of residents, since middle-aged families with young children are likely to be less mobile than younger persons.

2. The Employment Structure of Shetland

a) The 1971 structure

This section examines the employment structure of Shetland as it existed in 1971. The only data source available on an annual basis are the employment statistics provided by the D.E.P.'s ERII records. Since, in a subsequent section, the changing pattern of employment in Shetland over time is to be discussed, this source will provide the main basis of employment estimates throughout. However, the DEP figures are not without problems, one of the main ones being that self-employed persons are excluded, as are many part-time and spare-time workers.[13] These omissions are potentially a serious source of distortion, since in a small rural community such as Shetland, the number of persons falling into such categories is likely to be relatively large.

In the course of compiling the Input-Output Table, a comprehensive account of employment in Shetland was gathered from a variety of sources, including sample survey. Table 1.6 gives these industry employment estimates and the corresponding DEP figures for comparative purposes. As the figures show, the main differences between the two data sets, allowing for the varying methods of data collection and differences in industry definition, are in the Agriculture and Textile industries where the DEP figures grossly underestimate the number of persons employed. However, as discussed later, the number of employees in the first column could be misleading insofar as many of these employees are only part- or spare-time and will be counted in more than one industry. The figures

13. For a discussion on the use of employment statistics, see Mackay and Buxton (1965).

Table 1.6 : Employment Structure of Shetland 1971

Industry	No. of persons McNicoll	DEP
Agriculture	1384 (517)	58
Fishing	636 (517)	550
Quarrying	30	9
Fish Processing	723 (699)	808
Ship Repair	90	90
Textiles	2738 (658)	406
Other Manufacture	122	122
Construction	650	620
Utilities	60	57
Transport	383 (328)	248
Communications	250 (175)	137
Distribution	901 (812)	768
Professional Services/ Banking & Insurance	967 (867)	842
Other Services	421 (308)	352
Local Government	417	432
Total	6772 (6250)	5499

in brackets give a more accurate estimate of the number of full-time equivalent jobs in each industry where these are significantly different from the unbracketed figures.[14]

As mentioned above, for the rest of this chapter, the discussion will utilize the DEP figures, though the distortion thereby introduced should be borne in mind. The importance of Fishing and Fish Processing[15] is immediately apparent, these two industries accounting for almost 25% of total Shetland employment in 1971. Textiles (primarily knitwear) is the only other manufacturing industry of real importance, accounting for over 7% of total employment.

It is common in employment analyses to differentiate between 'Basic' and 'Service' sectors, usually implying the dependence of the latter on the former.[16] Such a distinction, which is always to a greater or lesser extent arbitrary and of dubious analytical merit, is entirely unnecessary in the present study since the various inter-dependencies in the economy are thoroughly explored in the discussion of the Input-Output table.

Table 1.7 gives the male/female breakdown of employment in Shetland in 1971 for major industry groups with the equivalent Scottish figures[17] included for comparative purposes.

Even at this level of aggregation, differences in the structures are revealed: the proportion of total employment in each of Primary, Construction, and Services is greater in Shetland than in Scotland, while in Manufacturing the proportion in Shetland is considerably less.

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14. See page 72 for discussion and method of conversion to full-time equivalence.
15. As the Input-Output Table will show, these industries are highly interrelated. See also Greig (1972).
16. See, for example, Tiebout (1962).
17. Source: British Labour Statistics Yearbook 1971 Tables 53 and 54.

Table 1.7 : Male/Female Employment in Shetland

Industry	per cent of total employment					
	Shetland			Scotland		
	Male	Female	Total	Male	Female	Total
S.I.C. Primary I-II	11.2	-	11.2	4.3	0.5	4.8
Manufacturing III-XVI	15.2	9.6	24.8	23.5	12.0	35.5
Construction XVII	11.0	0.2	11.2	8.1	0.5	8.6
Services XVIII-XXIV	26.9	25.9	52.8	24.8	26.3	51.1
$\sum$	64.1	35.1	100	60.7	39.3	100

Given the rural nature of Shetland, it is not surprising that the economy should be relatively specialised in Primary industries such as Agriculture and Fishing, while the lack of heavy industry in the locality explains the low manufacturing proportion. The greater proportion in activity in Construction in Shetland is perhaps explained by the respective positions of the two economies in their trade cycles: the Shetland economy, as will be discussed in the next section, was at the peak of a boom in 1971 because of the high levels of activity in the Fishing, Processing and Textile Industries simultaneously; the Scottish economy as a whole, on the other hand, was in a depression during that year because of recession in the very (heavy) manufacturing industries absent in Shetland.

Comparison of the male/female employment breakdown for both economies is also very interesting. As expected, in both the bulk of employment is male with female activity greatest in Service industries. However, Table 1.7 reveals that in all industry headings, the proportion of total employment accounted for by females is less in Shetland than in Scotland.

It is beyond the scope of the present study to determine whether the lower level of female activity in Shetland is caused predominantly by local social and other considerations resulting in a reluctance of females to enter the workforce (i.e. 'supply' factors) or by differences in relative male/female opportunities in the local labour market (i.e. 'demand' factors), though it would seem both types of forces operate to some extent.

b) Changes in the structure of Shetland Employment 1961-71

As measured by the DEP, total employment in Shetland in each year 1961-71 is shown in Figure 1.2.

The scales of the respective axes rather exaggerates changes in employment, which were small absolutely over the decade. In fact, total Shetland employment in 1971 was very little different from that in 1956. Differences in industry definitions and inclusion/exclusion criteria bedevil any analysis of employment time series statistics. For example, it was ascertained from the Lerwick Employment Exchange that the apparent decline in employment during 1968-70 was largely due to the exclusion of a group of fishermen hitherto included in the DEP figures, and included again in 1971. The dotted curve gives an approximate correction for this.
Although the changes in total employment in Shetland were small, unemployment figures for 1966-71,[18] reveal a steady annual decrease in the numbers wholly unemployed:

Table 1.8 : Unemployed in Shetland 1966-71

	Wholly unemployed in Shetland	
Year	January Peak	July Minimum
1966	611	310
1967	515	311
1968	563	251
1969	527	241
1970	432	163
1971	360	170

These figures substantiate local claims of a recovery of the Shetland economy in the late sixties and early seventies, particularly since, as was seen earlier, this period was one of net immigration.

18. The only years made available.

Table 1.9 indicates the changes in employment at various industry levels between 1961 and 1971. Again, it should be stressed that small variations cannot be given much credence because of various comparability problems associated with data collection and compilation.[19] Also it is not certain that these two years are at comparable points in the trade cycle. However, the purpose of this section is to indicate the recent development of the Shetland economy in broad outline rather than detail, and the data permits this.

Table 1.9 : Changes in Shetland Employment by Industry 1961-71

	absolute Δ employment		
Industry	M	F	T
Primary	+8	-57	-49
Manufacturing	+407	+269	+676
of which:			
Fish Processing	+221	+101	+322
Textiles	+110	+180	+290
Construction	-40	-9	-49
Services	-480	+133	-343
of which:			
Transport and Communications	-180	-2	-182
Distribution	-108	+2	-106
All industries	-105	+336	+231

Table 1.9 is most revealing: overall employment in Shetland was somewhat higher in 1971 than in 1961 (but not than in 1963, see Figure 1.2), but the increase was not evenly distributed between the sexes nor among the various industries. Male employment was in fact lower in 1971 than in 1961, however Figure 1.3 shows that male employment was fairly volatile throughout the decade and thus the difference, in a single year comparison, may not be significant. Female employment, on the other hand, although considerably higher in 1971 than in 1961, was remarkably stable over the decade, the increase being almost wholly attributable to two upward 'steps' in 1962 and 1971 itself. The figures suggest that, in total, job opportunities for women were more stable than those for men throughout the decade.

19. A major problem arises in the adoption of a new industrial classification (SIC) in 1968. However, the DEP provided adjustment details to make figures based on the different classifications as comparable as possible.

Manufacturing industry grew continuously throughout the decade, and manufacturing employment in both sexes is considerably higher in 1971 than in 1961. As table 1.9 indicates, most of the overall increase in manufacturing employment was accounted for by increases in Fish Processing and Textiles. Service industry, on the other hand, declined between 1961 and 1971, but in this instance the overall decline consisted of a substantial male decline, partially offset by a rise in female employment. In fact, further analysis of the data indicates that even female service employment declined somewhat in the latter half of the decade. Interestingly, although the trend in service employment throughout the decade was downwards, the proportion of total employment accounted for by Services in Shetland was still higher than that in Scotland in 1971 (see Table 1.7). Again, a substantial proportion of the overall decline in Services was accounted for by declines in two industries, Transport and Communications, and Distribution.

Wagstaff (1973) has examined changes in manufacturing and service employment in a number of Scottish counties, including Shetland, for the period 1951-66 and concludes:

> "In the Crofting Counties the drop in basic employment from 1951-61 ... left the region oversupplied with services .... Service employment in the subsequent five years fell ... absolutely."

It seems probable that a lagged relationship of this sort between service and manufacturing employment explains the observed changes in each in Shetland during 1961-71, but a detailed analysis of the reasons for Shetland employment changes before oil development is beyond the scope of the present study.

<u>Recent Developments</u>

Since 1971, changes in population and employment in Shetland have been dominated by local oil related development. While past trends will to some extent continue to influence the present, the magnitude of oil activity relative to the pre-existing structure is such as to cause substantial discontinuities, and even reversals, in previous trends. Data on more recent years is less reliable at present than the years up to 1971 because of lags in availability and interpretation. In particular, the annual population estimates of the Registar General are less reliable than the Census figures for 1971. However these estimates nevertheless clearly indicate a continued increase in population in Shetland: 17,740 in 1972 and 18,386 in 1973. Local sources have expressed the view that population has continued to rise since. The net migration component of this increase is estimated to be +350 in 1972 and +568 in 1973. No details of the age/sex structure are available, but it is clear from local sources that immigrants are now largely persons of working age coming to Shetland for oil related employment.

Employment has also risen: 5,700 in 1972 and 5,900 in 1973. Not surprisingly, construction employment has been growing: from 600 in 1971 and 1972 to 700 in 1973. Further growth in Construction employment is inevitable, and a construction force of well over 1,000 before the end of the decade probable. The remainder of the growth was entirely in the Service sector, reversing the trends of the previous decade.

The increase in employment was entirely concentrated in male employment, the level of female employment being the same in 1973 as in 1971. Interestingly, though employment rose by about 500 persons between 1971 and 1973, local wholly unemployed only decreased by approximately 60 persons between July 1971 and July 1973, confirming the point of the preceding paragraph that immigration during the period was primarily to take up employment.

Conclusions

This chapter has shown the development of the Shetland economy in the period immediately preceding oil activity. The population of Shetland has been shown to have declined continuously over a long period. This trend, however, was reversed in the period 1966-71 where the combination of a 'natural' increase and net immigration caused a growth in population over the quinquennium. This net immigration included net immigration in working age groups as well as in retirement age groups. The Shetland population was found to be 'older' than that in Scotland and the rest of the Highlands, though rather more similar to the latter.

In employment terms, Manufacturing was shown to have increased considerably over the decade 1961-71 for both males and females. This growth was almost entirely concentrated in two industries: Fish Processing and Textiles. These industries are notoriously volatile, the former because of the great variability of fish supply from one season to the next, the latter because Shetland knitwear has always been directed at the fashionable end of the market and is subject to the whims which fashion imposes.

Total employment was reasonably stable over the period with such 'peaks' as there were in 1963, 1966 and 1971, and 'troughs' in 1961, 1965 and 1970. Almost all the variability in total employment was in male employment, with female employment being remarkably stable over the decade. Male employment was rather lower in 1971 than 1961, primarily due to substantial reductions in male Service Industry employment. Female employment on the other hand, was higher in both Service and Manufacturing industries in 1971 than in 1961.

Finally, the movements of both population and labour over the period will tend to affect the activity rates[20] for both sexes, which are given for selected years in Table 1.10.

The fact that both male population of working age and male employment declined over the decade tended to keep the male activity rate fairly constant. On

20. Defined as $\frac{\text{actual employment M/F}}{\text{population of working age M/F}}$.

the other hand, female employment rose over the decade in spite of continued decline in female population of working age, and hence as Table 1.10 shows, female activity rates tended to rise during the period.

Table 1.10

	Activity Rates		
	1961	1966	1971
M	0.70	0.68	0.71
F	0.31	0.39	0.44.

Fig 1.1 Birth & Death Rates in Shetland and Scotland 1911)-70

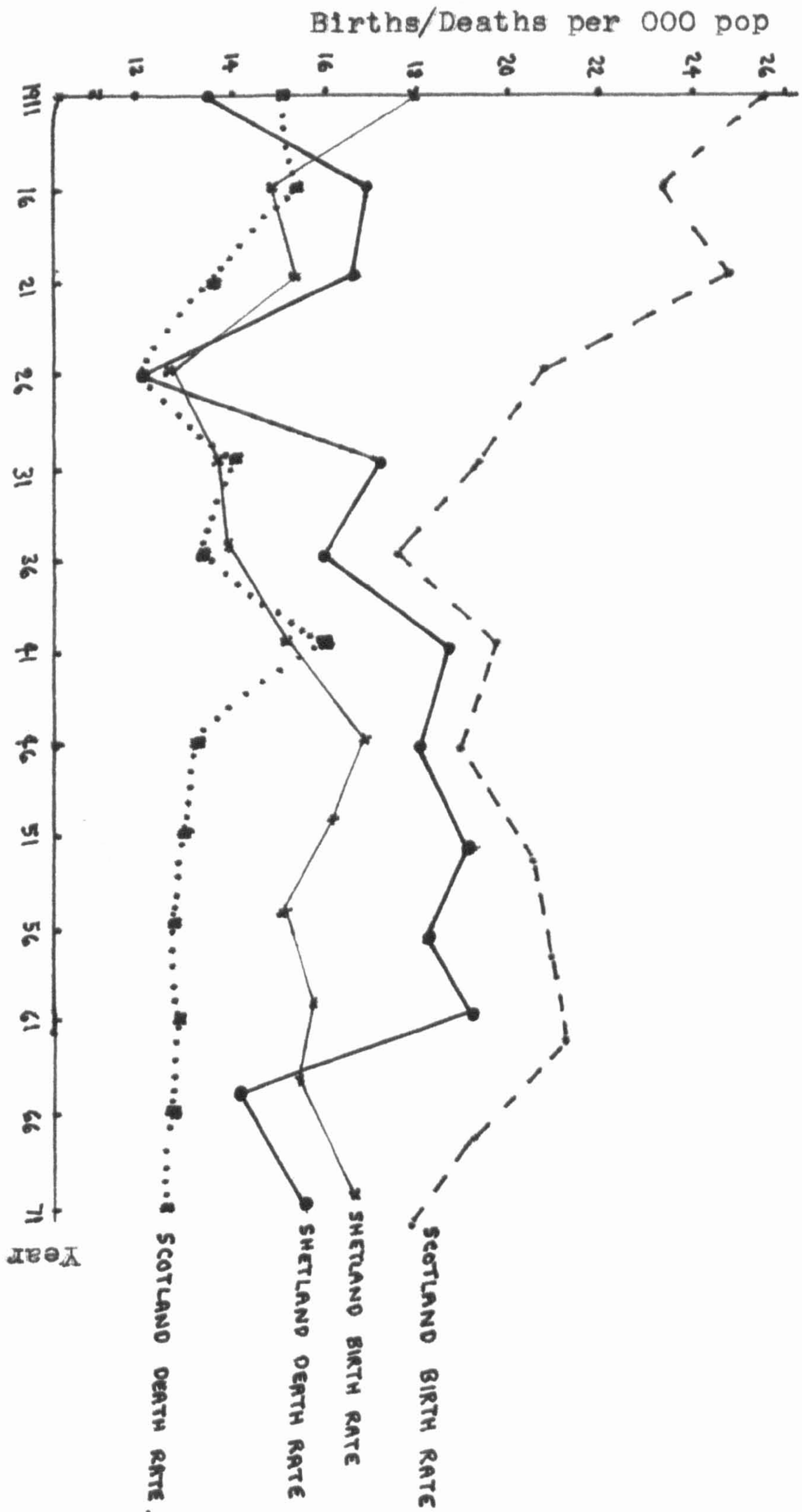


Fig 1.2 Employment in Shetland 1961-71

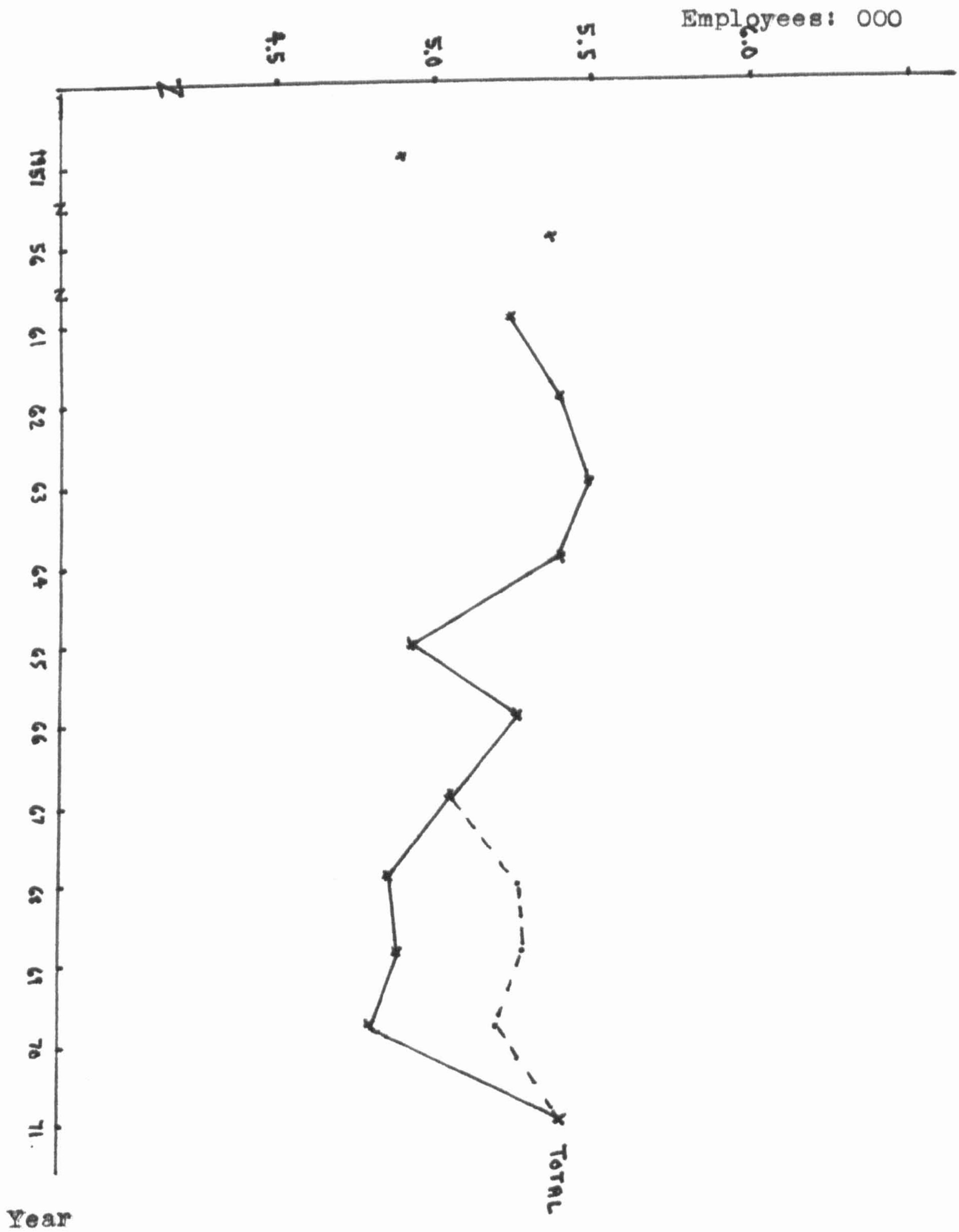
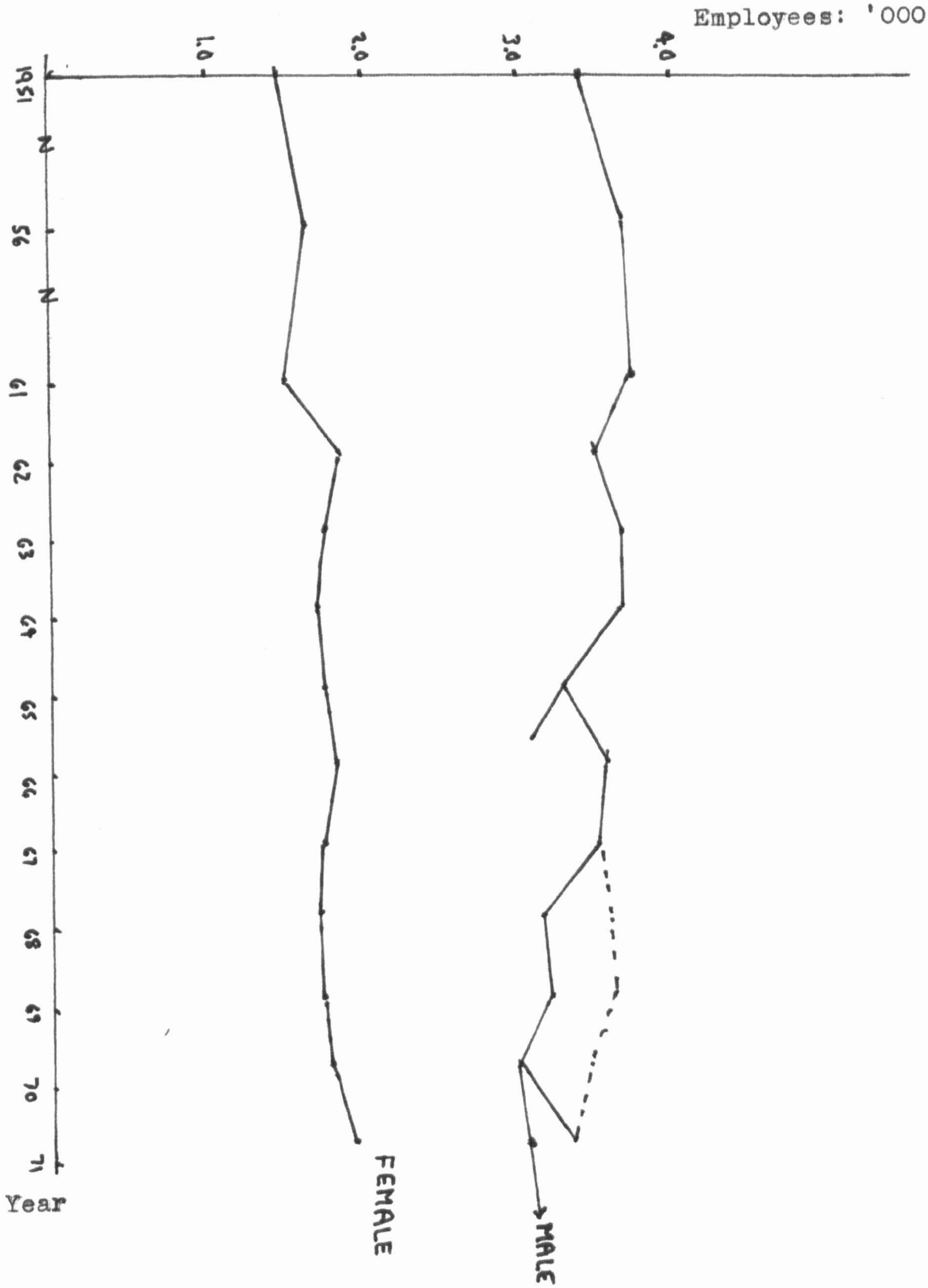


Fig 1.3 Male/Female Employees in Shetland 1961-71



CHAPTER 2 Input-Output Theory

1. This chapter outlines those elements of Input-Output theory and methodology employed in the subsequent empirical analysis. No attempt is made here to survey the entire theoretical literature of Input-Output, which is extensive and growing continually,[1] and a review of previous applied Input-Output work is left almost entirely to later chapters, particularly Chapter 3. Section 1 discusses briefly the advantages and disadvantages of Input-Output compared with the two other major regional impact methodologies: Keynesian multiplier and Economic Base. Section 2 presents relevant basic Input-Output theory; including basic multiregional theory. Section 3 outlines the model employed in the Shetland study, and finally, section 4 discusses the definition and derivation of various 'multiplier' concepts which are used extensively in subsequent analysis.

Section 1 Comparison of Alternative Impact Methodologies

As will become apparent subsequently, the use of Input-Output in an applied context requires the collection and careful processing of a large volume of empirical data. Since the alternative impact methodologies generally employ less empirical material, the use of Input-Output in a situation of resource constraint must be justified. Essentially, the Keynesian multiplier and Economic Base techniques fail relative to Input-Output analysis in three areas[2]: level of detail, coverage of secondary impact, and flexibility. Though these three limitations are not entirely

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1. See, for example, Input-Output Bibliography 1966-70 (1972).
2. A detailed review of Keynesian Multiplier and Economic Base techniques is beyond the scope of the present study. For early development of the former model in a regional context see Archibald (1967) and Wilson (1968), while Brownrigg (1974) contains a modern summary, including recent developments in the model. The literature on the Economic Base model is far more extensive, and is usefully surveyed in Stone (1973). Tiebout (1962) clearly outlines the basic analysis, while Wagstaff (1973) uses a more recent variant in a Scottish context.

independent (e.g. the level of detail in the analysis may affect the flexibility of the model), they are discussed individually below.

(a) Level of Detail

The number of industries individually identified in an Input-Output table is ultimately restricted only by the resources available to the analyst. Hence, the impact of a new development on the indigenous economy can be analysed at the industry level: the effects on individual local industries of importance (such as traditional mainstay industries or new growth industries) can be readily measured and analysed. Such a disaggregate analysis assists manpower planning, identification of capacity constraints, etc.[3] Economic Base analysis, on the other hand, is essentially a two sector model: the 'basic' sector comprising industries whose levels of activity are determined exogenously to the local economy (i.e. depend on economic conditions outwith the region), and the non-basic sector comprising those industries whose levels of activity are sustained by the local re-spending of basic industries. Algebraically the model is as follows:

$$Y = D + \check{X} \qquad (1)$$

$$D = bY \qquad (2)$$

$$D = \frac{b}{(1-b)}\check{X} \qquad (3)$$

Y = total regional income (or employment)

X = basic regional income (or employment)

D = non-basic regional income (or employment)

$\frac{b}{(1-b)}$ is the Base multiplier

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3. See Richardson (1972) especially chapters 1, 8, 9 for a general idea of the usefulness of Input-Output in this area.

Assuming the new development is interpreted in the form of an increment to basic regional income,[4] the model provides only an aggregate estimate of the secondary repercussions on the non-basic sector. Similarly, the Keynesian Regional Multiplier model provides an estimate of the aggregate change in regional income resulting from a given change in exogenous receipts. The model is a variant of the national income multiplier model in which each of the variables is given an appropriate regional value. The basic model is derived as follows:

Y_r	$= C_r$	$+ I_r$	$+ G_r$	$+ X_r$	$- M_r$	(4)
(Gross Regional Product)	(Regional Consumption)	(Regional Investment)	(Government Regional Expenditures)	(Regional Exports)	(Regional Imports)	

$C_r = c_r Y_d^r$ $\quad Y_d^r$ = regional disposable income (5)

$Y_d = (1-t_r-u_r)Y_r$ $\quad t_r$ = marginal regional tax rate

u_r = marginal regional unemployment benefits (6)

$I_r = \bar{I}_r$ (7)

$G_r = \bar{G}_r$ (8)

$X_r = \bar{X}_r$ (9)

$M_r = m_r C_r$ $\quad m_r$ = marginal propensity to import for consumption (10)

From equations (1)-(7), and letting $I_r+G_r+X_r = J_r$, it can be shown that:

$$Y_r = \frac{J_r}{(1-c_r(1-t_r-u_r)(1-m_r)} \tag{11}$$

Letting $\frac{1}{(1-c_r(1-t_r-u_r)(1-m_r)} = k_r$, the impact of any given change in J_r on regional income can be determined from:

$$\Delta Y_r = k_r \Delta J_r \tag{12}$$

This model has been used to measure the impact of new industrial developments[5]

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4. See, for example, Garrison (1972).

5. See Greig (1971) and Brownrigg (1974 op. cit.).

on regional economies, but as shown above, the regional repercussions are measured in highly aggregate terms. Certainly, disaggregate versions of both models have been constructed,[6] but as this is done, their cost advantages relative to the Input-Output framework disappear rapidly and many of the disadvantages discussed below will effectively still remain.

(b) Coverage of Secondary Impact

As discussed more fully in Chapter 3, the Input-Output model permits the estimation of two types of secondary regional impact effects: (a) indirect effects, resulting from inter-industry purchases created by the industrial development and (b) induced effects, resulting from the regional consumption expenditures from household income created by the industrial development.[7] Both the Economic Base and Regional Multiplier models omit parts of these effects and hence underestimate the secondary impact of the industrial development. The Economic Base model measures both indirect and induced effects but precludes the possibilities both of inter-industry transactions within the basic sector and of service sector purchases from the basic sector. To the extent that purchases and sales of these types exist in reality, the Economic Base model omits secondary impact effects.

Inspection of Table 3.1 indicates that most industries which might be considered as 'basic' in Shetland (e.g. Primary industries, Manufacturing, and Local Government) in fact do make sales both to other basic industries and to 'service' industries, and hence in Shetland Economic Base multipliers will underestimate equivalent Input-Output multipliers.

Similarly, the Keynesian model outlined above measures only the induced effects, omitting the indirect effects entirely. Table 3.9 gives the

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6. E.g. see Garnick (1970), Weis and Gooding (1968), Wagstaff (1973), and Brownrigg and Greig (1974).

7. See pp. 59-60 for a fuller discussion of these concepts.

indirect income generating potential of each Shetland industry, and, as is apparent from the figures there, this is significantly greater than zero for many local industries.[8] Relative to Input-Output, both the Keynesian Multiplier and Economic Base models therefore underestimate the secondary impact of new industrial developments. As will become apparent in Chapter 4, the secondary effects of oil in Shetland are of considerable importance, and omission of all or parts of components of them is therefore particularly undesirable.

(c) Model Flexibility

Though the basic Input-Output framework is founded on a number of fairly restrictive assumptions (see pages 30-31), these are not generally inviolate, and in Chapters 5 and 6, amendments to the basic framework are introduced, and the effects of their incorporation on the estimated local impact of oil measured. While the Economic Base and Keynesian models do not necessarily preclude the incorporation of technological change, say, their aggregate and 'partial' (i.e. they measure only parts of the secondary impact) nature make adjustments to the basic models difficult, unless they are in fact re-cast along essentially Input-Output lines.

In summary, the major virtue of the Economic Base and Keynesian models is their ability to provide relatively low cost estimates of the aggregate impact of a new industrial development. This estimate will not differ greatly from an equivalent aggregate Input-Output multiplier if secondary effects are not particularly important. If however, estimates of the

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8. A variant of the Keynesian model developed by Greig (1972) includes some indirect effects. Essentially Greig's measure of indirect effects involves using an $(I+A^S)$ matrix rather than the $(I-A^S)^{-1}$ matrix of Input-Output analysis (see pg. 29). A comparison of these two matrices for Shetland indicates that the Greig method underestimates the indirect income effect (as measured by the Input-Output model) by 40% on average, and underestimates the Type I Income Multiplier (see pg.37) by an average 13%. Therefore, even the incorporation of Greig's adjustment to the basic model does not entirely remedy its omission of indirect effects.

impact of the new development on individual local industries are required, if indirect and induced effects are important, and if the ability to vary the assumptions of the basic model is desirable, then the advantages of the Input-Output model in these areas are more than sufficient to offset its relatively higher cost of implementation.

Section 2 Basic Theory

Assume an n industry economy. Then by definition

$$X_i = \sum_{j=1}^{n} x_{ij} + Y_i \qquad i = 1 \ldots n \tag{13}$$

where X_i is the Gross output of industry i

x_{ij} is the quantity of output of sector i absorbed by sector j

Y_i is Final Demand (i.e. exogneous demand) for the output of sector i.

If it is now assumed that, for all x_{ij},

$$x_{ij} = a_{ij}X_j \qquad i, j = 1 \ldots n \tag{14}$$

i.e. that the output of sector i absorbed by sector j is a constant proportion of the output of sector j.

Then, substituting (14) into (13),

$$X_i = \sum_{j=1}^{n} a_{ij}X_j + Y_i \qquad i, j = 1 \ldots n \tag{15}$$

Equation system (15) in expanded form is,

$$\begin{array}{l} X_1 = a_{11}X_1 + a_{12}X_2 \ldots + a_{1j}X_j \ldots + a_{1n}X_n + Y_1 \\ X_2 = a_{21}X_1 + a_{22}X_2 \ldots + a_{2j}X_j \ldots + a_{2n}X_n + Y_2 \\ \vdots \\ X_i = a_{i1}X_1 + a_{i2}X_2 \ldots + a_{ij}X_j \ldots + a_{in}X_n + Y_i \\ \vdots \\ X_n = a_{n1}X_1 + a_{n2}X_2 \ldots + a_{nj}X_j \ldots + a_{nn}X_n + Y_n \end{array} \tag{16}$$

Taking all the X_i's over to the LHS,

$$X_1(1-a_{11}) - a_{12}X_2 \ldots -a_{1j}X_j \ldots -a_{1n}X_n = Y_1$$

$$-a_{21}X_1 + X_2(1-a_{22}) \dots -a_{2j}X_j \dots -a_{2n}X_n = Y_2$$

$$\vdots \quad \vdots \quad \vdots \quad \vdots \quad \vdots$$

$$-a_{j1}X_1 - a_{j2}X_2 \dots + X_j(1-a_{jj}) \dots -a_{jn}X_n = Y_j \qquad (17)$$

$$\vdots \quad \vdots \quad \vdots \quad \vdots \quad \vdots$$

$$-a_{n1}X_1 - a_{n2}X_2 \dots -a_{nj}X_j \dots + X_n(1-a_{nn}) = Y_n$$

Or

$$\begin{bmatrix} (1-a_{11}) & -a_{12} & \dots -a_{1j} & \dots -a_{1n} \\ -a_{21} & (1-a_{22})\dots & -a_{2j} & \dots -a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ -a_{j1} & -a_{j2} & \dots (1-a_{jj})\dots & -a_{jn} \\ \vdots & \vdots & \vdots & \vdots \\ -a_{n1} & -a_{n2} & \dots -a_{nj} & \dots (1-a_{nn}) \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_j \\ \vdots \\ X_n \end{bmatrix} = \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_j \\ \vdots \\ Y_n \end{bmatrix} \qquad (18)$$

which is, in matrix notation,

$$[I - A][X] = [Y] \qquad (19)$$

where I is an n-order identity matrix

$$A = \begin{bmatrix} a_{11} & a_{12} \dots & a_{1j} \dots & a_{1n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & a_{nj} & a_{nn} \end{bmatrix} \; n \times n$$

$[X]$ is an n x 1 matrix of industry gross outputs, and

$[Y]$ is an n x 1 matrix of industry Final Demands

Pre-multipying both sides of (19) by $[I - A]^{-1}$,

$$[I - A]^{-1}[I - A][X] = [I - A]^{-1}[Y]$$

$$\therefore \; [X] = [I - A]^{-1}[Y] \qquad (20)$$

$[I - A]^{-1}$ is known as the Leontief inverse after the founder of Input-Output analysis,[9] and equation system (20) presents the standard Input-Output result

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9. Refs: Leontief, W. (1953), (1936), (1951). The term 'Leontief Inverse' is used in Richardson (1972) especially Chapters 2 and 3.

that, given a bill of Final Demands, and the coefficients of the A matrix, the industry Gross Outputs necessary to produce that Final Demand can be calculated. In fact, although the foregoing is the conventional interpretation of equation (20), the system itself is more general in that, given any $n(n+1)$ of the (n^2+2n) variables in it, the other n can be calculated. This latter property is of more than theoretical interest, since in some empirical applications the Gross Outputs of certain industries may be fixed and given by capacity considerations, say, and in such cases these would be included in the system's exogneous variables.

The matrix A is a matrix of physical input coefficients, where a_{ij} measures the physical input of i required to produce one physical unit of j. Such a measurement system permits summation across rows, but not down columns, since the aggregation of diverse products such as fertilizer, yarn, steel, etc. is meaningless. Furthermore, in practice inter-industry flows are generally obtained in expenditure terms, i.e. the coefficient is a value one where

$$a^P_{ij} = x_{ij}P_i/X_jP_j \qquad (21)$$
$$= a_{ij}\ P_i/P_j$$

$a^P_{ij} = a_{ij}$ if the price of a unit of output of each sector is set at unity. This condition is satisfied by defining the unit of output of each sector to be that which sells for one monetary unit (in this instance the £). Using such value coefficients, the column entries for each industry can be summed and, for all i,

$$\Sigma_j a_{ji} = 1$$

Unfortunately, coefficients defined in value terms as above are no longer purely technologically determined as the physical coefficients are, but are susceptible to changes in relative prices.

At a general level, three assumptions are generally imposed on the Input-

Output system[10]: (a) Each sector has a single output, and a single input structure given by its column of coefficients. The single output assumption is made to avoid the problem of variations in 'product-mix', i.e. a single industry may produce many products, each of which has a different production schedule, and hence if the individual product-proportions in the industry's total output changes, the aggregate industry production schedule will change. The single input structure assumption ensures that there is no substitution among inputs.[11]

(b) For any sector, each input is proportional to that sector's output. This assumption, which is implicit in equation (14), is the best-known and most frequently criticized of all Input-Output assumptions, and is discussed further below.

(c) There are no external economies or diseconomies of production. This assumption ensures that the production of any sector does not affect, and is not affected by, the production of any other sector, other than through the Input-Output relationships specified in equation (16).

In summary, the crucial feature of most Input-Output studies is that they assume the relationship between each input and the corresponding output is one of linear homogeneity (degree one), i.e. constant coefficients of the form a_{ij}. Some of the ways in which coefficients may in fact change are alluded to in the discussion of the input-output assumptions above, but collectively these fall into five main types (i) coefficients may change as a result of economies of scale when output changes (ii) external economies or diseconomies may exist (iii) changes in relative prices may lead to substitution among inputs (iv) the industry output-mix may vary (v) technological change may lead to the creation of new production functions.

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10. E.g. see Isard, Methods of Regional Analysis, Chapter 8, M.I.T.

11. In fact if there were a number of discreet input-structures for each industry and the proportion of overall industry Final Demand satisfied by each structure was known and fixed, the single 'industry' could be sub-divided into a series of sub-industries in the Input-Output table, so that the 'single input structure' assumption is more closely realised in each sub-industry.

While in empirical input-output studies, the analyst attempts to define sectors in such a way as to minimise the possibility of coefficient change (e.g. by having each industry's output as homogeneous as possible), it is impossible to ensure that in all circumstances the assumption of constant production coefficients will be valid. Depending on the analysis, changes in production coefficients which are small in magnitude and/or take place slowly over time may be relatively unimportant. In any event, the validity or otherwise of the constant coefficients assumption can only be tested empirically.[12]

(b) Interregional Input-Output Theory

The fundamental change made to the basic theory described above in regional studies is the addition of a spatial element to all the flows. The most general regional model is one which classifies each flow by industry <u>and</u> region of origin and industry <u>and</u> region of destination.[13]

The 'Balance' equation for this general regional (n region, m industry), system is

$$ {}_{r}X_{i} - \sum_{s=1}^{n} \sum_{j=1}^{m} {}_{rs}x_{ij} = {}_{rr}Y_{i} + \ldots + {}_{rs}Y_{i} \ldots + {}_{rn}Y_{i} \qquad (22) $$

$$ i, j = 1 \ldots m $$
$$ r, s = 1 \ldots n $$

where ${}_{r}X_{i}$ is the Gross Output of industry i in region r

${}_{rs}x_{ij}$ is the flow of product from industry i in region r to industry j in region s

${}_{rs}Y_{i}$ is the flow of product from industry i in region r to Final Demand in region s.

As before, coefficients can be defined as

$$ {}_{rs}a_{ij} = {}_{rs}x_{ij} / {}_{s}X_{j} \qquad (23) $$

12. See Evans and Hoffenberg (1952). For tests of the validity of the assumption in actual Input-Output tables, see refs: Carter (1970), Sevaldson (1963), Miernyk (1968), Rey and Tilanus (208), McGilvray and Simpson (1969). As might be expected, the assumption is rather better in some circumstances than others, but, overall, the results are fairly encouraging at least for short-to-medium time periods and small changes in Final Demand.

assuming that the flow of output of industry i in region r to industry j in region s is some constant proportion of the output of industry j in region s.

Substituting (23) into (22)

$$ {}_rX_i - \sum_{s=1}^{n} \sum_{j=1}^{m} {}_{rs}a_{ij} \cdot {}_sX_j = {}_rY_i \qquad \begin{array}{l} i = 1 \dots m \\ i = 1 \dots n \end{array} \qquad (24)$$

As before (see equations (17)-(19)), given all the ${}_{rs}a_{ij}$'s and ${}_rY_i$'s, equation system (21) can be solved for the ${}_rX_i$'s.

Two points relating to equation system (24) are immediately apparent: (a) the volume of data required to implement a full-scale multiregional model of this type is considerably greater than that necessary to construct a single national table, (b) the assumption of constant coefficients in this case implies not only those conditions set out above in relation to equation (17), but also in addition the condition that trading patterns among the various regions remain fixed; that is there will be no variation in any industry in any region in its geographical pattern of suppliers and customers. Obviously such a requirement is extremely stringent, and while the paucity of actual multi-regional tables precludes final assessment of its empirical validity, such evidence as is available is not particularly encouraging.[14]

3. The Shetland Model

The Input-Output model used in the Shetland study falls between the national and multi-regional models described previously; in fact, the Shetland Input-Output table is a single-region one in which local inter-industry flows are individually enumerated, but purchases and sales of Shetland industries outside the region are contained in a single import row and export column respectively.

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14. Refs: Moses (1955), Riefler and Tiebout (1970).

Formally, for each industry i:

$$X_i^s = x_{i1}^s + x_{i2}^s \ldots + x_{ij}^s \ldots + Y_i^{s'} + E_i^s \qquad i = 1 \ldots n \qquad (25)$$

where X_i^s is the output of Shetland industry i

x_{ij}^s is the flow of products of Shetland industry i to Shetland industry j

E_i^s is the total Export demand for Shetland industry i's products

$Y_i^{s'}$ is other Final Demand for Shetland industry i's product.

That is, the output of each Shetland industry is sold either to other Shetland industries, to elements of Final Demand (excluding exports), or is exported.

We define coefficients, a_{ij}^s, such that

$$a_{ij}^s = x_{ij}^s / X_j^s \qquad i,j = 1 \ldots n \qquad (26)$$

i.e. the sales from Sheltand industry i to Shetland industry j are a constant proportion of total output of the latter.

As before, substituting (26) into (25) yields

$$X_i^s = \sum_n a_{ij}^s X_j^s + Y_i^s (Y_i^s = Y_i^{s'} + E_i) \qquad i = 1 \ldots n \qquad (27)$$

Or in matrix notation

$$(X^s) = (A^s)(X^s) + (Y^s) \qquad (28)$$

As before, this can be re-stated to yield

$$(X^s) = (I - A^s)^{-1}(Y^s) \qquad (29)$$

i.e. given the matrix (a_{ij}^s) of <u>domestic flow coefficients</u>[15] and a matrix of Final Demands, local industry Gross Outputs (X_i^s) can be calculated.

4. Multipliers

In the course of the ensuing discussion, use will be made of industry 'multipliers' of various types. The economic interpretation of these multipliers and their significance is discussed at the appropriate point in the analysis of the Shetland table, in the present section we merely consider the theoretical derivation of these multipliers. We consider

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15. Ref: McNicoll (1976).

three types: (a) output (b) Income (c) employment, but as will become apparent, the multiplier concept can be generalised beyond these three.

(a) Output Multipliers

The so-called type I output multiplier[16] is derived as follows: assume a one-unit change in Final Demand for industry i, then

$$(\Delta X^s) = (I - A^s)^{-1}(\Delta Y^s)$$

where $(\Delta Y^s) = \begin{pmatrix} 0_1 \\ \vdots \\ 1_i \\ \vdots \\ 0_n \end{pmatrix}$ n x 1

Let b^s_{ij} be the i,jth element of $(I - A^s)^{-1}$ then

$$(\Delta X^s) = \begin{pmatrix} b_{1i} \\ b_{2i} \\ \vdots \\ b_{ji} \\ \vdots \\ b_{ni} \end{pmatrix}$$

so that the total change in output resulting from a unit change in Final Demand sales by industry i is

$$\sum_{j=1}^{n} b^s_{ji}$$

The <u>type I Output Multiplier</u> is defined to be, for industry i,

$$_o k^s_i = \sum_{j=1}^{n} b^s_{ji} / 1 \qquad (30)$$

i.e. the multiplier is the ratio of the total change in Shetland output resulting from a unit change in Final Demand in industry i, to the unit change itself. Since by definition the denominator of such a multiplier will always be unity, it can be omitted from the expression.

The <u>type II Output Multiplier</u> is defined analogously to the type I above except that the inverse matrix from which it is derived has households <u>endogenous</u>. Formally, for the household sector, we add to equation system

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16. Refs: Hirsch (1959), Moore and Peterson (1955), Mierynk (1967) pgs. 42-50.

(12) an additional row and column of the forms:

$$\text{ROW} \quad : X_H^s = x_{H1}^s + x_{H2}^s \ldots + x_{Hi}^s \ldots + x_{Hn}^s + x_{HH}^s + Y_H^s$$

$$\text{COLUMN} : X_H^s = x_{1H}^s + x_{2H}^s \ldots + x_{iH}^s \ldots + x_{nH}^s + x_{HH}^s + V_H^s \qquad (31)$$

where X_H^s is the total output of the household sector (i.e. wages and salaries etc. on the income side; gross expenditure on the expenditure (column) side.)

x_{Hi}^s are the wages and salaries paid by sector i to households

x_{iH}^s is the expenditure made by households on the produce of sector i

Y_H^s are receipts by Households from outside the Input-Output system

V_H^s are payments made outwith the Input-Output system by households.

Again it is assumed

$$x_{Hi}^s = h_{Hi}^s X_i \qquad i = 1 \ldots n + 1 \qquad (32)$$

and the system can be solved for all X_i, including households, in terms of Y_i by

$$(X_*^s) = (I - A_*^s)^{-1} (Y_*^s) \qquad (33)$$

where (X_*^s) is the vector of local industry Gross outputs including households

(A_*^s) is the matrix of domestic flow coefficients including those for households

(Y_*^s) is the matrix of Final Demands, excluding household expenditure.

Industry type II multipliers derived from equation (33) are defined as

$$_o k_i^{*s} = \sum_{j=1}^{n+1} b_{ji}^{*s} \qquad i = 1 \ldots n + 1 \qquad (34)$$

i.e. the type II multiplier for industry i is defined to be the column sum of the i^{th} column of the household augmented inverse matrix. The relationship between type I and type II multipliers for a given industry is discussed later.[17]

The type I income multiplier is defined as follows for industry j:

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17. Ref: see page 66.

$$\frac{\sum_i h^s_{Hi} b^s_{ij}}{h^s_{Hj}} \qquad (35)$$

where h^s_{Hi} is the i^{th} industry's household row coefficient

b^s_{ij} is the i,j^{th} entry of the $(I - A^s)^{-1}$ matrix, households excluded.

That is, for industry j, the Type I income multiplier is defined to tbe total change in income resulting from a unit change in industry j Final Demand ($\sum_i h^s_{Hi} b^s_{ij}$) divided by the direct income change in industry j (h^s_{Hj}).

The type II (household endogenous) total income change for industry j is given by h^{*s}_{Hj}, the j^{th} element of the household row in the inverse matrix with households endogenous. As above, the Type II income multiplier is defined as $\frac{h^{*s}_{Hj}}{h^s_{Hj}}$.

Employment Multipliers

Assume an employment/production function[18] of the form $\alpha_i = E_i/X_i$ where E_i is total employment in industry i and X_i gross output of that industry.

Then the type I change in employment per unit sales to Final Demand of industry j is given by

$$\sum_i \alpha_i b^s_{ij} \qquad (a)$$

where b^s_{ij} is as defined above.

The type II change in employment for sector j is obtained from:

$$\sum_i b^{*s}_{ij} \alpha_i \qquad (b)$$

where b^{*s}_{ij} is as defined above. Type I and Type II multipliers can be obtained by dividing (a) and (b) respectively by the direct employment change in industry j.

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18. Refs: Moore and Peterson (op. cit.). Miernyk (1967b).

In summary, this chapter has discussed some of the advantages of Input-Output relative to other forms of impact analysis, and outlined the elements of Input-Output theory used in the subsequent empirical analysis. The following chapter analyses the Shetland Input-Output table, while chapters 4, 5, and 6 employ it to estimate various measures of the impact of oil on the local economy.

CHAPTER 3: Input-Output Analysis of the Shetland Economy 1971

Section 1 Format of the Input-Output Table

Table 3.1 describes the inter-industry relationships in Shetland for the year 1971. This table was constructed from data obtained primarily in a survey of Shetland firms and households undertaken by the author. Details of individual industry definitions and data sources for each are given in Appendix II. This table is known as the transactions table and indicates in £'000 the actual flows of goods and services of the various Shetland industries to and from one another and to and from other parts of the local and non-local (i.e. Imports and Exports) economy. Reading along any row, each cell entry indicates the quantity sold by the industry on the left to the industry at the top; conversely reading down any column, each cell indicates the amount purchased by the industry at the top from the industry on the left. Every cell entry can be interpreted in the same double-entry fashion: either as a sale from one industry to another, or as a purchase by the latter from the former.

The transactions table is divided into three main areas for analytical reasons which will become apparent later; in the meantime they are described briefly as follows:

(i) Intermediate (or Processing) Sector

In table 3.1, this sector includes all the industries from Agriculture to Households, and broadly speaking is the one in which the various local goods and services are produced and/or processed. As discussed in the theoretical exposition of Chapter 2, Input-Output analysis is often undertaken with households excluded from the Intermediate sector, and in the subsequent discussion of Shetland industry multipliers, both Type I and Type II (as defined in Chapter 2) will be derived. However in the analysis of the impact of Oil development on the indigenous Shetland economy Households will always be included in the Processing sector because of the importance of household interactions within a small region[1]. As

1. See page 62.

£'000 at producers' prices

Table 3.1 Shetland Input-Output Table, 1971

PURCHASES FROM \ SALES TO	Agriculture	Fishing	Quarrying	Fish Processing	Textiles	Ship Repair	Other Manufacturing	Construction	Utilities	Transport	Distribution	Prof. Services/Banking and Insurance	Other Services	Communications	Local Government	Households	TOTAL INTERNAL	FINAL DEMAND: Central Government	FINAL DEMAND: Tourism	FINAL DEMAND: Investment: Stocks	FINAL DEMAND: Investment: Fixed	FINAL DEMAND: Exports	FINAL DEMAND: Unrequited Receipts	TOTAL OUTPUT
Agriculture	81.8	8.1	—	—	—	—	74.3	—	—	—	—	8.3	13.5	—	—	188.2	374.2	—	—	250.0	11.1	376.0	—	1011.3
Fishing	—	—	—	1706.2	—	—	1.9	—	—	—	—	1.6	2.1	—	—	18.2	1730.0	—	—	—	—	288.8	—	2018.8
Quarrying	—	—	—	—	—	—	4.9	75.6	—	—	—	—	—	—	—	—	80.5	0.6	—	17.3	—	1.5	—	99.9
Fish Processing	—	—	—	799.7	—	—	19.5	—	—	—	—	—	—	—	—	20.4	839.6	—	—	70.4	—	4052.7	—	4962.6
Textiles	—	—	—	—	1.0	—	2.0	—	1.5	—	—	—	—	—	—	—	4.5	1.3	10.0	2.2	—	1711.4	—	1729.5
Ship Repair	—	265.2	—	—	—	—	—	—	—	15.6	—	—	—	—	—	—	280.7	—	—	6.0	—	—	—	286.7
Other Manufacturing	—	8.7	—	3.9	4.5	0.9	36.6	6.9	1.5	1.6	16.3	7.0	24.8	1.5	5.4	220.0	339.7	1.2	47.0	9.3	—	557.2	—	954.4
Construction	51.3	—	1.9	18.2	10.2	—	2.3	21.4	3.0	1.4	6.3	79.5	9.6	2.0	346.4	77.4	631.2	40.7	—	−2.6	2038.8	—	—	2708.1
Utilities	12.2	—	1.0	44.2	6.7	1.4	7.5	7.2	7.3	8.8	16.4	61.5	25.1	2.4	88.5	239.4	529.6	5.6	—	—	38.3	—	—	573.5
Transport	10.1	40.0	15.0	41.6	7.7	3.6	25.5	16.3	5.4	100.0	24.8	39.7	30.2	12.7	6.1	117.5	496.1	5.3	1.1	−0.6	5.4	—	748.6	1244.7
Distribution	80.9	15.9	3.2	103.6	49.6	2.8	32.5	91.7	16.7	2.7	2.9	17.1	23.6	13.3	2.8	924.2	1383.6	6.2	39.5	−0.4	15.0	—	—	1443.9
Professional Services/Banking and Insurance	25.5	7.9	0.2	18.9	7.9	1.3	5.4	9.6	1.1	0.0	0.3	6.6	14.7	1.3	1103.2	40.0	1244.0	534.7	—	—	—	—	—	1778.7
Other Services	8.6	0.0	4.9	7.5	11.5	0.0	53.0	19.2	0.7	15.8	7.9	25.5	4.3	0.2	10.7	922.3	1092.0	—	206.4	—	—	—	—	1298.4
Communications	1.5	0.0	0.1	12.5	16.1	1.6	3.1	9.7	4.0	3.2	34.4	14.7	20.1	1.1	2.6	53.9	178.6	32.8	1.0	—	60.7	13.5	—	286.6
Local Government	5.1	26.7	0.9	14.2	7.3	2.0	5.4	20.5	17.9	0.6	33.6	27.4	8.2	6.5	2.2	91.0	269.7	1706.1	—	—	—	—	—	1975.7
Households	523.5	1178.0	36.6	774.0	819.3	118.6	169.5	666.3	90.3	379.0	595.2	1251.0	505.8	266.4	250.1	24.1	7648.0	1685.3	130.6	—	—	—	726.1	10190.1
TOTAL INTERNAL	800.6	1551.0	63.9	3544.5	941.9	132.1	443.3	944.4	149.4	528.7	738.2	1539.9	682.1	307.5	1818.0	2936.6								
PRIMARY INPUT: Imports	331.0	270.6	31.0	694.3	521.0	153.7	452.5	1617.6	224.6	572.2	359.9	145.9	444.1	104.1	29.4	3807.2								
PRIMARY INPUT: Other V.A.	337.9	299.0	5.0	723.8	266.6	0.9	58.6	146.1	200.1	233.6	345.8	92.9	172.2	−125.0	128.3	3446.3								
PRIMARY INPUT: Subsidy	−458.2	−101.8	—	—	—	—	—	—	—	−89.8	—	—	—	—	—	—								
GROSS INPUT	1011.3	2018.8	99.9	4962.6	1729.5	286.7	954.4	2708.1	573.5	1244.7	1443.9	1778.7	1298.4	286.6	1975.7	10190.1								

an "industry", Households sell labour services (in return for earnings payments) to other industries as their "output", and purchase consumer goods and services as their "inputs". The critical distinction of industries included in the Intermediate sector is that the level of activity in each is determined at least in part <u>within</u> the local economy, i.e. the level of output, incomes, or employment in each is to a greater or lesser extent determined endogenously to the local system.

(ii) Primary Input

In the Shetland Table, Primary Input comprises Imports and Other Value Added. The latter category includes net profits, depreciation, business taxes and interest payments. Household Savings, Personal Income Tax, and National Insurance Payments are the main components of the Household "Other Value Added" entry. The treatment of Imports in this study is discussed in more detail subsequently. Payments to Primary Input are gross "leakages" from the Shetland economy, in that, once made, they create no further output or employment locally.[2] For example, tax payments to Central Government need not be respent in Shetland.

(iii) Final Demand

The columns of this sector indicate, by category of use, the volume of sales made by each intermediate industry outwith the processing sector. The theoretical exposition of chapter 2 indicated that, on the assumption that the levels of purchases by the various Final Demand categories are determined exogenously to the local economic system, the volume of output, income and employment in each intermediate industry is ultimately attributable to the level and composition of Final Demand. Imports directly to Final Demand sectors are not shown in Table 3.1, but are included subsequently where appropriate.

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2. There may in practice be some relationship between Primary Input and some elements of Final Demand, e.g. between Gross Profit and Unrequited Receipts (which includes distributed profits), and between Imports and Exports. In a single period analysis the former relationship is likely to be quite tenuous, while interregional trade 'feedback' is insignificant for a small region such as Shetland (see Brown (1967), Brownrigg (1974)).

(iv) Total (or Gross) Output

The Total Output of each industry is defined to be the total value of production of that industry during the course of the year. In most cases, Total Output has been equated with the value of sales adjusted for inventory change; however, in some instances, this interpretation is not particularly meaningful and alternative definitions have been adopted. This is explained in greater detail in Appendix II. Intermediate Output is that part of Gross Output which is sold within the Processing Sector. Total (or Gross) Input is similarly defined to Gross Output, being the total of all payments made by each industry during the course of the year. Intermediate Input, similarly, is the total of all purchases made within the Intermediate sector.

For each industry, by definition Gross Output ≡ Gross Input, but Intermediate Output is not necessarily equal to Intermediate Input for any industry. However, over the table as a whole, Intermediate transactions are self-cancelling so that total Final Demand ≡ total Primary Input.

Section 2 Valuation Conventions and Treatment of Imports

(a) Valuation Conventions

Correct interpretation of the cell entries in the transactions table requires knowledge of the conventions used in evaluating inter-industry flows. The magnitudes of such flows will generally differ under different valuation regimes. The important choice of convention in Input-Output analysis is between flow valuation at producers', or purchasers', prices. Before discussing this, however, a more general comment on the treatment of the trade and transport industries in the Shetland table is in order. As in most empirical Input-Output studies, these industries are treated as 'marginal' ones in the Shetland study, i.e. their outputs are measured by the gross trade and transport margins they impart respectively, the value of goods sold is not included. Similarly, their purchases are only those incurred in providing trade or transport services, the value of good bought for resale or transportation are not included. Some tables show all goods going through distributive or transport sectors,[3] but this leads to a significant over-estimation of the relative importance of these sectors, andmore importantly, conceals the real technical relationships among the various industries.[4]

Returning to the choice of pricing convention, as mentioned above the basic choice is whether flows should be valued at the price the producer receives or at the price the purchaser pays. The difference between the two is attributable to indirect taxes and subsidies and any trade and transport margins. There are a number of reasons for preferring a valuation system based on producers' prices, prominent among which are the following (i) In a system of purchasers' prices, the row total of each sector includes marketing costs and other margin costs incurred in each delivery of that sector's output. These costs will generally vary as output distribution varies and lead to changes in recorded total output, although actual production remains unchanged. Since the row totals are used as the denominators in calculating input coefficients, instability in the latter is increased under a purchasers' price regime.
(ii) Under purchasers' prices, margin costs are double-counted: both in the value of output of the producing sector and as inputs to the producer from the margin sector. Under producers' prices, margin costs are counted only once, as an input to the purchasing sector.
(iii) Under a system of producers' prices, margin costs will vary with the input structure which is generally more stable than the output structure which as discussed above will determine the variation in margin costs under a system of purchasers' prices.

Finally, and importantly in view of the later discussion on industry

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3. MacDowall (1973).
4. See page 30
5. For a fuller discussion see Evans and Hoffenberg (op. cit).

technology,[6] the system of producers' prices explicitly separates each element which makes up the value to the final purchaser. Therefore the value of each transaction under a producers' price regime corresponds more closely to actual physical flows, which in turn reflect industry technology.

Hence an industrial purchase of a good from a wholesaler is recorded as three separate purchases as follows:

(a) the purchase of the good (at ex-works prices from the manufacturing industry directly);

(b) the purchase of a wholesale margin from the distribution industry;

(c) the purchase of transport services in moving the good from the transport industry.

Two exceptions are made to this convention: (i) the value of Imports, which is discussed below, and (ii) the treatment of indirect taxes and subsidies, which are included in the flows and allocated to the industry which actually incurs them. The flows are therefore recorded at purchasers' prices in this respect.[7]

(b) Treatment of Imports

The treatment of Exports presents no problem in Input-Output analysis: exports of industry i are simply included in the i^{th} row of an Export Final Demand column, valued at producers' prices. There is no unique treatment of imports, however, and the convention adopted requires some discussion. Alternative treatments of imports usually hinge on the distinction between competitive and non-competitive imports. Competitive imports are commodities which are close substitutes for domestically produced goods. Non-competitive imports, on the other hand, have no close domestic counterpart. This distinction can often be difficult to draw empirically, but some commodities will generally be fairly clear

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6. See chapter 6.
7. Coincidentally, the conventions adopted in the Shetland table are almost indentical to those used in the Netherlands. See Tilanus (1966) pp. 19-22.

substitutes for domestic goods, while others will clearly not be produced locally.

Non-competitive imports are usually allocated to purchasing industries along a single row in the Primary Input sector. Competitive imports, on the other hand, are treated in a number of ways: for example, the competitive import commodities may be allocated along the same row as the domestically produced equivalent. Since the inter-industry flows contain both imported and domestic products, adjustments must be made in calculating the output of the local system. This is done by subtracting the value of competitive imports along any row from the Final Demand of that row prior to multiplication by the inverse matrix, i.e.

$$X = (I - A)^{-1} (Y - M) \qquad (36)$$

where $(I - A)^{-1}$ is the inverse matrix including competitive imports and $(Y - M)$ is obtained by deducting from each industry's Final Demand (Y_i), total competitive imports for that sector's output (M_i). This implies, however, that the level of competitive imports can be specified in advance, whereas this will normally be determined as part of the solution. One way round this problem is to assume

$$m_i = M_i / X_i \qquad (37)$$

i.e. competitive imports are a constant proportion of each sector's output. This yields for each industry i

$$X_i = a_{i1}X_1 \ldots + a_{ij}X_j \ldots + Y_i - m_i X_i \qquad (38)$$

which, in matrix notation, solves to

$$X = (I - A + M)^{-1} Y \qquad (39)$$

While the above is only an example of the treatment of competitive imports, the principle of dealing with such imports is fairly general: they are distributed along a row with domestic substitutes. This improves coefficient stability since purchasers' switching between domestic and substitute import sources will not affect an aggregate coefficient.

In the Shetland table, all imports are distributed along a single row, in the manner of non-competing imports. To the extent imports are non-competitive, this is of course perfectly satisfactory. If, however, some imports are competitive, substitution with domestic products may occur and the coefficients in the Shetland inverse matrix, which reflect domestic inputs only, will be subject to instability. In fact, the implicit assumption that imports are non-competitive in the Shetland study may be quite reasonable for two reasons: firstly, the range of domestically produced goods in a small rural economy such as Shetland is limited and many imports will have no domestic counterpart. Secondly, where domestic products are available, given the geographical isolation of Shetland, these are likely to be favoured over competing imports for reasons of accessibility and lower transport costs.

Finally, in the Shetland table Imports are valued at cash in freight (c.i.f.) prices, (i.e. foreign port value plus freight charges to domestic port plus insurance) plus any import duties payable. This import value, called domestic port value, is comparable with the value of domestic products at producers' prices, but it actually falls between a pure producers' or purchasers' price since it contains the margin items mentioned above.

Section 3 Descriptive Analysis of the Shetland Table

The preceding sections of this chapter have discussed the various definitions and conventions adopted in the Shetland Input-Output table. Given these, it is possible to begin the statistical analysis of the transactions table itself by deriving some simple empirical results from it. The importance of data pertaining to the year 1971 may not be immediately apparent in the context of local North Sea Oil development, which extends into the future; however, as will be discussed more fully in the next chapter, such information provides an ideal non-oil base against which the impact of oil can be assessed.

(i) Output

A measure of the total income[8] available to a region is given by its Gross Regional Product (GRP), which is analogous to Gross National Product in the U.K. accounts. Comparison of this statistic with the equivalent for other areas, or with GRP within the region itself at different periods, can aid in assessing the relative economic performance and progress of the study area. Comparison of GRP derived from the Shetland study for 1971 could be compared with GRP at various points in time as oil develops, permitting the region's development to be closely monitored.

GRP is not the same as the sum of industry Gross Outputs as the latter includes all intermediate transactions as well as 'value added' at each stage. GRP, on the other hand is measured by the summation of value added at each stage of production process, or equivalently by the value of goods which finally leave the production process only. GRP for Shetland in 1971 is derived in Table 3.2 from the transactions table:

Table 3.2 Shetland Gross National Product 1971

	£'000
Consumer Expenditure (Household Column - Other Value Added entry)	6743.8
Public Authorities Current Expenditure on goods and services (net of intra Government Transfers, debt interest and direct Government Imports)	4158.9
Investment (Fixed and Stock)	2509.8
Exports (including local Tourist expenditure) - Imports	-2322.4
Unrequited Receipts	1474.7
GRP at Market Prices	12564.8

This translates into £725 per head of population, compared with an equivalent figure of £1024 for the U.K. as a whole.[9,10]

8. By National Income Accounting conventions, GRP can be measured from the income or expenditure side; the latter method is used in the text.

9. Because of differences in definition, methods of data collection, etc. the Shetland and U.K. figures may not be exactly comparable.

10. U.K. GNP figure from Blue Book 1973, Table 1. U.K. population from the Annual Abstract of Statistics 1972, Table 14. Shetland population from Census of Population 1971.

Unfortunately, data on GNP for Scotland is not separately available,[11] and comparisons therefore can only be made with the U.K.

A detailed analysis of the reasons for the relatively low Shetland figure is beyond the scope of the present study, but preliminary analysis suggests the following contributory factors:

(a) Shetland is specialized in low labour productivity industries, and even in these industries output per head is lower in Shetland than in the equivalent U.K. industry. Table 3.3 illustrates this for the four industries listed: in every case Shetland Value Added[12] per capita is lower than that in the U.K. Furthermore, the first three industries, which are Shetland specialisms and jointly contribute most of its manufactured output, are respectively 93rd, 119th, and 137th in a U.K. league table of Value Added per head comprising 152 industries.[13]

Table 3.3 Value Added per capita: U.K. and Shetland, 1971 (£)

Industry	Shetland	U.K.
Fish Processing	2158	2300 (MLH 214)
Ship Repair	1328	2035
Textiles	1671	1676 (MLH 417)
Utilities	5007	5765

(b) Shetland has a relatively high proportion of its population outwith working age,[14] and their contribution per capita to GRP is relatively small (pensions, family allowance, etc.), thereby having a depressing effect on the mean per capita figure. This is demonstrated by examining GRP per

11. Begg, Lyth and Sorley (1975) have estimated Gross Domestic Expenditure for Scotland (defined as the sum of the first three items of table 3.2) for 1971 and obtained a per capita figure of £981 (market prices). On this basis the equivalent Shetland figure is £776, and estimated from Begg et. al., the U.K. figure is £960.

12. As implied in footnote 8 above, GRP can be measured from the Income (Value Added) side also.

13. All U.K. data from Wood (1975). Shetland Value Added is defined as wages and salaries and Other Value Added. The U.K. definition is slightly different and may impart a small upward bias to the U.K. figures.

14. In 1971 the proportion of the population under 15 and over 65 (60 for women) was 49% in Shetland compared with 41% in Scotland.

head of working population only, where the latter have been defined as those 'economically active' in the 1971 Census of Population. This yielded a GRP of £1617 per head compared with the U.K. figure of £1828. While it is notoriously difficult to ensure that employment or activity statistics for different areas are comparable, the change in Shetland GRP per capita as a proportion of that for the U.K. (88% of the U.K. equivalent as opposed to 71% on a population basis) suggests that the age structure of the Shetland population is indeed a contributory factor to Shetland's relatively low GRP per capita figure.

(c) It seems probable from survey work that relatively fewer transactions go through the market in Shetland than in the U.K., and since it is very difficult to record these for GRP measurement (though where possible they have been allowed for), an exaggeratedly low Shetland figure will be obtained. It is impossible to test this hypothesis quantitatively, but certainly such evidence as is available suggests earnings of income in kind, and even barter, are significant in Shetland, particularly in Agriculture, Fishing, and Textiles.

Finally, it should be remembered that the above analysis refers specifically to output per head, i.e. it discusses the labour productivity index[15] both by industry, and for the region as a whole, only. Assuming a two factor production function of labour and capital, however, it will generally be expected that the greater the capital input, the greater the productivity of labour[16], i.e.

$$\frac{\partial AP_N}{\partial K} > 0$$

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15. Defined as $AP_N = {}^{X}/N$ where AP_N is the labour productivity index, X is total output (in Value Added terms) of industry i or region r, N is total labour input of industry i or region r. See Murray-Brown (1966).

16. See Henderson and Quant (1958).

where K is the capital input. Hence the lower labour productivity in Shetland than in the U.K. may reflect less capital intensive (i.e. more labour intensive) methods of production in use on the Islands. Unfortunately, data on capital inputs was unobtainable in the survey, but again qualitative evidence, including comments from many leading local business men, strongly suggests that production methods in use in most Shetland industries are generally labour-intensive relative to their U.K. counterparts. The importance of this finding will become apparent in Chapter 6 where the prospects of oil-induced technical change are discussed.

<u>(ii) Income</u>

Total Household Income in Shetland in 1971 is seen from table 3.1 (intersection of Household row and Total Output column) to have been just over £10 million, or £34.7 per household per week. This compares with an average weekly household income of £38.5 for the U.K. as a whole and, more favourably, with a Scottish average of £34.6,[17] i.e. the average Shetland household in 1971 was no worse off than that in Scotland as a whole.

It is interesting to compare Household Income in Shetland with that in other regions for which input-output tables have been published, and such a comparison is presented in table 3.4.

Even allowing for distortions introduced by the adjustment mechanism (see footnote 19), each of the regions cited seems to have lower per capita income than the U.K., and Shetland is low even in comparison with most of the other regions. However it does seem significant that Shetland has a higher per capita income than the only other region listed in the Highlands and Islands (Sutherland). Unfortunately it is not possible to obtain income figures for these regions for a number of years to compare

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17. U.K. and Scottish household income figures from the Family Expenditure Survey 1971, Table 56.

relative growth rates; therefore it is impossible to say whether Shetland's relative performance improved or worsened over time. Objective data on unemployment and migration (see chapter 1), as well as local opinion, suggest that Shetland's economic performance improved significantly, relative to its own past at least, over the period 1966-71.

Table 3.4 Estimate per capita Income in Various Regions 1971[18]

Region[20]	Income/head £	Population in year of compilation	Year of Compilation
Peterborough	756	80,000	1968
St. Andrews	673	10,120	1965
Anglesey	644	58,000	1969
Shetland	588	17,300	1971
Sutherland	553	13,500	1970
U.K.[19]	852	-	1971

Individual industry components of Household income payments are found in the cell entries of the Household row in Table 3.1. As shown there, Central Government is the single largest payment-maker to households, contributing 16.5% of all Household receipts itself. However, the traditional mainstays of the Shetland economy, Fishing, Fish Processing, and Textiles, collectively paid over 27% of all Household income in 1971.

(iii) Trade

An island economy such as Shetland's is necessarily heavily dependent on trade with other areas, both as suppliers of its requirements and as markets for its products. On average (output weighted) industries

18. Where the tables were compiled for years other than 1971, the per capita figures were adjusted by U.K. Personal Income 1971/U.K. Personal Income in year of compilation derived from the Blue Book 1973, Table 2.

19. Derived from Blue Book.

20. The results for each region were obtained from the following Studies: Peterborough:Morrison (1973), St. Andrews: Blake and McDowall (1967), Anglesey: Sadler et. al. (1973), Sutherland: McDowall (1973).

purchased 30% of their inputs through imports and exported on average 23% of their outputs. Construction and Households are the biggest importers absolutely, but Construction and Ship Repair import the greatest proportion of their inputs, both over 50% of total, reflecting the lack of local supply of the materials and parts required by these industries. Three industries exported more than 50% of their Gross Outputs: Fish Processing (82%), Textiles (99%), and Other Manufacturing (63%). These industries are also the largest exporters absolutely. The 'openness' of the Shetland economy is exemplified when the average Import and Export proportions given above are compared with those for the U.K. whose output-weighted average import content in 1968[21] was approximately 8% (Shetland 30%) and whose average export content was approximately 7% (Shetland 23%).

A "balance of trade" figure for Shetland can be computed by adding Exports, (net of direct Imports) Tourist Expenditure and Unrequited Payments,[22] and deducting Imports. Total Exports in 1971 were £8,911,000, while total Imports amounted to £9,926,000, yielding an overall deficit of £1,015,000. Given some of the specific problems of measurement mentioned in footnote 22, and the more general difficulties of estimating trade flows (particularly in 'invisible' items) in a small region, the actual magnitude of the deficit can only be regarded as very approximate, though the existence of such a deficit is indisputable. This deficit is of course balanced

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21. U.K. Input-Output Tables 1968, CSO.

22. Due to data inadequacies, part of Transport output which should be internal had to be allocated to Unrequited receipts; however this overestimation of 'Exports' will be approximately offset by a corresponding overestimation of Imported Transport services. The offsetting effect will be less than complete to the extent that Transport output actually goes to elements of Final Demand other than Exports or Tourism. Further, the volume of 'Exports' will also be over-estimated by the amount of Household Unrequited Receipts which are profits distributed by <u>local</u> firms, though this latter is probably very small.

elsewhere, for example by Central Government. Identifiable Central Government expenditure in Shetland (defined as the sum of entries in the Central Government column plus production and price subsidies) in 1971 amounted to £5,836,000, or £279 per head of population. As closely as can be estimated[24] the equivalent U.K. figure was £258 per capita. In view of the relative importance of agriculture (which is heavily subsidised) and the higher proportion of dependents in Shetland's population, it is not surprising to find Central Government expenditure higher per head in Shetland than in the U.K. as a whole.

(iv) The Structure of Shetland Industry

The disaggregate nature of the transactions table permits the detailed examination of the local inter-industry relationships among the various Shetland industries. A whole literature has evolved in Development Economics on the concept of linkages and their argued importance in the growth process.[25] In particular: backward linkages measure the purchases made locally by a given industry and, it is argued, measure the potential of this industry to induce local creation and development of its supplying industries. Similarly, forward linkages are created by the local sales of an industry, and it is argued that development may be encouraged 'forward' by the availability of domestic supply, the creation of new markets by these suppliers themselves, etc. While it is beyond the scope of the present thesis to argue the merits and demerits of the linkage concept in growth and development,[26] the idea does have some interest in the present context since the analysis of the emergence of the oil industry in Shetland is in many ways analogous to new industrial development in a Lesser Developed Country and much the same type of local pressures and stimuli might be

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24. Blue Book 1973, Table 37.
25. The pioneering work in this field is Hirschman (1958).
26. See Raj (1975), Thorburn (1973).

expected. Furthermore, the idea of technological change being induced by linkage effects is discussed explicitly in Chapter 6. It will generally, however, be found more useful to use the 'multiplier' concept, discussed theoretically in Chapter 2 and empirically in the next section, in the analysis of Oil impact on Shetland. The discussion and empirical derivation of 'linkages' per se is not therefore elaborated in detail here, though Table 3.5 does illustrate a simple measure of linkage for each Shetland industry. This could be called the Total Direct Linkage,[27] and is measured by

$$T_i = (\sum_j x_{ij} + \sum_j x_{ji})/X_i \qquad (40)$$

i.e. the sum of local purchases and sales as a proportion of total output[28].

Table 3.5 Total Direct Linkage

Industry	T_i
Professional Services	1.57
Fishing[29]	1.55
Quarrying	1.45
Ship Repair	1.44
Distribution	1.37
Other Services	1.37
Utilities	1.32
Communications[29]	1.18
Local Government	1.06
Households	1.04
Fish Processing	0.88
Other Manufacturing	0.82
Agriculture[29]	0.80
Transport[29]	0.77
Construction	0.58
Textiles	0.55

The results in Table 3.5 are interesting, reflecting considerable differences in the degree of local interdependence of the various industries. However

27. The significance of the term 'direct' in this context will become apparent in the subsequent discussion on multipliers.

28. For other measures of linkage, see Panchamukhi (1975), Rasmussen (1957).

29. In these four industries, the measures of linkage were derived using total purchases as the denominator, defined as Gross Input plus the absolute value of subsidies (or losses).

the entries reflect both backward and forward linkages, and as discussed above, the economic effects of each are quite different.[30] Furthermore, the linkage method is best suited to analysing the potential repercussions of new industrial development and hence is particularly useful for development planning. On the other hand, the analysis of the actual impact of an exogenous change in demand for the products of various local industries is best served by the multiplier framework described below.

Section 4 Multiplier Analysis

The analysis of section 3 is useful in describing the local economic environment within which the incoming oil industry will develop. It also provides some pre-oil macroeconomic indicators against which the effects of oil can be measured. However, this in itself would scarcely justify the expense and effort involved in constructing an input-output table, since most of these results could be obtained by less costly forms of analysis. However, as shown theoretically in chapter 2, by making certain assumptions about the nature of the inter-industry flows, it is possible to derive from the transactions table a powerful tool which itself can be used to analyse the impact of Oil development on Shetland on an individual industry basis. As shall be seen, as long as these assumptions are valid, the effects of oil can be measured as accurately with a 1971 transactions table as with one for any more recent year. Indeed had the basic Input-Output table been constructed for any year subsequent to 1971, by which time oil development was beginning to affect the Shetland economy, it would have been difficult to identify these oil-related effects since no pre-oil base would have been available. These, and other points on the use of Input-Output in the analysis of Oil Impact, will be discussed in more detail in Chapter 4.

30. For example, Textiles has a backward linkage of over 0.5, but sells very little of its output locally, and hence has a very small forward link. Hirschman (op. cit.) states that backward linkages are more significant than forward in development, and the multiplier analysis of subsequent sections concentrates exclusively on these.

At present, we wish to translate the theoretical discussion of chapter 2 into an empirical analysis of the Shetland transactions table (table 3.1). As described in chapter 2, we define domestic flow coefficients by the equation

$$a^s_{ij} = x^s_{ij}/X^s_j \qquad i,j = 1 \ldots n. \qquad (41)$$

These coefficients for the Shetland table are summarised in Table 3.6, which is known as a domestic flow coefficient matrix.

Table 3.6 Domestic Flow Coefficient Matrix

	Primary	Manufacturing	Construction	Distribution	Other Services	Households
Primary	0.029	0.225	0.028	-	0.004	0.020
Manufacturing	0.088	0.109	0.003	0.011	0.008	0.024
Construction	0.017	0.004	0.008	0.004	0.062	0.008
Distribution	0.032	0.024	0.034	0.002	0.011	0.091
Other Services	0.051	0.039	0.031	0.081	0.235	0.144
Households	0.555	0.237	0.246	0.412	0.383	0.002

For simplicity, Table 3.1 is aggregated to a 6x6 transactions table[31], and Table 3.6 is derived from the aggregate transactions table as follows: the inputs (column entries) of each industry are divided by the Gross Input[32] of that industry, thus expressing each input as a proportion of Gross Input. For example, the coefficient of 0.004 at the intersection of the Construction row and Distribution column is obtained by dividing the corresponding flow in the aggregate transactions table (£6,300) by the Gross Input of the Distribution industry (£1,443,900). Reading down a column of Table 3.6 indicates the proportions in which total purchases

31. The aggregation scheme is as follows: Primary: Agriculture, Fishing and Quarrying. Manufacturing: Fish Processing, Textiles, Ship Repair and Other Manufacturing. Construction, Distribution, and Households remain as in Table 3.1. Other Services: all other industries in Table 3.1.

32. By definition for any industry Gross Input ≡ Gross Output (see page 42).

of the industry at the top are divided among local industries on the left. Since some of most industries' purchases will be imported goods and Value Added, the sum of column coefficients for most industries in Table 3.6 will be less than unity. As an example, reading down the Manufacturing column indicates that in 1971, 22.5% of Manufacturing expenditure was on local Primary products, 10.9% on local Manufacturing output itself, 0.4% on local Construction, and so on.

As discussed in chapter 2, the central assumption in Input-Output analysis is that each industry's purchasing pattern as described in Table 3.6 will remain constant even if the total purchases of that industry change from those used in actually calculating the coefficients. If the output (or input) of the Construction industry changes from £2.7 million to £3.0 million, the assumption implies that 2.8% of this £3 million will be spent on local Primary output, 0.3% on local Manufacture, and so on; that is, the column proportions in Table 3.6 still apply.

As outlined in chapter 2, there are a number of ways in which these domestic flow coefficients may change, and the particular problems raised by this possibility in the analysis of the impact of oil will be discussed in chapter 5. For the moment, it is assumed that the coefficients remain constant. Chapter 6, in fact, suggests that, in spite of the magnitude of oil impact on the Shetland economy, many of the conditions necessary for relatively stable coefficients may exist in the region.

The theoretical exposition of chapter 2 demonstrated that, given the domestic flow coefficient matrix, the Gross Output of each local industry can be derived from the expression

$$X^s = \left(I - A^s\right)Y^s \qquad (42)$$

where Y^s is the matrix of Final Demands. Since these elements of Final Demand are determined exogenously to the local economy, it is not expected that their expenditure patterns need be constrained by simple proportionality relationships. In table 3.1, six Final Demand sectors are individually identified. However, it should be stressed that the allocation of activities to Intermediate, or Final Demand, sectors adopted in the Shetland Table is not unique; it may be appropriate in some analyses to have activities transferred from the Intermediate sector to Final Demand or vice-versa. For example, Households and Local Government are often included in Final Demand,[33] implying that there is no necessary relationship between payments and receipts in these sectors, at least in the time period under consideration. On the other hand, Export Base Theorists would tend to include all activities except exports in the endogenous (Intermediate) sector, leaving Exports as the sole exogenous variable.[34]

Chapter 2 shows that theoretically the level of activity in every intermediate industry can be ascribed to the level and composition of Final Demand. Empirically, this arises from the fact that an intermediate industry can only increase its sales if other intermediate industries or Final Demand sectors are willing to increase their purchases of its goods. In the former case[35], then, to pay for these increased purchases, the second processing industry will have to increase its own sales, again either directly to Final Demand or to a third processing industry, and so on. Thus the level of output of each industry depends finally on its, and other industries', sales to Final Demand; the level and patterns of demand of the latter group of sectors is, as explained above, determined outwith the Shetland economy.

The above discussion outlines the process of output determination and income generation in the Shetland economy, in contrast with the analysis of section 3

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33. Households are, of course, included in Final Demand in the calculation of Type I multipliers (see chapter 2 page 35). When households are included in the Intermediate sector, the constancy of household expenditure coefficients is justified by the stability of behavioural consumption patterns, rather than by technical relationships.

34. Ref: Tiebout (1957) and (1962).

35. If the latter (i.e. increase in sales to Final Demand), then the point is made directly.

above which described the level of activity in each industry (and in the local economy as a whole) without explaining how this level came to be.[36]

This process, which transmits changes in Final Demand throughout the whole economy, can now be analysed in more detail. By way of example, assume that demand for Shetland Primary products from abroad increases by £100 i.e. the Export column entry for Primary industry increases by £100. This direct increase in demand for Primary goods starts a 'chain reaction' in the regional economy, for to increase its sales by £100 the domestic coefficients table (Table 3.6) shows that Primary industry must purchase £2.87 from itself, £8.75 from local Manufacture, £1.70 from local Construction, and so on. Now, those industries supplying Primary industry have experienced an increase in demand for their products, and they in turn will have to purchase more inputs to produce the additional output. For example, reading down the Manufacturing column of Table 3.6 shows that to increase its output by £8.75, Manufacturing will buy £1.97 (0.225 x £8.75) from Primary, £0.96 (0.109 x £8.75) from itself, and so on. Similarly, to provide the requisite amount to Primary, every other industry will increase its purchases in the proportions indicated by the appropriate column in Table 3.6. To meet this new demand for their output, industries will have to make further purchases, thereby increasing sales still further, and so on. This round by round increase in the level of output of each industry resulting from the initial direct increase in demand from Primary Output is known as the indirect effect on output. The total indirect effect can be measured by summing the individual indirect effects of successive rounds. In practice the series tends to converge fairly rapidly, so that the cumulative total after a few rounds is a close approximation to that obtained after a theoretically infinite number of rounds.

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36. The distinction drawn here is exactly analogous to that drawn between Income accounting and Income determination in National Income Analysis. See Shapiro (1970) pages 103-105.

If households are included in the intermediate sector so that Household income and expenditure are endogenously determined, then an increase in sales to Final Demand by any industry will increase Household income (as measured by the appropriate Household row coefficient). This increase in income will in turn be translated into Household expenditure in accordance with the Household column coefficients. This increased demand by households for their products will induce industries to increase their output, thereby increasing the incomes accruing to households, who in turn will further increase their expenditures, and so on. The increased level of activity brought about by an increase in Final Demand as a result of the Household income-consumption relationship is known as the induced effect on output.

To summarise, a change in Final Demand for the products of any industry will have the following effects: (a) the direct effect as measured by the initial change in Final Demand sales (b) the indirect effect, which arises because local industries purchase goods and services from one another in the process of operating their businesses (c) the induced effect, which arises because a change in output will change the level of Household income. This change in income will cause changes in Household expenditure which in turn affect the level of industrial outputs, in an iterative fashion.

The total (i.e. direct, indirect, plus induced) change in industry outputs arising from a given change in Final Demand is obtained from:

$$\left(\Delta X_*^s\right) = \left(I - A_*^s\right)^{-1}\left(\Delta Y_*^s\right) \quad (43)$$[37]

This equation is the basic model employed in the analysis of Oil Impact in the following chapter. As discussed there, the various local oil industry expenditures are treated as increments to Final Demand, and given the A_*^s matrix derived from the 1971 transactions table, the above equation

37. See chapter 2 page 33 for theoretical discussion of this model.

system is used to calculate the total resulting output changes in each Shetland industry. In the present chapter, the effects on non-oil related Final Demands are analysed and various 'multipliers' derived for indigenous industries. The former, again, will assist in the assessment of oil impact by comparison with other Final Demand elements, while the latter provide an additional tool in calculating the local impact of oil as well as clarifying the complexity of local inter-industry relationships.

As explained above, a change in sales to Final Demand by any industry will have indirect and induced repercussions throughout the Shetland economy. For many purposes it is useful to estimate the total change in activity resulting from any specified change in Final Demand sales of a single particular industry. For example, if the Final Demand sales of the Fishing industry increase by £100, what will be the total change in output or income, say, in Shetland? As becomes apparent from the foregoing discussion, the total effect is generally expected to be greater than the direct effect because of secondary repercussions. This type of question is answered in the 'multiplier' concept, which was discussed theoretically in chapter 2 and empirically below.

(i) Output multipliers

An industry output multiplier is defined to be the number of times the direct change in its sales to Final Demand must be multiplied to obtain the total change in output in Shetland. Output multipliers of this type can be calculated for each intermediate industry in the Shetland table.[38] Type I multipliers are, as indicated in chapter 2, defined to be multipliers derived with households excluded from the Intermediate sector, while Type II are multipliers derived with households included in the Intermediate

38. See chapter 2 page 35 for a theoretical derivation of the output multiplier.

sector.[39] That is, Type II multipliers include indirect and induced effects. As will be seen, induced effects are of particular importance in a small regional economy and their inclusion better reflects the regional forces of output and income generation. For this reason, although Type I multipliers are discussed in this chapter for illustrative purposes, the subsequent analysis of local oil impact will be primarily concerned with Type II (i.e. including induced) change.

Type I and Type II output multipliers for Shetland, based on the 1971 transactions table, are presented in table 3.7.

Table 3.7 Shetland Output Multipliers

Industry	Type I	Rank	Type II	Rank
Agriculture	1.33	4*	2.35	5
Fishing	1.24	6	2.25	6
Quarrying	1.33	4*	1.97	7
Fish Processing	1.76	2	2.52	3
Textiles	1.08	14	1.88	8*
Ship Repair	1.06	15	1.74	12
Other Manufacturing	1.37	3	1.87	10
Construction	1.10	13	1.58	14
Utilities	1.14	10*	1.47	15
Transport	1.14	10*	1.68	13
Distribution	1.13	12	1.84	11
Professional Services	1.20	7	2.39	4
Other Services	1.17	9	1.88	8*
Local Government	1.93	1	2.90	1
Communications	1.18	8	2.72	2

* equal.

A number of interesting points emerge from table 3.7. Firstly, the Type II multipliers are consistently larger for each industry than the equivalent Type I, which is to be expected since the latter omit the induced output-generating effects mentioned earlier. Secondly, the ranking of multiplier values changes somewhat between Type I and Type II. In general, industries whose Household payments are a comparatively small proportion of total intermediate payments tend to rank relatively higher in Type I multipliers, while industries whose Households payments are a

39. Refs: Richardson (op. cit.) pages 33-49.

relatively high proportion of total intermediate payments tend to rank relatively higher in Type II. This is particularly noticeable in the case of Communications. Again, given that the importance of induced effects depends on the Household income-consumption relationship, this is not surprising. Thirdly, individual industry multipliers vary widely in value. For example, the Type II multipliers range from 1.47 (Utilities) to 2.90 (Local Government), a ratio of almost 1:2. An aggregate multiplier, such as the Keynesian regional income multiplier[40], would conceal these differences.

As discussed above, these Output multipliers describe the total change in Output in Shetland resulting from a given change in Final Demand in a specified industry. For example, if exports of Textiles increase by £1,000, the appropriate Type II multiplier of 1.88 indicates that total Shetland output will increase by £1,880, i.e. that indirect and induced effects will increase output in Shetland by £880 in addition to the original £1,000 change in output of Textiles. The multipliers are assumed to operate symmetrically, so that a decrease in Final Demand for Textiles of £1,000 would generate a further decrease in output of £880.

The value of a multiplier for a given industry reflects the degree of local interdependence of that industry - the greater the interdependence, the larger the value of the multiplier. As such, the output multipliers are related to the linkages described in section 2, particularly since the latter can also be derived from the coefficients of the $(I - A^s)^{-1}$ matrix. The multipliers, however, reflect backward linkages only, and this derives from the demand orientation of the analysis: all exogenous change takes place in Final Demand, and local supply is assumed to adjust accordingly. This characteristic of Input-Output analysis is not especially detrimental for the current aim of estimating oil impact for two reasons:

40. Aggregate and disaggregate variants of this model were discussed in chapter 2 section 1.

firstly, the backward linkages of oil activity within Shetland are far more significant than forward linkages, and secondly, while the degree and direction of industrial expansion induced by 'backward' linkage effects can be seen fairly clearly from the pattern of local oil-related purchases, induced forward linkage expansion is much more uncertain since the goods and services made available by local oil development may be inputs for any one of a number of industries, and, more importantly, any industry contemplating a Shetland location would have to be sure of a market for <u>its</u> products, irrespective of the availability or otherwise of local suppliers. The <u>quantitative</u> analysis of oil impact of the subsequent chapter is therefore concerned only with 'backward' linkage effects, though the possibility of oil-induced change through forward linkage is discussed qualitatively in Chapter 6.

Returning to the present analysis, comparison of industry multipliers for different regions would ideally provide a measure of the relative degrees of local interdependence within these regions. In general the more advanced an economy the more specialised production becomes, leading to an increased degree of structural interdependence[41]; similarly, the larger and more self-sufficient a region, the greater the level of local interdependence expected. Unfortunately, the value of the multipliers are not independent of the industry definitions and accounting conventions adopted, nor of the degree of aggregation of the table,[42] so that comparison of the Shetland multipliers with those derived from other studies can only be made with great caution. Bearing these points in mind, Table 3.8 compares

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41. See Leontief (1963).

42. In general, the greater the level of aggregation the greater the apparent interdependence. However there is some evidence that multipliers for a given industry do not vary substantially with the degree of aggregation of other industries. See Doeksen and Little (1968).

Shetland output multipliers with those calculated in other studies for industries which may be broadly comparable with their Shetland equivalents.

Table 3.8 Regional Output Multiplier Comparisons

	Shetland		Sutherland	Angelsey[43]	U.K.
Industry	Type I	Type II	Type II	Type II	Type I
Agriculture	1.33	2.35	2.22	1.87	1.86
Fishing	1.24	2.25	2.37	-	1.45*
Construction	1.10	1.58	1.59	1.82	1.71
Professional Services et al	1.20	2.39	2.23	1.96†	-
Communications	1.18	2.72	-	1.76	1.30

* includes Forestry
† excludes Insurance, Banking, and Finance

The type I Shetland multipliers are in every instance lower than those for the corresponding U.K. industry. In spite of the difficulties of comparison, this is almost certainly explained by the relatively greater level of leakages (lower local interdependence) from the Shetland economy, which ensures that at each round a significant proportion of industrial expenditure is remitted outside the region and hence plays no part in succeeding rounds of output generation.

Table 3.8 also indicates that the Type II industry multipliers in Sutherland, the area which one would expect to be most similar to Shetland both in industrial structure and degree of self-sufficiency, are indeed very close to their equivalent Shetland values, though overall the Shetland multipliers seem marginally higher than those for Sutherland, particularly when Manufacturing is taken into account.[44] All Shetland multipliers listed are larger than the corresponding ones for Anglesey though the ranking

43. In the Anglesey study, the type II multipliers are modified in a fashion which reduce their value relative to those which would be obtained using the Shetland method. See: Sadler, Archer and Own (1973).

44. The output multiplier for Sutherland Manufacturing is 1.68 while those in Shetland range from 1.74 to 2.52 individually, with an output-weighted mean of 2.27.

of multipliers (except Communications) is the same in both groups. To what extent this is due to the downward bias imparted to Type II multipliers in the Anglesey study (footnote 43) is impossible to say without further study.

(ii) Income Multipliers

The output multipliers described in the previous section give a useful summary statistic of the degree of local interdependence of each industry. However, of more interest to planners and policy-makers is the degree to which variations in Final Demand will affect the level of income paid to households. The derivation of the Income Multiplier is given in equation (35) in chapter 2, and these are defined to be, for each industry, the ratio of the total change in income to the direct change in income. Type I and Type II multipliers, defined as before, are given in Table 3.9.

Table 3.9 Shetland Income Multipliers

	£ Change in Shetland Income per £1000 sales to Final Demand				Multipliers	
Industry	Direct	Indirect	Induced	Total	Type I	Type II
Agriculture	518	137	102	757	1.26	1.46
Fishing	584	82	103	769	1.14	1.32
Quarrying	366	106	73	545	1.29	1.49
Fish Processing	156	332	74	562	3.13	3.60*
Textiles	474	36	79	582	1.08	1.24
Ship Repair	414	22	68	504	1.05	1.22
Other Manufacturing	178	141	50	369	1.79	2.07
Construction	246	48	46	340	1.20	1.38
Utilities	157	52	32	241	1.33	1.54
Transport	305	44	54	403	1.14	1.32
Distribution	412	55	72	539	1.13	1.31
Professional Services, etc.	703	63	119	885	1.09	1.35
Other Services	390	65	70	525	1.17	1.23
Communications	930	62	154	1146	1.07	1.23
Local Government	127	518	74	719	5.08	5.66*

* See page 68 for an explanation of the high values of these multipliers.

As before, the type I multipliers are lower than the corresponding type II since they omit the induced effects, given in column 3 of Table 3.9. Assuming the consumption function is linear homogeneous of degree one, the ratio of each Type II multiplier to the corresponding Type I is a constant (for proof, see Sandóval (1967)). For Shetland, this constant is approximately 1.15. Other examples of this ratio are 1.13 for Peterborough,[45] 1.29 for St. Louis,[45] and 1.55 for Utah.[45]

As before there are wide variations among both Type I and Type II multipliers, with Fish Processing and Local Government clearly the highest. However, the way in which income multipliers are traditionally defined (as a ratio with direct income payments as the denominator) means that industries with high direct income payments tend to have low multipliers and vice versa. Further, to create a unit change in direct income requires different changes in Final Demand in each sector; for instance, £193 of Final Demand sales are required in Agriculture to generate £100 of direct income, while to create this amount of direct income in Utilities would require £637 of sales to Final Demand.[46] The information in Table 3.9 can therefore be interpreted in two mutually consistent ways: (a) The multipliers can be used to assess the relative importance of secondary income generation in each industry, given a specified change in direct income in that industry. For example, for each £1000 of income created directly for workers in Fishing, another £140 will be created in the Shetland economy indirectly, while a further £176 will be generated by induced effects, making a total income change of £1,316. This total change could be obtained immediately by multiplying the £1000 direct income change by the Type II multiplier for Fishing. This interpretation will be useful in the analysis of oil impact, where multipliers will be derived for major areas of oil activity, and will provide a useful summary measure of the local repercussions whatever the specified level of direct income payment by oil-related

45. Refs: Peterborough: Morrison (1973); St. Louis: Hirsch (1959); Utah: Moore and Petersen (1955).

46. The increase in Final Demand in sector i necessary to create £100 of direct income is given by £100$/h^s_{Hi}$ where h^s_{Hi} is the household row coefficient in sector i.

firms.[47] (b) The total change in Household income resulting from any specified change in Final Demand can be obtained. Again this interpretation is useful in measuring oil impact, particularly where variations in the pattern as well as the level of oil expenditures must be allowed for. This interpretation is also useful in assessing the individual indigenous industry breakdown of oil impact. For example, an oil-related increase in Construction expenditure of £10,000 will increase incomes in the Construction industry by £2,460, further increase Shetland incomes by £480 through indirect linkage effects, and still further increase incomes £460 through induced consumption effects, making a total increase in Shetland household income of £3,400.

The variations in multiplier values reflect the substantial differences in both indirect and induced effects among the various industries. Fish Processing and Local Government, because of their significant local inter-industry linkages, have very high indirect income components.[48]

Ultimate Source of Shetland Income 1971

As explained earlier, if Households are included as an intermediate industry, then the level of household income will be determined by Final Demand in the same manner as other intermediate industries' outputs. The

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47. This point is important because, as discussed in Chapter 4, the level of oil-related activity in Shetland, lying as it does primarily in the future, cannot be predicted with absolute certainty. It is important therefore that the tools of analysis are sufficiently flexible to allow for variations in the level of direct activity.

48. Because of its demand orientation (see pp. 58-60), input-output analysis attributes a significiant part of Fishing income indirectly to Fish Processing because of the large volume of purchases by the latter from the former. At many times in the past, the relationship between these two industries may have been supply orientated, i.e. Fishing may have induced activity in the Fish Processing industry in a forward-linkage effect. This is the approach to these two industries adopted by Greig (1972 op. cit.), and of course leads to radically different multiplier values for both.

level of household income attributable to each industry is obtained by multiplying the Final Demand sales of that industry (in £000) by the appropriate figure in column 4 of Table 3.9. For example, Fish Processing in selling £4,123.1 thousand to Final Demand generated approximately £2.3 million of household income in Shetland (£562x4,123.1). However, given the proposed treatment of oil development as a category of Final Demand (see chapter 4 page 85), it is also of interest to determine the level of household income generated by each category of Final Demand, both to demonstrate the methodology and provide non-oil Final Demand figures for comparison purposes. This is obtained as follows: Let f_{ic} be the i^{th} entry in the c^{th} Final Demand column. Then total income generated by Final Demand column c is:

$$Y = \sum_i h^{*s}_{Hi} f_{ic}$$

where h^{*s}_{Hi} is the total income generated by one £ output of industry i, derived from the Leontief inverse with households endogenous.

The results are presented in Table 3.10.

Table 3.10 Sources of Income by Category of Final Demand

Category	% Share of Final Demand	Total Income Generated £'000	% of Total
Exports (excluding Tourism)	46.0	4011.2	39.4
Central Government	25.9	3701.1	36.3
Unrequited Receipts	15.6	1138.2	11.2
Investment	9.1	1035.4	10.2
Tourism[49]	3.3	304.9	3.0
Total	100	10190.8	100

The high proportion of income generated by Central Government is interesting, but not surprising given that regional policy demands a high level of Central Government involvement in small regions such as Shetland (see also page 76). What *is* surprising is the low proportion of total income generated by Tourism, which is not typical of other broadly similar regions as shown in Table 3.11. The high proportion of total income generated by exports exemplifies the openness of the Shetland economy with respect to

49. 'Tourism' in fact includes business trips.

the outside world.

Table 3.11 Income Generated by Tourism 1971

Region	Household Income generated by Tourism % of Total
Skye*	>20
Anglesey	20
Sutherland	15
St. Andrews	10
Shetland	3

* Skye results from Brownrigg and Greig (1974).

The low proportion of income (and employment, see page 76) generated by Tourism in this pre-oil situation has important implications in the current context, for concern is often expressed that oil-related industrial development will destroy the attractiveness of affected areas in the Highlands and Islands to tourists, and hence an important source of local income may be lost. Certainly oil development in Shetland may cause a decline in the number of tourist visitors to the Islands,[50] but it is obvious from Table 3.10 that, economically at least, the detrimental effects of this cannot be too substantive.

From table 3.10 and the various column sums of Final Demand, a further set of multiplier relationships between Household income and Final Demand can be derived. Dividing the total income generated by each category of Final Demand by total expenditure of that category yields the Household income generated per average £ of expenditure in each Final Demand Category. The results are shown in Table 3.12.

Central Government has the highest multiplier, creating on average £884 of local Household income for every £1000 of its expenditure. This is because a large proportion of Central Government expenditure goes to households directly, while most of the remainder is spent in industries with large income components, either directly (Professional Services) or indirectly (Local Government). Unrequited Receipts similarly has a

50. Ref: Chapter 5 pages 134-135.

large direct household payment component, which again raises its Income generating effect. The Export and Tourist multipliers have the same value, but are built up in very different ways: the former includes no direct payments to households, but those sectors exporting do have relatively high Type II income generating potential. The latter on the other hand, has a fairly high direct income component, but secondary income generated is relatively low.

Table 3.12 Income Generated per £ of Average Expenditure on Final Demands

Source	Multipliers (£)
Central Government	0.884[51]
Unrequited Receipts	0.772
Exports (excluding Tourism)	0.573
Tourism	0.573[51,52]
Investment	0.412

(iv) Employment Multipliers

The repercussions of a change in Final Demand on Regional Output and Income will ultimately have some impact on regional employment. However, the estimation of regional employment multipliers analogous to the Income and Output multipliers described above is complicated by two additional difficulties: firstly, it is difficult to derive a simple relationship between employment and any of the magnitudes observable in the Input-Output table, such as Output or Income. The problem arises because as Output increases, say, employers may simply utilise their existing labour forces more intensively through overtime, incentive

51. Total expenditure on these categories includes expenditure on goods directly imported by them, which are not shown in the respective columns of the transactions table.

52. Income generated in Shetland per £ of Tourist expenditure (57p) is higher than that in St. Andrews (34p), Sutherland (45p), or Skye (31p). The aggregation of Hotels and Catering, which tends to have a low income generating effect, with Other Services may impart an upward bias to the Shetland multipliers. Rough adjustment for this yields a revised Tourist Multiplier for Shetland of 0.51. Remaining differences are probably caused by real differences in local linkages and regional differences in the composition of Tourist expenditure. In this latter respect, the relatively high proportion of Bed and Breakfast tourists in Shetland is important in raising the multiplier value, since this type of accommodation payment is made directly to households.

bonuses, etc.; so that output (and income) may change significantly without employment, measured in the number of persons employed, varying at all. Secondly, in a rural economy such as Shetland there is a great deal of unrecorded part-time and spare-time employment which is extremely difficult to estimate accurately. A related problem is how to translate such employment into common units even if it could be identified: for example, how many casual jobs could be said to be equivalent to one full-time job? It is not even clear that such a comparison is meaningful.

These problems can be overcome to some extent by estimating industry employment-production functions[53] in which industry employment <u>measured in man-years</u> is related to industry Gross Output. Unfortunately, there was insufficient data available to convert Shetland employment to man-years. Furthermore, to derive even a straight-line employment-production function requires at least two point-estimates of employment and output, while the Input-Output table provides at best only one. Therefore to estimate employment multipliers in the present study, it has been assumed that industry employment is directly proportional to industry output, i.e.

$$E_i = \alpha_i X_i \qquad (44)$$

where E_i = total employment in industry i, α_i is the (constant) employment-production coefficient of industry i, and X_i is Gross Output of industry i. This permits the coefficient, α_i, to be estimated from the employment-output relationship in 1971 alone.[54] Also, to obtain inter-industry consistency, employment in each industry has been converted to Full Time Equivalency (FTE) by assuming 1 part-time job = $^1/5$ one full-time job, and 1 spare-time job = $^1/10$ one full-time job. While admittedly

53. See Chapter 2, page 37.

54. Using this value of α to estimate the employment change resulting from a given change in output implies that the marginal employment coefficient in each industry is the same as the average. For reasons discussed above (page 71), this may not be the case, and some of the implications of alternative assumptions are discussed in chapters 5 and 6.

crude, these weights, based on local discussion and other studies,[55] are felt to better reflect the relative contribution of each type of employee than by equally weighting them all.[56]

The mathematical derivation of Type I and Type II employment multipliers is given in Chapter 2, and the economic rationale is as follows: assume that in a specified industry Final Demand sales change sufficiently to change employment in that industry by one FTE. This change in Final Demand sales will have secondary employment repercussions throughout the economy, so that the total change in Shetland employment will be greater than direct change of one FTE in the industry concerned. An employment multiplier for a given industry is defined to be the total change in Shetland employment as a ratio of the direct change in FTE employment in the industry concerned. Employment Multipliers for each industry are given in Table 3.13[57].

Table 3.13 Employment Multipliers

Industry	Employment Multipliers[58] FTE's
Local Government	3.08
Fishing Processing	2.82
Other Manufacturing	2.21
Utilities	1.76
Fishing	1.63
Agriculture	1.55
Quarrying	1.51
Other Services	1.51
Communications	1.36
Construction	1.35
Transport	1.32
Professional Services et al	1.32
Textiles	1.28
Ship Repair	1.22
Distribution	1.19

55. Ref: Greig (1972, op. cit.)

56. The Industries primarily affected by spare- and part-time problems are Agriculture and Textiles. As shown in Chapter 4, local oil-development is not expected to have a great impact on these industries, and therefore the estimates of oil-generated employment are not sensitive to the assumed Full-Time Equivalency of spare- and part-time employment.

57. In view of the problem of degree of labour utilization mentioned in the text, it may be wise to regard the multipliers in Table 3.13 as showing the maximum probable changes in total employment. The minimum value for any multiplier will be 1.00, assuming the creation of a new job does not actually decrease employment anywhere in the economy.

58. Only Type II are given here. As before, Type I will be lower.

The most apparent fact about these multipliers is that they are fairly small: only three are greater than 2.0 and almost half are less than 1.5. Hence the assumption sometimes made in regional analysis of a universal multiplier of 2 would significantly over-estimate most industry values in the Shetland context.

For many purposes, it may be more important to know by how much Final Demand in a given industry must change to change total employment in Shetland by one FTE. This information, which we shall call sales/employment multipliers, is given in Table 3.14.

Table 3.14 Sales/Employment Multipliers

Industry	Final Demand Sales required to change employment by one FTE (£)
Communications	1318
Distribution	1525
Local Government	1539
Professional Serices, et al	1592
Agriculture	1684
Textiles	2050
Quarrying	2208
Fishing	2504
Fish Processing	2514
Ship Repair	2610
Transport	2971
Other Services	3010
Construction	3245
Other Manufacturing	3535
Utilities	5626

The great differences in sales required to generate an additional job depend on both the labour intensiveness of the various industries as well as their inter-industry linkages.[59] Hence although Fish Processing has a very high employment multiplier, the direct employment created per unit increase in output is comparatively small, thereby depressing the total employment change per unit of output. On the other hand, Distribution

59. It should be remembered that in the price system used in the Input-Output table (see pp. 42-44), in some industries the change in sales revenue given in Table 3.14 will not be sufficient to cover the costs incurred in providing the increased output, therefore additional losses or subsidies will be required. Industries affected in this way are Agriculture, Fishing, Transport, and Communications.

has the lowest Type II multiplier, but because of its very high direct employment/output ratio, it requires one of the lowest changes in Final Demand sales to change total Shetland employment by one FTE.

Using the sales/employment multipliers from Table 3.14 in conjunction with the actual Final Demand sales of each industry for 1971 from Table 3.1, it is possible to find the employment generated by each industry in that year. This is summarised in Table 3.15.

Table 3.15 Source of employment by Industry, 1971

Industry	% of total employment generated
Primary	8.5
Fish Processing	28
Textiles	14
All Manufacturing	45
Construction	11
Local Government	19
All Services (including L.G.)	35.5
Total, All Industries	100

Table 3.15 is revealing: no less than 72% of all employment in Shetland was generated by only four industries: Fish Processing, Textiles, Construction, and Local Government. The results in this table also expose the oversimplification of Economic Base models which as indicated in Chapter 2 assume all employment is generated by 'Basic' industries, which are defined in a number of ways, but generally are primarily Primary and Manufacturing. In Shetland only 54% of all employment was generated by these industries.

Table 3.10 and the discussion of it, showed that ultimately all income in Shetland could be attributed to Final Demand. All employment can also be attributed in this way, and Table 3.16, which is analogous to Table 3.10, indicates the employment in FTE's attributable to each category of Final Demand.

Comparing Tables 3.16 and 3.10 shows that while the ranking of categories according to their income or employment generation remains broadly the same,

Table 3.16 Source of Employment by Final Demand Category, 1971

Category	% share of Final Demand	Total FTE's	% of Total
Exports (excluding Tourism)	46.0	3037	48.6
Central Government	25.9	1752	28.0
Investment	15.6	950	15.2
Unrequited Receipts	9.1	372	6.0
Tourism	3.3	140	2.2
Totals	100	6251	100

the relative importance of each category is substantially different between the two tables. In particular, Exports are seen to be very clearly the main single source of employment in Shetland with Central Government some way behind, whereas these two categories generate very similar amounts of household income. The explanation of this lies in the relatively high proportion of Government expenditure which is direct income to households. This tends to raise the Government contribution to total household income compared with other sources, only some small fraction of whose payments goes directly to households. On the other hand, Central Government payments to households create very little employment directly, meaning its total contribution to employment tends to be reduced relative to those sectors with high direct employment creation.

As with income, the number of FTE jobs generated per unit expenditure of each Final Demand category can be estimated. Table 3.17 presents these results, using £10,000 as the unit of expenditure. Table 3.17 shows that, in spite of the comments made above, Central Government is in fact almost as 'efficient' as Exports in converting expenditure into employment. Thus, given the composition of expenditure in each of these two categories, the differences in employment generated by Government and Export expenditures reflect almostl entirely differences in the actual level of expenditure in each of these categories.

Again, Tourism fares badly, and in Shetland at least, Tourism seems not only to be a minor contributor to income and employment in absolute terms,

Table 3.17 Employment Generated per £10,000 Expenditure on Final Demands

Category	FTE Employment
Exports (excluding Tourism)	4.34
Central Government	4.18
Investment	3.77
Tourism	2.63
Unrequited Receipts	2.52

but also to be comparatively inefficient in transforming such expenditure as is made into income and employment. These two criticisms of Tourism, though interrelated, lead to differences, at least in emphasis, in policy considerations. The low absolute expenditure may lead to a policy which attempts to increase the level of tourist activity (particularly of high-expenditure categories of Tourists) in the region; while the inefficiency of Tourist expenditure in creating employment or income would lead to a policy which emphasised the need to direct Tourist expenditure to those industries which have high total income or employment[60] generation per £ of expenditure and/or which attempts to increase the income/employment generation potential (through increased local inter-linkages, for example) of those industries on which Tourist expenditure is actually centred. In general, an area may experience problems of insufficient Final Demand, of Final Demand composition, and of industrial structure simultaneously, but while their solutions need not be independent, different emphasis in policy may be required to tackle each directly.

(v) Trade

Regional industries import goods and services in the process of production (or consumption). The levels of outputs of industries are determined, as previously explained, by the level and composition of Final Demand. Therefore, as with employment or income, the level of Imports can ultimately

60. The preceding discussion has demonstrated that these need not be the same industries.

be attributed to Final Demand.[61] The volume of imports generated in Shetland by each category of Final Demand in 1971 is given in Table 3.18.

Table 3.18 Imports Generated by Final Demand Categories

Category	% of Total Final Demand	Total Imports generated £'000	% of Total
Exports	46.0	4173	42.1
Central Government	25.9	2470	24.9
Investment	15.6	1983	20.0
Unrequited Receipts	9.1	933	9.4
Tourism	3.3	364	3.7
Totals..	100	9923	100

Exports generated the greatest absolute volume of Imports which is not surprising since it is the largest single itemof Final Demand; it did however generate a smaller proportion of total than might be expected from its share of Final Demand, in contrast with Investment which accounts for a considerably higher proportion of imports than would be expected from its share of Final Demand. The reason for these findings becomes evident in Table 3.19 where Investment is shown to generate significantly more imports per £ of expenditure than any other category.

The high import-generating effects of Investment reflect a virtual absence locally of materials required for capital production so that industries engaged in production for investment must import virtually all their material requirements. In particular, Construction, which is the main local industry producing for investment, has to import all its steel, timber, etc. the only available local materials are some stone and quarried aggregates. Tourism also generated a relatively large volume of imports per £ of expenditure. However, in this instance, every £ of Tourist expenditure is

61. The analytical treatment is identical to that for employment (see Chapter 2 page 37 and above page 76) with an import/output, rather than employment/output, coefficient being used. Any other category of Primary Input can be treated analogously.

a direct addition to Export receipts; hence every additional £100 of Tourist expenditure actually improves the Balance of Trade by approximately £32. This does not compare favourably with other Export items, which on average improve the Balance of Trade by £44 for every £100 increase.

Table 3.19 Imports Generated per £ of Expenditure

Category	£
Investment	0.786
Tourism	0.684
Unrequited Receipts	0.632
Central Government	0.590
Exports	0.561

This concludes the discussion of the 1971 Shetland Input-Output Table. The empirical derivation of the various 'multiplier' values, based on the theoretical foundation of Chapter 2 will be used extensively in the subsequently analysis of the impact of oil on the local economy, and the detailed picture of the immediately pre-oil situation will provide a suitable background against which this impact can be set.

CHAPTER 4 : The Impact of Oil on Local Income, Output, and Employment

The preceding two chapters provided the theoretical and empirical framework within which the analysis of the impact of oil development on the economy of Shetland will take place.

Using this framework, the 'gross' impact of oil development on local incomes, output, and employment is estimated in this chapter. Variations to the assumptions of the basic model, whose incorporation yield estimates of 'net' oil impact, are discussed in Chapters 5 and 6. One of the most important advantages of Input-Output analysis is this adaptibility in practical situations which are not closely approximated by the assumptions of the basic model.

The nature of oil development in Shetland, and its treatment in the present study, are discussed in section 1. Subsequent sections analyse the impact of this development on the indigenous economy.

(i) The Nature of the Study

The oil industry in Shetland has been divided into three main areas of activity: (a) Oil Supply Bases (b) The Sullom Voe Terminal Complex and (c) Oil-Related Construction.[1] Each of these is discussed in greater detail in subsequent sections, and the present interest is in the <u>general</u> treatment of the oil industry in Shetland. Firstly, it is important to realise that currently the pattern of oil-related development in Shetland is still in a considerable state of flux: the Supply Bases are still

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1. In correspondence, the then Chief Executive of Shetland Island Council suggested that transportation be regarded as a separate activity. However, it seems more useful to regard this as a secondary repercussion of the activities named in the text, these latter representing the 'last line' of <u>local</u> oil activity, i.e. the activities with no further local forward linkages. This point is discussed subsequently in the text, but obviously there is no unique definition of the oil 'industry' and the current one is to some extent arbitrary, but is in common currency both within and outwith Shetland.

growing towards their expected peak, while the Sullom Voe Terminal is not yet operational at all, and of course the level of oil-related Construction employment is expected to vary considerably as various projects are started and finished. Hence while it would be possible to analyse the impact oil development <u>has had</u> on the Shetland economy since 1972, this would be of little interest, since as intimated above, such development is still in its infancy and the pattern of impact in the past might little anticipate that of the future, particularly since no terminal operations would be included at all.

The greatest interest therefore is in forecasting the local impact of oil-related development when the latter has reached some fairly stable level. This exercise is in the nature of a <u>partial forecast</u>, falling between the historical impact studies of Sadler et al (1973) and Miernyk (1967b), and the complete forecasts of Almon (1966) and Tiebout (1969).

The exact form of the model used is:

$$(\Delta X)_t = (I - A_{1971})^{-1} (O)_t \qquad (45)$$

where $(\Delta X)_t$ is a vector of changes in local Gross Outputs at time t. As discussed below 'time' here may refer to some given year, <u>or</u> the time at which oil activity reaches some particular level.

$(I - A_{1971})^{-1}$ is the Leontief Inverse derived from the 1971 Shetland Input-Output Table described in Chapter 3.

$(O)_t$ is a matrix of local oil industry expenditures at time t. The justification for this treatment is discussed on pages 85-87

This model is less comprehensive than a complete forecast of the economy at time t which would be given by

$$(X)_t = (I - A_t)^{-1} (Y)_t \qquad (46)$$

where $(X)_t$ is a vector of local industry Gross Outputs at time t.

$(I - A_t)^{-1}$ is the Leontief inverse derived from a year t coefficients matrix

$(Y)_t$ is a matrix of Final Demand expenditures at time t.

Forecasting the entire matrix of Final Demands is unnecessary, and indeed inefficient, if the aim is only to estimate the local impact of oil for: $(Y)_t = (Y^*)_t + (0)_t$ where $(0)_t$ is as defined above, and $(Y^*)_t$ is a matrix of local Final Demands excluding oil Final Demands. Thus:

$$(X)_t = (I - A_t)^{-1}(Y^*)_t + (I - A_t)^{-1}(0)_t \qquad (47)$$

so that the impact of oil Final Demand expenditures is given by

$$(\Delta X)_t = (I - A_t)^{-1}(0)_t$$

as before.

In fact, the use of equation (45) as a measure of oil impact on local Gross Outputs does not allow for the possibility that oil may have affected the emergent local industrial <u>structure</u> (i.e. A_t) as well as local Final Demand. To estimate this let

$$(X^*)_t = (I - A^*_t)^{-1}(Y^*)_t \qquad (48)$$

where A^*_t is the local domestic flow coefficient matrix which would exist at time t without oil development in Shetland, and $(Y^*)_t$ is as defined before.

Comparing equations (47) and (48) indicates the impact of oil on local Gross Outputs is given by:

$$(X)_t - (X^*)_t = (I - A_t)^{-1}(Y^*)_t - (I - A^*_t)^{-1}(Y^*)_t + (I - A_t)^{-1}(0)_t$$

i.e. $(\Delta X)_t = (B)(Y^*)_t + (I - A_t)^{-1}(0)_t$ (49)

Where (B) is a matrix representing $(I - A_t)^{-1} - (I - A^*_t)^{-1}$ i.e. the differences in local structure induced by oil development.

Comparing equations (45) and (49) indicates that the model employed in the current analysis differs from the more general model in two respects:

(a) (B) is assumed to be zero, i.e. oil is assumed not to change local industrial structure. The validity of this assumption in the Shetland context is discussed in detail in Chapter 6, and some attempt to estimate non-zero elements of B is made.

(b) A_t is assumed to be equal to A_{1971}. This is essentially a simplifying assumption imposed by resource limitations available for the study. The forecasting of coefficient change is difficult and uncertain (see Richardson (1972), Chapter 9, for a summary of the problems involved), and the problems are compounded in this case by the fact, discussed below, that different values of 't', and hence A_t, will be required for the various forecasts to be made. In fact, given the methodology adopted, no less than four estimates of A_t would be required. In the circumstances, there is probably little to be gained in terms of forecasting accuracy from replacing a known and constant base (A_{1971}) structure with various highly uncertain estimated structures. Of course, if the actual A_t structure does not differ greatly from A_{1971}, little error will be introduced by the use of the latter in estimating oil impact. The analysis of Chapter 6 suggests that, in some respects, the structure of the Shetland economy may change fairly slowly over time, implying that little distortion is introduced by the use of A_{1971}.

The forecasting of the level of oil development can itself be approached in a number of ways: for example, the development paths of each of the oil activities could be traced through time, either continuously or at discrete intervals. This procedure is the most satisfactory if the local effects of oil are to be estimated at any particular point in the future. However there are a number of problems involved in using this approach in the present study: firstly, because of slippages in the timing of North Sea Oil Developments, changes in extraction rate policy, etc., the levels of activities over time, and at any particular point in time, are considerably less certain than the ultimate level which each particular activity will attain. Secondly, a detailed breakdown of the local expenditures of each oil activity is generally only available at one or at best a few levels.

In particular, given the predictive nature of the exercise, it is difficult to obtain empirical expenditure estimates for any level of activity other than 'current' or 'fully operational' for each oil sector. Since the assumption of a smooth intermediate transition path, or the assumption that expenditure levels can be simply related to the growth paths of measurable variables such as employment, is likely to be considerably in error,[2] this casts considerable doubt on the feasibility of using time as the reference base for the present forecasting exercise. Some attempt to assess the development of oil-related industry through time is made in a later section, but the primary empirical analysis is not specifically related to calendar time, as discussed below.

Given the above difficulties in analysing the impact of oil in Shetland at specific future points in time, an alternative, suggested in the above paragraph, has been adopted in the present study as the primary focus of attention. In subsequent sections the local impacts of the <u>three</u> oil sectors described above are analysed at the <u>fully operational</u> level of each sector's activity. This attempts to avoid the two difficulties described above, firstly because, within a certain range, the expected level of local activity in each sector, when fully operational, is known with a fair degree of certainty, and secondly, as intimated above, it is in many instances more easy to obtain reliable data for a fully-operational facility than one at some intermediate stage of development. In fact, as will be discussed where appropriate, the nature of actual available data still required the use of proxy variables for scaling purposes, though the problem was less acute than it would have been had the previous form of analysis been adopted. A corollary of adopting a fully-operational reference base is that the impact of each of the three sectors is analysed primarily in isolation, since the level of activity in each does not necessarily, and does not in practice, reach full operation at approximately the same point in calendar time. Hence, an impact analysis of all three activities fully-operational simultaneously will not correspond to any real-world situation, and would be of little policy interest.

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2. Because of discontinuities in starting/stopping various operations, economies of scale, fixed vs variable costs, etc.

<u>(ii) The method of analysing the Local Impact of Oil</u>

The model used to assess the impact of Oil on the Shetland economy, given in equation (45), is an incremental variation of equation (29), Chapter 2, i.e.

$$\left(\Delta X_*^s\right) = \left(I - A_*^s\right)^{-1}\left(\Delta Y_*^s\right) \qquad (50)$$

where ΔX_*^s is a vector of changes in local industry Gross Outputs, including Households.

$\left(I - A_*^s\right)^{-1}$ is the previously described inverse matrix derived empirically from Table 3.1, households endogenous.

$\left(\Delta Y_*^s\right)$ is a column vector of local purchases by each oil sector. There are six such column vectors: two for each of the sectors, Oil Supply Bases, Tanker Terminal, and Oil Construction.[3] In other words, oil-related expenditures are treated as increments to Final Demand, and their effects on Gross Output estimated via the Input-Output inverse matrix. Once the series of industry Gross Output changes is obtained, it is possible, as demonstrated in Chapters 2 and 3, to estimate income and employment changes also. Therefore, the only empirical estimates necessary to implement the model are the <u>direct</u> changes in outputs, income, and employment caused by each oil sector, the <u>indirect</u> and <u>induced</u> local changes are derived via the $\left(I - A_*^s\right)^{-1}$ inverse matrix, where A_*^s is derived from Table 3.1 in the manner described on pages 56-57 Of course, estimation of the impact of oil in this fashion assumes the assumptions of the model as described in Chapters 2 and 3 remain valid. As suggested in the introduction to this chapter, revisions to these assumptions are discussed in detail subsequently, particularly in Chapters 5 and 6.

The treatment of the oil sectors as additions to Final Demand requires some discussion, since it has certain theoretical and empirical implications. Firstly, as discussed in Chapter 3, the inclusion of any sector in Final Demand implies that the sector's level of output is determined exogenously to the local economy; in other words changes in the level of activity in the Final Demand sector may induce changes in the level of activity in other

3. These correspond to alternative estimates of the level of activity in each sector, and are discussed further in the appropriate sections. Apart from Oil construction, these are broadly 'lower' and 'upper' case estimates.

local industries, but the reverse is not true. Given the demand orientation of the Input-Output model, this assumption is largely justified if the sector in question sells all its output outwith the local economy. In the case of oil-related sectors in Shetland, this is largely the case, for the level of activity in each of the Shetland oil sectors is almost entirely dependent on the levels of exploration, development, and production, activities in the various North Sea Oil fields, and the latter are determined by Company and Government policies made entirely outwith the Shetland economic system. As this implies, the receipts of Shetland-based oil firms come almost entirely from contractors based outside Shetland, and hence, as required of a Final Demand element, their levels of output are little influenced by local industry activity.

The preceding paragraph does, however, suggest an alternative approach, which would be to include the three oil sectors as individual industries in the Intermediate sector, making local purchases in the course of their operations, and selling all their output to Final Demand sectors such as 'Oil Rigs', 'Development Platforms', etc. This procedure would have two advantages: firstly, it would indicate clearly the source of the receipts of Shetland-based oil companies, and secondly, and more importantly, it would permit oil firms to make sales to other local companies in the model if this actually occurs in practice.[4] Quantitatively, such local sales have not been found to be significant, and hence empirical estimates of the impact of oil activities on local output, etc. will not differ greatly between the alternative treatments. However the existence or creation of such forward linkages per se could induce new investment (see pages 53-54) or technological change (see pp. 164-165) in the local customer industries,

4. The actual empirical estimates of the changes in local income and employment between the two treatments of Shetland oil firms will only differ to the extent this does occur.

and hence though small as quantitative flows, be important in impact. For reasons to be described below, the treatment of oil activity as an intermediate local industry raises considerable difficulties empirically, and in the present study the following compromise approach has been adopted: in the quantitative analysis of this chapter, the oil sectors are treated as components of Final Demand and therefore no forward linkages are included. Since the analysis is based on the Input-Output assumption of no changes in local industrial structure through new industry creation, technological change, etc. this is reasonable given the small magnitudes of local oil industry forward flows. In the qualitative discussion later in this chapter, and particularly in the next chapter, the possibility of relaxing some of these assumptions, and permitting forward linkages, is considered.

It was mentioned above that there are great difficulties in estimation if the oil sectors are included in the Intermediate sector. Foremost among these is the problem that if an oil sector is included as an intermediate industry, then measures of both Gross Output and Gross Input have to be found and balanced. As will become apparent subsequently, data on receipts and total expenditure breakdown is simply not available, particularly, of course, for the Sullom Voe Terminal. A second problem is that inclusion in the Intermediate sector then constrains the expenditure breakdown of the oil sector to the 'constant proportions' assumption of the analysis, any changes requiring re-inversion of the complete matrix. As discussed above, the forecasting nature of the exercise makes it desirable that the impacts of different levels and compositions of oil-related expenditure can be assessed quickly and readily, and this is best served by the inclusion of the oil sectors in Final Demand.

This completes the discussion of the nature and method of oil impact analysis. In subsequent sections, we turn to the empirical estimation of this impact.

(iii) Brief resume of Oil Developments to date in Shetland

This section provides background information on the timing and nature of oil developments in Shetland to date as a preliminary to the detailed impact forecasts of subsequent sections. Since this type of non-analytical survey of oil-history in Shetland has been discussed in detail elsewhere,[5] the present coverage can be brief.

The initial allocations of North Sea 'blocks' in 1964 and 1965 had no impact on Shetland whatsoever since drilling activity was concentrated in much more southerly waters. However, some indication that the Northern North Sea might hold oil and gas deposits came in June 1968 when the 'Cod' gas field was discovered in Norwegian waters, and again in September of that year, when commerical oil deposits were found in Danish waters. Results in Scottish waters were disappointing until Amoco discovered the Montrose field (yielding 50,000 barrels per day (bpd)) east of Peterhead in December 1969. Further major discoveries followed: the BP Forties field in October 1970, and the Auk field in 1971.

By early 1971, exploration activity had begun in waters north-east of Shetland, and in July 1971, Shell-Esso discovered the very large Brent field (550,000bpd) one hundred miles north-east of Shetland, although they did not make the find public until mid-1972. Since then, further fields off Shetland have been discoveredand proven commercial, as drilling activity in the northern North Sea has heightened: Ninian (310,000bpd), Thistle (180,000bpd), Dunlin (110,000bpd) and Cormorant (45,000bpd).[6] The current situation (December 1976) is summarised in Figure 4.1.

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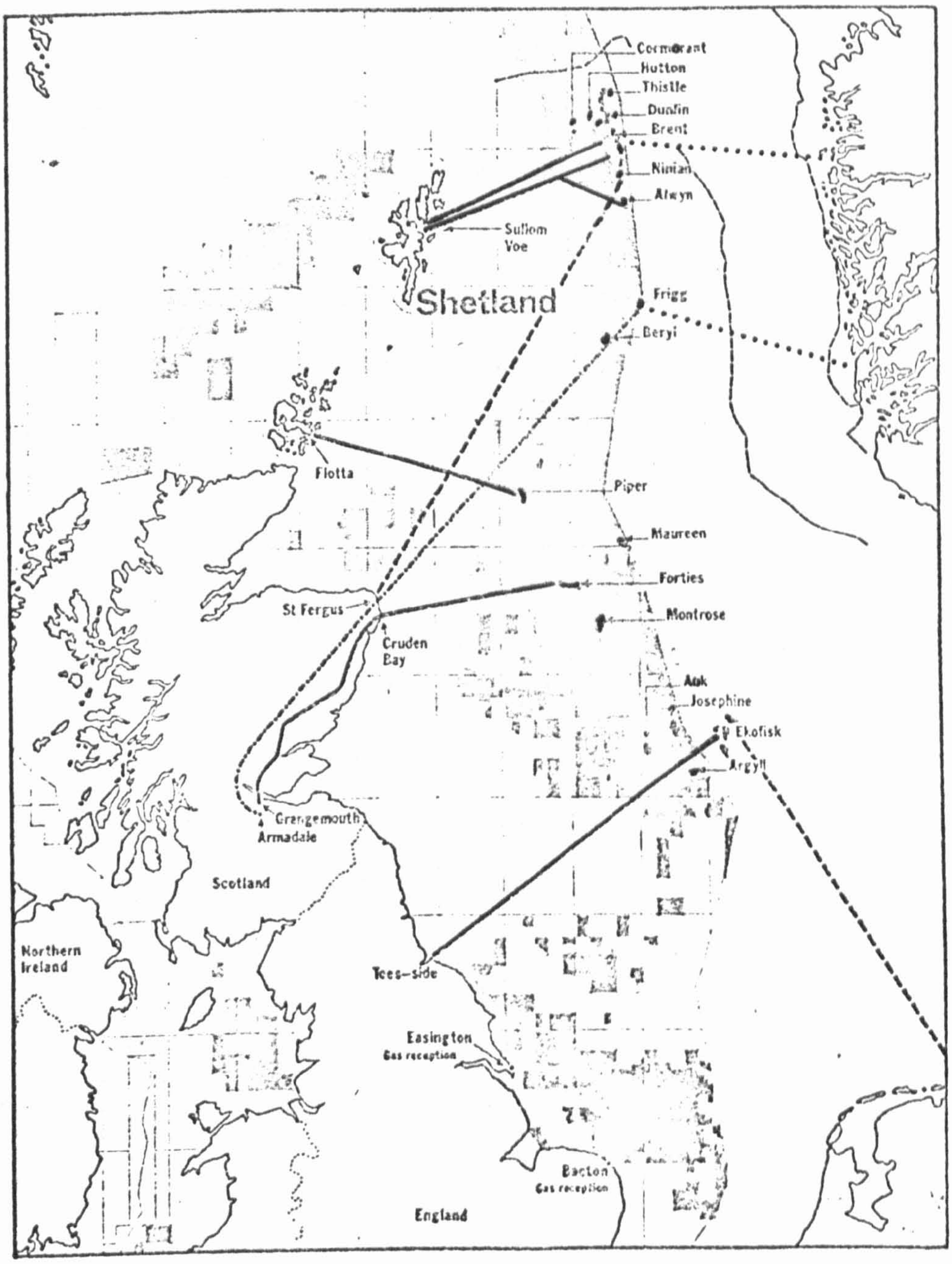
5. Nicholson, J.R. (1975), Button, J. (1976).
6. In addition, Hutton and Alwyn fields have been discovered but not yet declared commercial (December 1976).

Figure 4.1 Known Oilfields in the North Sea (1976)



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reproduced from J Button (Ed) <u>The Shetland Way of Oil</u> Thuleprint 1976

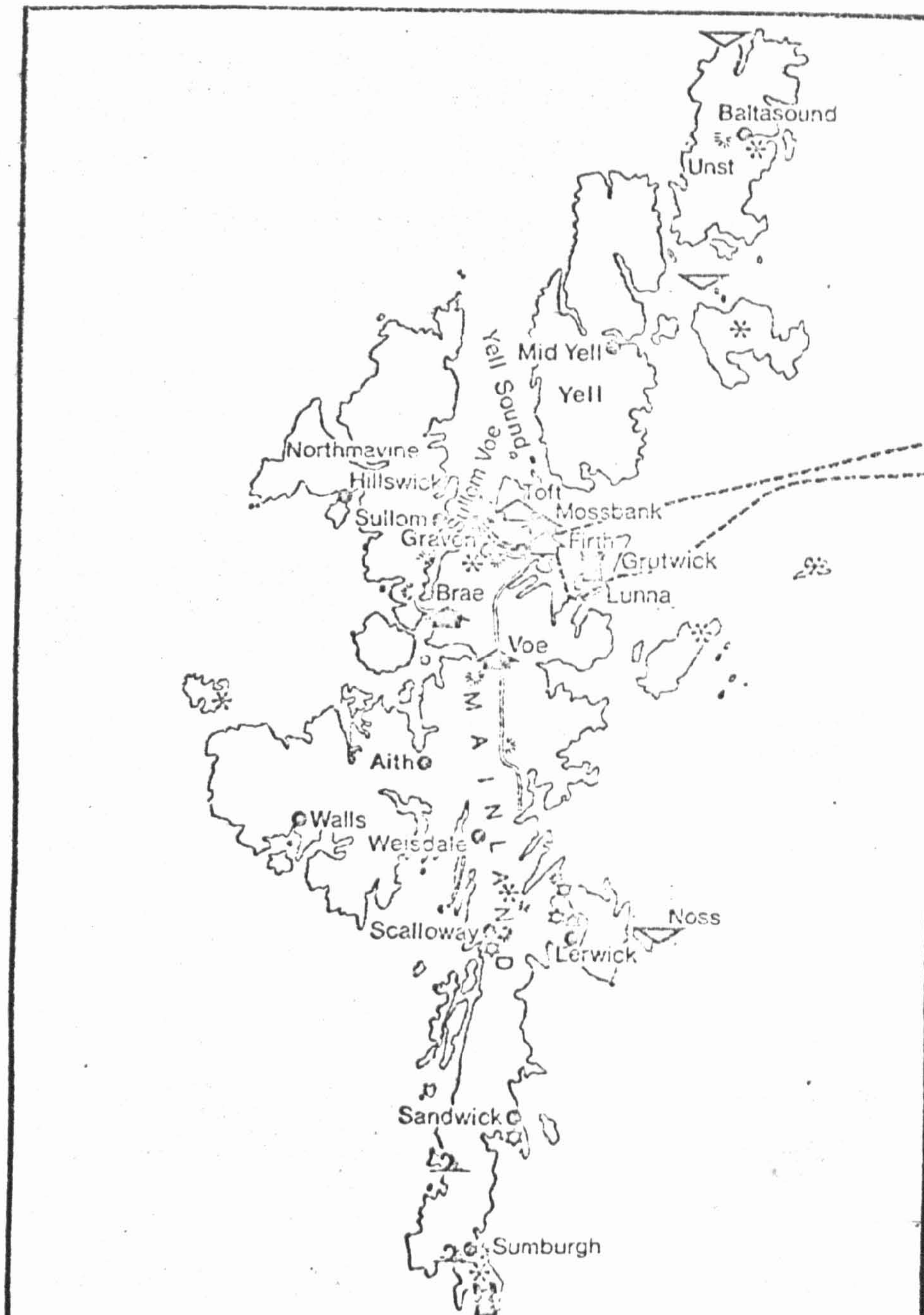
The initial impact of this activity in Shetland, which began in mid-late 1971, was largely concentrated in increased harbour activity as supply vessels servicing the drilling rigs started to use Lerwick as an on-shore base. By early 1972, it became apparent that Shetland could play a major role as a service area for northern North Sea fields, and purpose-built Supply Bases began to be proposed and subsequently constructed.

In August 1972, the announcement by Shell-Esso of the Brent field made it probable that Shetland would provide the landfall for at least one oil pipe-line, and indeed Shell had already drawn up preliminary plans for piping oil from this field to a tank storage complex at Sullom Voe. The (then) Zetland County Council also wished large-scale oil developments to be concentrated in Sullom Voe to prevent their proliferation throughout the region. To ensure their ability to pursue this strategy and to be able to exercise control on subsequent developments, the County Council sought, and were eventually granted in the Zetland County Council Act of 1974, wide-ranging powers. Under this Act, the Council could act as port and harbour authority in the Sullom Voe area, could compulsorily acquire land for oil developments in that area, could issue or refuse dredging and construction licenses, could enter into commerical ventures, and finally could establish an internal financial Reserve Fund.

Using these exceptional powers, the Island Council (as now) have already been able to ensure their major aims: all of the major oil developments have been channeled to the Sullom area, including the landfall of a second pipeline from BP's Ninian field. The landfall, of these two pipelines alone (others are possible in the future), the processing and storage facilities for the oil from them, and the harbour facilities required to transport this oil, already ensure that the Sullom Voe complex when complete will be the largest of its kind in Europe. The Council have also ensured their joint-partnership with the oil companies in the control and operation of the terminal, and have reached agreement with the oil companies that the

Figure 4.2

Oil-related Developments in Shetland (1976)



11

KEY: --- oil pipeline * airports & airstrips

oil service bases oil terminal

expanded settlements quarries

construction villages

reproduced from J Button (Ed) The Shetland Way of Oil Thuleprint 1976 latter will pay the Council, in addition to all statutory payments such as harbour dues and rates, certain 'disturbance monies' which already amount to £4 million, and could total £25 million by the end of the century.

This summary of recent oil developments in Shetland, though brief, serves nonetheless to justify to fundamental tenents of the present study: firstly, the use of 1971 as the most recent pre-oil economic structure is clearly valid: oil had minimal impact on the Shetland economy throughout that year, but by the end of 1972 had grown too substantially to be ignored. Secondly, it is equally apparent that the major areas of oil development are in Supply Base activity and in the operations of the Sullom terminal, the impact of both of which is considered in details in subsequent sections. In addition, the effects on the local economy of constructing the facilities required by the above activities is discussed in detail.

(iv) The Impact of Oil Supply Bases on the Shetland Economy

(a) General

The maintenance of exploration rigs and production platforms in offshore activity requires a continuous supply of materials, foremost among which are tubulars, bulk chemcials, bagged chemicals, cement, water, and fuel. In addition, provisions and transportation for up to 70-85 offshore crewmen are required. The function of the Supply Base, therefore, is to provide the on-shore link with the offshore rigs. This is elaborated below, but first the reasons for choosing a Shetland location for such a facility are discussed briefly.

Certain 'desirable' criteria have been specified for a geographical location for an Oil Supply Base. A typical list of such criteria[7] would

7. E.g. see Churchfield (1972).

include an all-weather harbour, deep water anchorage, Telex and telecommunications, proximity to an Air/Heliport, road and rail links, and proximity to a centre of population. While certain of these criteria, particularly the latter two, are not well met in Shetland, the geographical location of the Islands with respect to the more northerly oilfields in the East Shetland basin would seem to make it more economical to provide certain Supply Base services from there than from alternative mainland ports such as Aberdeen. It has been claimed that for any given base location, fields more than 150-200 miles from it are better serviced by alternative closer sites.[8] This implies that the most northern fields, including the large Brent/Ninian complex, can be more economically serviced from Shetland than any other area of Scotland (though certain Norwegian ports such as Stavanger could prove economically competitive in supplying these fields). One of the Shetland Bases, Hudsons, state in their literature that:

> "Operating from Shetland means considerable savings of fuel and time over operations based on either Peterhead or Aberdeen, amounting to nearly £1000 per trip ... also shows considerable savings on helicopter movements."

In discussion, other Shetland operators stated that, because of the high costs of maintaining rigs in the North Sea (over £20,000 (1974 prices) per day whether they are working or not), the time saved in providing essential operating supplies is likely to be a strong determining factor in the location of supply bases in the Shetland Islands in addition to any savings in fuel costs. However, the disadvantages of a Shetland location such as those mentioned above, and more importantly the accumulated advantages for Supply Base location which Aberdeen has accrued by being 'first in the field',[9]

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8. Scotland and Oil (1973), page 53.
9. Time and again in interview, oil operators stated that one of Shetland's main disadvantages in attracting oil industry is its comparatively late start in the business.

have led to a specific type of Supply Base development in Shetland. The type of Supply Base facility which has emerged in Shetland is generally of an 'advanced storage' or 'forward' nature: primarily engaged in storage, handling, and transhipment of the various goods and materials required offshore. Thus, rig and supply vessel crews primarily have mainland headquarters and homes, as do senior company personnel.[10] Also, importantly, engineering and repair facilities featured in mainland bases are not prominent in Shetland Supply Bases. As discussed in Appendix III, this latter can make a significant difference to the number of employees associated with a base facility.

(b) The Level of Supply Base Activity in Shetland

The estimation of Supply Base expenditure in Shetland, and its breakdown into local industrial components, is derived primarily from a survey of Shetland Supply Bases in Shetland undertaken by the author, coupled with forecasts (from a number of sources) of the expected level of Supply Base activity in the region. A detailed discussion of the derivation of the expenditure estimates is given in Appendix III, pp. 216-220, from which Table 4.1. (Appendix Table III.2) is reproduced.

Table 4.1 shows the estimated local expenditures by Oil Supply Bases at the peak of their activity. 'High' and 'Low' estimates are given to allow for uncertainty in the forecasting of various components of the expenditure function (again, details are found in the Appendix), and these are intended to represent upper and lower bounds to expected Supply Base expenditures.

If the columns of Table 4.1 are to be used directly as the $(O)_t$ of equation (45) (page 81) for Oil Supply Bases, then one further assumption is required, i.e. that Supply Base households have the same expenditure patterns as Shetland households. This is not a theoretical requirement since it would

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10. This point is important in assessing the potential for 'spin-off' benefits from oil technology to local Shetland industries. See pages 112-113

Table 4.1: Annual Gross Peak Local Supply Base Expenditure (1971 producers' prices)

Shetland Industry	Low	£'000	High
Agriculture	0		0
Fishing	0		0
Quarrying	1.4		1.7
Fish Processing	0		0
Textiles	0		0
Ship Repair	0.8		1.0
Other Manufacturing	4.9		6.2
Construction	9.2		11.7
Utilities	2.9		3.8
Transport	134.8		171.5
Communications	5.1		6.4
Distribution	2.0		2.6
Professional Services et al	1.5		1.9
Other Services	30.7		39.1
Local Government	10.8		13.8
Households	416.1		653.9
TOTALS	620.2		913.6

be simple to replace the single household expenditure entries in Table 4.1 with columns showing household consumption by industry. Rather, the difficulty arises empirically that Shetland households have been found on average to have an expenditure pattern significantly different in some respects from that in Scotland or the U.K.,[11] and some of the employees in Service Bases may be immigrants from these or other areas. Unfortunately the proportion of total Service Base employment which will ultimately be immigrant is not known, and if it were, there would still be great difficulty in estimating *ex ante* their expenditure pattern, particularly the breakdown between *local* and *non-local* purchases. Therefore, the present assumption represents a simple 'extreme' case, easily amended as and when data becomes available. However, it can be said that a large proportion (75%) of Supply Base employment currently (1976) is local, and company policy in this area is to employ locals wherever possible,[12] so that the problem of immigrant workers may not be too important in *Supply Bases* though, in general, a high proportion of oil workers are likely to be immigrant. Furthermore, studies have shown[13] that immigrant families generally have a lower propensity to consume

11. See McNicoll (1974).
12. See Chapter 5 page 137.
13. Refs: Greenwood and Short (1973).

locally than local households; so that using Shetland propensities would over-estimate local expenditure of such households. On the other hand, one of the major consumption behaviour differences between Shetland and U.K. households is the much higher propensity to save of the former; so that using Shetland propensities would under-estimate expenditure of an average U.K. immigrant household. These off-setting tendencies may help to minimise differences in aggregate local expenditure between Shetland and immigrant families, though the problem of possible differences in the commodity breakdown of expenditure remains.

Bearing this difficulty in mind, Table 4.2 shows the changes in Shetland industry Gross Outputs resulting from local Supply Base expenditure as given in Table 4.1, using equation (45) for the calculation.

Table 4.2 Gross Peak Change in Industry Gross Outputs resulting from Supply Base Expenditures

Industry	Low	£'000/year (1971 prices)	High
Agriculture	14.4		21.7
Fishing	2.0		3.1
Quarrying	2.2		2.9
Fish Processing	1.6		2.5
Textiles	0		0
Ship Repair	3.2		4.1
Other Manufacturing	21.0		30.4
Construction	19.8		27.1
Utilities	22.2		32.4
Transport	159.6		205.8
Communications	11.8		16.3
Distribution	60.0		90.4
Professional Services et al	16.6		23.1
Other Services	87.2		124.4
Local Government	19.8		27.2
Households	572.6		871.9
TOTALS	1014		1483

Table 4.2, which shows the direct, indirect and induced changes[14] in local industry Gross Output resulting from the direct expenditures of table 4.1, gives a more accurate estimate of the local impact of Oil Supply Bases than

14. The economic meaning of 'indirect' and induced' effects is given on pages 59-60.

Table 4.1 which estimates direct repercussions only. Comparisons between the two tables are revealing: of course, no industry entry in Table 4.2 is less than the corresponding one in Table 4.1, since the direct expenditures of the latter are included in the former;[15] however, many entries in Table 4.2 are considerably greater than the corresponding ones in Table 4.1 because of important indirect and induced effects. For example, Agriculture, Fishing and Fish Processing show increases in Gross Outputs, though Supply Bases make no purchases directly from these industries. The increase is primarily an induced one through consumption of these products by households. Similarly, Other Manufacturing, Utilities, and Distribution, show important secondary increases.

The total changes in industry Gross Outputs for 'Low' and 'High' Supply Base levels of activity are respectively £1.0 million, and £1.5 million, per annum. This yields a Type II output multiplier for Oil Supply Bases of 1.63 ('Low'), or 1.62 (High)[16] i.e. every £1 of direct Supply Base expenditures creates another 62p approximately of output through secondary repercussions. The comparatively large significance of secondary effects on local output (i.e. 60% of the direct change) provides justification for the use of the Input-Output methodology to ensure their inclusion in the impact estimates (see pages 26-27). The Household figures in Table 4.2 are particularly interesting since they represent the 'High' and 'Low' estimates of the total change in wage and salary payments in Shetland resulting from Oil Supply Activity. In other words, at their peak, it is estimated that Oil Supply Bases will increase Shetland Household income by £570,000-£870,000 per annum. This is made up of a £420,00-£650,000 direct change,

15. This is discussed in more detail in Chapter 5, pages 131-132.

16. The difference between the two multiplier values arises because the column vectors of direct Supply Base expenditures are not scalar multiples of one another.

and a £150,000-£220,000 indirect plus induced change. This yields a Type II Income Multiplier for Oil Supply Bases of 1.38 (Low) and 1.33 (High).

This total change in household income can be broken down into income changes in individual local industries. This is obtained by multiplying the direct household row coefficient of each industry by the Gross Output change in that industry obtained from Table 4.2. The results are shown in Table 4.3.

Table 4.3 Gross Peak Changes in Industry Income Payments generated by Supply Base Expenditure

Industry	Low	£'000/year (1971 prices)	High
Agriculture	7.4		11.2
Fishing	1.1		1.8
Quarrying	0.8		1.1
Fish Processing	0.2		0.4
Textiles	0		0
Ship Repair	1.4		1.8
Other Manufacturing	3.8		5.4
Construction	4.9		6.7
Utilities	3.5		5.1
Transport	48.6		62.7
Communications	11.0		15.2
Distribution	24.7		37.3
Professional Services et al	11.7		16.3
Other Services	34.1		48.6
Local Government	2.6		3.5
Households[17]	1.4		2.1
OIL SUPPLY BASES	416.1		653.9
Totals	573.3		873.1

Comparing the total income generated by Supply Bases with the local expenditure of such Bases yields an Income per £ expenditure ratio of £0.92 (Low) or £0.95 (High). This compares favourably with the Income/Expenditure ratios for other Final Demand categories given in Table 3.11. However, the latter expenditures are total, and for strict comparability, direct Supply Bases imports have to be added to their local expenditures. Churchfield[18] has

17. These are income payments by Households to Households for domestic service, etc.

18. Churchfield (op. cit.).

estimated that Supply Bases' local purchases in a Scottish region may be only 15% of their total expenditures. If this accepted, then the Income/Total Expenditure ratio becomes approximately £0.14, which is considerably lower than any other Final Demand category. These disparate findings are not at all inconsistent: merely reflecting the presumption that Supply Base local purchases are a considerably smaller proportion of total than that in any other Final Demand category.

Finally on Income, if Supply Base expenditure was a real net addition to Shetland Final Demand in 1971, all other things equal, then real household income in Shetland would be increased by 6-9% over the 1971 level.

As described for other sectors in Chapters 2 and 3, the direct, indirect, and induced changes in employment resulting from Oil Supply Base activity can also be estimated, again on an individual industry basis. The results are presented in Table 4.4.

Table 4.4 Gross Peak Change in Industry Employment Generated by Oil Supply Bases

Industry	Low	FTE's	High
Agriculture	5.5		8.3
Fishing	0.6		0.9
Quarrying	0.6		0.8
Fish Processing	0.2		0.4
Textiles	0		0
Ship Repair	1.1		1.4
Other Manufacturing	2.6		3.8
Construction	4.6		6.3
Utilities	2.2		3.3
Transport	40.9		52.7
Communications	6.6		9.1
Distribution	33.0		49.9
Professional Services et al	7.9		10.9
Other Services	19.2		27.3
Local Government	4.3		5.8
Households	1.2		1.9
SUPPLY BASES	210		330
Totals	340.5		512.8

The total employment generated in Shetland as a result of Supply Base activity therefore ranges between 340-510 FTE jobs approximately. This yields a Type II Employment multiplier for Oil Supply Bases of 1.62 (Low) and 1.55 (high), with a mean of 1.59. Comparison of this multiplier value with those of indigenous Shetland industries given in Table 3.13 indicates that Oil Supply Bases rank relatively highly in this respect, falling between Fishing (1.63) and Agriculture (1.55); respectively fifth and sixth in indigenous rankings. As discussed in Chapter 3, this type of multiplier is useful in demonstrating the importance of indirect and induced effects relative to direct change, and the high ranking of Oil Supply Bases in this statistic shows that the secondary repercussions in this industry are more important relative to direct effects than in a majority of indigenous industries.[19]

Tables 4.2-4.4 illustrate two points on the differing impacts of Oil Supply Bases: firstly, the <u>relative</u> impacts on the various Shetland industries change depending on whether Output, Income or Employment is used as the unit of analysis. This results from the fact that the income and employment coefficients differ from one another for a single industry and among industries.

Secondly, the secondary Income and employment created by Supply Bases in indigenous industries is not distributed equally among the latter. In particular, the major impact, however measured, is seen to be concentrated in the Service sectors. This is demonstrated in Table 4.5 for employment only, which is obtained by aggregation from Table 4.5.

Table 4.5 Supply Base-Induced Changes in Employment by Sector

Sector	Employment Change FTE's[20]	% of Total
Primary	8.3	5.3
Manufacturing	4.8	3.1
Construction	5.5	3.5
Services	138.1	88.1
TOTAL	156.7	100

19. The point made in footnote 57 of Chapter 3 must also be borne in mind, and the secondary repercussions in the text of Supply Bases may be best regarded as a maximum.

20. For brevity, only the <u>mean</u> of Low and High estimates is given. These estimated employment changes are 'gross', 'net' addition may be less if there are 'negative multiplier' effects or technological change (see chapter 5 pp. 132-140, and chapter 6, pp. 174-176).

The total employment generated in Shetland by Oil Supply Bases is approximately 6-9% of total employment in Shetland in 1971, the most recent pre-oil year. On an individual industry basis, the employment generated by Supply Bases is approximately 1% of the 1971 level in Primary, Manufacturing, and Construction, and approximately 5% in services.

This concludes the discussion of the impact of Oil Supply Bases on the economy of Shetland for the present; subsequently some other relevant considerations will be discussed, including the probable pattern of development of local Supply Base activity over time. In the meantime, we turn to the second main area of oil activity in Shetland: the Sullom Voe Terminal.

(v) The Impact of the Sullom Voe Complex on the Shetland Economy

(a) General

The treatment of the Sullom Voe facility in this impact study is exactly analogous to the preceding treatment of local Supply Base activities, i.e. direct expenditures by the Terminal locally are estimated and are assumed to be an increment to Final Demand. The inverse matrix from the 1971 transactions table is then used to derive the resulting changes in local industries' Gross Outputs, wage payments, and employment. Given the equivalence of treatment, parts of the preceding discussion of Supply Bases need not be re-iterated, and, in the main, the present analysis focuses on (a) the general nature of the Sullom facility, (b) the estimation of its direct expenditures (primarily in Appendix III), and (c) estimation of the local impact of these expenditures.

Considering the former first; in the most general terms, the Sullom Voe complex provides the landfall for oil pipelines from the Brent/Ninian complex of oil fields in the Northern North Sea, storage for oil landed, and marine terminal facilities for oil trans-shipment to other areas. As discussed subsequently, this represents a 'firm minimum' view of the facilities likely to be incorporated in the Sullom Voe Complex.

More specifically the facilities provided in the Sullom Voe Complex can be summarised under two headings 'Pipeline Requirements' and 'Tanker Terminal Requirements'. The following are the primary facilities required by 'Pipeline Requirements':

1. Incoming Piple Landfall. At least two, and possibly four, 36" diameter pipelines will make their landfall at Sullom Voe from the Brent/Ninian fields. Pipeline capacity will be of the order of 1 million barrels per day (bpd), and metering and sampling equipment will be associated on-land with each incoming pipeline.

2. Water and Gas Separation Plant/Stabilization Plant. It may be necessary to stabilize the crude oil before it is suitable for tanker loading, and this process could lead to the 'boiling off' of gas and light fractions which are then available for fuel. It will also be necessary to heat crude oil arriving at sea temperature prior to storage. The facilities involved in these operations include oil/gas separators, stabilisation columns, adsorption/absorption columns, steam generators, heat exchanges, pumps, compressors, etc.

The quantities of propane and butane in North Sea Oil make it possible that Liquid Petroleum Gas (LPG) separation and loading facilities may be required. This would involve absorption and fractionation columns, pumps, process vessels, refridgeration equipment, LPG storage tanks and a loading jetty.

3. Buffer Crude Storage facilities. Provision has to be made in the Terminal for 'buffer' storage of crude oil to compensate for the generally differing rates of reception and discharge. A major debate between the oil companies and the Shetland Island Council has been in progress since the inception of the idea of the Sullom Voe Complex on whether crude oil should be stored above ground in conventional steel tanks, or in underground

caverns. Primarily for its lower cost, the oil companies favoured the former, while for largely environmental reasons the Island Council favoured the latter. At the time of writing (December 1976), it seems probable that surface storage will in fact be used, with compensation being made to the Island Council.

'Tanker Terminal Requirements' are as follows:

4. Booster Pumps. Oil will be drawn from the storage units and passed to the main loading pumps by booster pumps, which will be metered to measure the flow of crude for sale and fiscal purposes.

5. Main Loading Pumps. These pumps provide, the pressure necessary to push the oil through the loading lines into the tankers.

6. Main Loading Jetties. Oil quantities associated with the first pipeline will require three tanker loading jetties, each suitable for berthing VLCC tankers (up to 300,000 tons). Additional pipelines could require further berths. Each jetty will be 300 metres long extending into 35 metres water depth. Each will carry loading piplelines, fire/foam lines, lighting, and transport facilities.

7. Ballast Water reception and Clearing Tanks. Many of the carriers arriving will have water ballast, and since this is oil-contaminated, it must be collected and treated onshore before final discharge into the sea.

8. Other port and Onshore facilities. In addition to the facilities outlined above the Terminal will feature a large range of others generally associated with this type of development. Among these are included: an electricity power station, firefighting facilities, pilotage/ tug/cargo boat services, communications and transport (including air), offices, warehousing and storage, medical services, and some personnel accommodation.

In spite of the brevity of the above description, it is apparent that the Sullom Voe development is of very large scale and incorporates a multitude of heterogeneous activities. This latter, in particular, can lead to difficulties in estimating employment and expenditure levels for the complex as a whole. Details of the estimating procedures are given in Appendix III, and the relevant results are summarised below. Firstly, it is estimated that a fully operational Tanker Terminal at Sullom Voe will employ 380-445 full-time equivalent persons, and the limits of this range are used subsequently as 'Low' and 'High' employment estimates respectively. Secondly, 'Low' and 'High' expenditure estimates for the Terminal in each indigenous Shetland industry are given in Table 4.6 (identical to Appendix III Table 4).

Table 4.6 Direct Local Purchases Estimates for the Sullom Voe Complex (fully operational)

Shetland Industry	Low	£'000 (1971 prices)	High
Agriculture	2.0		2.4
Fishing	0.4		0.4
Quarrying	0		0
Fish Processing	0		0
Textiles	0		0
Ship Repair	15.3		18.1
Other Manufacturing	1.4		3.5
Construction	139.0		229.4
Utilities	12.2		12.2
Transport	267.6		305.8
Communications	8.0		9.4
Professional Services et al	2.4		2.8
Distribution	3.5		3.9
Other Services	49.3		57.0
Local Government	1042.5		1737.5
Households	764.5		903.5
Totals	2308.1		3286.0

While the actual numerical entries in Table 4.6 are subject to error, two points stand out clearly: firstly the volume of direct local expenditure made by a full operational Sullom Voe Terminal is greater than peak Supply Base expenditure by a factor of almost four; and secondly, like Supply Bases, the Terminal's expenditure is not spread evenly among indigenous industries; in particular the Terminal's local expenditure is forecast to be concentrated in four Shetland industries: Construction, Transport, Households, and Local Government. The expenditure on construction is for repairs and maintenance only; new construction, which is a 'capital' item, is considered separately in the following section. Payments to Local Government are entirely rates; 'disturbance' payments, local barrelage taxes, etc. which have been negotiated between the Shetland Island Council and the oil companies are not included.[21] The reason for the differential treatment is that the assumption implied in the analysis that these additions to rate receipts will be spent in the same proportions as non-oil rates (derived from Table 3.1) may, for reasons discussed subsequently, be reasonable. However, the Island Council have stated explicitly that any disturbance receipts will not be spent on rateable items, and hence a different treatment is required for these.

The changes in industry Gross Output, income and Employment resulting from the above direct Terminal expenditures can be derived as before, and these are given in Table 4.7.[22]

Table 4.7 Oil Terminal-induced changes in Shetland Industry Output, Income, and Employment

Shetland Industry	Gross Output Low £000/yr (1971 prices)	Gross Output High	Household Income Low £000/yr (1971 prices)	Household Income High	Employment Low £000/yr (1971 prices)	Employment High
Agriculture	49.5	69.2	25.4	35.5	18.8	26.3
Fishing	7.3	10.1	4.0	5.5	2.2	3.0
Quarrying	11.0	17.9	4.0	6.5	3.0	4.9
Fish Processing	5.0	7.0	0.6	0.8	0.6	0.8
Textiles	0	0	0	0	0	0
Ship Repair	21.0	25.2	9.2	11.0	7.2	8.6
Other Manufacturing	57.9	83.6	10.5	15.2	7.2	10.4
Construction	380.4	624.2	94.1	154.4	88.3	144.9
Utilities	139.6	207.9	22.0	32.8	13.9	20.7
Transport	352.6	424.2	107.4	129.2	90.4	108.7
Communications	36.7	51.4	34.2	47.9	20.5	28.7
Distribution	208.3	293.9	85.6	120.8	114.3	161.2
Professional Services	625.1	1032.7	440.6	727.9	297.4	491.3
Other Services	244.4	332.2	95.6	129.9	52.5	71.4
Local Government	1095.6	1801.3	142.6	236.6	236.2	391.9
Households	1837.4	2552.1	4.5	6.3	3.8	5.3
TANKER TERMINAL	2308.1	3286.0	764.5	903.5	380	445
TOTALS	-	-	1844.8	2563.8	1336.3	1923.1

21. Payments of this type are discussed in Chapter 5, pages 156-157.

22. As in the case of Supply Bases, payments to Terminal employed households are assumed to be spent in the same proportions as local households. See pages 94-96 for a discussion.

Considering the 'Low' estimates first, the direct expenditure of the Sullom Terminal of £2.3 million is expected to create a total change in local output of £5.1 million (including the Terminal's £2.3m), or equivalently, an indirect plus induced change in local output of £2.8 million. This yields a Type II Output Multiplier for the Sullom Terminal of 2.21. Similarly, direct Income payments of £765,000 by the Terminal are estimated to create secondary local income payments of £1.1 million, making a total change of £1.9 million approximately. The Type II Income Multiplier for the 'Low' estimate is therefore 2.41 and total income created per £000 of Terminal expenditure is £799. Finally the 'Low' estimate of total employment change (including the Terminal itself) is 1336 FTE's and the Type II employment multiplier is 3.52.

Considering now the 'High' estimates, the total change in Gross Output resulting from £3.3 million direct expenditure is £7.6 million, yielding a Type II multiplier of 2.29. The total 'high' change in income payments is £2.6 million, giving a Type II Income Multiplier of 2.84. Similarly the total change in employment is 1890 FTE's, and the Type II employment multiplier is 4.25.

The very high values of the employment multiplier for the Tanker Terminal are not surprising in view of the capital intensive nature of the project (which tends to imply large intermediate payments and hence secondary employment creation relative to direct employment). For example, the Alberta refinery study (Datametrics Ltd (1976)) found a local employment multiplier (Type I) of over 3.0. However, in both the High and Low impact estimates it can be seen that a large proportion of total secondary employment (e.g. 56% of 'low' secondary employment) is generated in the Professional et. al. and Local Government industries, as a result of the high rate payments of the Sullom Complex. In view of this, it is fair to ask both whether these substantial increments to the rate receipts will be spent in the 1971 proportions through which the secondary estimates are derived, and whether the employment/output ratio derived for these sectors will continue to be applicable given such discontinuous increments to output. Both points are discussed subsequently, and for the present the assumption of applicability of 1971 coefficients (including employment) is retained.

Some of the more important results described above are summarised in Table 4.8.

Table 4.8 Summary of Sullom Terminal Impact

	Low	High
GROSS OUTPUT:		
Total change in Local Gross Output/annum	£5.1 million	£7.6 million
Type II output Multiplier	2.21	2.29
HOUSEHOLD INCOME:		
Total change in Local Income	£1.9 million	£2.6 million
Type II Income Multiplier	2.41	2.84
Income generated per £000 Direct Expenditure	£795	£777
EMPLOYMENT:		
Total change in Local Employment	1336 FTE's	1890 FTE's
Type II employment Multiplier	3.52	4.25
Employment generated per £10,000 direct expenditure	5.8	5.8

Comparison of the 'Low' and 'High' estimates shows the various Type II multipliers to be universally higher in the latter case. This is because the expenditure column for the High estimate is not simply a scalar multiple of the 'Low', and, as the relative multiplier values imply, indirect and induced effects are relatively more important given the 'High' expenditure proportions.

As in the case of Supply Bases, the impact of the Tanker Terminal is not divided equally among indigenous industries as shown below.

Table 4.9 Terminal-induced Employment Changes by Sector

Local Sector	% of Total Secondary Employment creation by Terminal: Low	High
Primary	2.5	2.4
Manufacturing	1.6	1.4
Construction	9.2	10.0
Services	86.7	86.2
	100	100

The proportions do not vary substantially between 'High' and 'Low', and it is apparent from both sets of figures that, as in the case of Supply Bases, the major impact of the Sullom Voe complex will be in the local Service sector. The total employment generated by the fully-operational Complex will be as much as 21-30% of all employment in the 1971 pre-oil Shetland economy, indicating the great local impact of this facility.

The local impact of the Sullom Terminal in conjunction with other oil activities is discussed subsequently, firstly, however, the local impact of oil-related construction in isolation is analysed.

(v) The Impact of Oil-Related Construction on the Shetland Economy

(a) General

In most impact analyses the effects of any Construction activity are not included.[23] This is usually acceptable, since such activity is generally of short-term duration (perhaps 1-3 years) and as such has little permanent impact on the local economy. However, in other studies the authors have felt that construction activity was of sufficiently long duration, and of such size, that it would induce change in the local economy, and hence should be incorporated in any analysis of a project with an important construction phase.[24] Brownrigg summarises his reasons for including construction in his analysis of the local impact of Stirling University as follows:

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23. Refs: Miernyk (1967b), Isard & Kuenne (1953), Miller (1957).
24. Brownrigg (1973), Sadler, Archer and Owen (op. cit.).

> "... its volume and duration make it a significant medium term source of new income and employment for the local economy"[25]

Certainly, as will become apparent below, the volume of oil-related Construction in Shetland is of very great magnitude, and its duration could extend over a decade or more, and hence in the present study the omission of this activity would considerably underestimate the overall impact of oil-related development on the local economy. Two points must be made, however, before the analysis of oil-related construction can proceed: Firstly, and perhaps obviously, given the format of the model and the preceding treatment of Oil Supply Bases and the Sullom Terminal, it is not the cumulative total of construction expenditure which is included in Final Demand, but rather some annual construction expenditure total. The selection of the annual figure to be used is discussed subsequently. Secondly, only expenditures made directly in oil related construction are included; specifically, expenditures made in the construction of Supply Base and Tanker Terminal facilities. Specifically excluded are induced construction expenditures in local industrial or infrastructural development.[26]

(b) The level of Oil-Related Construction Activity in Shetland

Two independent estimates of the level of oil-related construction in Shetland have been made by Mackay (op. cit.) and Llewellyn-Davies (1975). These forecasts, which were cast in employment terms, are summarised in Table 4.10.

Both estimators expect further declines in oil-related construction employment in years subsequent to 1981. Two points are immediately apparent

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25. Brownrigg (op. cit.) page 125.
26. The inclusion of an induced construction component would lead to a type of multiplier-accelerator model. See Chapter 5 pages 148-153.

Table 4.10 Estimated Levels of Oil-Related Construction Employment 1976-81

Year	Mackay	L.D.
1976	900	1100-1600
1977	900	1000-1500
1978	750	900-1350
1979	600	850-1300
1980	400	850-1300
1981	400	850-1300

from Table 4.10: firstly, Llewellyn-Davies' estimates are consistently higher than Mackay's, and secondly, both sources expect oil construction employment to peak around 1976/77. Recent developments suggest that Mackay's estimates are too low, and Llewellyn-Davies more probable. However, two adjustments to the latter also seem appropriate in view of recent developments: firstly because of 'slippages' in North Sea Development both within and outwith Shetland, the time-path of construction employment is likely to be lagged by 1-2 years, and secondly, the number of Supply Base berths required will now probably be less than the figure used in estimating Supply Base construction employment, and hence the latter may be lower than originally forecast. In view of these points, and in consultation with local representatives, the following adjusted forecasts are employed subsequently.

Table 4.11 Adjusted Oil-Related Construction Forecasts 1976-81

Year	Terminal		Bases, etc.		Total	
	Min	Max	Min	Max	Min	Max
1976	600	900	200	300	800	1100
1977	900	1100	200	250	1100	1350
1978	900	1200	100	150	1000	1350
1979	900	1200	50	100	950	1300
1980	800	1100	50	100	850	1200
1981	800	1100	50	100	850	1200

These employment estimates are used subsequently <u>only</u> as indications of the direct employment change resulting from oil related construction and as a proxy measure of the <u>time-path</u> of oil-related Construction expenditure, the latter, of course, being the necessary data for use in the Input-Output

Table.[27] Because of unavailability of data on output/capita on any construction project remotely resembling the Sullom Terminal, the employment figures above unfortunately could not be used to derive construction expenditure estimates. The estimation of expenditure is described below.

T. Buyers of B.P. (Shetland Times 12:12:75) is quoted as saying that the total cost of the Sullom Voe Terminal is likely to be of the order of £350–£400 million (1975 prices). This figure related to a 100-150m tons/year terminal, and it is not clear how this translates into an annual expenditure figure, particularly since initial plans are for the construction of a 60–75m ton/year terminal. More immediately useful figures are available from Llewellyn-Davies who estimate that total oil-related construction expenditure in Shetland to 1981 will be approximately £100 million (1974 prices). Converting this to 1975/76 prices by an appropriate index[28] suggests a total local expenditure of £150m+ at 1975/76 prices to 1981. This does not seem unreasonable in view of Mr Buyer's statement above, particularly since Supply Base expenditure is only a small proportion of total. Therefore, we take £100 million (1974 prices) as a reasonable estimate of total oil-related construction expenditure in Shetland over the period 1975-81. On a simple annual average basis, this translates to £16.7 million per year. Assuming, however, that the time path of expenditure follows that of employment, peak construction expenditure may be expected to be £18.8 million in 1977 and 1978. Both these figures will be used in subsequent analysis.

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27. Of course, the annual levels of construction expenditure need not be directly associated with each equivalent year's level of construction employment, but the patterns are expected to be fairly close, and the latter is very much easier to forecast than the former.

28. $\frac{\text{Construction Materials Price Index 1st Quarter 1976}}{\text{" \quad " \quad " \quad "}}$ /2nd/3rd Quarter 1974.

(c) Direct Oil Construction Expenditure

Section (b) above provides estimates of 'average' and 'peak' oil-related construction expenditures in Shetland during the period 1975-81. However, to estimate the impact of this expenditure on the local economy, it is necessary to divide the gross figure into non-local and local components, and subsequently to divide the latter into appropriate local industry categories. This is particularly difficult in the case of construction because of (a) the substantial direct leakages from construction expenditures in a small economy such as Shetland (see pages 78-79) and (b) the fact that, for reasons described in Appendix III, the assumption that construction workers' incomes are spent in the same proportions as the average Shetland household will not be tenable (in contrast to the Supply Base and Tanker Terminal analyses where it was argued that the average Shetland household expenditure pattern might provide a reasonable first approximation to that of directly oil-related households).

Because of these difficulties, and associated problems in direct collection of important data components, the estimation of local oil-related construction expenditure was of necessity somewhat indirect and laborious. Precise details are given in Appendix III pages 226-233, and the results of the series of calculations are summarised in Table 4.12 below.

Table 4.12 Local Direct Oil-Related Construction Expenditures

Shetland Industry	Peak £'000 (1971 prices)	Average (to 1981)
Agriculture	0	0
Fishing	0	0
Quarrying	483.4	429.7
Fish Processing	0	0
Textiles	0	0
Ship Repair	0	0
Other Manufacturing	137.2	122.0
Construction	398.5	354.2
Utilities	65.3	58.1
Transport	452.9	402.5
Communications	93.4	83.1
Distribution	138.7	123.2
Professional Services et al	1.7	1.5
Other Services	280.0	248.8
Local Government	65.3	58.1
Households	0	0
Totals	2116.4	1881.2

Expenditures made locally by oil-related construction workers are included in both columns.

As in the case of Supply Bases and the Tanker Terminal, these direct oil construction expenditures can be used in equation (45) to estimate the changes in local output, Income, and employment. These results are shown in Table 4.13.

Table 4.13 Total Changes in Shetland Activity Resulting from Local Oil-Related Construction Expenditures

Shetland Industry	Average Output £000	Average Income £000	Average Expenditure FTE	Peak Output £000	Peak Income £000	Peak Expenditure FTE
Agriculture	36.8	18.9	14.1	41.4	21.3	15.8
Fishing	4.6	2.5	1.4	5.2	2.9	1.6
Quarrying	441.6	160.6	120.5	496.8	180.7	135.5
Fish Processing	6.2	0.8	0.8	6.9	0.9	0.9
Textiles	0.4	0.2	0.1	0.5	0.2	0.1
Ship Repair	7.3	3.2	2.5	8.2	3.6	2.8
Other Manufacture	160.9	29.1	19.9	181.0	32.8	22.4
Construction	399.5	98.9	92.8	449.4	111.2	104.4
Utilities	109.8	17.3	10.9	123.4	19.5	12.3
Transport	551.1	167.8	141.2	620.1	188.8	158.9
Communications	106.0	98.7	59.2	119.1	111.0	66.6
Distribution	259.6	106.9	142.9	292.2	120.3	160.7
Professional Services	65.1	45.9	31.0	73.3	51.7	34.9
Other Services	376.4	147.2	82.9	423.6	165.7	93.3
Local Government	90.5	11.9	19.7	101.8	13.4	22.2
Households	911.2	2.2	1.9	1025.1	2.5	2.1
OIL CONSTRUCTION	1881.2*	3080+	1065.0[29]	2116.4*	3460+	1197.1[29]
Totals	-	3992.1	1806.8	-	4486.5	2031.6

\+ wage and salary payments to oil-related construction workers

* Direct local purchases as defined in Table 4.12.

Considering the average figures first, Table 4.13 indicates that direct local expenditures related to oil construction of £1.9 million create a total change in local Gross Output of £3.5 million, yielding a Type II Output Multiplier of 1.87. This is only one of a number of possible Output Multipliers and, as defined above, is not directly comparable with the indigenous

29. These employment figures were derived by dividing the estimated total wage bill paid by construction (see page 226) by the average Gross wage paid to Construction workers (given by local oil-related contractors at ≃ £80/week 1974 prices). These estimates lie comfortably within the ranges given in Table 4.11.

construction industry's output multiplier of 1.58, since the denominator of the latter includes direct leakages into imports and other Value Added made by the latter, while the denominator of the oil construction output multiplier as defined above includes only local expenditures. This has the effect of raising the value of the oil-construction multiplier relative to that of indigenous construction. Two other 'output multiplier' types of relationships, which perhaps shed greater light on the relative effectiveness of oil-related construction in generating local output, are described below:

(a) a denominator which, broadly speaking, included "all payments made within Shetland", could be defined as direct industry purchases plus wage and salary payments. This yields the result that £4.5 million of oil construction expenditure creates a £3.5 million change in local Gross Output, or a 'multiplier' of 0.78. The dramatic reduction in the multiplier value from that above reflects the very high direct leakage component of construction workers' expenditure.[30]

(b) A denominator which includes all expenditures connected with the construction of oil-related facilities. For an 'average' year this has already been estimated at £11.6 million (1971 prices), and hence the creation of Gross Output per £ of total construction expenditure is £0.301. The further considerable decrease in the 'multiplier' value reflects the extent of direct leakages in the industry purchases of oil-related construction activity.

Turning to Income, the 'average' year direct income payments of £3.1 million are seen to create indirect and induced local income receipts of £912,000, yielding a Type II income multiplier of 1.30. Since in this

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30. Table 3.8, Appendix III indicates that, on average, only about 15% of oil Construction workers' Gross Incomes are spent on the output of Shetland industries compared with about 29% for an average Shetland household.

instance, the denominators of the oil-related and local construction industries measure the equivalent variable (i.e. direct wage and salary payments made by the industry) the multipliers are in this instance comparable, and the lower figure for oil-related construction (1.30 compared with 1.38) suggests that, in terms of Income at least, oil-related construction has somewhat smaller secondary effects within Shetland than indigenous construction. Total Income generated per £ of local expenditure (defined as in (a) above) is £0.89. Income generated per £ of total expenditure is £0.34.

Finally, on 'average' year employment, total FTE employment deriving from oil-related construction activity is estimated at 1807; 1065 directly employed in construction, and 742 indirectly employed in local industry as a result of local construction expenditure. This yields a Type II employment multiplier for oil-related construction of 1.70.[31] As in other oil-related industries, the impact of construction is not spread evenly among local industries; being concentrated mainly in Quarrying, Local Construction, Transport, Distribution and Other Services.

There is no need in this instance to consider in detail the 'peak' construction estimates, since the 'peak' column of Table 4.12 is a scalar multiple of the average column with a multiplicative factor of 1.125. Hence, the absolute changes in local income, output and employment are simply 1.125 times greater in the peak case than in the average year, while multiplier-type ratio relationships are the same in both cases. In any event, if peak construction expenditure levels are of short-duration, little local activity in addition to that created by 'average' expenditure may be induced by them.

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31. In contrast to the comparison of Income Multipliers, this oil-related construction employment multiplier is higher than the indigenous construction industry equivalent. Inspection of the data indicates that this is not caused by differences in the local purchasing proportions of the two construction 'industries', though these exist, but rather by the difference in the direct employment/output ratio in each: the local value being approximately double the oil-related value. Since direct employment forms the denominator of the type II multiplier, the lower the above ratio, the higher the type II multiplier tends to be.

The significance of the fact that a comparatively short-term activity such as construction has a great impact in local activity is discussed in Chapter 7. In the meantime, we begin to tie together the preceding strands of the local impact of various oil activities by attempting to add a time dimension to the analysis.

(vi) A Partial Forecast of the Shetland Economy in 1982

At the outset of this chapter, a case was made for the treatment of each oil activity individually on a fully-operational basis. The major difficulties cited there of uncertainties as to the timing of various operations and of estimating expenditure patterns for partially operational facilities still apply with undiminished force; however, it remains a fact that in reality at any given point in time all of the above oil-related activities will impact on the economy of Shetland, and the total local impact of oil will be the sum of the separate impacts of each activity.

The preceding analysis has examined the impact of each oil activity individually at its maximum level; this not only optimises the use of available data, but is in itself important information for many policy and planning purposes. However, when forecasting for a specific year in real time, it is probable that any or all of these oil activities will be operating below their peak, and hence adjustments to the above data will be required. We will, as described subsequently, make unavoidably crude adjustments to the expenditure functions derived above for each activity to attempt to forecast the impact of oil on the Shetland economy of 1982. There is no especially compelling reason for choosing 1982 as the forecast year but two considerations favour it: firstly, the Sullom Terminal is expected to become fully operational as defined above in that year, and since this is the longest lasting local oil activity, it seems appropriate that the forecast should give it full account.[32]

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32. It also means that further tampering with the already problematic Terminal expenditure data can be avoided.

Secondly, in contrast, in 1982 all the above activities will still be at a reasonably high level, and so the forecast will contain a reasonable 'balance of each.

The model used is a variant of the one used throughout this study and is described in equation (51) below:

$$\left(\Delta X_*^{so}\right)_{1982} = \left(I - A_*^s\right)_{1971}^{-1}\left(\Delta Y_*^{so}\right)_{1982} \qquad (51)$$

where ΔX_{i1982}^{so} is the total change in Gross Output in industry i in 1982

$\left(I - A_*^s\right)_{1971}^{-1}$ is the Leontief Inverse matrix for 1971

$\left(\Delta Y_*^{so}\right)_{1982}$ is the matrix of oil industry expenditures in 1982.

Two points on equation (51) are appropriate: firstly, no attempt is made to forecast the levels of Final Demand in each industry in 1982, merely the changes in Final Demand resulting from oil activity; hence the forecast is a 'partial' one. Secondly, it is assumed that the indigenous structure of the local economy (measured by A_*^s) is the same in 1982 as in 1971.[33] This assumption, which has of course been implicit throughout the analysis, is discussed in some detail in an earlier section, and again in Chapter 6 where it is argued that in some respects, at least, it may not be as drastically inaccurate as it seems at first appearance.

Figure 4.3 shows the estimated time-path of development of oil-related facilities in Shetland from 1976-82, based on information from survey, Mackay, A.G. (1975), and Llewellyn Davies (1975).

Figure 4.3is very approximate, but does indicate the most probable path of development to, and in, 1982. Construction having peaked around 1977,

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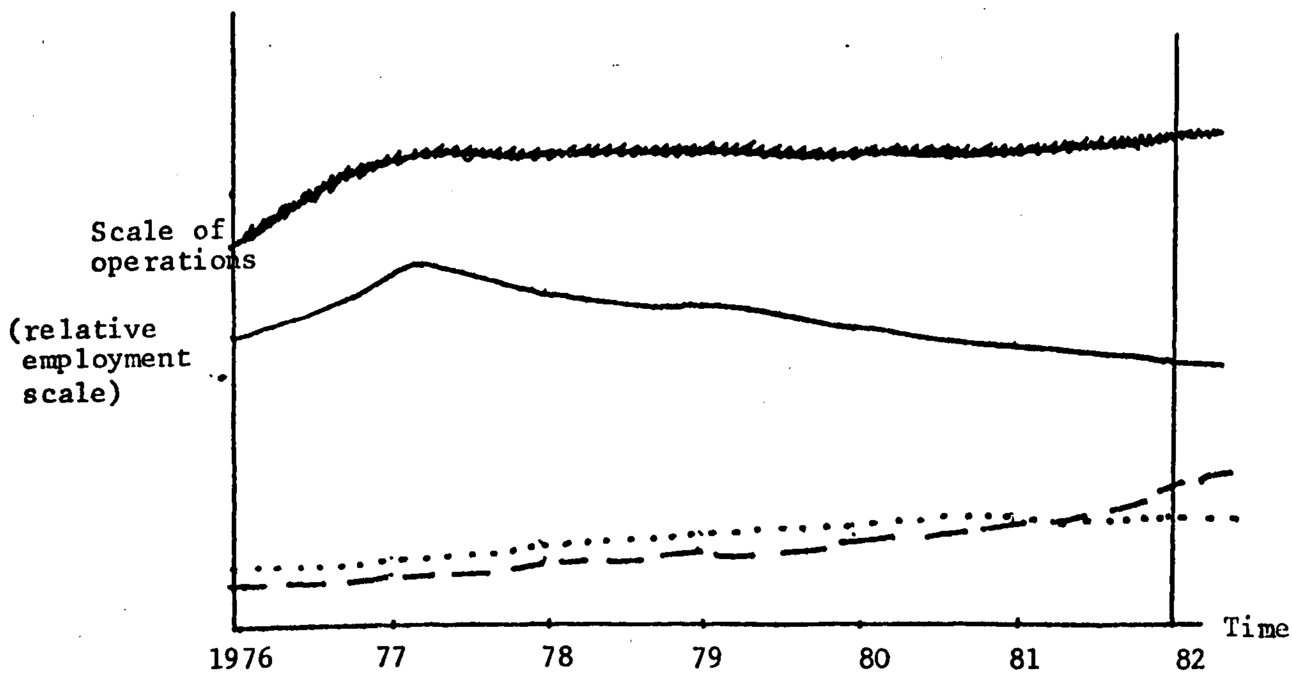
33. It is also assumed that the employment/output ratios derived in 1971 are still applicable in 1982. These assumptions are, of course, analogous to those made in earlier sections with 1982 replacing t. See pages 81-83.

Figure 4.3 Estimated Time Path of Oil Development in Shetland



will decline steadily thereafter to perhaps 70% of peak activity by 1982. Supply Base activity will rise slowly to its peak around 1980-81, and probably decline very slowly thereafter, being about 95% of peak in 1982. Tanker Terminal activity will rise steadily to 1982, at which point we assume it becomes 'fully operational' as defined in the text. To convert the approximate activity levels of Figure 4.3 to expenditures for use in equation (51), we make the crude but necessary assumption that expenditures, in total and item-by-item, vary from their fully-operational values in direct proportion to the change in the level of activity, i.e. a 10% reduction from peak activity implies a 10% reduction in expenditure, etc.

Applying this to the various direct expenditure estimates above yields the following estimates of total oil-related expenditures in Shetland in 1982, shown in table 14.14

A number of points are apparent from Table 4.14: firstly, by 1982, the Oil Tanker Terminal is forecast to be the largest oil-related expenditure source, being greater than the other two items combined. Secondly, the combined expenditure of these activities in 1982, represents a very considerable

Table 4.14 Estimated Oil Expenditures in 1982

Shetland Industry	LOW[34] S.B.+	T.T.	£000 (1971 prices) C.	HIGH[34] S.B.	T.T.	C.
Agriculture	0	2.0	0	0	2.4	0
Fishing	0	0.4	0	0	0.5	0
Quarrying	1.3	0	338.4	1.6	0	338.4
Fish Processing	0	0	0	0	0	0
Textiles	0	0	0	0	0	0
Ship Repair	0.8	15.3	0	1.0	18.1	0
Other Manufacture	4.7	1.4	96.0	5.9	3.5	96.0
Construction	8.7	139.0	279.0	11.1	229.4	279.0
Utilities	2.8	12.2	45.7	3.6	12.2	45.7
Transport	128.1	267.7	317.0	162.9	305.8	317.0
Communications	4.8	8.0	65.4	6.1	9.4	65.4
Distribution	1.9	2.4	97.1	2.5	2.8	97.1
Professional Services	1.4	3.5	1.2	1.8	3.9	1.2
Other Services	29.2	49.3	196.0	37.1	57.0	196.0
Local Government	10.3	1042.5	45.7	13.1	1737.5	45.7
Households	395.3	764.5	0	621.2	903.5	0
Totals	589.2	2308.1	1481.5	867.9	3286.0	1481.5

\+ S.B. = Supply Bases, T.T. = Tanker Terminal, C. = oil construction.

addition to Final Demand in the Shetland economy. In 1971 Final Demand was £15.5 million, and oil activity in 1982 is expected to create Final Demand expenditures of £4.4-£5.6 million. Hence, by 1982, Oil activity Final Demand itself will be almost one-third as much as all Final Demand in 1971, and it is obvious that, irrespective of developments in non-oil Final Demand categories in the intervening period to 1982, by then Oil will certainly be one of the major sources of exogenous receipts to the Shetland economy[35]. Finally, many of the indigenous industries found to be of particular importance to the pre-oil Shetland economy (e.g. Agriculture, Fishing, Fish Processing, and Textiles) are seen from Table 4.14 to be scarcely directly affected (from the point of view of

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34. 100% of 'Low' fully-operational Terminal expenditure, 95% of low Supply Base, 70% of peak construction. Similar proportions in each case for 'High' estimates N.B. Construction expenditure is the same in both cases.

35. If oil expenditure was added to the 1971 transactions table Final Demand sector, ceteris paribus, it would be the second largest single category below Exports (£7.1 million).

expenditure) by Oil activity at all. This does not preclude the possibility of further oil-induced demand for the output of these industries through secondary repercussions and the extent of this will become apparent when total changes in Gross Output, Income, and Expenditure are considered below.

Table 4.15 shows the changes in indigenous industry Gross Outputs resulting from the above direct oil-related expenditures.

As discussed above in connection with Table 4.14 the impact of oil expenditures is not divided equally among indigenous industries: certainly some industries (e.g. Agriculture) which do not benefit directly from oil do experience some increase in demand as a result of secondary repercussions, but the overall pattern of impact is broadly the same in both Tables with the notable exception of Professional Services whose substantial indirect linkages mean its total increase in demand is substantially greater than its direct increase. Table 4.15 is not discussed in detail itself, but rather used to provide the more interesting employment data of table 4.16. However, some interesting statistics emerge from it: for example, aggregate oil related expenditures in 1982 of £4.4 million (Low) create £8.8 million total change in local Gross Output, yielding an aggregate Type II Multiplier for oil activity in Shetland in that year of 2.01 (The 'High' multiplier is 2.07).

More importantly, total household income receipts in Shetland resulting from oil activity in 1982 is expected to be between £3.1-£4.1 million (1971 prices). Hence, by 1982, income payments in Shetland by the oil industry alone will be as much as 30-40% of all income payments by all sources in 1971. Direct Income payments, from Table 4.14, by the oil industry will be £1.2-£1.5 million, yielding a Type II income multiplier of 2.58-2.73.[36]

36. If all oil related construction payments to households are included, the total income change would be £5.5-£6.5 million, and the direct change £3.6-£3.9 million, yielding a Type II multiplier of 1.53-1.67.

Table 4.15 Oil-Induced Gross Output Changes in 1982

£'000 (1971 prices)

Shetland Industry	LOW SB	LOW TT	LOW C	LOW Total	HIGH SB	HIGH TT	HIGH C	HIGH Total
Agriculture	13.7	49.5	29.0	92.2	20.6	69.2	29.0	118.8
Fishing	1.9	7.3	3.6	12.8	2.9	10.1	3.6	16.6
Quarrying	2.1	11.0	347.8	360.9	2.8	17.9	347.8	368.5
Fish Processing	1.5	5.0	4.8	11.3	2.4	7.0	4.8	14.2
Textiles	0	0	0.4	0.4	0	0	0.4	0.4
Ship Repair	3.0	21.0	5.7	29.7	3.9	25.2	5.7	34.8
Other Manufacture	20.0	57.9	126.7	204.6	28.9	83.6	126.7	239.2
Construction	18.8	380.4	314.6	713.8	25.7	624.2	314.6	964.5
Utilities	21.1	139.6	86.4	247.1	30.8	207.9	86.4	325.1
Transport	151.6	352.6	434.1	938.3	195.5	424.2	434.1	1053.8
Communications	11.2	36.7	83.4	131.3	15.5	51.4	83.4	150.3
Distribution	57.0	208.3	204.5	469.8	85.9	293.9	204.5	584.3
Professional Services	15.8	625.1	51.5	692.4	21.9	1032.7	51.5	1106.1
Other Services	82.8	244.4	296.5	623.7	117.9	332.2	296.5	746.6
Local Government	18.8	1085.6	71.3	1175.7	25.8	1801.3	71.3	1898.4
Households	544.0	1837.4	717.6	3099	828.3	2552.1	717.6	4098.0
SUPPLY BASES	589.2	0	0	589.2	867.9	0	0	867.9
TANKER TERMINAL		2308.1		2308.1		3286.0		3286.0
OIL CONSTRUCTION	0	0	1481.5	1481.5	0	0	1481.5	1481.5

Table 4.16 Forecast of Oil-Generated Employment in Shetland in 1982

	LOW			£'000 (1971 prices)	HIGH			
Shetland Industry	SB	TT	C	Total	SB	TT	C	Total
Agriculture	5.2	18.8	11.1	35.1	7.9	26.3	11.1	45.3
Fishing	0.6	2.2	1.1	3.9	0.9	3.0	1.1	5.0
Quarrying	0.6	3.0	94.9	98.5	0.8	4.9	94.9	100.6
Fish Processing	0.2	0.6	0.6	1.4	0.4	0.8	0.6	1.8
Textiles	0	0	0.1	0.1	0	0	0.1	0.1
Ship Repair	1.0	7.2	2.0	10.2	1.3	8.6	2.0	11.9
Other Manufacture	2.5	7.2	15.7	25.4	3.6	10.4	15.7	29.7
Construction	4.4	88.3	73.1	165.8	6.0	144.9	73.1	224.0
Utilities	2.1	13.9	8.6	24.6	3.1	20.7	8.6	32.4
Transport	38.9	90.4	111.2	240.5	50.1	108.7	111.2	270.0
Communications	6.3	20.5	46.6	73.4	8.6	28.7	46.6	83.9
Distribution	31.4	114.3	112.5	258.2	47.4	161.2	112.5	321.1
Professional Services	7.5	297.4	24.4	329.3	10.4	491.3	24.4	526.1
Other Services	18.2	52.5	65.3	136.0	25.9	71.4	65.3	162.6
Local Government	4.0	236.2	15.5	255.7	5.5	391.9	15.5	412.9
Households	1.1	3.8	1.5	6.4	1.8	5.3	1.5	8.6
SUPPLY BASES	200	0	0	200	314	0	0	314
TANKER TERMINAL	0	380	0	380	0	445	0	445
OIL CONSTRUCTION	0	0	838	838	0		838	838
Totals	324	1336	1422	3082	488	1890	1422	3800

These relatively high Income Multipliers reflect the general capital intensitivity of oil activity in Shetland.[37]

Table 4.16 below shows the secondary employment forecast to be created by oil developments in 1982.

Table 4.16 indicates that 3000-3800 full-time jobs could be created by oil activity in Shetland in 1982. Of these, 1400-1600 are expected to be in the oil industry itself, with a further 1600-2200 generated in local industries through secondary repercussions. This yields an overall oil-related Type II employment multiplier of 2.17-2.38. Reference to Table 3.13 shows that this oil-related multiplier ranks highly in comparison with indigenous industry employment multipliers. As mentioned previously, this reflects the relative capital-intensity of oil activity so that direct employment per unit of output is relatively low,[38] and also that a relatively high proportion of local oil expenditure is in labour-intensive local industries, so that secondary employment creation per unit of expenditure would be relatively high. This latter point is substantiated to some degree by the fact that oil activities creation of 7.04 full-time jobs per £10,000 of local expenditure is higher than any other Final Demand Category (see Table 3.17). However, the above figure includes oil employment itself, and is measured with <u>local</u> expenditure as the unit. The very large leakage component of oil expenditures would imply that employment creation per £10,000 <u>total</u>

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37. Jones, T.T., <u>Sectoral Income and Multiplier Effects Scotland 1963</u>, University of Dundee Occasional Papers No. 1, 1974 page 17.

38. If the total of purchases in Table 4.14 is used as the measure of oil Gross Output, then in fact oil ranks highly relative to indigenous Shetland industries (6th) in terms of direct employment/unit of output. However, this is not the appropriate comparison since the purchases by the oil industry in Table 4.14 are only <u>local</u> purchases, not gross purchases. Comparing employment/unit <u>local</u> purchases for every industry, oil drops to fourth from bottom (interestingly only the three industries <u>above</u> oil in terms of multipliers are below it), and since only local purchases generate secondary employment, this is the more valid comparison and substantiates the point in the text.

expenditure would be very much lower. It is beyond the scope of the present study to pursue this particular point any further, rather we wish to consider the importance of this new employment in the Shetland context.

The creation of 3-4 thousand new jobs in a small economy such as Shetland represents an enormous disturbance in the local labour market, the extent of which can be gauged from the fact that oil-created employment alone in 1982 represents 50-60% of all employment in Shetland in pre-oil 1971. As discussed in Chapter 6, the magnitude of the local impact of oil is such that the constant-coefficients assumptions employed in the quantitative analysis may be unrealistic. However, the analysis remains useful in (a) providing "first approximate" estimates of the magnitude of local impact (b) directing the analyst to particular areas worthy of more detailed study, and (c) providing a base for sensitivity analysis to ascertain whether or not realistic changes in some coefficients greatly affect the estimates or not. In the meantime, we assume the assumptions valid and use the foregoing estimates[39] in subsequent discussion.

Table 4.16 shows that, just as each individual oil activity impacts disproportionately on local industries, so at any point in time the total oil impact affects some industries more than others. This is clearly illustrated in Table 4.17 which demonstrates that total employment created by oil in Shetland is not spread equally among the various indigenous industries: direct employment in the oil industry itself has, as would be expected, the largest single proportion of total employment;

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39. It should be borne in mind that virtually any conceivable change in coefficients will not change some of the more substantive conclusions presented above. For example, a 20% reduction in all local employment/output coefficients by 1982, representing a very substantial increase in labour productivity over a 5 year period, would still lead to oil-created employment in 1982 of 2,700-3,400, approximately 90% of the estimates in Table 4.16 and still 40-50% of all 1971 Shetland employment.

however, this is less than 50% of total, indicating the relative importance of secondary employment. Among local industries, the differential secondary impact is quite striking: only a very small proportion of employment created is in local manufacturing, the major proportion being in services (45% of total), with large individual industry impacts in Transport, Professional Services, and Distribution.

Table 4.17 Proportions of Total Oil Employment in 1982 by Individual Industry

Industry	% of Total*
Primary	4.2
Manufacturing	1.1
Construction	5.7
Transport & Communications	9.7
Distribution	8.4
Professional Services et al	12.4
All Other Services	14.7
Oil	43.8
	100

* Mean of 'High' and 'Low' estimates.

Finally, using 1971 as a pre-oil reference, it is possible to place the total impact of oil activity in the context of the non-oil Shetland economy. Using the employment by industry can be compared directly to industry employment in 1971. Of course, non-oil induced growth and decline will probably change the distribution of employment among local industries from that in 1971 by 1982 also, but this is not relevant to the current discussion.

Table 4.18 draws the comparison between 1971 Shetland employment and oil-created Shetland employment in 1982 on an industry basis.

The most dramatic change in the pre and post-oil situations is in the oil industry itself: from contributing zero per cent of total employment in the pre-oil base - at the 1982 level, oil grows to the largest single employer in Shetland unless substantial non-oil induced growth occurs elsewhere in the economy in the interim. Column (3) of Table 4.17 indicates the employment created in each industry by oil as a percentage of the 1971

Table 4.18 Comparison of Shetland Employment: Pre and With Oil Industry

Industry	Total employment		(2) as % of (1)	proportion of Total	
	(1) 1971	(2) 1982 Oil* Created		1971 %	1982 Oil Created
Agriculture	517	40	8.0	8.3	1.2
Fishing	517	4	0.8	8.3	0.1
Quarrying	30	100	333	0.5	2.9
Fish Processing	699	2	0.3	11.2	0.1
Textiles	658	0	0	10.5	0
Ship Repair	90	8	8.9	1.4	0.2
Other Manufacture	122	28	23.0	2.0	0.8
Construction	650	195	30.0	10.4	5.7
Utilities	60	29	48.3	1.0	0.8
Transport	328	255	77.7	5.2	7.4
Communications	175	79	45.1	2.8	2.3
Distribution	812	290	35.7	13.0	8.4
Professional Services	867	428	49.4	13.9	12.4
Other Services	308	149	48.4	4.9	4.3
Local Government	417	334	80.1	6.7	9.7
Oil Activity	0	1508	-	0.0	43.7
TOTALS	6250	3449	55.2	100	100

* Arithmetic mean of 'Low' and 'High' estimates

employment in each industry. The fact that no percentage is less than zero indicates that no local industry's employment is assumed to decline as a result of oil activity. As discussed in a subsequent section, this finding is guaranteed automatically by the assumptions made in the Input-Output analysis; modifications of these assumptions to permit negative effects are possible (see pages 132-140). In certain industries, however, scarcely any increase in employment result from oil: Fish Processing and Textiles experience no oil induced employment growth whatsoever, and in Agriculture, Fishing, and Ship Repair oil induced increases are less than 10% of the 1971 levels. As has by now become obvious (e.g. see Table 1.6 , Table 3.1, Table 3.15 etc.), the first four of these industries were not only among the major employers in Shetland in 1971, but more importantly were among the major <u>generators</u> of local income and employment at that time. Hence the important conclusion emerges that many of the key sustainers of the pre-oil Shetland economy will themselves receive virtually no impetus from the emergence of oil activity in the region, at least in terms of employment creation (exactly analogous conclusions apply to output and income creation). This will be referred to again in the next chapter.

However, although the traditional mainstays of the Shetland economy seem unlikely to expand significantly as a result of oil development, the analysis has demonstrated that other local industries will receive significant boosts from oil. The absolute magnitude of the change in output, income and employment in each local industry induced by the three major local oil activities has been analysed in detail throughout this chapter, as has the proportional breakdown of total oil-induced change among the various local industries. Table 4.18, for the first time relates oil induced change to the pre-existing local economy, and column (3) shows that certain industries will be considerably larger with-oil, ceteris paribus, than pre-oil. The biggest individual industry change is in quarrying, which would be over four time as large (in employment terms) with-oil. However, this industry was such a small contributor to total employment in 1971 that even the relatively large change induced by oil would still leave the industry contributing a mere 1% of total Shetland employment in the 'with-oil' situation, in the absence of non-oil related change in employment structure.
Other local industries would increase significantly relative to their pre-oil situation: notably Transport and Local Government, whose oil created employment is over 80% of its 1971 level. In fact in every service industry oil-created employment is over 35% of its 1971 level, and this, coupled with the virtual lack of oil-induced growth in local manufacturing, could lead to re-distribution of total employment away from manufacturing towards services.[40]

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40. Manufacturing and Services accounted for 25% and 48% respectively of total local (i.e. exlcuding oil) employment pre-oil. In oil-related employment the manufacturing proportion is only 1%, while Services are 45% of total.

In summary, by 1982, oil activity will lead to an increase in Shetland employment of 50% of the 1971 level. Of this increase, just under half, will be directly employed in oil-related industries themselves, the rest being in jobs created in indigenous industries through indirect and induced repercussions of local oil expenditures. This secondary employment will not be distributed equally among local industries, but rather will be heavily biased towards indigenous service industries. Ceteris paribus, this will lead to a relative decline in importance of local manufacturing and a concomitant increase in relative importance of local Services.
In the longer term, local oil-related Construction will disappear entirely, and Supply Base activity will also decline, though very much more slowly and probably to a level not far below that suggested in Table 4.14. Given this, and the very much greater level of Terminal activity than Supply Base activity, the very long-run impact of oil in Shetland will approximate the local impact of the former, estimated in this Chapter (see pages 101-109).

(vii) Summary of Findings in Section (iii)-(v)

The preceding section attempted to analyse the impact of all three oil activities on Shetland at a particular point in time, with 1982 chosen for the latter. However, for reasons discussed in the introduction to this Chapter, the main emphasis throughout has been on quantifying the local impact of each activity in isolation, when 'fully operational'. In sections (iii)-(v), this analysis was undertaken for Oil Supply Bases, The Sullom Voe Terminal, and Oil Construction respectively. The present section merely draws together some of the major findings of these sections to facilitate comparisons and quick reference.

Firstly, the absolute amounts of output, income, etc. created by each activity are compared in Table 4.20.

Table 4.20 Comparisons of Expenditure, etc. of fully-operational Shetland oil facilities[41]

Activity	Direct Local Expenditure[42] £000(1971)	Δ Shetland Gross Output £000 (1971)	Δ Household Income £000 (1971)	Δ Employment
Oil Supply Bases	620-914	1014-1483	573-872	350-510
Sullom Voe Complex	2308-3286	5101-7525	1837-2522	1336-1890
Oil-Related Construction[43]	1881	3571	3992	1807

Table 4.20 demonstrates clearly that of the three major oil activities in Shetland, Supply Bases are on a considerably smaller scale than the others. The Sullom Voe Terminal and Oil-related construction are not dissimilar in magnitudes of absolute local impact: the former's direct local expenditure and gross output creation is greater, though the latter pays more income (most of which is of course directly leaked outside Shetland) and creates more employment.

Table 4.21 compares various multipliers for the three oil-related activites

Mutliplier		Supply Bases	Tanker Terminal	Construction
Type II Gross Output	(1)	1.62-1.63	2.21-2.29	1.87
Type II Income	(2)	1.33-1.38	2.41-2.84	1.30
Type II Employment	(3)	1.55-1.62	3.52-4.25	1.70
Income/£ local expenditure	(4)	£0.92-£0.95	£0.78-£0.80	£0.89
Income/£ total expenditure	(5)	£0.14	-	£0.34
Employment/£10,000 local expenditure (FTE's)	(6)	5.6	5.8	4.0

One or two points of interest are immediately apparent from Table 4.21: firstly, the output, income, and employment Type II multipliers are all

41. Largest value in each column underlined.

42. Defined as additions to local Final Demand.

43. 'average' year figures.

considerably higher for the Tanker Terminal than the other two oil activities. As discussed in the appropriate section, this reflects the greater importance of secondary effects relative to direct effects in this activity. However, rows (4) and (5) show that, despite its relatively high secondary income generation, the total income created by the Tanker Terminal per £ of expenditure is lower than the other two oil activities.[44] This implies that, in income terms, the relatively high secondary effects of the terminal are not sufficient to offset the low direct income per £ of expenditure, so that total income created per £ expenditure is lower than that for Supply Bases and Oil Construction. Row (6) shows that the situation is different in employment terms: here the large secondary employment creation of the Terminal is just sufficient to ensure that, despite its low direct employment/expenditure ratio, the Terminal has the highest total employment/expenditure ratio.

This completes the detailed empirical analysis of the impact of Oil on the Shetland economy, using the basic Input-Output framework. The next chapter looks briefly at some modifications to the Input-Output model which might, in the present case, improve the accuracy of the empirical estimates. Chapter 6 steps rather further away from the basic framework and considers the impact of oil on local industry technology and the economic implications of such impact.

44. The total annual expenditure of the Terminal is not known, but the proportion of local is unlikely to be higher than for the Supply Bases (15%), giving a figure of <14p income per £ total expenditure.

CHAPTER 5 : Other Considerations Affecting Estimated Oil Impact

The detailed study of oil impact in the previous chapter was undertaken using the framework of Input-Output Analysis. As discussed in Chapter 2, this framework implies a number of assumptions, and the accuracy of preceding empirical estimates depends on their reasonableness in the particular case of Shetland and oil. In this chapter, some economic repercussions which could result from local oil activity, but were not included in the foregoing analysis, are discussed briefly. As will become apparent, most of these economic effects imply modifications to the basic Input-Output assumptions. It is, however, a strength of the Input-Output model that, given the necessary empirical data for implementation, a great variety of amendments and modifications to the underlying assumptions can be incorporated into the analysis without destroying the basic features of the model. Unfortunately, in the present study, sufficient data is not available generally to integrate subsequent considerations into the empirical ananlysis, and therefore the discussion focuses mainly on the methodology of inclusion of each modification and only gives a generalised estimate of the practical importance of each in the context of Shetland and Oil.

The following assumptions implicit in the preceding empirical analysis of the impact of oil on Shetland are reviewed in this section:

(a) The impact of oil on any local industry is at worst zero.

(b) The inclusion of oil in Final Demand does not affect any other element of Final Demand.

(c) Supply of output of each local industry can expand to meet whatever demand is placed on it by oil.

A fourth assumption that the level of local technology (as implied by the A_s matrix) will remain unchanged as a result of oil activity is discussed in the subsequent chapter.

It is not suggested that the above list of those assumptions which may require modification is comprehensive, but survey work indicates that those included are among the most interesting and relevant in the Shetland context. Considering each in turn:

(a) Negative Effects on local industry of oil activity

The possibility that the local establishment of oil-related industry could cause the decline of indigenous regional industries has received considerable attention not only in Shetland but in all areas of Scotland where oil activity is located. The assumptions of the preceding Input-Output analysis, however, precluded the possibility of a decline in the level of activity in any local industry for the following reason: the change in Gross Output of industry i resulting from oil activity O is given by:

$$\Delta X_i = b_{i1}\Delta Y_1^o + b_{i2}\Delta Y_2^o \ldots + b_{ij}\Delta Y_j^o \ldots + b_{in}\Delta Y_n^o$$

where ΔX_i is the change in Gross Output of industry i

ΔY_j^o is the change in industry j Final Demand resulting from oil activity O

b_{ij} is the i, jth entry of the $(I-A_s^*)^{-1}$ matrix.

Now inspection of Tables 3.1 and 3.6 shows that every entry e, is positive or zero. Hence every $b_{ij} \geq 0$. Similarly inspection of Tables 4.1, 4.6, and 4.12 shows that for the three types of oil activity operating in Shetland, each $\Delta Y_j^o \geq 0$. Hence, since for all i, j, $b_{ij} \geq 0$ and $\Delta Y_j^o \geq 0$, the above expression shows that ΔX_i must be ≥ 0. However, in reality it is possible that oil activity could lead to the decline of other Shetland industries in a number of ways, of which three are considered here: market substitutability, resource competition, and external diseconomies.

(i) Market substitutability. This effect would arise if the emergence of oil activity in the region made available goods and services which competed directly with those of indigenous industries and reduced the markets of the latter. In fact, it is obvious that the products of oil and local industries are not generally substitutes in the Shetland case, and this effect can be largely discounted.

(ii) Resource Competition. The foregoing analysis assumed that the resource requirements for all industries can be met simultaneously, without inter-industry competition. However, in Shetland, competition for limited actual resources between oil and indigenous companies has become apparent to a greater or lesser extent in a number of markets; in particular, land use, capital, accommodation, and labour. Competition between oil-related and indigenous activities for land in Shetland does not seem to have been particularly intensive since the major proportion of the Island is largely uninhabited by industry or population, and the oil companies seem generally to be prepared to establish their facilities in hitherto unoccupied land (e.g. Hudson's Supply Base at Sandwick, Norscot's Base at Greenhead, and the Sullom Voe Complex itself, were all sited in essentially uncultivated areas). A small amount of agricultural land has been lost to oil developments, but, while this has undoubtedly caused social disruption to individual crofters, its overall economic impact is likely to be very small.

The survey did not suggest that indigenous firms were suffering because of Shetland capital being attracted to lucrative oil-related projects. Certainly local capital is being invested in oil-induced activities; particularly in the provision of the various services for which, as shown in the previous chapter, oil is expected to create a significant demand, but no local concern suggested that this outlet for local funds was 'starving' themselves of desired capital. Many indigenous firms seem to use non-local supply sources for funds, in particular the national banks.

The accommodation shortage caused in Shetland as a result of local oil development is threatening to reduce the volume of Tourist traffic to the Islands. This is a difficult hypothesis to substantiate since the available statistics on hotel occupancy, etc. include oil-visitors as well as tourists; also, it is impossible to say how many tourists would come to Shetland even if accommodation were freely available. Without a detailed study of the subject, it is difficult to place empirical estimates on this effect. However, the previous analysis does provide some data relevant to the problem. For example, Table 3.16 shows that Tourism created 140 FTE jobs in Shetland in 1971, and since there were approximately 11,100 tourists in that year, an average 0.013 job/tourist ratio is indicated. Hence, for every 1,000 tourists who would have come to Shetland if accommodation had been available, but do not because it is not, Shetland suffers an opportunity loss of 13 jobs. Assuming, for illustration, that each additional oil employee leads to one less tourist through direct competition,[1] a net 'trade-off' between oil and tourism can be established. Table 4.16 shows that, on average, each oil employee creates approximately 2.17-2.38 total jobs in Shetland, or 1.17-1.38 in local industry, excluding oil itself. Hence, in a direct exchange of 1 tourist for 1 oil employee, indigenous Shetland industry gains 1.157-1.367 full-time jobs. Put another way, each direct oil employee would have to lead to the loss of 90-105 tourists before indigenous employment would start to suffer. There is no evidence that an oil-induced decline in Tourism of this magnitude is occuring, and hence we can be certain that oil secondary employment creation is positive; however, if some tourists have been driven away because of oil, there will be some reduction in the absolute amount of employment creation. Given the figures cited above, any such reduction is likely to be small.

1. This is the worst possible case for oil; in practice many oil workers will be local, or come to stay with relatives, etc., and hence not directly competing with tourists for accommodation. Competition between the two groups seems to be occuring both through accommodation rationing ('first-come, first-served') and through rising accommodation prices.

Resource competition between oil and local industries in the labour market is more interesting because in practice in Shetland it is likely to be much more important. Previous discussion has shown that at any given time the oil industry may employ up to 1500 people itself and create local industry employment for perhaps 1500 more. This represents a demand for labour equal to approximately $^1/3$ of the total population of working age in 1971, and given the low absolute volume of unemployment (e.g. 215 men and women in December 1975), the fairly high activity rates already existing in the Island (see Table 1.10), and low absolute increments to the working population through 'natural' causes (inevitable given the small total population locally), it is obvious that there is insufficient slack in the indigenous labour force to fill these oil induced positions. In these circumstances, two possibilities emerge: firstly, re-distribution of the local labour force can occur, so oil obtains labour at the expense of other industries and/or,secondly, immigrant labour can take up the unfilled vacancies.[2]

It is the former possibility which is under consideration here, but is must be made quite explicit what is intended: we are not interested in employees in local industries who join oil firms who would otherwise have been made redundant through non-oil induced local industry contraction. As discussed later, this type of movement of local labour has occured.

We are interested in occasions where, through oil-induced pressure on the local labour market, indigenous firms are forced involuntarily to contract, or from an analytically equivalent view,are unable to undertake

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2. A third possibility exists: firms may utilize existing labour more efficiently, or adopt more capital-intensive techniques, to economise on the scarce labour resource. This is discussed in the next chapter. The possibility that the oil industry would have to curtail its activities because of local labour shortage is considered too improbable to warrant discussion.

a desired expansion. In these cases, the difference between the local industry's desired level of activity and its realisable level must be set against oil as a negative effect. The Input-Output framework is not particularly suitable for analysing these employment movements, since employment is peripheral to the basic model. However, the extent of these negative effects can be estimated in the model by assuming (a) each employee "lost" to a local industry reduces the output of that industry by the reciprocal of the employment/output ratio calculated before, and (b) all the output reduction arising in (a) is concentrated in Final Demand. As discussed in footnote 3 this is entirely a simplifying assumption. This then allows the net impact of oil to be calculated by:

$$\left(\Delta X^{o}\right) = \left(I-A\right)^{-1}\left(Y^{o}-Y^{oN}\right) \qquad (52)$$

where Y^{oN} is the matrix of Final Demand sales 'lost' to local industries as a result of local oil activity. Since the pattern of 'net' oil Final Demand is likely to be different from its 'gross', the various oil-related multiplier values derived above cannot be used for sensitivity analysis. However, there is some evidence at present, of a purely qualitative type, on the type of movement from local industry to oil developing in Shetland: firstly, and perhaps surprisingly in view of the figures cited above, there seems at present to be comparatively little movement of labour of the 'involuntary' type described above, from local industries to oil.[4] There are a number of reasons for this: firstly, simultaneous to the build-up of oil employment in Shetland in the early seventies, there was a (non-oil created) slump in local industries such as Fishing, Fish Processing, and Textiles through a decline in demand for their products. Hence many local manufacturers were voluntarily

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3. A more satisfactory procedure might be to allocate the 'lost' output proportionately along the appropriate industry row and adjusting the coefficients matrix accordingly, but this would involve re-calculation of the entire inverse matrix every time estimation of 'negative' impact was attempted.

4. This is confirmed by Nicholson (1975), and in G. Hunter's 'Fisheries and Oil' in Button (1976).

releasing labour at that time, and movements of workers to oil, apparently from local industries, were in fact from 'unemployed' resources. Secondly, the oil operators in Shetland seem to be aware of their potentially disruptive influence in the local labour market, and avoid where possible 'pirating' labour from local firms. Many operators claim that they do not bid above going regional rates for particular worker groups. Thirdly, many Shetlanders seem to find significant non-monetary benefits in employment in traditional indigenous industries, and given possibly small monetary incentives mentioned before to join oil firms, find their net advantage is to remain in current employment.

On the other hand, some 'involuntary' labour movement has occured as a result of oil, particularly since, through overtime, bonuses, etc., oil-related employment can often offer higher total earnings than comparable indigenous jobs. Isolated areas of activity have suffered particularly badly; e.g. the number of local bakers has decreased considerably; the local milkround no longer operates, etc.

As is apparent from the examples, many of these cases are fairly trivial economically (though perhaps quite disruptive socially), and probably of longer-term importance is the possible emergence of a negative 'rachet' effect in the main traditional local industries of Agriculture, Fishing, Fish Processing, and Textiles. What seems to be happening is that every time these industries go into even mild recession, workers leave them, with or without their employer's blessing, to take up oil-related employment. When the recovery should be taking place, however, indigenous firms are unable to re-attract this lost labour, and full recovery is frustrated by shortage of manpower. Hence each cyclical 'peak' will be lower than the preceding one. There seem to have been one operation of this ratchet already in Shetland, with local industries being unable to re-attain previous output peaks in 1975/76, due to loss of labour in 1972/74.

The above discussion has centred primarily on the possibility of local labour transferring to <u>directly</u> oil-related jobs, but as shown in Chapter 4, oil will also create many secondary job opportunities and these may also be filled by workers leaving certain indigenous industries. The extent and direction of this type of labour movement proved impossible to estimate at the time of the study, but it must be noted that, to the extent that secondary job opportunities differ in type from direct oil-related opportunities (e.g. female part-time as opposed to male full-time), the currently observed pattern of local labour movement to direct oil jobs discussed above may not adequately describe the probable pattern of labour movement to secondary jobs. It is obvious that the labour market questions raised by oil-developments in Shetland are complex and extensive, and a detailed analysis of them is unfortunately beyond the resources available for the present study. However, it is apparent that if oil-induced employment opportunities are filled extensively by a 'reshuffling' of existing indigenous labour, then the <u>net</u> addition to Shetland employment generated by oil-activity would be considerably less than the <u>gross</u> estimates of Chapter 4. The extent to which net Output (and perhaps Income) estimates would be altered by this would depend on the ability of firms involuntarily losing labour to change to more capital-intensive means of production. This is discussed further in Chapter 6.

The conclusion on 'resource competition' must be that oil activity in Shetland will attract resources from local industries, hindering the growth of, or hastening the decline of, the latter, and hence the 'net' income and employment created by oil will be lower than the 'gross' estimates given in Chapter 4. The <u>extent</u> of the difference between the net and gross impacts is very difficult to estimate: in some areas, e.g. accommodation and tourists, the negative effects are likely to be negligible in aggregate. In others, particularly in the attraction of labour from key activity-generating indigenous industries, the potential for 'negative' oil impact is considerable. However the above discussion suggests that even these effects may not be too substantial, particularly if local industries do not suffer too many, and too violent, cyclical fluctuations caused by external market forces.

(c) External Diseconomies. In the context of Oil in Shetland, the most important item under this heading is the possibility of damage to local industry through pollution. The likelihood of oil pollution in Shetland has been discussed in a large number of documents,[5] and there seems to be some concensus that air-borne pollution is likely to be negligible. There is considerably more disagreement on the probable extent of sea-pollution, the major differences arising from varying assessments of the probability of a large scale leakage, either from tanker or pipeline, in Shetland waters. Even if the possibility of large scale oil pollution of the sea is discounted, it seems certain that some pollution on a smaller scale will occur, particularly in the Sullom Voe area. If this does happen, then certain inshore fishing grounds, particularly shellfish beds, will be damaged,[6] with consequent damage to the Fishing (and probably Fish Process) industries. In 1975, the proportion of the total value of fish landed accounted for by shellfish was 7.5%. This proportion was approximately the same as the equivalent in 1971, where shellfish landed brought a total value of £159,000. The loss of this produce through oil pollution, interpreted as a loss in Fishing Final Demand would cause a gross reduction in Shetland incomes of £123,000 (1971 prices) and a loss in Shetland employment of 64 jobs.[7] This represents a reduction in both Income and Employment of approximately 1% relative

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5. E.g. the recent report by the Sullom Voe Environmental Group (1976).
6. E.g. see Shetland Island County Council minutes (November/December 1974). Since the time of writing this section on pollution, a study (L. Johnston, 'The Environmental Impact' in Button (1976)) has confirmed the views expressed in it on the probable extent and direction of environmental impact (though Johnston did not consider its economic ramifications).
7. The loss in Shetland Income and Employment is estimated using the appropriate multipliers in Tables 3.9 and 3.14 respectively.

to the 1971 levels. It is also possible that oil pollution, particularly of a visual nature, could lead to a decline in the level of Tourist activity in Shetland. This is thought, however, to be unlikely, since few of the oil-related developments in Shetland are sited in areas of especial tourist attraction. In any event, the discussion on Tourism in the preceding section makes it apparent that the decline in tourist activity would have to be very substantial before there would be significant negative effects on the local economy. The conclusion on oil pollution must therefore be that, barring a major spillage, the adverse effects of such pollution on indigenous Shetland industries are likely to be fairly small.

In summary, it would seem that the introduction of oil activity into the Shetland region <u>will</u> lead to reduction in the levels of activity in certain local industries, primarily through competition for limited local resources and to a lesser extent through external diseconomies. Since the assessment in Chapter 4 of the impact of oil on the local economy does not allow for 'negative multiplier' effects, the values given there over-estimate the actual net impact of oil. However, the foregoing discussion, though fairly non-rigorous, suggests that these negative oil-induced effects may not be too substantial; so that the over-estimation of the 'net' impact of oil implied in the 'gross' impact values of Chapter 4 will not be great. This judgement would be considerably less valid if the negative 'ratchet' effect discussed above turns out to be of some importance.

The effects of oil on Final Demand

In the analysis of Chapter 4, the expenditure of the oil industry in Shetland was assumed to be an addition to that region's bill of Final Demand. As discussed there, this is quite justifiable since, to all intents and purposes, oil purchases locally are an exogenous injection into the regional economy. However, the additional assumption implicit in the analysis of Chapter 4 that each category of Final Demand is independent of all others may not be strictly accurate. For example, total Final Demand for industry i may be given by

$Y_i = Y_{i1} + Y_{i2} + \dots Y_{in}$, but $Y_{ij} = f(Y_{i1} \dots Y_{im})$. In this case a change in $Y_{i1} \dots Y_{im}$ will not simply bring about changes in regional activity as given by the $(I-A)^{-1}$ matrix, but will change Y_{ij}, which will also bring about secondary change in regional activity. In short, the introduction of the oil industry into Shetland may lead to changes in other elements of Final Demand, which of course will change the overall impact of oil. This is rather different from the discussion of Chapter 4 which was concerned with oil effects on local industry activities whereas this section shall consider oil effects on local Final Demand categories directly. We wish to consider three intra-Final Demand relationships: (a) Unemployment benefit/Oil (b) Public Sector Employment/Oil (c) Induced Investment/Oil.

(a) Unemployment benefit/Oil

The analysis of Chapter 4 assumed implicitly that the Gross Change in Shetland household income was also the net change. However, if the persons taking up the new oil-induced jobs were previously unemployed, then in reality, the net change in regional income will be equal to the Gross change less unemployment and related benefits, i.e.

$$\Delta Y_n = \Delta Y_G + u\Delta U^s \qquad (53)$$

where ΔY_n is the net change in regional income

ΔY_G is the gross change in regional income

u is the "average" amount of unemployment benefit/Capita

ΔU^s is the regional change in unemployment, (in absolute terms) i.e. when unemployment goes down ΔU^s is negative and vice versa.

Obviously if the numbers entering employment from unemployment are relatively high, and the unemployment benefit/capita a substantial proportion of the gross wage, the net addition to Shetland wages and salaries of oil-induced activity would be relatively small, and the measured impact of local oil developments consequently reduced.[8] This consideration could easily be entered into the analysis in (at least) two ways: firstly we could define a new household row

$$x_{Hi}^{s'} = x_{Hi}^{s} - \alpha_i b \qquad i = 1 \ldots n \tag{54}$$

where $x_{Hi}^{s'}$ is the net wage bill paid by sector i

x_{Hi}^{s} is the gross wage bill paid by sector i

α_i are the number of new employments in industry i which were previously unemployed

b is the average per capita unemployment benefit (assumed independent of particular industries).

Hence net wage coefficients are obtained for each industry by

$$h_{Hi}^{s'} = \frac{x_{Hi}^{si'}}{X_i} \tag{55}$$

Incorporating these net wage coefficients in the Leontief Inverse yields the total (direct, indirect and induced) change in local activity, after allowing for loss of local unemployment benefit payments, i.e.

$$\Delta X^{s'} = (I - A_*^{s'})\Delta Y_o' \tag{56}$$

where $\Delta X^{s'}$ is the adjusted vector of local industry Gross Outputs

$(I-A^{s'}_*)$ is the adjusted household-endogenous Leontief inverse

$\Delta Y_o'$ is the matrix of local oil purchases. Direct household payments by the oil industry must, of course, also be reduced to the extent that the oil industry employs previously unemployed people.

Since $\forall\, h_{Hi}^{s}, h_{Hi}^{s'}; h_{Hi}^{s} \geq h_{Hi}^{s'}$, it follows that $\forall\, \Delta X_i^{s}, \Delta X_i^{s'}; \Delta X_i^{s} \geq \Delta X_i^{s'}$, i.e. the gross change in every local industry output is greater than or equal to the net change.

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8. This adjustment, rarely made in Input-Output, is common in Keynesian multiplier analysis where the change in disposable income is made equal to the change in Gross income less reductions in unemployment benefit payments.

Secondly, the individual intermediate (and oil industry) income payments could be left as gross, but for every unemployed person joining the labour force as a result of oil activity, the aggregate Final Demand payments of Central Government to households (which in the Shetland Study includes aggregate unemployment benefits) be reduced by an appropriate amount of unemployment benefit.

i.e. $Y'_{HG} = Y_{HG} + u\Delta U^s$ (ΔU^s is negative)

where Y'_{HG} are the net Central Government payments to households, Y_{HG} are the Gross payments, $u\Delta U^s$ is as defined above. Now $\Delta U^s = -f(\Delta Y^o)$ and $\Delta Y_{HG} = g(\Delta U^s)$ and therefore $\Delta Y_{HG} = -z(\Delta Y^o)$. That is, the change in initial unemployment is an inverse function of oil-related Final Demand and the Central Government column household row entry is a function of the change in the level of unemployment; so that the change in the Central Government expenditure is inversely related to oil industry purchases.[9]

The negative effects of this oil-induced reduction in unemployment benefit are likely to be very small in Shetland. As discussed already in this chapter, and as is apparent from Table 1.8 the immediately pre-oil situation in Shetland saw only a small number of local persons as registered unemployed. In fact the annual figure for 1971 was approximately 250 persons, which represents a mere 8% of the total oil-induced employment needs for 1982, for example. If we assume, by way of illustration, all of these persons were employed in the oil industry in 1982, and using Greig's[10] estimate of a marginal unemployment benefit/Income ratio of 0.1

9. There is a small internal multiplier here, since the reduction in unemployment benefit Final Demand will itself tend to prevent unemployment falling as low as it would in the absence of this effect, thereby reducing the loss of unemployment benefits ... etc. This is easily incorporated in an iterative process in which unemployment is allowed to fall as low as it would if no reduction in benefit occured, the reduction in benefit is then incorporated causing a small rise in unemployment, increasing the benefit ... etc. The fractions involved at each roundare so small as to ensure speedy convergence to equilibrium.

10. Ref: Greig (1971, op. cit. page 45).

overall, the reduction in direct income payments by the oil industry would be a mere £65,000 or approximately 2% of the gross total. If this income would all have been spent in the same proportions as indigenous Shetland households in 1971, the direct, indirect, and induced reduction in oil impact income would be approximately £75,000; less than 1.5% of the total gross oil-induced change. In fact, it is most unlikely that oil activity would reduce local unemployment to zero, since within the pool of unemployed there are generally "unemployables", i.e. chronically sick, etc., and hence the above is an over-estimate of the difference between 'gross' and 'net' wages and salaries under the conditions specified. However, there remains a serious problem in estimating those who are not actually unemployed at any moment in time, but who would be were it not for the simultaneous job creation of oil activity. The opportunity loss in unemployment benefit of these persons should also be offset against oil payments. Table 1.8 indicates that in a pre-oil depression (1966) annual unemployment in Shetland could rise as high as ≃ 500 on average. (It is possible that there might be a secular rise in the indigenous unemployment rate in Shetland similar to that experienced in the U.K. over the decade 1965-75, though Table 1.8 does not support this. If this were so, the possible total of unemployed in a 'non-oil' situation could be above 500, in which case the loss of unemployment benefit and the resultant reduction in oil-generated income would be greater. It is unlikely any such effect would substantially alter the conclusion below. If 500 is therefore assumed to be the probable peak of unemployment in the non-oil economy during the period of local oil activity, the figures given above suggest that the maximum reduction in total oil-created income would be ≃ 3%. Hence, it seems unlikely that the inclusion of unemployment benefits in the analysis will significantly alter the conclusions of Chapter 4. The relative insignificance of inclusion of an 'unemployment benefit effect' in the present study does not imply such an effect need be insignificant elsewhere (e.g. in a region with a large pool of locally unemployed). To the author's knowledge, no other Input-Output impact study has considered the inclusion of this effect in any detail, either theoretically or empirically.

(b) Public Sector Employment/Oil

Some analysts have hypothesised that some employment will be created in a region through forces other than the secondary repercussions of changes in Final Demand. In particular, it is stated that the increase in population created by net immigration (or the opportunity gain in population resulting from the stemming of net emigration) will, per se, result in increased employment in 'public services' such as Health, Education, and Local Authority services. Greig states the case thus:

> "... some employment may not be related to increased income, but to increased population, and hence to the increase in employment (given that the employees are immigrants or potential emigrants). In particular, employment in education, health, and local authority services ... would be likely to be related to the size of the workforce."[11]

Greig's statements apply to the Keynesian multiplier model,[12] where, in general, all Government expenditures are assumed autonomous and income and employment multipliers are independent. In the Input-Output framework, of course, income and employment multipliers are both derived from the Leontief inverse matrix, and in the Shetland study, the Local Authority (including Health and Education) has been included in the intermediate sector, and hence is already implicitly assumed endogenous. Hence, much of the secondary repercussion in public sector employment envisaged by Greig is probably already incorporated in the estimates of Chapter 4, particularly if Final Demand changes are related to immigrant population pressures. It may still be, however, that some employment is generated directly by the population increase. This would be

11. Ref: Greig (1971 op. cit.) page 32.
12. See Chapter 2 page 25

incorporated as follows:

(1) $\Delta Y_{LG} = f(\Delta P)$

i.e. the change in Central Government payments to local Government depends on the change in local population.

(2) $\Delta P = f(\Delta E^{i})$

i.e. the change in population is a function of the change in immigrant (or potentially emigrant) labour.

(3) $\Delta E^{i} = f(\Delta Y_{LG}, \Delta Y^{o})$

i.e. the change in employment is a function of the change in Final Demand.

This is a system of simultaneous equations, which can be solved simultaneously or iteratively. Some idea of the potential magnitude of this effect may be gained as follows: from the transactions table, Central Government expenditure on Professional and Local Authority services per head in 1971 was £128. Llewellyn-Davies, Shetland Island Council consultants, estimate that through oil-related immigration, Shetland's permanent (i.e. excluding temporary construction workers) population will have risen by 1981 to 22,900 from 17,500 in 1971. If it is assumed that real per capita Central Government expenditure remained constant at the 1971 level, an increase in Central Government expenditure per annum of £690,000[13] is indicated by 1981. If this incremental expenditure is divided between Local Government and Professional Services in the same proportions as in 1971 (i.e. 76% and 24% respectively), Table 3.14 shows this would increase local employment by 444 full-time jobs. If, further, some allowance is made for the fact that construction workers, though 'temporary' may induce increases in public services, the change in total employment could be higher e.g. assuming there are 900 construction workers in Shetland in 1981, and assuming arbitrarily that for provision of public services, 5 construction workers are equivalent to 1 permanent resident, another 15 jobs would be created.

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13. All money figures in 1971 prices.

These calculations suggest that the "Greig effect" could generate significant additional employment to that estimated in Chapter 4. However there are a number of reasons for believing the above calculation may be a substantial overestimate: firstly, the assumed constancy of per capita expenditure omits the possibilities of increasing returns to scale, which may be substantial, given the relatively low initial levels of these activities in Shetland. Secondly, the real increase in per capital income in Shetland resulting from oil may lead to reductions in per capita requirements in certain areas of Government expenditure (e.g. health, social work, etc.), offsetting expenditure increases caused by greater absolute numbers of people. Thirdly, and possibly most importantly, it is assumed implicitly in the above argument that increases in local public sector activity brought about directly through oil Final Demand expenditures and indirectly through population increase are independent and additive. In fact the two forces will operate simultaneously and interactively, and the overall total increase in activity is likely to be less than the sum of the individual components (see comments on page 145 above).[14]

In summary, the inclusion of a Public Sector Activity/Population interaction in the analysis could lead to a significant increase in the estimated total impact of oil on the Shetland economy. Again, the possibility of including such an effect in an Input-Output impact study seems to have received little attention in the literature. The analysis undertaken above suggests that omission of this factor in 1982, say, could underestimate the total employment impact of oil by 10-15%, though this figure is likely to overestimate the effect, for the reasons outlined above. Again, lack of resources precludes a more accurate empirical assessment

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14. In addition, the current (1976) cut-backs in public spending may lead to a reduction in real per capita spending, and hence to a reduction in the Greig effect.

of this effect, though its possible importance indicated above suggest that it should be incorporated in Input-Output impact studies generally.

<u>(c) Induced Investment/Oil</u>

The substantial increases in output in Shetland which are expected to result from local oil developments will, unless considerable excess capacity exists, in all probability create requirements for additional capacity within the local economy; so that the oil-related increases in Final Demand will require investment goods as well as intermediate goods. This means that certain components of investment are effectively removed from Final Demand and made endogenous. The induced investment effect is, theoretically, easily included in the model.[15]

Let k_{ij} represent the stock of industry i used per unit of output of industry j over time period t, then

$$X_i = \sum_{j=1}^{n} a_{ij}X_j + \sum_{j=1}^{n} k_{ij}\dot{X}_j + Y_i \qquad i = 1 \ldots n \qquad (56)\ 7$$

where

$\dot{X}_j$ is the change in output of industry j over period t

k_{ij} shows the fixed capital is i plus inventories of i necessary to produce one unit of j

$$\therefore k_j = \sum_{i=n} k_{ij} = \sum_{i=1}^{n} \frac{K_{ij}}{X_j} = \frac{K_j}{X_j} \qquad (57)\ 8$$

where K is capital stock. That is, the total of column j in the capital coefficients matrix shows the total capital requirements for industry j to expand its output by 1 unit, and therefore is the Capital-Output ratio for industry j.

Conceptually, therefore, the inclusion of induced investment in the Shetland model is straightforward. However major problems arise in empirical

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15. Refs: Almon (1963), Leontief (1953, op. cit.), Dorfman (1954), Mierynk (1970).

implementation. Firstly, the Capital-Output ratio used (henceforth $^K/O$) should relate only to expansion investment, not replacement, but in practice it is difficult to distinguish between the two. Secondly, expansion may only take place if existing resources are fully utilized,[16] but there are problems of defining 'full capacity' and empirically defining the extent of excess capacity. Thirdly, technological change may imply an entirely different K/O ratio for new capital to that for existing capital. Fourthly, in a small region such as Shetland, investment will take place with the aid of imported capital goods, so a 'leakage' factor has to be estimated, and finally, at the sub-regional (Shetland) level in the U.K., published data pertaining to industry K/O ratios is almost entirely lacking; so that the required information can, at best, be obtained only by direct survey.

Resources to overcome the difficulties above in an empirical study were not available to the author, and hence subsequent discussion again considers only highly simplified situations to attempt to give some estimate of the magnitude of the induced investment impact of oil on Shetland. Brownrigg[17] used a simple model to estimate the induced investment effects of the University of Stirling on its local environment, and a suitable adaptation of this seems adequate for present purposes.

Brownrigg assumes that investment in new capacity will be created by the 'expenditure pressure' of immigrants, and his data relates to this concept. This would be unsatisfactory in Shetland if much of the expansion effects were internally created; however, as discussed below immigrants are in fact likely to occupy a major proportion of expansion

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16. On the other hand, expansion may take place although existing resources are not fully utilized because of various market imperfections, complicating matters still further.

17. Ref: Brownrigg (1971).

employment, and in any event a crude correction factor can be applied. Brownrigg's estimated capital-output ratio is in fact a 'net capital stock'/immigrant earnings ratio. The denominator in this expression is not totally satisfactory since in practice a unit output change is likely to comprise intermediate and Other Value Added components as well as income payments. However, as long as the proportions of each item remain approximately constant, earnings can be used as a proxy for output. Brownrigg estimates a K/O ratio of 2.43 for induced investment, as defined above. The problem now, therefore, is to find an estimate of immigrant earnings to which this ratio can be applied. Firstly, we ignore for the moment oil construction workers who, being temporary, may have a different induced-investment effect from permanent immigrants. Now, as Figure 4.3 shows, other oil-related employment is expected, in aggregate, to grow fairly steadily to 1982 at about +67 full-time jobs per year. Assuming secondary employment created by these jobs follows a similar pattern, and taking, for simplicity, the mean of Supply Base and Terminal multipliers, another 116 jobs could be created per annum; implying that between 1976-82 an average of +183 jobs per annum could be created as a result of (non-construction) oil activity. Assuming the oil jobs command an average oil salary derived from Chapter 4 (£1993) and the secondary jobs command the 1971 average Shetland real wage (£1230), the total annual increment to incomes would be £276,200. Given the formulation of the model, the maximum annual induced investment will occur if all these employees are immigrant. In this case, given the K/O ratio above, investment induced annually will be £671,200. This figure, however, is not the one required to estimate the induced investment impact on Shetland. Two modifications are required: firstly, it is unlikely that expansion of new capacity will occur instantaneously after the expansion in demand. Brownrigg, following

Archibald[18] assumes capacity expansion induced in year 1 will be completed at the end of year 3. However given continuous immigration, which we are assuming, the volume of induced investment in any year will in fact equal the total given above (i.e. in year t, induced investment will be $^1/3$ year t + $^1/3$ year t-1 + $^1/3$ t-2). Given that oil-related expansion began before 1976 by over three years, we can in this instance assume that from 1976 to 1982 the volume of induced investment per annum will be stable at £671,000. Secondly, and more importantly in this case, the direct leakage component of this investment outwith the Shetland economy must be allowed for. Brownrigg estimates a construction leakage fraction of 0.7-0.8 which he applied to direct and induced investment. However, our own analysis suggests that in Shetland, the leakage component may be higher (see pages 227-228), and for oil-related construction is estimated at 0.89 overall. However, this latter does assume all oil-related construction wage payments go to temporary immigrant labour who, as has been seen, have a very high leakage factor themselves. If all wage and salary payments associated with induced investment went to local households, the leakage factor would be reduced by as much as 0.04. Since in fact, it does seem probable (given current local experience) that much of the induced investment activity will be undertaken by Shetland firms, the leakage factor will be reduced to 0.85.

The result of these rather involved proceedings is that local Final Demand expenditure as a result of induced investment is estimated at £100,700 per annum between 1976 and 1982. This estimate omits, however, any induced investment associated with oil-related construction. There are a number of reasons for assuming this will be proportionately less for direct employees than in other oil-related activities; construction workers, as discussed above, spend less locally and hence exert less

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18. Ref: Archibald (op. cit.).

pressure; local businesses will hesitate to expand capacity to satisfy what is known to be a temporary demand, preferring to operate existing capacity more intensively, etc. However, it is probable that construction will have induced effects, at least through its secondary employment creation. Table 4.11 shows that peak construction employment is estimated at approximately 1200 around 1976/1977. Assuming that, for present purposes, 1 construction worker will generate one-third as much induced investment as other oil workers, this gives 400 'equivalent' units; added to this are approximately 840 oil construction-induced secondary jobs. Again, assuming all these employees are immigrants and that employment grows linearly from zero in 1971 to maximum in 1977, this implies an annual increment to the local labour force of +207. Using the same basic data as above, except that the average wage per construction worker is taken as £2891 (derived from Table III.5, Appendix III), this yields an induced-investment change in local Final Demand of £133,400. Until 1977 at least therefore, the increment to Final Demand in Shetland as a result of induced investment is estimated at £234,000 per annum.[19] If this is spent in the same proportions as other local investment, then Tables 3.12 and 3.16 show that induced investment will create £96,000 of income and 88 full-time jobs in Shetland. If all the local component of induced investment was spent in local construction £79,000 and 66 jobs would be created.[20]

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19. Of course the decline in oil-related activity may result in induced dis-investment in a negative multiplier-accelerator cycle. This is not discussed in detail in the text, but is mentioned again in Chapter 7.

20. There would in addition be a small internal multiplier: these jobs created by induced investment would probably themselves create some further induced investment .. and so on. However the direct leakage of induced investment is so large that subsequent rounds can be ignored in present circumstances, particularly since the first round estimates are imprecise themselves.

These estimates are crude, but without undertaking a major study in its own right, it is difficult to improve on their accuracy. Nor is it necessary that the figures be especially accurate for present purposes, where it is merely desired to obtain an estimate of the order of magnitude of the effect, perhaps to indicate whether its importance warrants further study. The suggestion is that employment in local industries will not increase significantly as a result of induced-investment effects. However, two results of induced investment do seem to be important: firstly, at £1.5 million/annum (≃ £1 million after 1977/78), this investment represents a substantial increase to local capacity. The implications of this are discussed in Chapter 7. Secondly, the provision of induced capacity will itself involve a significant temporary addition to the construction force. If output/capita is the same as in local construction, an induced-investment construction force of perhaps 240 persons is indicated.

This section is the least satisfactory in the present chapter, both because of the inadequate data and because of the treatment of an essentially dynamic phenomenon in a static framework. The correct treatment of induced investment would require the dynamic formulation of the Input-Output model described above, but its implementation is beyond the scope of the present study. The only conclusion which seems to emerge with any persuasion in this section is that the inclusion of induced investment as an endogenous repercussion of oil development does not substantially increase the estimated impact of oil development on the local economy. The effect is likely to be of relatively short duration with high direct leakages throughout its lifetime. This is substantially in agreement with Miernyks' findings that, given Final Demand, the vectors of total outputs derived with and without investment endogenous differed in aggregate by less than 1%.[21] However, the temporary construction squad involved in

21. Ref: Mierynk (1970 op. cit.).

extending capacity may be fairly sizeable over a short period.

III Local Supply Constraints

An implicit assumption in the analysis of Chapter 4 is that local supply can expand, if necessary with increased capacity, to meet whatever demands are placed on it by oil developments. This need not necessarily be the case in practice for a number of reasons e.g. there may be a considerable time lag between increased demand and provision of new capacity, finance for new capacity locally may not be forthcoming, and cost differentials may make alternative sources less expensive than expansion of local ones. If, for any of these reasons, local supply in the time period under consideration is not forthcoming to meet postulated Final Demand in that period, two possibilities exist: (a) Final Demand must be reduced until it is consistent with local supply or (b) Final Demand is met by importing any excess over local supply capacity. Theoretically, these considerations can be introduced into the analysis either in a linear programming form, with an optimization function (e.g. maximise GRP, maximise local employment, etc.) and a series of appropriate linear constraints on supplies from local industries or, more usefully in the present context, the implications of supply constraints on imports and Final Demand could be forecast and the impact estimates adjusted appropriately.

Unfortunately, in the present study, no data exists to make the desired adjustment quantitatively, however the following general points can be made: firstly, reference to the appropriate tables in Chapter 4 indicate which local industries will experience the largest increases in demand as a result of local oil developments. It is probable that these industries would have the greatest difficulties in instantly adjusting supply. Secondly, it is most unlikely that unavailability of supply in Shetland would mean frustration of any oil industry Final Demand if the latter were at all important to North Sea operations, since given the great costs involved in developing North Sea fields and the country- (and world-) wide facilities of most of the operating companies, alternative supply sources are both essential and feasible. Thirdly, it is more probable that manufactures, or other easily transportable goods, can be provided by importation than various services which are not easily transportable among regions.

These three points taken together suggest that, given oil Final Demand as inviolate, this, and associated secondary demands, will be met either be importation or at the expense of non-oil Final Demand where local supply is insufficient to meet total demand. Given that the latter phenomenon is most likely to emerge in Shetland service industries, because these generally are expected to experience the greatest oil-induced increase in demand, it seems probable that frustration of non-oil Final Demand will be significant in cases of local supply constraint since services are not easily imported. Given data on existing supply capacities industry-by-industry, and the differential costs of alternative incremental sources of supply, it would be possible to make some quantitative estimates of the likely magnitude and direction of this effect. However, it can be stated categorically that, wherever local supply is insufficient to meet oil-induced demand, the local impact of oil will be reduced, whether the supply deficit is met by importation or frustration of demand.

In summary, this chapter has discussed some deviations from the Input-Output assumptions of Chapter 4 which may occur in Shetland in practice, and hence whose incorporation would improve the impact forecasts. Few, if any, of these modifications have been incorporated in previous Input-Output studies, even in the outline form of the present chapter, but as is apparent from the above discussion, their inclusion could radically alter the estimates of the impact of a new industrial development on the local economy. In Shetland, the following effects seem particularly important and would merit further study: oil vs. local competition in the labour market, Public Sector Employment-Population interactions, induced investment, and local supply constraints. Any of the foregoing could in future emerge as a sufficiently significant local phenomenon to cause radical departures from the forecasts of oil-induced impact given in Chapter 4. However, as discussed in the appropriate sections, none of them seem likely to do so given the current trends. Though, individually, none of the foregoing effects might cause significant departures from the forecasts of Chapter 4, the simultaneous inclusion of all could do, but this possibility is lessened, at least in aggregate, by the fact that to some extent they are mutually offsetting: the Public Sector and induced investment effects would tend to increase estimates of impact relative to Chapter 4 base estimates, while resource competition and supply constraints would tend to reduce them.[22] It is not of course suggested that the opposing forces will entirely cancel each other, even in the aggregate, and certainly the differential impact of each on an individual industry basis may be significant.

Finally, in this chapter, a brief word must be said on the 'disturbance' payments to be made to Shetland Island Council by the oil companies with respect to the Sullom Voe Terminal. These payments are the result of private negotiations between the local authority and the oil companies involved (BP and Shell) and are in addition to, not substitutes for, statutory payments made by the oil companies to the Island Council. The amount of these payments is not certain, since they are calculated by

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22. Allowance also has to be made for the fact that induced investment and supply constraints may be inversely related, although in a disaggregate model both can occur simultaneously.

a "complex" formula involving the number of pipeline landfalls at Sullom, the volume of oil flowing through the terminal, and the annual rate of inflation. However, it is known that these payments will be substantial: the Council's Chief Executive estimated minimum disturbance payments of £28 million (1975 prices) between 1975 and 1999.[23] Converting to 1971 prices and an annual basis, this translates into £811,000 per annum. It is obvious from looking at Table 4.14, that, in 1982 say, the expenditure of these payments would represent a significant additional injection to the local economy. Unfortunately it is not known what the pattern of disbursements would be. This is not a problem of non-revelation of data by the parties concerned, but simply that the Island Council themselves have not yet developed any detailed strategy on how the funds should be spent. Current local thinking seems to suggest that the sums received from the oil companies should be accumulated as capital till the 'post-oil' period, and only interest receipts on this capital be spent in intervening period. Of course, as the capital sum grows, these interest receipts themselves will be substantial. On the pattern of expenditure, whether only interest or interest plus capital is disbursed, the Island Council have already stated categorically thatthe funds will not be used to meet normal rate expenditures, but rather will finance 'development and social projects';[24] in particular, it would seem, the funds will be employed in attempts to protect and develop the non-oil local economy. Once the pattern of expenditure is known, the Input-Output framework can be used to estimate its impact on local income and employment.

23. Shetland Times 16/5/75.

24. Shetland Times 6/6/75.

CHAPTER 6 : Oil-Induced Technological Change in Shetland

Thus far, the analysis has been based on the model:

$$(\Delta X_t) = (I-A)^{-1}_{1971}(\Delta Y_t)$$

't', the reference time period, has been defined in either theoretical time terms as 'the period when the facility under consideration is fully operational' or in real time terms such as 'the year 1982'. However for both types of analysis, the Leontief inverse matrix was derived from the 1971 transactions table, i.e. the technical and trade relationships are assumed to remain constant in the 1971 pattern. The previous chapter discussed a number of ways in which this simplifying assumption might be modified, e.g. the possibility of trade flows altering as a result of local supply constraints; however the possibility that the techniques of production themselves might change between the base and reference periods was not considered. If such technical change did in fact occur, it could have important implications for the estimation of the local impact of oil, because given (ΔY_t), if

$$A_t \neq A_{1971}, \text{ then } (\Delta X_t)_{/A_t} \neq (\Delta X_t)_{/A_{1971}}$$

Of course, technical change between base and reference period may occur for reasons not related to the local emergence of oil, and this will affect the estimates of oil impact as described above. However, in the present chapter, the discussion is restricted to those changes in indigenous industry techniques directly attributable to local oil activity. Formally, the discussion concerns a A^o_{1971} matrix, i.e. the basic 1971 matrix modified by oil-induced technical change. No attempt is made presently to develop a <u>complete</u> A^o_{1971} matrix, since this would require a major study in itself.[1] While some general comments will be made on the quantification

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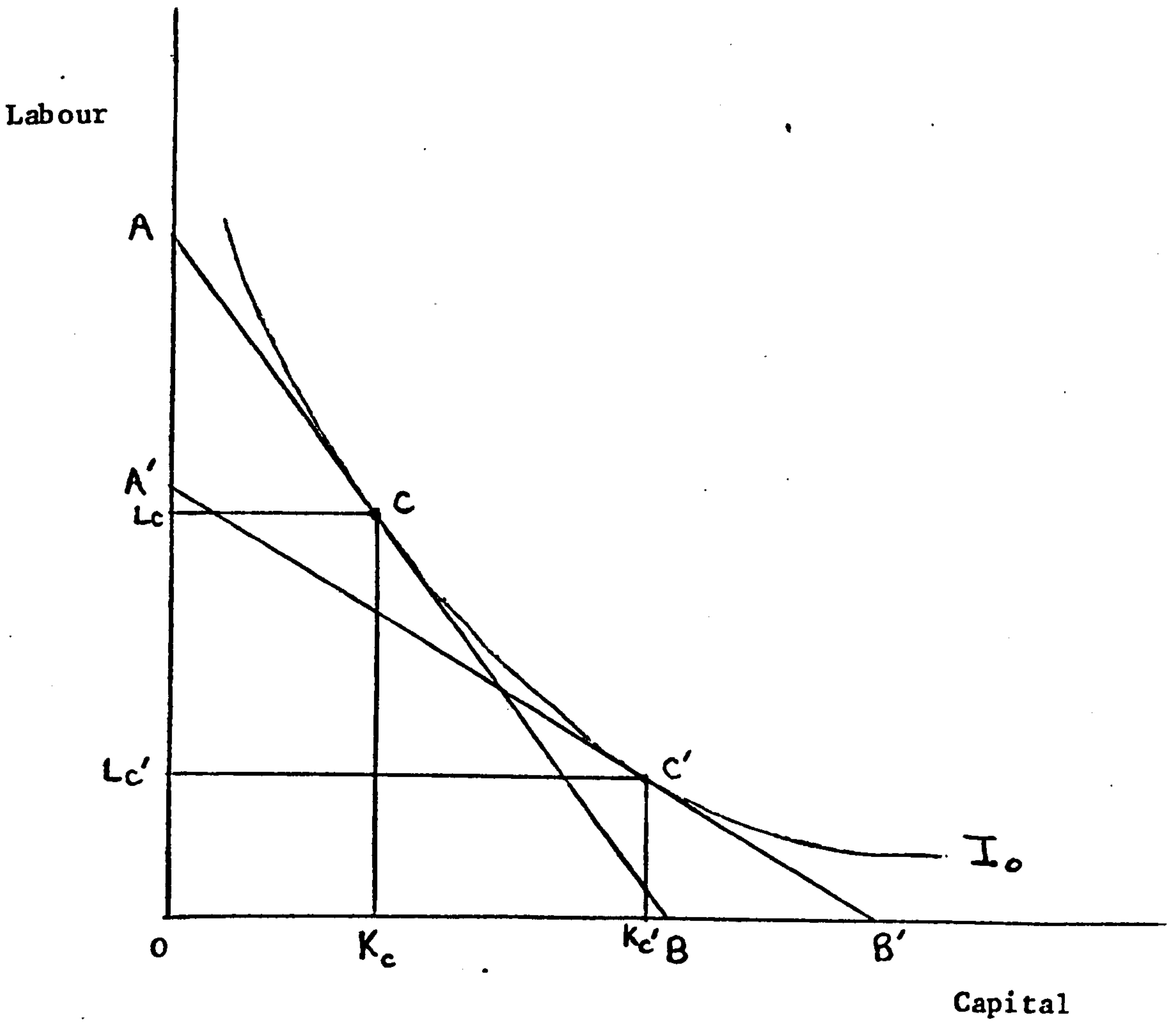
1. As will become apparent subsequently, the employment/output and capital/output ratios may also change as a result of technical change.

Figure 6.1.



of oil-induced technical change, the primary purpose of this chapter is to develop a framework for classifying and analysing the processes by which local oil activity could induce technical change in indigenous industries.

The framework constructed identifies three broad types of process by which local technical change may be induced. The framework is intended to be comprehensive, but the types of processes are not mutually exclusive; i.e. any induced technical change will result from one or more of these processes at work. The three process are described below in turn, along with the estimated operation of each in Shetland.

(A) General Regional Expansion Processes

These are processes which affect the choice of indigenous firms among known techniques. Three such processes seem relevant in the present context: firstly, the emergence of local oil activity may change the relative prices of factors to indigenous firms, and hence alter the most profitable factor combination (or 'technique') which these firms can choose. This is demonstrated in Figure 6.1 which is the standard isoquant diagram of elementary production theory.[2] The change in slope of the cost lines between AB and A'B', implying an increase in the relative price of labour, changes the least-cost choice among 'technically efficient'[3] techniques from C to C'.

It is too early in the development of oil activity in Shetland to analyse the movement of relative factor prices from historical data. Furthermore, insufficient data exists on local industries' capital-output ratios to

2. Ref: e.g. Baumol, W.J. (1965).
3. Ref: Brown (1966, p. 9-12).

permit the total demand for capital caused by local oil activity to be estimated.[4] However, given that most investment expenditures by Shetland firms will be made outside Shetland (see pages 77-78 in markets generally relatively large to their requirements, it may not be unreasonable to assume that the real price of capital to local firms will not be affected by local oil activity.[5] On the other hand, it has been shown that, given the difficulties of moving labour, particularly on a permanent basis, there is an element of 'localness' in the labour market,[6] and the preceding chapters have demonstrated clearly that oil-induced activity could cause a substantial rightward shift of the demand curve for local labour, particularly since a survey (undertaken by the author) of the oil operators in Shetland indicated that they would hire Shetlanders whenever possible. General concensus among indigenous firms is that this oil-created demand for labour has led to real increases in local wage rates.

The above two points taken together suggest that the effect of oil activity in Shetland on local relative factor prices is to make labour more expensive relative to capital than it would otherwise be. This suggests, ceteris paribus, that there will be a tendency to move towards more capital-intensive techniques among indigenous firms, and discussion with local industry representatives showed that they were aware of more capital-intensive techniques which it would be possible for them to introduce, and had no irrational managerial 'hostility' towards such techniques. However, in spite of the above analysis, there is little indication that oil will induce movements towards capital intensive

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4. But see chapter 5 pages 148+ for a tentative estimate of induced investment.

5. In effect, it is assumed that the addition of the direct and secondary capital demands created by oil activity in Shetland will only move the market demand curve for capital by a trivial amount, or assuming discreet capital markets, that the secondary capital requirements of indigenous firms will be trivial additions to their market demand curves.

6. Refs: Mackay, Boddy, etc. al. (1971), Jones (1970).

techniques, solely by increasing the relative price of labour, in the short to medium term at least. The fundamental reason for this is that movement around an isoquant to alternative techniques of production may not be as costless as suggested by figure 6.1. It is possible to elaborate on this by reference to the Shetland knitwear industry, for which the following reasons were given for making the speedy introduction of capital-intensive techniques unlikely: (a) the organisational and technical skills necessary for capital intensive production methods are not readily available in Shetland, either in the knitwear factories themselves or in 'backup' servicing industries; (b) The investment required for extensive mechanisation would be greater than any Shetland company could afford to undertake. (If the investment is profitable, this of course reflects imperfections in the capital market.) (c) The size of the market for high-quality fashion knitwear (which the Shetland product is) may be toc small to permit efficient operation of mechanised techniques. (d) The very important point raised by Salter[7] that changing from an existing technique to a new one involves comparing the operating costs of the former (capital being a sunk cost) with the operating plus capital costs of the latter.

Hence, it would seem in Shetland at present that any oil-induced increase in the cost of labour with existing techniques is insufficient to cause indigenous firms to switch to new capital-intensive techniques with possibly higher intermediate costs and certain investment costs. Over time, however, as existing equipment is scrapped, the new relative price ratio may influence a change towards more capital intensive replacement techniques.

There are two other 'regional expansion' effects to be considered, related to the backward and forward linkages of the oil industry within the

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7. Ref: Salter (1966).

local economy (see pages 53-54). Backward linkage effects may change indigenous techniques in three ways: firstly, new markets may be opened up for indigenous firms making hitherto unprofitable products and processes worthwhile. Secondly, changes in the scale of output, if there are economies of scale, may change the least-cost choice of technique.[8] Thirdly, increase in demand for local industry products will, as seen in the previous chapter, lead to induced investment for expansion of capacity. This investment itself is an important vehicle for the diffusion of new techniques,[9] since new capital generally embodies the most modern technology.

The extent and pattern of the backward linkages of oil in Shetland has been thoroughly explored in chapter 4, and it is apparent from that analysis that the major backward linkage impacts are in local service industries predominantly. There is some evidence of changes in local techniques, for one or more of the reasons described above, as a result of oil-related backward linkages. For example, local Distribution experiences an increase in demand both through oil operating purchases (primarily impinging on local wholesaling) and through consumption expenditures of oil-related employees (primarily affecting local retailers). Considering the former first; a number of companies, such as North Sea Marine Rig Services and the British Oxygen Co., have been established primarily to provide wholesaling services for the three major areas of local oil activity discussed in Chapter 4. The 'technique' employed by these firms is somewhat different from local firms in that speed and reliability of delivery are of paramount importance, almost irrespective of cost, and their entire mode of operation is geared towards providing the former. There are also suggestions that local wholesalers intend to construct larger

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8. This point is, of course, pertinent to both increases and decreases of output; so that 'negative' effects of oil may also lead to changes in local industries' techniques.

9. Ref: Salter (op. cit.).

storage and warehousing facilities, which will probably reduce the labour unit per unit of wholesale 'output'.

On the retailing side, pressures on the supply of services have generally been met to date by taking up 'slack' within existing organisational structure. (This itself will affect technical coefficients as discussed subsequently.) However, it seems probable that eventually chain stores and supermarkets will be established on the Island which will employ considerably different techniques of operation from the traditional corner shop.

Transport facilities have also changed greatly as a result of oil demands placed on them. Foremost among these changes is the Sumburgh Airport development which involved runway extensions and the installation of a sophisticated instrument navigation facility, greatly improving the all-weather landing capability at the Airport. Similar examples can be found in other local industries such as Quarrying, Construction, and other service trades.

The final 'expansion' effect to be discussed is related to the creation of forward linkages locally by oil operators. The Input-Output analysis of Chapters 4 and 5 assumed that the local oil companies had no local forward linkages. The reasons for adopting this assumption are given elsewhere (see pages 85-87), and these remain valid since we are not abandoning the empirically-derived assumption that the monetary value of such flows are sufficiently small to omit. However, it is possible that oil-related companies may be able to provide key materials, equipment, and services that permit the use of certain techniques in indigenous industries that were hitherto impracticable because of the inaccessibility of appropriate 'back up' (e.g. see the foregoing discussion of the mechanisation of the textile industry). The Supply Bases' main functions are to provide storage and handling facilities, and as far as capacity permits, they will, in the words of one representative 'provide these services to anyone'. The main potential beneficiaries in terms of harbourage and handling facilities would obviously seem to be the local fishing fleet; however, the Fisheries Officer states that, in general, non-oil related harbour space and handling equipment was sufficient for the needs of the fishing fleet. The point was also made, both by the Fisheries Officer and oil industry representatives, that much of the oil-related equipment has greater capability than required by indigenous firms and would generally be inefficient in such uses.

The Sullom Terminal would be able to provide similar services to local industries as the Supply Bases, and the above arguments apply to the Terminal also. It is possible, though extremely uncertain, that gas removed from the oil as it is landed at Sullom might be used as a fuel source by the local Electricity Board, necessitating extensive modifications to the plant to the latter.

Finally, the oil-related wholesalers can, and do, obtain a wide range of goods for local firms; primarily in areas of working clothing, machine parts, spares, etc.

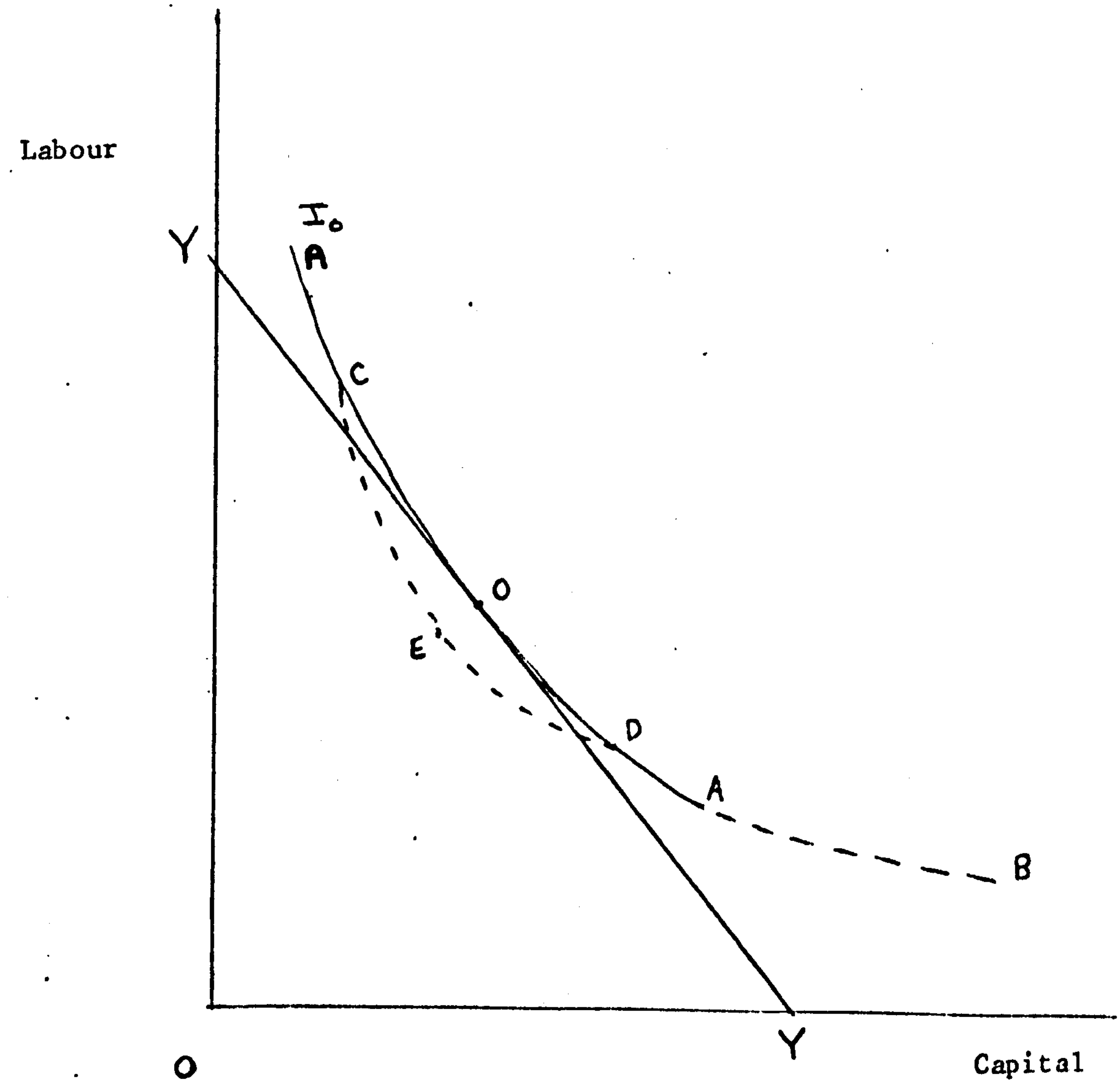
In summary, changes in local techniques resulting from the general regional expansion effects of oil development seem largely restricted in Shetland at present to those associated with backward linkages. There are isolated instances of forward-linkage effects, but generally of small impact, and relative price induced changes would seem more likely to evolve in the longer term, if at all.

We turn now to the second set of processes which are given the generic heading of:

(B) Technical Extension Processes

The essence of Technical Extension Processes is that they increase the perceived range of techniques of indigenous firms. These techniques

Figure 6.2.



already exist elsewhere in the same industry, but for various reasons (e.g. communication costs; uncertainty, ignorance, etc.) have not disseminated to regional firms. Our hypothesis is that the emergence of oil activity in the region will aid in diffusing these techniques; perhaps by providing necessary communication channels or by themselves demonstrating the viability of the technique and thereby reducing uncertainty among local firms.[10] This can be expressed diagrammatically as in figure 6.2.

AA represents an isoquant of indigenous industry i's production function pre local oil activity. For reasons suggested above, local oil development may either extend the range of techniques available to regional industry i, such as making techniques represented by AB available, or it may introduce more technically efficient (i.e. less of capital and labour can be used) methods, such as represented by CED. The latter is diagrammatically identical to the representation of technological change; however, it is not industry i's technology which has changed, only that regional firms have moved nearer their industry's technological frontier.

Whether expansion of the possible range of techniques available to indigenous firms will result in actual adoption of new techniques depends on relative factor prices. For example, if the price line is YY, then technical extension along CED will lead to new least-cost techniques,[11] while extension along AB will not.

It is impossible at this time to identify any instances of oil-induced technical change in indigenous Shetland industry through 'technical

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10. Ref: Quinn (1969) mentions the importance of geographical proximity in transferring technology from multinational Enterprises.

11. Of course, the availability of superficially lower cost techniques does not, as discussed previously, necessarily lead to their adoption.

extension' processes. This is not particularly surprising since oil development is a recent occurence in Shetland, and information on industry best-practice techniques could, at best, only be available over 2-3 years. Various studies[12] have indicated that information on techniques precedes adoption of such techniques by a time lag which is variable but usually measured in years. Since information diffusion is an essential prerequisite to technical diffusion, it is pertinent at the present time to examine the extent and direction of information flows between the new oil industry and the indigenous economy to try to estimate the potential for technical change through technical extension processes.[13]

Technical information can be disseminated throughout the economy in two ways: (i) through the movement of such information itself (ii) through the movement of persons or goods in whom such information is embodied.

Considering each of these in turn, firstly the movement of technical information from the oil industry to indigenous Shetland industry, which the survey showed to be taking place in a number of ways. Technical journals, which were found to be important intra oil industry transmitters of information,[14] were considerably less important in inter-industry transfers of information from oil to indigenous firms. This is because different industrialists generally subscribe to different sub-sets of journals, and few journals cover inter-industry grounds. The Island newspaper (The Shetland Times), and other local media, were regarded as useful information channels on oil by local firms, and vice-versa. Advertising and special features such as the Norscot supplement in 1975 or the recent 'Oil News' supplement are the main communication vehicles

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12. Ref: Hakinson (1974) p. 73, Gebhart & Hatzold (1974) pp. 37-38.

13. The flow of information itself could also create possibilities of local technological change which is discussed in the subsequent section. Hence the discussion in the text has relevance in that section also.

14. This agrees with the findings of Hakason (op. cit. page 71) on the importance of journals as information channels.

in this medium.

Public meetings and conferences on oil topics are another source of information for local companies. Public meetings are held at intervals on numerous aspects of oil development,[15] and a number of local companies are represented at the Offshore Europe Conference in Aberdeen (last held in 1975). The latter seems to have been fairly well received by those involved, but a survey of local businessmen suggested that in general, the information provided at these formalised gatherings is too superficial or irrelevant to be especially useful to them. Many reported that informal contacts with oilmen proved a more useful communication channel.

Official or semi-official industry representation seems, for some Shetland industries, to have established fairly close contact with the local oil companies on specific issues. For example, the Fisheries Officer liases between the fishermen and oil operators, and reports that a great deal of formal and informal discussion takes place between these groups on topics such as the condition of the seabed, pipeline routing, damage to fishing gear, pollution, etc. Other local industries seemed to find the local Chamber of Commerce a useful communication channel. Indeed, many respondents in indigenous <u>and</u> oil-related firms stated that the Chamber was <u>the</u> single best source of information on oil for the local community and vice-versa. In this respect, the Chamber seems to be filling the role of 'technological gatekeeper'[16] within Shetland. Discussion with the Chairman revealed that the development of the Chamber as an information exchange between oil and the local community is a deliberate policy being actively pursued and extended.

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15. A recent example (December 1975) is the public talk by T. Buyers of B.P. on the oil-related opportunities for the local business community.

16. Ref: Allen (1971).

Turning now to the transmission of 'embodied' technical information in persons or goods, the potential for the latter is determined largely by the extent and type of backward and forward linkages, which were discussed earlier; and it is evident from previous discussion of these that the goods and services bought and sold among local industries by oil-related firms will not generally have a high technological content, or, more relevantly, will not have a different technological content from goods bought from and sold to local firms by other sources. One Base manager described the goods/technology relationship as follows:

> "We purchase 80%[17] of our requirements in Shetland, but the other 20% is the high technology end. Our local purchases are predominantly bulk, low technology."

It seems probable therefore that little technical change will be induced in Shetland industry as a result of product technical characteristics required, or supplied, by the local oil industry as long as trading patterns between the two business communities remain as they are at present.

The transfer of technical know-how embodied in skilled personnel is recognised to be extremely effective,[18] and can be considered in two stages: firstly, the level and types of skills imparted by the oil companies to their employees and secondly the degree of inter-industry mobility of these employees.

Oil operators in Shetland characterised their overall labour requirement as 'unskilled'. However, within this generalisation, there are various areas where skills are required, and the oil companies seem prepared to offer appropriate training in these skills. Some of the skill areas mentioned include welding, turning, heavy crane operation, heavy goods vehicle driving; and, on the management side, courses in personnel

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17. This proportion seems high in view of the discussion of Chapter 4, but it includes the value of goods bought through local distribution, whereas the Input-Output analysis included only the local distribution margin of these.

18. Ref: Doctors (1969).

management, supervisory training, etc. Much of the training, of course, involves extending workers' existing skills rather than teaching them entirely new ones.

As discussed in Chapter 5, the magnitude and direction of inter-industry labour flows is difficult to estimate at present. There is some evidence of small-scale two-way flows between the oil industry and the Fishing and Fish Processing industries, but it is not known if these workers returning to indigenous firms have enhanced skill levels or not. There is, in fact, some tendency for the better qualified and more successful Shetlander hired by oil-related companies to be retained within the company and moved to another area when required.[19]

Given this, and also the fact that many of the most highly skilled jobs are filled by intra-company transfers <u>into</u> Shetland, or by recruitment of non-Shetlanders on an (at best) semi-permanent basis, it seems unlikely that movement of skilled personnel from oil-related to indigenous firms will be a major source of technical change in the latter in the short to medium term. In the longer term (perhaps twenty-five to thirty years), as the oil industry begins to decline permanently in Shetland, skilled and semi-skilled workers, especially native Shetlanders, may seek employment in other local industries. It is impossible to predict whether there will be local demand for these workers at the appropriate time, and whether their oil-learned skills will prove useful in indigenous firms.

The third group of processes inducing local changes in techniques is given the family title of <u>Technology Enlargement Processes</u> (C). The General Regional Expansion and Technical Extension processes discussed above share the common factor that, though they may lead to the adoption of techniques

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19. The implications of this trend are further discussed in the subsequent section.

'new' to the regional firm, the techniques which they do cause to be adopted are already fully-articulated within industrial processes essentially similar to those of the adopter. Crudely, they cause "diffusion" of techniques. Technology Enlargement Processes, on the other hand, enlarge the range of techniques available on an industry-wide basis, i.e. they create techniques which are entirely new. These processes would involve "innovation" and "invention". The regional firm is faced with an expanded feasible technical set through the introduction of entirely new techniques, and again may choose to re-select their most appropriate method.

At the time of survey (March 1976), no significant instances of 'spin-off' or 'technology transfer'[20] from oil to indigenous industries, was noted, i.e. no new indigenous techniques seem to have been created by adapting oil technology. In some ways this is not surprising since the comments made before on the time lag between the introduction of technical information in an environment and its subsequent adoption and adaption have even more force in the case of entirely new technological developments. Hence, it may be some years before actual spin-off technologies begin to emerge. However, even allowing for this, the general prospects for transfer of oil technology to local industrial uses do not seem encouraging, since many of the 'ingredients' required for such transfer appear to be absent in the Shetland situation.

For example, few oil-related staff in Shetland have sufficient knowledge or authority to undertake strategic decisions onnew product and process developments of their own volition. In any event, as discussed previously,

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20. For a definitional discussion of these and other items, see Fischer & Mc Nicoll (forthcoming). It is sufficient to note here that definitional debate in this area is confusing and contradictory and embroilment in it would serve no purpose in the present context.

personnel of this type exhibit a high degree of intra-industry mobility; so that their expertise is unlikely to become available to Shetland firms even if they are transitorily Shetland based. However, it might be possible for some imaginative entrepreneurs, particularly native Shetlanders working for oil companies (of which there are a number in reasonably senior positions), to recognise potentially profitable new products or processes within the local industrial framework, and move to companies (or even set up their own companies) where these can be exploited. The aforementioned tendency of movement of talented Shetlanders from the Islands within the oil companies would tend to mitigate against this however.

Furthermore, industrial Research and Development which could both create new techniques and ease their adoption, is largely absent in Shetland in both the oil-related and non-oil related sectors. Local Government R & D exists in the form of the Island Council's R & D Department, as well as various specific research functions carried out by the Fisheries Office, the Department of Agriculture, etc. There is no evidence that any of these bodies are currently exploring the possibility of spin-off of oil technology in any depth.

In summary, the possibilities of oil-induced technical change among indigenous Shetland firms seem limited. The most likely types of change will result from 'general regional expansion' effects, particularly in the elimination of 'x-inefficiency'[21] and through economies of scale. Technical extension and technology expansion as defined above seem unlikely to have a major local impact, particularly in the short to medium term, given the empirical evidence on the slow nature of the development and diffusion of change of this type. This is generally encouraging for the assumption of 'no technological change' implicit in the Input-Output analysis, and suggests that the A^o_{1971} matrix may not be too dissimilar to the basic

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21. This occurs when factors are employed at less than maximum technical efficiency. See Leibenstein (1966).

A_{1971} matrix. In other words, a potentially important source of error in the estimated impact of oil may not in fact be very serious. However, we wish to conclude by considering briefly the possible changes in the impact estimates resulting from those technical changes which are thought probable.

Movement towards capital intensive techniques, more efficient use of factors, economies of scale, and technological change (i.e. less of all factors to produce a given output) all may be induced to a greater or lesser extent by oil developments, and suggest, in aggregate, that in indigenous industries labour input per unit of output may decline. This will obviously have repercussions on the employment-generation of oil, but the difficulty is in measuring its magnitude. A detailed analysis of this is beyond the scope of the present study, but from the individual returns gathered for construction of the Input-Output table it is at least possible to identify employment/output coefficients for different firms and hence acquire a range of industry coefficients which are known to be technically feasible within Shetland, and it might be assumed that the oil-induced forces mentioned above would tend to drive the various employment/output coefficients towards the industry minimum.[22] Table 6.1 shows the 1971 average and minimum employment coefficients for those industries where appropriate data is available.

Table 6.1. Industry Employment/Output Coefficients

Industry	Average FTE/£000	Minimum
Agriculture	0.511	0.307
Fish Processing	0.141	0.023*
Textiles	0.380	0.206
Construction	0.240	0.187
Transport	0.264	0.184*
Distribution	0.562	0.389
Other Services	0.237	0.219*

22. The possibility of oil creating new industry minimums by expanding available techniques is ignored since, as is apparent from the preceding discussion, it is likely to be relatively unimportant.

The figures in Table 6.1 must be treated with the greatest caution: the samples in every case are so small that no statistical significance can be attached to any coefficient differences; errors in measurement are probable; and in some industries, the range of firms included is so heterogeneous that the minimum employment coefficient may be for an 'outsider' firm type. The coefficients asterisked are those where this is most probable. However, the figures do agree with the findings of others[23] that 'best-practice' coefficients can differ substantially from the industry average, in this case being generally 60-70% of the average. If oil pressures caused the industry minimums of 1971 to be the industry averages of 1982, and if no other coefficients change, then the secondary employment created by oil would be 200[24] less than estimated in Table 4.16. If all local industry employment/output coefficients were reduced to 70% of the 1971 level, secondary oil employment would be approximately 500[24] less than estimated in table 4.16, reducing the overall oil employment multiplier from 2.17 to 1.79. It is, however, most unlikely that changes in estimates of this magnitude will occur, for a number of reasons: firstly, it may be excessively costly for indigenous firms to move to minimum-labour techniques (indeed these may not be profitable at all). Secondly, oil pressures to reduce labour input will not be exerted equally among local industries and in no instance might be sufficiently strong to drive the coefficients all the way to the minimum, particularly over a comparatively short period. Thirdly, it was suggested above (page 162) that techniques reducing labour inputs may simultaneously increase intermediate inputs.[25] Ceteris paribus,

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23. E.g. Salter (op. cit.) and Mansfield (1968).

24. 'Low' estimates. In fact, if this structural change did occur, the repercussions on the non-oil industrial economy would also have to be allowed for (i.e. the $B(Y^*)_t$ element of equation (49), chapter 4, page 82), leading to an even greater reduction in estimated net oil-created employment.

25. Carter's (1970) analysis also suggests this.

this will tend to increase every b_{ij} of the Leontief inverse, i.e. the total change in output of industry i associated with a unit change in sales to Final Demand by industry j will increase. Since the total employment in industry i generated by a unit Final Demand vector is given by $e_i\sum_j b_{ij}$, simultaneous decreases in e_i and increases in b_{ij}'s will tend to be partially offsetting in total. Hence, while some reduction in local employment/production coefficents is likely, it is improbable that the reduction in estimated oil employment generation would be as large as suggested above.

CHAPTER 7 : Summary and Conclusions

This chapter reviews the objectives of the thesis and the extent to which they have been realised in practise. The main empirical findings are summarised and some possible implications of them discussed subsequently. Desirable attributes and limitations of Input-Output methodlogy in impact forecasting became apparent during this study, and these are discussed where appropriate.

1. Objectives of Thesis

The primary objective of the thesis was to analyse the impact of oil developments on certain important economic variables in Shetland.

As the study progressed, this objective took on a more precise formulation. In particular, two important decisions on the scope of research were made at an early stage: firstly, the local economic variables analysed in detail were restricted largely to incomes, employment, and output. Some type of selection was indicated by early evidence that oil impact in Shetland pervaded many areas that could broadly be termed 'economic', and it became apparent that insufficient resources would be available to study them all in any depth.[1] The approach adopted, therefore, reflected a positive decision to measure certain aspects of oil impact as thoroughly as possible rather than analyse a broader spectrum of areas of impact more superficially. The areas of economic impact selected for detailed study reflect their importance to the region, and, to a lesser extent, their compatibility with available impact methodologies. This interdependence of theory and practice, implicit in all applied research, is discussed further below.

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1. For example, it was obvious at the outset that oil developments would affect, in addition to the variables mentioned in the text, others such as the absolute level of prices, local income distribution and developments of labour skills as well as many socio-cultural and environmental variables which could have economic repercussions. Some of these were touched on in Chapters 5 and 6.

The second decision made was to concentrate on the study of indigenous industries and the non-oil economy, i.e. the oil industry in Shetland would not in itself be considered in greater detail necessary than required to assess its impact on local industries. This treatment of the oil industry is justified on 'opportunity cost of resources' grounds: the nature and extent of oil developments themselves in Shetland had been discussed in detail in a variety of consultative documents and plans, and further research in this area seemed wastefully duplicative. The resultant changes in the indigenous economy, on the other hand, had been superficially analysed in these documents, and further careful research seemed merited.

Given that the primary aim of the thesis was to provide estimates of oil impact on certain areas of the local economy, it seemed desirable that these estimates should, as far as possible, possess certain attributes: firstly, it was felt the various estimates of impact should be on as disaggregate a basis as possible. This was because early survey work indicated that inter-industry differences in impact were likely to be considerable, and it would greatly reduce the policy usefulness of the study if these differences were concealed in aggregate impact estimates. The empirical results of the study, presented at approximately SIC level, confirmed the desirability of disaggregating the estimates of impact. These results are discussed further below.

Secondly, since oil developments in Shetland were in their infancy at the outset of the project, the aim had to be to forecast their impact on the local economy when they had 'matured'. Defining 'maturity' in this sense proved by no means simple as is discussed subsequently, but at present it is the implications of the ex ante nature of the study which must be considered. Most impact studies in the literature have been ex post i.e. they have estimated the regional effects of a new development after it has reached 'maturity' (defined in a variety of ways) within the locality. This approach, where possible, permits, at least ideally, absolute accuracy in impact measurement. Resources can therefore be employed intensively in data collection and model development in the knowledge that succeeding estimates can be made more and more accurate until the single 'correct' answer emerges. The forecasting nature of the present study, while not precluding refinement of individual impact estimates, seemed to require a change in emphasis. The essential difference in an impact forecasting exercise is that, assuming the future cannot be known with certainty, it becomes impossible to measure the local effects of the new industrial development with 100% accuracy. This realisation suggested (a) that the study should provide a range of alternative forecasts encompassing the 'most likely' estimates and (b) that the study should take place within a framework which could incorporate new empirical material as it emerged in the course of the oil industry's development.

As suggested earlier, the main aims of the thesis were empirical and the selection of an appropriate methodology was a consequence of these. It would be wrong, however, to overemphasise this hierarchical structure: in fact, the empirical aims were themselves modified in the knowledge of the capabilities of alternative impact methodologies. Comparison of various possible frameworks within which the impact study could be made (including Keynesian Mutliplier, Economic Base, and Input-Output) suggested that, while not ideal in all respects as discussed later, Input-Output had a number of features which made it attractive in the present context: firstly it provided impact estimates at detailed individual industry level; indeed, in practice, the level of detail would be largely determined by available resources. Secondly, in spite of its seemingly rigid assumptions, this model offered the desired ability to incorporate new empirical data as it became available, and, indeed the basic assumptions themselves seemed to be modifiable if required. Finally, this framework seemed particularly atractive in a technological-economics study, since its industry coefficients reflect industry technology and this characteristic made it possible to analyse the way in which the interaction of oil and local technologies (as reflected in the respective industry coefficient columns) caused changes in Shetland incomes, employment and output. Furthermore, it made it possible to suggest ways in which oil developments might induce changes in indigenous Shetland technology, and analyse the quantitative effects of such changes via a suitably modified coefficients matrix.

Given the empirical aims of the study, and the preliminary selection of an Input-Output framework to attain these aims, the theoretical objectives of the study became (a) to test the usefulness of the Input-Output model in an applied exercise of this nature (b) to explore the possibilities of modifying the basic Input-Output assumptions where they seem unrealistic in Shetland, and assess the extent to which the empirical impact estimates are altered by such modifications. The extent to which these and the other objectives discussed above were realised is considered subsequently.

2. Main Results of the Thesis

In Chapter 1, the analysis of employment and population developments in the decade immediately prior to oil activities indicated that this period, particularly between 1966-71 was one of local prosperity. Unemployment declined continuously over this period, and over 1966-71 there was net immigration of population. This latter reversed a long-run trend of net emigration. Industry employment statistics suggested that the traditional mainstays of the Shetland economy, Agriculture, Fishing, Fish Processing, and Textiles, were responsible for this prosperity, though confirmation of this had to await the Input-Output analysis of Chapter 3. The detailed structure of the immediate pre-oil Shetland economy is discussed below, but the indications of local prosperity at that time made in Chapter 1 had potentially important implications for the impact of oil on the local economy: firstly, it suggested that, if the 'non-oil' economy remained buoyant during the period of oil activity, competition for local resources, particularly for labour, might become intense. This possibility was explored in various parts of the thesis, especially in Chapter 5, but resource constraint precluded a detailed analysis of the effects of oil developments on local factor markets and this caused some difficulties throughout the study. Unquestionably, a study of oil-induced factor movements and changes in factor prices, itself a major exercise, would be highly complementary to the present work. Secondly, and as it has emerged, more importantly, the prosperity of the economy gave local politicians and officials the justification and confidence to negotiate very favourable terms for the Shetland community with the incoming oil companies. Some of the details of these agreements are given in section 3 of Chapter 4.

Chapter 2 outlined the basic elements of Input-Output theory, concentrating primarily on those utilized in the subsequent applied analysis. A brief comparison between Input-Output and other forms of impact analysis was also made in this chapter.

Chapter 3 described the results of an Input-Output table of Shetland for the year 1971 constructed by the author for the purposes of analysing oil impact. This table (Table 3.1) was useful not only in providing a detailed picture of the immediately pre-oil local economy, but also in providing empirical values for the local structural coefficients matrix (Table 3.6) necessary for an Input-Output analysis of oil impact. Some of the more important results of Chapter 3 were as follows:

(i) At a purely descriptive level, the Input-Output table provided estimates of many important elements of Shetland's regional accounts. Among these was an estimate of Gross Regional Product for Shetland for 1971 of £12.5 million or £725 per capita. This was considerably lower than the equivalent U.K. figure of £1024. Possible reasons for this seemed to be Shetland's specialisation in nationally-low labour productivity industries, and its higher-than-national proportion of dependent population, among others. Total income receipts of households in Shetland for 1971 were estimated at £10 million, or £34.7 per household per week. Again, this was lower than the U.K. equivalent of £38.5, but was comparable with Scotland's £34.6. Finally, it was possible to estimate a Balance of Trade deficit for Shetland in 1971 of £1 million, given Exports at £8.9 million and Imports at £9.9 million. This figure is less reliable than most of the others, however, because of the difficulties of estimating 'invisible' trade items.

(ii) The analytical properties of the Input-Output system were considered in the context of the Shetland table. In particular, the difference between 'direct' and 'total' (i.e. direct plus secondary) impacts of exogenous changes in local Final Demands was explained, and the related concept of industry 'multipliers' developed. A distinction between Type I and Type II multiplier effects was drawn based on the latter's inclusion of household consumption-income interrelationships. Given their inclusion of a greater number of secondary repercussions, the latter are generally larger for any given industry than the former. This is demonstrated quite clearly below where the Type I and Type II multipliers found for agriculture are reproduced:

Agriculture Multipliers[2]

	Type I	Type II
Output	1.33	2.35
Income	1.26	1.46

Sixteen Shetland industries including households, were identified separately and multipliers derived for each. The industries individually included were chosen either because of their importance to the pre-oil Shetland economy or because it was anticipated that they would play an important role in oil development. The multipliers derived varied widely from industry to industry: Type II output multipliers ranged between 1.47 (utilities) to 2.90 (local government), income multipliers between 1.22 (ship repair) to 5.66 (local government), and employment multipliers between 1.19 (distribution) and 3.08 (local government). The inter-industry differences in multiplier values justify the detailed approach of Input-Output, since they would be concealed by some aggregate regional multiplier.

The industry multipliers derived in Chapter 3 provide an essential tool for the subsequent analysis of oil impact. However, they are also of interest in revealing the structure of the local economy. For example, the larger the industry multiplier values, the greater the extent of local interdependence <u>ceteris paribus</u>. Industry multipliers in Shetland were generally significantly higher than unity indicating a significant degree of local industrial interdependence, perhaps surprisingly in a small region. To some extent the large multiplier values reflect the

2. Only Type II employment multipliers were derived.

fairly aggregate nature of the table, and more importantly the inclusion of essentially non-industrial activities such as Households and Local Government in the intermediate sector, however local interrelationships do seem to be important in the Shetland economy and the ability of the Input-Output model to allow for these in the estimation of impact is a particularly desirable characteristic in the circumstances.

The final type of result derived in Chapter 3 employed the multiplier concept, in conjunction with known Final Demands for 1971, to calculate the ultimate external sources of local income and employment in that year. The findings indicated that exporting activities generated the largest proportions of income and employment (39% and 49% respectively), but Central Government payments were also important, creating 36% of income and 28% of employment. A surprising finding, which had implications for the local impact of oil, was that tourism was a relatively insignificant activity in Shetland, creating only 3% of income and 2% of employment.

Using the empirical Input-Output framework developed in Chapter 3, Chapter 4 presented the estimates of local impact of oil developments within Shetland. The analysis of this chapter was a fairly straightfoward implementation of Input-Output impact methodology, though the forecasting nature of this particular exercise required a few adaptations, discussed in the text (pages 80-84)

Three major areas of oil activity were separately identified, and their impact analysed. These were: Oil Supply Bases, the Sullom Voe Terminal Complex, and Oil-Related Construction. These three activities give essentially comprehensive coverage of the direct oil developments which have arisen in Shetland. Other developments in transport, distribution, etc. are regarded as secondary repercussions of these. While it is possible to become involved in terminological wrangles over what is, or is not, a 'direct' oil activity, the definition adopted in the present study is useful and sensible in that there are no further forward local oil linkages beyond the Supply Bases and Tanker Terminal. The inclusion of the construction of Supply Bases and the Terminal as a major separate area of oil activity in its own right and the assumption that it will generate secondary impact in the region, would not be justified if construction was expected to be a short-term activity. However, as discussed in Chapter 4, oil-related construction is expected to be a significant activity within Shetland for many years and therefore it must be presumed that it will create indirect and induced local repercussions. This characteristic of oil-related construction, i.e. sufficiently long-term to create local repercussions, but nonetheless essentially impermanent, has important policy implications which are discussed subsequently.

For reasons discussed in the text, the best forecasts were obtainable by considering each direct oil-activity at its fully-operational level. Unfortunately, since in reality the three oil sectors reach full operation at different periods, the 'fully-operational' impact of each on the local economy had to be estimated in isolation. Analysed in this way, the three areas of direct oil development were forecast to have the following impacts on the regional economy: (a) Oil Supply Bases, at the peak of their operations, are expected to spend £0.6-£0.9 million in Shetland (1971 prices). This expenditure could create a total of 350-500 jobs in the region and add £0.6-£0.9 million to local wages and salaries (b) The fully-operational Sullom Voe complex is estimated to spend £2.3-£3.3 million per annum locally. The complex could create employment of 1300-1900 jobs, and income of £1.8-£2.5 million per annum (c) Oil-related construction, in an 'average' year, could create £4.0 million in wages and salaries and generate employment for 1800 persons full-time.

Much of the income and employment created by these oil activities will, of course, be internal i.e. will be generated within these sectors themselves. For example, the breakdown between direct and secondary employment was estimated to be 63% direct/37% secondary for Supply Bases, 26% direct/74% secondary for the Sullom Voe terminal, and 59% direct/41% secondary for Oil-related Construction. These statistics indicate that for Supply Bases and Construction work, the greater proportion of employment created by them will be within those activities. In the case of the Sullom Voe complex, on the other hand, employment generation will be largely secondary, reflecting the different characteristics of this activity (see pages 106-107). These differences in importance of direct and secondary impacts are reflected in the values of the derived multipliers for each activity, since by definition relatively greater secondary effects will lead to higher multipliers. Type II Income and employment multipliers were estimated to be:

	Income Multiplier[3]	Employment Multiplier[3]
Supply Bases	1.36	1.59
Sullom Voe Complex	2.63	3.89
Oil Construction	1.30	1.70

As discussed above, the multiplier values for the Sullom Terminal are consistently higher than those of other oil activities, but all three sectors' multipliers are relatively high compared with those of local industries given in Chapter 3. (For example, the employment multipliers given above rank respectively 6th, 1st, and 4th, compared with sixteen indigenous industries.) It is important, however, to be aware that all this says is that, relative to direct local effects, oil industries' secondary local effects are more substantial than those of most indigenous industries. This in itself is interesting, but it would be an over-simplification to infer from this that, in their brief period on the

3. Mean of estimates in Table 4.21.

islands, oil companies had become more 'integrated' into the Shetland economy than firms who had been there for many years. Apart from general problems in interpreting multipliers in this way, in the present context the local versus oil industry comparison depends critically on whether account is taken of direct leakages or not.

The above multipliers tend to hide the important finding made in Chapter 4 that the oil sectors in Shetland have very high direct leakage factors: well over 80p of every £1 expenditure by each of these activities will be spent on direct imports, and hence have no repercussions on the local economy.[4] Ignoring this expenditure on imported goods inevitably tends to overestimate the relative local interactions of the oil industries. For example, consider the total (i.e. local plus direct import) expenditure required by each industry to generate one local job. For local industries this ranges between £1300-£5600; on the other hand, for Supply Bases the total expenditure required is £11,900 and the other oil activities' required expenditures are also much higher than any indigenous industries. Hence, it is important to be aware of whether 'local' or 'total' oil expenditure is used as the basis of calculation, though, of course, if the relevant direct import coefficient is known, the transition from one base to the other is relatively simple.

Turning now to the individual industry breakdown of secondary oil impact, it was found that the effects of oil developments differed widely among local industries. A summary of results is given below:

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4. In contrast, the highest direct import coefficient for any indigenous Shetland industry is 0.60 (Construction).

Local Sector	% of Total Secondary Employment created by Supply Bases	Sullom Terminal	Oil Construction
Primary	5.3	2.4	23.9
Manufacturing	3.1	1.4	4.5
Construction	3.5	10.0	13.3
Services	88.1	86.2	58.3

These figures clearly demonstrate the inter-industry differences in local impact generated by the oil activities. It is also clear that the major impact of each oil activity occurs primarily in the local service sector, particularly in the cases of the Supply Bases and the Sullom Terminal. The relative lack of oil-stimulation to local manufacturing is also quite clearly illustrated, and some of the implications of this are discussed further below.

The above discussion has summarised some of the most important results derived from analysing the local impact of each oil sector in isolation. In reality, however, all three activities will be operational simultaneously, at least in the medium term, and the actual impact on the Shetland economy will be some weighted combination of the three individual impacts.

Major, if not insoluble, problems were encountered in (a) estimating the level of activity in each oil sector at any given point in the calendar time and (b) deriving expenditure functions for non-fully operational oil activities, but it was felt important that some attempt should be made to estimate the combined impact of the various oil sectors on the local economy, and therefore, based on a number of highly simplifying assumptions discussed in the text, a forecast of estimated oil impact in Shetland in the year 1982 was derived. The results obtained are at best suggestive of how overall oil impact may develop in Shetland in the future, but are none the less interesting for that.

The 1982 forecast suggested that, in that year, oil activities might spend £4.4-£5.6 million locally, generating £3.1-£4.1 million in household incomes, and 3000-3800 job opportunities. Somewhat less than half of the income and employment created was expected to be direct (i.e. wichin oil activities themselves), yielding respective multipliers greater than 2.0 for 'aggregate' oil activity. Already by 1982, the Sullom Voe Terminal will be the largest single oil sector in the region, and in the longer term, as the other oil activities decline, the total impact of oil will more and more reflect its impact. These figures, unless grossly in error, demonstrate clearly the magnitude of the effects of oil developments on the Shetland economy: estimated Final Demand for oil alone in 1982 is approximately 30% of all Final Demand in Shetland in pre-oil 1971. Similarly, oil-created wages and salaries could be 30-40% of 1971 total household incomes, and oil-induced employment opportunities could, by 1982, be 40-50% of all employment in Shetland in 1971.

This very substantial aggregate impact will not be distributed equally among local industries, just as the impact of individual oil activities was not. The industrial sector breakdown of oil-created employment in 1982 is estimated to be: Primary 4.2% of total; Manufacturing 1.1%, Construction 5.7%, Services 45.2% and the Oil industry itself 43.8%. Again it is clear that the major local impact will occur in Service industries; indeed, the figures suggest that oil activities may generate more secondary employees in local services than they employ themselves. Other industries, such as Quarrying and Construction, will, *ceteris paribus*, expand considerably over their 1971 levels, but industries such as Fishing, Fish Processing, Agriculture and Textiles, which as discussed above were the foundation of the pre-oil Shetland economy, are not expected to receive any stimulus from oil developments in the region, at least in terms of the variables considered in this analysis.

The foregoing discussion summarises the main findings of the detailed Input-Output study of oil impact on the Shetland economy, and it is possible to make a preliminary assessment of the usefulness of Input-Output methodology in permitting the stated objectives of the work to be realised.

It would seem at this stage that such an assessment must be favourable: the methodology provided estimates of the impact of oil on a number of key economic variables[5] which were both comprehensive and detailed. These were felt to be necessary attributes of the chosen framework, and this was justified by the results which demonstrate clearly the considerable differences in individual industry impacts, and the importance of inclusion of all secondary impact effects. Furthermore, the generation of alternative impact forecasts proved quite straightforward, as did the incorporation of new oil data as it emerged. The latter capability proved especially useful since data on oil activities was being obtained until a very late stage of the study. The ability to present the results in alternative formulations of multipliers, etc. was an additional benefit which helped in their interpretation.

While the analysis of Chapter 4 demonstrated the usefulness of Input-Output in this type of study in many respects, it was essentially an application of basic Input-Output methodology , and the validity of the results derived by this depend on whether the assumptions on which the analysis is premissed are realised in practice. In other words, Chapter 4 showed that Input-Output could generate empirical results of the <u>type</u> desired, but these results might be grossly inaccurate if

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5. Indeed, given suitable data, the impact of oil on others, such as capital accumulation and pollution, could have been estimated within the Input-Output framework.

assumptions of the model were violated. The assumptions of the basic Input-Output analysis were discussed in various parts of Chapters 2, 3 and 4, and need not be re-iterated here. However, it was felt that, in the present study, some modifications to the basic framework employed in the analysis of Chapter 4 would improve the accuracy of the impact estimates. It was also felt that the attempted incorporation of such modifications would provide a useful test of the flexibility or otherwise of Input-Output.

No attempt was made to provide a comprehensive review of all Input-Output assumptions. Rather, a limited number of modifications, which seemed particularly appropriate in the present context, were considered. Specifically, in Chapter 5 the following amendments to the basic model were discussed: (i) the incorporation of 'negative multiplier' effects (ii) allowance for interaction between oil Final Demand and other Final Demand elements (iii) incorporation of local supply constraints. A fourth amendment, the possibility of oil-induced changes in local technology, was considered in detail in Chapter 6 and is discussed separately below.

Considering amendments (ii) and (iii), their inclusion in the Input-Output model does not seem particularly difficult at the theoretical level, and it is surprising that they have not generally been included in previous Input-Output impact studies, especially since, as discussed below, they may significantly alter empirical impact estimates. Amendment (i) on negative impact, on the other hand, is rather awkward to handle theoretically: the basic model, as discussed in the text, does not permit of negative effects, and their incorporation at an abstract level can cause problems. A major difficulty is that many of the negative impact effects may arise from resource competition in factor markets, i.e. because of supply conditions, and the Input-Output model is essentially demand-orientated; so that supply-induced reductions in local activities have to be re-interpreted in terms of sales reductions, etc. Another problem is that the use of negative coefficients in the transactions matrix (i.e. industry a's sales go down by a specified amount for every unit of expenditure by industry b) seems unsatisfactory since assumed constancy of this type of coefficient seems unjustified. The most satisfactory solution may be to utilize the iterative Input-Output formulation,[6] and make necessary adjustments in some or all of the 'rounds' as appropriate.

Empirically, insufficient resources were available in the Shetland study to wholly integrate the suggested modifications into the empirical analysis. However, some attempt was made to estimate the probable direction and magnitude of each effect, though the results obtained were highly tentative.

In spite of these difficulties with data, the discussion of chapter 5 indicated, in broad outline, the probable importance of each of the afore-mentioned modifications in the Shetland context. Firstly, negative impact effects were expected to arise, primarily through the involuntary loss of labour by indigenous firms to oil-related opportunities. Because of the hitherto discussed absence of a detailed labour market study, it was impossible to quantify this loss, but the study suggested it was not sufficiently substantial to offset more than a small proportion of the positive impact of oil developments estimated in Chapter 4. Other negative factors such as seabed pollution (on a minor scale) and dissuasion of tourists were expected to have very minor impact. Overall, the negative impact of oil in Shetland might cause a 'loss' of employment of 200-300 jobs, which should be offset against its job creation estimates of Chapter 4. It is possible, however, that if local industries slumped for external reasons, that their labour would be permanently lost to

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6. $X = (I + A + A^2 + A^3 \ldots)Y$

oil opportunities, in which case any subsequent 'frustrated' recovery should be set as a loss against oil. No estimate of this effect was possible.

A number of possible Final Demand interactions were also considered and their impact estimated: the loss in local unemployment benefits created by oil job opportunities should be included as a 'negative' effect, but in Shetland it was estimated that the correction required would be negligible, since the absolute number ofunemployed persons in the region is very small. A reduction of perhaps 50-100 in estimated oil-generated employment would probably be sufficient to allow for this factor. Another interaction considered was the possibility that the immigrant increase in population would per se create employment in public sector industries such as health, education, etc. It was estimated that this interaction could increase oil-generated employment by as many as 450 jobs However, for reasons discussed in the text, this is likely to be an upper-maximum figure, and a more realistic one might be additional employment of 200-300.

Induced investment was the last Final Demand interaction considered, and obtaining a quantitative estimate of the importance of its inclusion proved particularly difficult. In fact, the results seem to indicate clearly that any effects will be of short duration, and of a minor nature given the high direct leakages from investment expenditures. Employment estimates might b increased by a small number of 'semi-permanent' jobs by the inclusion of induced investment effects, though even these would disappear in the medium to long-term.

The final modification to the basic model considered was the possibility that local supply would be unable to rise sufficiently to meet oil-induced demands, in which case requirements will have to be satisfied by imports or demands reduced. In either case, the estimates of local impact of Chapter 4, will overstate the actual effects. Unfortunately, although it was possible to make general remarks on this modification, it proved impossible to estimate its effect quantitatively.

Overall, the inclusion of modifications of the above type seems feasible, and are potentially important in practice. However, the empirical data required, in addition to the basic Input-Output material, to estimate quantitatively their effect is substantial and proved beyond the resources of the present study. As far as could be estimated, the total impact of the proposed modifications seemed to be broadly self-cancelling in the aggregate, in which case the aggregate estimated impact of Chapter 4 may require little alteration as a result of their inclusion, although individual industry impacts could be altered. If supply constraints locally are quantitatively significant, it is probable that the net effect of the modifications would be negative, i.e. their inclusion would reduce aggregate impact estimates.

Chapter 6 considered the possibilities of oil developments in Shetland generating changes in local industry technology. Such induced technical change would change coefficients in the Input-Output matrix, and hence alter the estimated impact of oil. However, this chapter did not concern itself primarily with the estimation of coefficient changes *per se*. There were a number of reasons for this: firstly, Input-Output is useful in estimating the income and employment repercussions of identified technological changes, but does not explain how the technological changes themselves arise. Secondly, technical development often occurs slowly over time and would be unlikely to have induced major changes in coefficients at the time of the study. Finally, if coefficient changes were identified by survey at different points in time, it would not be possible without deeper research to attribute such changes to oil-related or other factors.

For all these reasons, it was decided to analyse the forces for technological change created by local oil developments directly. The results of this analysis could subsequently be interpreted in terms of Input-Output coefficient changes, and the effects on local income and employment estimated. Three broad types of factor potentially leading to indigenous technical change were identified, and the importance of each factor in Shetland estimated by survey.

The results suggested that the possibilities for oil-induced technical changes in local industries is limited. The costs of changing technology, the limited customer/supplier relationships between oil and indigenous companies, the lack of movement of senior skilled personnel from oil companies to local firms, and genuinely limited possibilities of utilizing oil technology in indigenous industries, all reduce the prospects of extensive oil-based indigenous technological development. It was felt, however, that the combination of a number of factors could lead to significant changes in certain coefficients. Specifically, expected movements towards capital-intensive techniques, the more efficient use of labour, economies of scale, and actual technological improvement, would all combine to produce lower employment-output coefficients in indigenous industries than existed in 1971. A preliminary attempt to assess the magnitude of this effect on estimated oil employment creation was made by using 1971 'best-practice' employment coefficients as a proxy for average industry coefficients post oil-induced technical change. There is no necessary reason for believing that these best-practice coefficients, which were in any event only available for a small number of industries, are accurate estimates of the desired coefficients, but in the circumstances there seemed to be little alternative if quantitative estimates of the effects of technological change were to be obtained.[7] Given this qualification, the results suggested

7. The use of U.K. average industry coefficients, which do not reflect Shetland production conditions at all, seemed even less desirable.

that the reduction in employment coefficients caused by oil developments could substantially reduce the estimated employment generation of these developments. However, since income and output per head might be expected to <u>rise</u> as a result of the above processes, the reduction in oil-induced output and income estimates is likely to be less than the reduction in employment estimates.

This concludes the summary of the main empirical results of the study and the assessment of Input-Output methodology. The final section below considers some of the implications for policy of these findings.

3. Policy Implications and Conclusions

The empirical analysis of oil impact in the study illustrates quite clearly that the effects of oil developments on the Shetland economy will be of major proportions absolutely, and relative to the pre-oil indigenous economy.

In addition to magnitude, oil developments in Shetland are characterised by rapid growth over a short period, differential impact on local industries, and subsequent decline over a period of 10 years (Construction) to perhaps 30-40 years (Sullom Terminal). These characteristics of Shetland oil development have important implications for local policy making.

Firstly, the rapid growth of oil activity in Shetland between 1971 to the present (1976) has caused considerable problems in providing the social, physical, and industrial infrastructural requirements of the new development. 'Bottlenecks' have been encountered in each of these areas because of time-lags between supply and demand. Housing and roads exemplify areas in which oil generated expansion of demand has been immediate and substantial, while supply has perforce grown very much more slowly. In an attempt to minimise the disruptive effects of oil demands on <u>indigenous</u> infrastructure, a strong locational policy with respect to oil-related developments has been adopted to induce them to locate in areas designated by the local authority. Generally, this policy has been to permit oil development in existing settlements only if the latter can expand to encompass them comfortably.[8] Otherwise, policy has been to encourage the location of essential oil-related activities in new, largely self-contained, settlements. This policy has been adopted in the siting of the tanker terminal, where the intention is to create 'new towns' around existing small communities at Sullom Voe, Brae, Firth, and Voe.

While this dual approach to oil development location is generally agreed to have eased pressured on local infrastructure, it has not been entirely successful in this respect since it has proven impossible to prevent 'spillage' of oil-related demands, particularly for consumer services, from the new settlements to existing villages and towns.[9] In addition, problems have arisen because the relatively attractive social and economic conditions in new settlements such as those at Sullom are attracting families from outlying communities in Unst and Yell, endangering the viability of the latter. The resolution of both these problems may prove difficult because they may require conflicting policy decisions: the reduction of 'leakage' of oil demands would require a more extensive range of facilities in the new 'oil towns'; the provision of such additional facilities could, however, exacerbate the movement of families from existing settlements. Possible solutions could involve the establishment of a new growth centre (based, perhaps, on oil activities) in the northernislands themselves, so that workers and their families in these areas could commute easily from existing communities to employment

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8. This type of policy has generally been followed in towns like Lerwick, Scalloway, and Sandwick.

9. An important example of this is the extensive 'migration' of oil-related construction workers from Firth into Lerwick every weekend for social activities.

and social opportunities. Alternatively the idea of self-contained new towns could be abandoned altogether and oil employees and their families be dispersed widely among existing settlements, whose infrastructural facilities are extended accordingly. In this way, everyone would commute to work, and existing communities would be less endangered by the tendency to gravitate to a central place.

Further policy considerations arise through the differential impacts of oil activities on various local industries within Shetland, particularly when these are considered in conjunction with the differential rates of growth and decline in these oil activities themselves. Firstly, the analysis of Chapter 4 demonstrated that, neither individually nor in combination, will the oil-related developments in Shetland generate significant additional activities in the traditional 'basic' industries of the region, such as Agriculture, Fishing, Fish Processing, and Textiles. Indeed, as discussed in Chapter 5, the detrimental effects of oil within the local economy could result in overall negative net impacts by oil on these industries. Two points can be drawn from this: firstly, if local oil developments are occuring to a significant degree at the expense of indigenous industries, then the net regional growth in employment and wealth resulting from these developments is considerably reduced. Given the inevitable social disruption of a change of basic structure on this scale, it might be felt that oil developments within the region should be discouraged or even prevented. In fact, the analysis in the text suggests that the net impact of oil on the area's wealth is likely to be substantial during the period in which oil operations are actually taking place. However, and secondly, the lifetime of oil activities in Shetland is likely to be fairly short, and the most serious consequences of current permanent decline in the traditional basic industries are likely to be felt post-oil. As shown in the text, the industries which are most susceptible to net 'negative impacts' of oil developments are precisely those which generated the major proportions of employment and income in the immediate pre-oil local economy. The implications of this are obvious: if the traditional industries have declined permanently through oil activities in the region and have not been replaced by new industrial developments meantime, then the post-oil Shetland economy could probably only sustain a lower level of real income and employment than existed pre-oil. From a policy point of view, this suggests either that indigenous industries should be prevented from declining if possible e.g. by subsidising their wage bill to allow them to offer wage rates competitive with oil firms or by awarding grants for improved equipment to permit them to maintain output with less labour; or alternatively, new industrial developments which can survive local competition with the oil industry should be phased in. The choice between these strategies (indeed, both could be adopted) depends of course on the anticipated costs and benefits of each.

The preceding discussion has considered the long term policy problems arising from the negative effects of oil on the traditional basic industries. In fact, policy considerations of a similar nature arise through the positive effects of oil developments on a different subset of local industries. As shown in Chapter 4, the changes in levels of activity as a result of oil are, ceteris paribus, likely to be quite substantial. Unless offsetting reductions in activity in non-oil basic industries are of a magnitude not currently anticipated, industries such as quarrying, construction, and virtually all services will expand their employment, output, and presumably capacity, considerably as a result of local oil developments. Indeed, local evidence indicates that expansions of this nature are already taking place. In addition, extensions and improvements to indigenous infrastructure are taking place quite extensively as a result of the new demands imposed by oil.

In summary, it seems certain that by the late 1970's - early 1980's significant increments to local employment, capacity, and infrastructure will have been generated by oil developments in the region and will be largely or wholly sustained by their continuation in the locality. The situation could, in these circumstances emerge as one of classic 'boom and bust' when the oil industry leaves i.e. high local unemployment, excess industrial capacity and underutilized public and private infrastructure. The problem is exacerbated by the fact that oil construction, at least, will decline rapidly leaving little opportunity for employees and capacity dependent on this activity to be painlessly transferred to new ventures. The problem for policy makers therefore is either to attempt to ensure a smooth, orderly, contraction of the local economy as the oil industry declines or alternatively to attempt to develop sufficient new industrial activity to take up 'slack' resources as they emerge in the oil run-down. The problems involved in the successful implementation of either of these strategies are likely to be enormous.

The above are some of the major policy difficulties facing local decision-makers in the short and long term. Resources will be available to tackle these problems, particularly the 'disturbance' payments received by the local authority from the oil companies, but a detailed discussion of specific alternatives open to policy makers is beyond the scope of the present analysis. The present study nevertheless provides factual information on the 'base' indigenous economy and on the local impact of oil which is essential in the assessment of policy implications and the formulation of appropriate strategies. In addition, the Input-Output table could provide an applied framework within which alternative possible policies could be examined and their impacts measured.

APPENDIX I : Estimation of Net Migration in Shetland : methodology

This appendix attempts to estimate migration flows in Shetland for the periods 1961-66 and 1961-71. The method used is based on that of B.M. Swift in 'The Lothian Regional Survey and Plan',[1] and consists of calculating a hypothetical 'natural' population structure for 1966 and 1971 using 1961 as a base. Comparing these hypothetical structures with the actual population breakdowns as given in the 1966 and 1971 censuses yields differences which are attributed to net migration flows in the relevant sex/age group during the period in question.[2] The method of calculating the 'natural' population, also from Swift, is as follows:

a) from the Annual Report of the Registrar General for Scotland (henceforth ARRGS) Table 7 (after 1967) find the number of births by sex for a given year, and add this number to the age group 0-4.

b) deduct, for both sexes, the given year's deaths by age group.

c) 'Age' a predetermined percentage of the survivors in each age group after operation b) by one year. Applying procedures a)-c) iteratively to the 1961 population base gives an estimate of the population of any year on the assumption that the only changes in population structure are those due solely to 'natural' causes (i.e. recorded births and deaths post 1961, and normal 'ageing'). In any age group in any year the difference between the actual population as recorded by independent sources and the hypothetical population as determined above is attributed to net migration flows: if actual population is less than natural population, the difference is attributed to net emigration in that age-group; and vice-versa.

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1. B.M. Swift, 'The Lothian Regional Survey and Plan', Vol. 1, H.M.S.O. 1966, Chapter 3.

2. The results obtained for 1966 can be expected to be as accurate as those for 1971, since the actual population structure in the 1966 census is derived from a 100% sample in Shetland, unlike most other areas which were 10% samples.

The most accurate data available was that obtainable from ARRGS Table 55 (C2.15 after 1967) which gives the breakdown of Shetland deaths by sex and age group for each year.[3] The age groups used in this table are ten-year apart from the ages 0-15 which are broken down into five-year age groups. It was felt that ten-year age groups were sufficiently fine for present purposes and that any ease of computation acquired by having equal age groups throughout was outweighted by the accuracy gained by using the figures as given.

The 'ageing' process was made on the general assumption that survivors' birthdays fell evenly throughout the year; so that 10% were 'aged' into the following age group each year in ten-year age groups, and 20% in five-year age groups. Exceptions to this general rule were made for both sexes in the age groups 0-4 and 55- and above. In the former age group allowance must be made for the fact that the death rate in the age group 0-1 is generally very much higher than in the group 1-4. The cumulative effect of this is that less than 20% of this age group (i.e. 0-4) will be aged four. The 1961 Census Summary Table 4 indicated that 19% of Great Britain's children in the age group 0-4 were aged 4, and it was decided to use this proportion for the annual ageing process for this age group. In the older age groups the death rate increases so regularly with age that it is reasonable to assume that survivors will be distributed asymetrically in these groups, being clustered at the lower ages in the groups. The Great Britain Census 1961 Summary Tables 4 indicated that 8% of males and 9% of females were respecitvely aged 64 in the age group 55-64 and 7% of males and 8% of females were respectively aged 74 in the age group 65-74, and it was decided to use these proportions in ageing the corresponding Shetland age groups.

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3. NB All figures used are corrected for transfers. of families in/out of region.

Finally allowance had to be made for the fact that Census figures refer to April of the Census year, while ARRGS figures refer to the whole year. Thus births and deaths before April 1961 are already included in the Census population figures which are used as a base and hence to avoid double-counting should not be included when estimating the 'natural' change in population in later years from this base. Similarly, the births and deaths in 1966 and 1971 to April should be included. Since the ARRGS does not give a monthly breakdown of occurences of births or deaths, the simplest possible assumption was made i.e. that births and deaths were distributed evenly throughout the year so that three-quarters of 1961 births and deaths were included and one-quarter of 1966 and 1971, depending on the year being compared. Also three-quarters and one-quarter respectively of the normal proportion were 'aged' in these years.

The results obtained by the above methods and assumptions are outlined in Table 1. It should be noted that these results only show the aggregate effect of migration in each age group; they do not indicate the age structure of those actually migrating. For example, an additional person in the age group 35-44 (i.e. over and above that calculated as the 'natural' population for that age group) in 1971 may have immigrated at age 26 in 1961 or 43 in 1970 and so on; while someone immigrating at 42 in 1967 would be in the age group 45-54 in 1971.

Also, the non-availability of relevant data makes it impossible to determine the volumes of births and deaths associated with migrants: ideally, the 'natural' population shoudl include births and deaths of members of the original population who emigrate during the period and exclude those of immigrants. It is not felt that this factor will introduce significant error since the number of births and deaths involved is likely to be small and it is not clear that the pattern of births and deaths will differ significantly between emigrants and immigrants.

APPENDIX II : Data Collection and Processing for the Shetland Transactions Table

Early regional transactions tables were constructed on the basis of National Input-Output coefficients with regional Gross Output weights. Various procedures, such as the Location Quotient method, were used to obtain Regional Trade coefficients.[1] More sophisticated studies permitted the use of actual regional data where available though still relying mainly on adjusted national data.[2] Tests have been run on the reliability of the estimates obtained in this way by comparing a national coefficients-based table with an actual survey one for the same region,[3] assuming the survey table to be correct. While there is some dispute on the merits of adjusted national coefficients as revealed by these tests, the empirical results suggest that individual industry multiplier values may be substantially in error, and it has been argued strongly that the overall accuracy will not in any event be sufficient for the type of fine-grain regional analysis on forecasting, structural change, etc. required in the present study.[4]

Experiments along these lines in the Shetland context were not very encouraging. A small region is so different from the national average, both in terms of industry technology and industry product-mix, that national coefficients do not seem to be accurate estimates of regional coefficients. While the problems of cross-hauling[5] may be fewer in a small region such as Shetland than in a larger, more complex, economy, the very "openness" of the Shetland economy makes it very difficult to obtain

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1. Ref: Nevin, Round and Roe (1966), Richardson (op. cit. Chapter 6).
2. Ref: e.g. Moore and Petersen (op. cit.).
3. Refs: Czamanski and Malizia (1969), Morrison and Smith (1974), Schaffer and Chu (1969), Walderhaug (1972).
4. Ref: See Miernyk 'Comments' on Czamanski (op. cit.).
5. The simultaneous importation and exportation of a single industry's products. This can be viewed as a problem of aggregation, but may nevertheless only be soluble by separate identification of individual products (including brands).

reasonable estimates of regional domestic coefficients by mechanical adjustment of national coefficients even if the latter accurately depicted local technical conditions.

In view of the above, it was decided, in line with most recent regional Input-Output studies, to construct the Shetland transactions table primarily from local data. Two basic variants on this approach have appeared in the literature: either the table has been constructed initially with adjusted national data and reviewed extensively with local survey information,[6] or the table has been constructed from the outset with local survey data, using adjusted national data only where the former is not available.[7] Although ideally the two approaches should converge on the same "best accuracy attainable" table, it was felt that the latter approach would encourage use of national data to be minimised, and thereby give a closer approximation to the 'actual' regional transactions table. In practice, three main data sources were employed:

(1) Local Survey Data. This was data obtained specifically for the input-output study through appropriate questionnaires (see Appendix IV for an example questionnaire), either in personal interviews or less frequently by mail.

(2) Local Secondary Data. This is published information directly relating to Shetland; for example: other studies of the region, census and other Government statistics, local newspaper reports, etc.

(3) Non-Local Data. This is primarily national Input-Output data, Census of Production reports, etc. though some reference was made to other regional studies.

Since resources available for the study were extremely limited, it was

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6. Ref: Blake and McDowall (1967).

7. Refs: Morrison (op. cit.), Sadler et al (op. cit.).

decided to concentrate field research on those industries which were most important to the local economy, and to a lesser extent to survey the larger firms in these industries in order to sample the largest possible proportion of Gross Output in each industry.[8] Identification of major industries was based on Department of Employment data. Furthermore, it was decided initially to survey only manufacturing and primary industries since such evidence as exists suggests that national coefficients, if these had to be used, were rather better approximators of regional service coefficients than of regional manufacturing coefficients.[9]

In the event, the initial survey was sufficiently successful to permit field work to be undertaken in most of the other named industries and sectors. The individual industries identified in the table, and the main data sources for each are as follows:

1. Agriculture. This includes all farming and crofting activities in Shetland. The main sources of data on purchases and sales were the publications Farm Incomes in the North of Scotland 1971-72 (North of Scotland College of Agriculture), the HIDB report Survey of Agriculture in Caithness, Orkney and Shetland, and information from the Department of Agriculture and Fisheries (DAFS). The first named provided information by farm type, sometimes specifically from a Shetland sample, sometimes for a 'crofting counties' sample. The latter was assumed to be representative of equivalent farm types (e.g. dairy, hill, croft) in Shetland. Details on the distribution of Shetland farms by type was obtained from DAFS, and marrying the two sets of data using gross output weights provided the 'average' set of

8. It was realised that large and small firms in the same industry might have different technical coefficients, but if the latter produced only a small proportion of industry output the average coefficients would be closely approximated by those of the larger firms.

9. Ref: Schaffer and Chu (op. cit.).

of purchases and sales data for Shetland farming. A Gross Output Control Total was derived with the kindly assistance of Mr M.A. Daw of the North of Scotland College. The geographical pattern of purchases and sales was obtained from discussion with local industry representatives supplemented by a small mail survey of agricultural holdings on the Island. Variations in purchasing and sales patterns among the responding sample were small.

2. Fishing. This industry encompasses the activities of Shetland based boats only. Purchases and sales by foreign boats are allocated to the export column and import row respectively under the appropriate industry heading. Good data on the purchases of this industry was obtainable from local fish merchants, who act as accountants for the boats. Dr M.A. Greig of Stirling University who had previously undertaken an economic study of fishing in Shetland[10] was also very helpful in providing relevant information, particularly on the geographical distribution of purchases and sales. The DAFS were able to provide an exact figure for the value of fish landed by local boats, which was used as a Control Total.

3. Quarrying. This industry covers all quarrying activities on the Island including Local Authority quarries. It does not include concrete block making which comes under "Other Manufacturing". Data on Local Authority quarries was obtained directly from the Local Authority, but it proved impossible to obtain data locally on private quarries. Coefficients for the latter were therefore estimated by suitable adjustment of national coefficients from the <u>U.K. Input-Output Tables 1970</u>. Gross Output for the private quarries was also obtained from U.K. data, by assuming output/employees is the same in both Shetland and the U.K. 23% of total industry Gross Output was accounted for by private quarries.

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10. Ref: Greig (1972 op. cit.).

4. Fish Processing. This encompasses all processing of fish, including fish meal production. Data on this industry was obtained directly by sample survey, and grossed up on an employment basis. 46% of the total estimated Gross Output was covered by the sample.

5. Textiles. This includes all textile manufacturing activity in Shetland, primarily Hosiery and Knitwear, but also Woollen and Worsted and other sundry items. Data on factory production were obtained directly from the survey and grossed up on an employment basis. The control total so obtained tallied well with total industry production reported in HIDB Special Report 4: The Shetland Woollen Industry, which also provided useful information on other aspects of the industry. The report, in particular, provided an estimate of home production which was updated on the basis of discussions with local industrialists. The production coefficients for household output were adjusted from factory coefficients on a judgemental basis to allow for the different production conditions. 58% of industry Gross Output was included in the sample.

6. Ship Repair. Information on this industry was obtained by direct survey. Survey Gross Output accounted for 32% of the estimated industry total which was obtained by grossing up on an employment basis.

7. Other Manufacturing. This is a very heterogeneous industry containing in effect all other manufacturing industries not individually identified above, e.g. leather goods production, milk processing, printing and publishing etc. Resources were not available to sample these small industries directly, though employment figures for each were available. Using this latter information, control totalsfor each industry were estimated individually by assuming Shetland per capita output in each industry was the same as in the U.K. equivalent. The U.K. employment and Gross Output figures were obtained from British Labour Statistics 1971 and Census of Production 1971 respectively. Breakdown of local purchases by each industry was obtained by simple Location Quotient adjustment of the

national equivalents[11] as contained in the U.K. Input-Output Tables 1970, supplemented by discussion with local industry representatives. These individual industry purchases were aggregated on the basis of their local Gross Output weights.

8. Construction. This industry encompasses all construction activity on Shetland including Local Authority construction. The output and purchases data for the latter were obtained directly from the Local Authority, while data on private construction were obtained primarily from direct survey. Approximately 10% of all construction was covered by the private sample. Since, in DEP records, construction employment includes Local Authority construction employees, it was impossible to gross up the sample data by private employment to obtain private construction output, since the number of Local Authority employees was not known precisely. Instead total Gross Output (including Local Authority) was estimated by:

$$\frac{\text{Shetland Construction Employment 1971}}{\text{GB Construction Employment 1971}} \times \begin{array}{l}\text{GB Construction}\\ \text{Gross Output 1971.}\end{array}$$

GB employment figures (including Local Authority employment) were obtained from British Labour Statistics 1971, while GB Construction output was obtained from Housing and Construction Statistics. Other procedures were used to estimate construction output as 'checks', and gave encouragingly similar Gross Output estimates to the above.

As is conventional in Input-Output analysis, the construction row shows only maintenance construction, all new construction being allocated to Fixed Investment.

9. Utilities. This industry covers electricity and water, there being no gas production in Shetland. Data was obtained primarily by direct

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11. Ref: Richardson (op. cit.) Chapter 6.

survey, and to a lesser extent, adjusted national figures. 78% of industry Gross Output was covered by the survey.

10. Transport. The row of this industry shows only the sales made internally by transport, not those made in respect of transporting goods to and from the Island. The transport column on the other hand contains the purchases of all transport activity based on Shetland, and is counterbalanced by an item of transport unrequited receipts. It proved impossible to effect a proper distribution of this latter item along the transport row, though it is known that much of it would be in 'Exports' anyway. 20% of industry employment was included by a sample survey, but because of the non-representation of certain parts of the industry in the sample and also incompleteness of the sample data, substantial use had to be made of other local and non-local data sources.

11. Distribution. This industry includes both wholesale and retail distribution. Turnover in the retail sector was estimated by:

$$\frac{\text{Retail Employees Shetland 1971}}{\text{Retail Employment Scotland 1971}} \times \begin{array}{l}\text{Retail Turnover}\\ \text{Scotland 1971.}\end{array}$$

The Scottish Turnover figure was obtained from the Census of Distribution 1971.[12] The turnover for the wholesale business was derived from the sample. In empirical input-output studies, as discussed in the text, the output of the Distributive industry is generally measured in terms of its gross margin rather than its turnover, and details of gross margins and breakdown of purchases were obtained from the survey. 58% of total wholesale turnover was accounted for in the sample, and 10% of total retail turnover was included.

12. Professional Services/Banking and Insurance. This industry includes all professional acitivities in Shetland, including banking and insurance. Health and education, including those services provided by the Local

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12. Subsequent to the preparation of the table, the turnover for Shetland retail was released in the Census of Distribution Area Tables. This differed from that calculated by less than 4 per cent.

Authority, are included and account for approximately 90% of the total Gross Output of the industry. Local Authority expenditure on these items is recorded in the intersection of the Professional Services row and Local Authority column. Gross output of health and education was defined as the sum of operating expenditures and a breakdown of purchases was obtained from Local Authority accounts and other Government publications. Banking and insurance Gross Output was also defined in terms of expenditures, requisite data being obtained by survey. Outputs of other services such as vetinary surgery, architecture, and law, were estimated from a variety of sources, in particular relevant Prices and Incomes Board Reports.

13. Other Services. This is another large heterogeneous sector including garages, hotels and catering, public houses, etc. In hotels, catering, and public houses, the value of food, drink, and tobacco is included in the value of their output, not merely the margin on these goods as is done in Distribution. In garages, only the margin on petrol sales is included in output. It is generally extremely difficult to obtain data on this sector, and the present study proved no exception. Data was eventually obtained from a wide variety of sources including a sample survey which covered approximately 10% of total industry Gross Output.

14. Communications. This industry encompasses all the activities of the GPO. Benefits and other transfers paid through the Post Office are <u>not</u> included, only operating payments and revenues incurred by providing this agency service. Data was obtained by direct survey supplemented by GPO national accounts and U.K. input-output data.

15. Local Authority. The output of this industry was defined as total expenditure on revenue account. Data on purchases and sales for this sector were obtained directly from the Local Authority.

16. Households. Total household income was estimated in a number of

ways including grossing up by number of households from a survey undertaken in Shetland. All of these measures gave similar results and so the survey figure was used. Breakdown of household purchases both by commodity and by geographical location was obtained in the survey and supplemented where necessary by Family Expenditure Survey data. Approximately 10% of Shetland households were included in the Shetland survey.

17. Central Government. This column includes the following (i) current operating expenditures of the various government departments based in Shetland; (ii) local operating expenditures of the RAF base in Unst; (iii) payments made for the provision of various services locally, e.g. payments to health and education, rate support grant, etc.; (iv) transfer payments made to households such as retirement pensions, family allowance, and unemployment benefit. Items (i) and parts of (iii) and (iv) were estimated from national data appropriately adjusted for differences in the age/sex structure of the population and rate of unemployment. The remainder of item (iii) was obtained from Shetland County Council accounts, and parts of item (iv) were obtainable from the local household survey. Item (ii) was estimated from a study of RAF base expenditures made in the Highlands.[13]

18. Tourism. Data on this sector was mainly secondary in nature though the local Tourist Office provided as much information as possible. In particular, extensive use was made of the raw data for the Skye Tourist report which the authors[14] kindly made available.

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13. Greenwood and Short (op. cit.).
14. Ref: Brownrigg and Greig (1974).

After an initial transactions table had been constructed from the above data base, it was taken back to Shetland for comments from industry and Government representatives. Comments obtained from these individuals were very encouraging and only one or two individual entries were felt to be significantly in error; these latter were then appropriately adjusted.

In spite of the care exercised in gathering and checking the data, it is inevitable that information gleaned from such a wide range of disparate sources will not be entirely mutually consistent. Therefore, the final transactions table must be "balanced" to eliminate discrepancies, though, fortunately, in the present instance the residuals to be allocated were very small, being in no case greater than 10% of the relevant industry's Gross Output. The balancing operation was undertaken by Mr R. Burdekin of IBM, who used variants of the RAS and Stephan techniques which permitted adjustments to be thrown mainly on those figures which had been regarded as least reliable in the first instance. Interestingly, in the course of trial balancing runs, coefficients were changed by as much as 100%, but in no instance were industry output multipliers affected other than in the second decimal place. While the adjustments made were not intended as, nor fulfill the requirements of, a complete sensitivity analysis, the findings are very encouraging and suggest that minor deviations in the transactions table from the 'true' regional structure will not significantly affect results.[15]

15. This characteristic of empirical Input-Output analysis has been noted before in the literature, see Moore F.T. (1955).

Table II.1 Allocation of Shetland Input-Output Industries to 1968 SIC Classification

Shetland Heading	1968 MLH Order
Agriculture	001
Fishing	003
Quarrying	101, 109
Fish Processing	part 214, part 219
Textiles	414, 415, 417
Ship Repair	370
Other Manufacturing	221, 229-232, 335, 367, 381, 396, 432, 469, 471, 485, 499
Construction	500
Utilities	602-603
Transport	702-707
Communications	708
Distribution	SIC order XXIII
Professional Services/ Banking and Insurance	SIC orders XXIV and XXV
Other Services	SIC order XXVI
Local Government	906
Households	-

APPENDIX III : Estimation of the Level and Composition of Oil-related Developments in Shetland

This appendix discusses in detail the estimation of local expenditures by the various oil-related activities, which were employed in chapter 4 as oil Final Demand columns. Supply Base, Sullom Terminal, and Oil-related Construction, expenditures are considered in turn.

I. The Level of Supply Base Activity in Shetland

As stated in the text (pages 93-94) the level of activity in Supply Bases depends on the number of rigs and platforms in the northern area of the North Sea. Given forecasts of the latter, it is possible, given 'rule of thumb' figures relating to the number of boat movements per rig, and the number of boat movements requiring a berth, to arrive at a total number of berths required to service the expected levels of activity in northern North Sea fields. This total number of berths can then be divided among possible geographical locations according to known economic, political etc. criteria.

This exercise has been undertaken for Shetland Supply Base berths by at least four independent authorities, and it need not be repeated here; however, known developments since their estimates were made will be incorporated. All of the available estimates, by Livesey and Henderson (1973), Llewellyn-Davies (1975), Trimble (1975), and the National Ports Council, placed the maximum number of berths required in Shetland at 30. However, more recently slippage in North Sea development has occured, and associated with this, the level of exploration activity is considerably lower than predicted. For example, the actual number of supply boat movements through Shetland bases in 1975 was 1097, compared with 2568 estimated by Trimble in his analysis of the required number of berths.[1] In general, most experts have revised their estimates of North

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1. Shetland Times (5/12/75).

Sea activity, both offshire and onshore, towards 'longer and lower' peaks.[2] In Shetland specifically, there is, furthermore, local political pressure to keep the number of berths constructed locally firmly under control; indeed, recently (New Statesman 13/2/76) the assistant planning officer of Shetland Island Council is quoted as saying that the number of berths in Shetland is restricted to 27.

If nothing else, the above discussion serves to emphasise the great difficulty in forecasting oil related activity discussed in Chapter 4 of the main text. However, in view of these findings, and my own more recent discussions (April 1976) on the point in Shetland, the Llewellyn-Davies estimated range of berth requirements of 22-28 berths seems to reasonably cover the probable limits at both ends and is subsequently adopted.

Direct Supply Base Expenditure

As described in Chapter 3, the Shetland Input-Output table has been constructed in terms of producers' prices, and hence for compatibility Supply Base purchases must be expressed in producer prices also, i.e. purchases of trade or transport services (measured as margins) are separated from purchases of actual goods (valued at ex-works prices). Furthermore, since 'Supply Bases' rather than, say, 'Oil Rigs' are the Final Demand entry, the value of local manufacturers bought by the Supply Bases for re-distribution to the rigs, and any local distribution or trade margins on any such goods (i.e. irrespective of whether the good is manufactured locally or imported by the local distributor), are included in Supply Base expenditure. Hence, the definition of Supply Base expenditure used in this study is not 'current operating expenditures' but rather 'all current local expenditures', adjusted to producers' prices.

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2. See in particular Mackay, D.I. (1975) 'North Sea Oil Through Speculative Glasses'.

The types of goods and services which the Bases are likely to purchase are fairly well documented, but quantitative estimates of the expenditure on each category is limited and data on the geographical purchasing pattern virtually non-existent. In the current study, the primary data source was an expenditure survey of Service Bases in Shetland undertaken by the author in 1975. Five local Bases, representing over 60% of the estimated number of berths, co-operated in the study, though the quality of the returns was highly variable, and of course could only relate to year 74/75 expenditures. Berths are used as the common unit, and the average expenditure per berth is given in Table III.1. A secondary source[3] was used to check the data and complete any blanks.

Table III.1 Supply Base Expenditure per Berth

Shetland Industry	Annual Local Current Expenditure per berth £000 (1974 prices)
Agriculture	0
Fishing	0
Quarrying	0.09
Fish Processing	0
Textiles	0
Ship Repair	0.05
Other Manufacturing	0.32
Construction	0.60
Utilities	0.19
Transport	8.82
Communications	0.33
Distribution	0.13
Professional Services et al	0.10
Other Services	2.01
Local Government	0.71
Households	15.41
TOTAL	28.76

The large figure for transport in Table III.1 is primarily Harbour Dues paid by the Supply Bases to the local Harbour Authority.

The Shetland Input-Output table is, of course, constructed for 1971 in 1971 prices, and therefore to estimate the real increment to local

3. Ref: Churchfield (1972).

expenditures made by Oil Supply Bases, it is necessary to deflate the elements of Table III.1 by appropriate price indices

i.e. $\hat{p}Y_B(1974) = Y_B(1971)$

where

$$\hat{p} = \begin{bmatrix} \frac{P_1(1971)}{P_1(1974)} & 0 & \dots & 0 \\ 0 & \frac{P_2(1971)}{P_2(1974)} & \dots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & \dots & 0 & \frac{P_n(1971)}{P_n(1974)} \end{bmatrix} \quad 16 \times 16$$

$Y_B(t)$ is current expenditure per berth at time t prices.

In the present study, a single price deflator was used for all industries, thereby implicitly assuming no changes in industry relative prices during the period 1971-74. Unfortunately the rapid price inflation over this time makes it unlikely that this assumption will be strictly valid empirically, but the alternative would be to try to obtain appropriate price indices for each Shetland industry individually, and this is virtually impossible given the lack of regional price indices, definitional differences between the 'industry' and the price index, etc. Each element of Table III.1 was in fact deflated by the Index of Wholesale Prices July 1971/Index of Wholesale Prices July 1974, a factor of 0.695, and the results are not reproduced here.

It is assumed that the expenditure per berth is constant over time, so that the total for all forecast Shetland berths can be obtained by grossing up by the number of berths. There is some evidence to suggest that, in fact, as offshore activity changes from exploration to production, the nature of the base services will change with material requirements becoming routinised. However, the local expenditure of the bases is unlikely to change much, since, as Table III.1 illustrates, the main local purchases are of a general service nature.[4]

The number of staff per berth in the sample was approximately nine[5] in 1974/75, however since none of the bases had its complete complement of berths at that time, this figure is not a reasonable estimate of the eventual staff-to-berth ratio. Nor is it possible from this information to deduce whether the eventual staff-to-berth ratio will be lower or higher than nine, since the relative magnitudes of 'fixed' and 'variable' staff with respect to berth numbers is not known. Therefore the eventual, fully-operational, employment per berth must be estimated from other sources.

Mackay (1975) suggests that the type of 'forward' base predominant in Shetland would imply a fairly low employment-to-berth ratio of 6-8 jobs. This is in sharp contrast to the assumed 15-20 job/berth of the Island Council consultants based on mainland experience. In Shetland, only one base, the Norscot base, has the fairly extensive engineering facilities, etc., common on the mainland; therefore, it is assumed that the 15-20 job/berth ratio applies in the Norscot base fully operational, and the 6-8 job/berth ratio applies in all other bases. Since the Norscot base will almost certainly have nine of the forecast number of berths, the total estimated employment in Supply Bases when fully operational ranges over 210-330.

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4. For reasons discussed below, the household payments made in aggregate by bases will not be obtained by grossing-up on a number of berths basis.

5. The sample from which this figure is derived is different from that used in the calculation of Table III.1 because of differences among questionnaire responses, and therefore the wages per employee cannot be obtained by dividing the Household payments per berth by 9. Wages and salaries per employee derived from a consistent sample were approximately £2,90C (1974 prices).

Total local Supply Base expenditure can now be estimated with Table III.1 supplemented by the above information. All expenditures per berth are grossed up by the number of berths except wages and salaries which are grossed up by employment to allow for changes in the ultimate employment/berth ratio from the survey figure (see pages 218-219).

Two estimates are given under the following assumptions:

(a) 'Low' assumptions (1) 210 employees

(2) 22 berths

(b) 'High' assumptions (1) 330 employees

(2) 28 berths.

Table III.2 presents the Gross Peak local Supply Base expenditure forecast for Shetland (1971 prices), based on Table III.1 and the above assumptions. The 'low' and 'high' estimates are expected to bound the direct effects of Oil Supply Bases on Shetland when they are at maximum local operation.

These are the expenditure estimates employed in the text as Oil Supply Base Final Demand (see page 95).

Table III.2 Annual Gross Peak Local Supply Base Expenditure at 1971 producer's prices

Shetland Industry	Low	£,000/year	High
Agriculture	0		0
Fishing	0		0
Quarrying	1.4		1.7
Fish Processing	0		0
Textiles	0		0
Ship Repair	0.8		1.0
Other Manufacturing	4.9		6.2
Construction	9.2		11.7
Utilities	2.9		3.8
Transport	134.8		171.5
Communications	5.1		6.4
Distribution	2.0		2.6
Professional Services, etc.	1.5		1.9
Other Services	30.7		39.1
Local Government	10.8		13.8
Households	416.1		653.9
Totals	620.2		913.6

II. Derivation of the Level of Local Terminal Activities

(i) Direct Employment in the Sullom Voe Complex

Unlike the preceding section on Oil Supply Bases, the current discussion estimates the direct employment in the Sullom Terminal before estimating its direct expenditure. This is done essentially because in this case it is necessary to estimate household wages and salaries from employment data and the former are a major component of local Terminal purchases.

In the early forecasts of the likely level of employment in the Sullom Terminal, figures had to be derived using various 'rule-of-thumb' ratios generally obtained from inspection of other already existing oil terminals elsewhere. One of the most generally used methods of estimation was the 'employment/throughput' ratio. For example, Livesey and Henderson (op. cit.) provide the following ratios for backup-facilities.[6]

75M tons/yr = 135 jobs

100M tons/yr = 155-240 jobs

200M tons/yr = 200-320 jobs

Livesey and Henderson's best single point estimate for 200M tons/year throughput[7] was as follows:

Crude Oil Terminal	150
Marine Terminal	240
Ancillary	60
LPG[8]	100
	550

6. In this case, employment in tugs, pilots, mooring boats, repair yard, harbour control, and buoy tender.

7. This was their best estimate of the probable throughput at Sullom, later forecasts are considerably lower as discussed subsequently.

8. Because this facility is not certain to be included at Sullom, it is not included in the subsequent discussion. However, as pointed out on page 224, since its local purchases are unlikely to be anything other than wages and salaries, its local impact can be easily estimated by adding an 'LPG column' with a single entry, in the Household row, derived by average wages times number of LPG employees.

However, these single point estimates conceal a wide range of possibilities as revealed by the Llewelyn-Davies (op. cit.) figures, which are based on Livesey-Henderson's.

Table III.3 Llewelyn-Davies Estimated Sullom Voe Employment

	100M tons/year		200M tons/year	
	min.	max.	min.	max.
Oil Terminal*	90	140	130	200
Power Station/ Base facilities	30	50	40	60
Water Supply/ Sewage/Airstrip	10	15	10	20
MARITIME				
Boat Crews/Customs/ Health	140	210	180	280
Harbour Office/ Admin.	10	20	15	25
Maintenance	5	10	5	15
	285	445	380	600

* includes management, loading clerk and operatives, maintenance engineers, clerks, firemen, drivers and electronics.

As Table III.3 clearly shows, the possible range of employment for this type of facility at a given throughput is so large that conceivably employment at 100M tons could be greater than that at 200M tons.

Some clarification (and further confusion) was generated by Mackay's[9] estimation that (a) the earlier forecasts of a 200M ton throughput were exaggerated, with 100M tons/year a more probable figure and (b) the joint-user characteristic (i.e. not every facility duplicated for each operating company) of the Sullom Complex would push employment towards the lower end of the range. Based on (a) and (b), Mackay estimated that a 100M ton/year terminal would employ 350 persons, and an LPG plant would add another 60-70.

The above synopsis of the available employment estimates is given, not only to demonstrate the methods of estimation, but also to show the difficulty of arriving at any reasonable forecast, even as a range, from them. In fact, although Mackay's estimates are as recent as 1975, developments since

9. Mackay, A.G. (op. cit.).

then have clarified the situation still further,[10] and a rather narrower range of employment can now be specified with greater certainty. Firstly, Mackay's belief that 100M tons/year is likely to be the maximum flow through the Sullom Terminal seems fairly reasonable in the light of revised expectations for the North Sea as a whole,[11] and in view of the statements of oil operators actually involved in the Sullom facility.[12] Secondly, Mr Buyers and Mr Arthur of BP (see footnote 12) have both confirmed that the terminal when 'fully operational' at 60-75M tons/year will employment 400 persons divided evenly between the oil terminal and marine terminal, plus another 50 if LPG is established. It is less certain how employ· will change if throughput increases, but it will certainly increase very much less than proportionately.

As in the case of the Supply Bases, the considerable uncertainty surrounding the probable level of employment in the Sullom Voe Terminal makes it desirable to select a range (hopefully reasonably narrow) within which the actual level of employment will probably lie. Rather than select arbitrary cut-off points at either end of the range, the present study, in the light of the preceding discussion, selects a range based on Livesey and Henderson figures of 380 jobs (200M tons/year min.) - 445(100M tons/year max.). It is felt that, given the statements by oil industry representatives,

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10. This highlights quite clearly the problems of forecasting developments in the North Sea where things are changing so rapidly. Hence the usefulness of a stable base, such as the pre-oil Input-Output table, against which changes in the pattern of local oil development can be measured and assessed.

11. For example, Lovegrove's recent estimate of peak North Sea activity is 150M tons/year in total (Lovegrove (1975)), and it has been estimated (Scotland and Oil (op. cit.)) that 60% of North Sea production will be landed at Sullom i.e. - 100M tons/year.

12. Mr T. Buyers (Shetland Times 12/12/75), and Mr E. Arthur, B.P.'s two chief Lerwick-based executives, have stated that the Sullom Terminal will be built initially to handle 60M-75M tons/year by the early/mid 1980's, with possible further extensions to 100-150M tons/year at an unspecified time thereafter.

this range will certainly include the level of employment at Sullom for 60-75M tons/year, the stated mid-1980's target throughput, and may at the upper end allow for any increase in employment consequent upon an increase in annual throughput to 100 + M tons[13]. The 'fully operational' employment range for the Sullom Voe Terminal is therefore estimated to be 380-445 excluding LPG (but see footnote 13)) and assuming surface storage (underground storage would add about 13 more jobs).

(ii) Direct Sullom Voe Expenditures

As before, all expenditures are in 1971 producers' prices, and all conventions are analogous to those used in assessing the local impact of Oil Supply Bases. The major difference between the present impact analysis and the Supply Base one is that in the latter expenditure data was available from the Bases themselves, whilst no such primary survey data is available for the Terminal.

While the absence of direct survey expenditure data is a handicap, and reduces the degree of reliability of the figures ultimately derived,[14] there are a variety of other sources which permit reasonable estimates of local expenditures by the Terminal to be obtained. These sources could be summarised as follows:

(i) Local Non-Survey This refers to published source material which relates directly to expenditures made by the local terminal (e.g. articles by Mr Buyers of B.P. (12/12/75) and Mr Clark of Shetland Island Council (June 1975) in the local Shetland Times), and material which relates to technical details of the terminal from which local expenditures can be estimated. The

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13. The upper end figure, given Mr Buyers' estimates of Terminal and LPG employment (400 and 50 respectively) and the comment in footnote 8, may be taken as a point estimate of employment of a 60M ton Terminal plus LPG.

14. Though, as stated in the text, in this case even survey expenditure data could only be forecast estimates.

reports by Livesey and Henderson and Llewelyn-Davies were particularly important in this latter respect. This derivation of economic, from technical, data has some precedent in the literature on the derivation production functions from engineering data,[15] which is broadly what was attempted in the present exercise. However, the estimation of the technical-economic relationships in the present study was far less sophisticated than in some of the references and consisted of considering, in consultation with an engineering colleague, for example the level of repairs and maintenance expenditure associated with the known physical structure; or again, of considering the ability of Shetland marine engineers to provide the marine engineering capability implied by the Terminal's activities, and so on.

(ii) Non-Local Non-Survey These consisted of sources which could provide data on other similar terminal facilities in other sites from which, hopefully, relevant analogies for the Sullom facility could be drawn. Unfortunately, these sources were less extensive than might have been desired though some useful information from Bantry Bay, Milford Haven, and Great Yarmouth was obtained.

(iii) Wholly Secondary These are sources which are not derived from Terminal studies at all, and are of course used only when the former are wholly unobtainable. Examples are the estimation of fresh vegetables and meat bought by the Terminal canteen from Family Expenditure Survey data on consumption of such goods, and the estimation of the proportion of total Professional expenditures made locally from relevant Shetland Supply Base information.

The estimates are given in Table III.4.

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15. Refs: Chenery (1953), Walters (1963).

Table III.4 Estimates of Local Purchases by the Sullom Voe Complex @ 60M-100M tons Throughput

Shetland Industry	Low	£000 (1971 Prices)	High
Agriculture	2.0		2.4
Fishing	0.4		0.5
Quarrying	0		0
Fish Processing	0		0
Textiles	0		0
Ship Repair	15.3		18.1
Other Manufacturing	1.4		3.5
Construction	139.0		229.4
Utilities	12.2		12.2
Transport	267.6		305.8
Communications	8.0		9.4
Professional Services etc.	2.4		2.8
Distribution	3.5		3.9
Other Services	49.3		57.0
Local Government	1042.5		1737.5
Households	764.5		903.5
Totals	2308.1		3286.0

III. Oil-Related Construction Expenditure

The magnitude and timing of oil construction activities are discussed in the text (chapter 4 pp. 109-110). The estimation of local purchases, and their industry breakdown, proved difficult, however, and the procedures adopted are discussed in this section. Local industrial purchases were distinguished from consumption expenditure by oil-construction workers for reasons which will become apparent subsequently. At present, the estimation of the former is considered below.

(i) Local Industrial Expenditures

From the 1968 Census of Production for Construction, Wages and Salaries were found to be 26.5% of total industry expenditures. Assuming the same proportion holds in oil-related construction in Shetland, this implies that £4.43 million (average) and £4.98 million (peak) will be paid in wages and salaries, leaving £12.3 million (average) and £13.8 million (peak) expenditure on other inputs.[16] These total expenditures were broken down

16. Oil-related construction expenditure was estimated in the main text (Chapter 4, page 111) as £16.7 million p.a. (average) and £18.8 million p.a. (peak).

into individual items in the same proportions as in the 1968 Census of Production for Construction. Using Shetland survey Construction data, including one return from an oil-related Construction firm, these individual expenditures were divided into local versus non-local components. The resulting local expenditure estimates are shown in Table III.5

Table III.5 Local Oil-Related Construction Industrial Purchases

Shetland Industry[17]	Peak Year £000 (1974)	Average Year
Agriculture	0	0
Fishing	0	0
Quarrying	695.6	618.3
Fish Processing	0	0
Textiles	0	0
Ship Repair	0	0
Other Manufacturing	197.4	175.5
Construction	573.4	509.7
Utilities	94.0	83.6
Transport	376.0	334.2
Communications	131.6	117.0
Distribution	52.6	46.8
Professional Services	0	0
Other Services	94.0	83.6
Local Authority	94.0	83.6
Households	0[18]	0
TOTAL	2308.6	2052.3

The totals of Table III.5 indicate that approximately 16.5% of total operating expenditures made by oil Construction are local, or equivalently, 83.5% are directly 'leaked' out of the Shetland economy.[19] This result seems to accord fairly well with Brownrigg's estimate of a 75% direct Construction leakage for Stirling, bearing in mind that the latter is a larger (population 90,000), more self-contained region, so that direct leakages out of it would be expected to be somewhat less

17. In dividing total oil construction expenditures in the proportions of Table III.5, it is implicitly assumed either that no local firms obtain directly oil-related construction contracts, or if they do that their purchases are in the proportions indicated in Table III.5 rather than in those given in the Construction column of Table 3.1. In fact, the former is largely true: virtually all significant oil construction contracts have gone to non-Shetland firms (see Shetland Times 24/6/76).

18. This assumes all construction workers are immigrant. See next section.

19. Ref: Wilson (op. cit.).

than in Shetland.[20] This is an important finding since, of course, expenditures remitted directly outwith the local economy have no output or income generating effects within it and hence concentration on total expenditures in instances, such as the present one, where the proportion of direct non-local payments is high would give a misleading impression of the impact of the activity on the local economy.

(ii) Direct Household Expenditures

In the analysis of the impacts of Oil Supply Bases and the Tanker Terminal on the Shetland economy it was assumed that expenditure patterns of employees in these activities would be the same as those of local Shetland households as expressed in the Household columns of Tables 3.1 and 3.6. It was admitted that this was largely a simplifying assumption, since some of these employees may be immigrant, with different expenditure patterns from locals. However, it was hoped that such an assumption would not be an excessive distortion of reality since not all employees in these facilities would be immigrant, and furthermore immigrant employees of this nature would tend to be 'permanent' i.e. would establish family homes, etc. in Shetland and, as such, their expenditure patterns may tend to resemble similar local households. However, in the case of oil-related Construction employees, the assumption that their consumption behaviour is the same as an 'average' Shetland Household is emphatically not justified. There are two related reasons for this: firstly, virtually all oil-related construction workers will be immigrant (see The Shetland Times 3/4/76) and, secondly, these workers will be primarily 'temporary' immigrants, living in hostels or other rented accommodation, with family homes remaining outside Shetland. This type of 'Household' has been

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20. Ref: Brownrigg (1974, op. cit., pages 74-76).

shown to have consumption behaviour very different from the 'average'.[21] Hence the local expenditures of these employees has to be estimated separately. Unfortunately, resources were not available to obtain local expenditure patterns of these individuals by direct survey, and so largely secondary information had to be used in the estimation process. Again unfortunately, there were no available studies which gave estimates of the expenditure behaviour of temporary construction workers (Mackay's paper cited in footnote 21 merely notes some of the peculiarities of their consumption patterns). However, a study by Greenwood and Short[22] analysed in detail the expenditure patterns of service personnel in the RAF bases of Kinloss and Lossiemouth, and this had a number of features which made it useful in the present context: firstly, separate expenditure columns are given for a number of personnel types identified by age, marital status, etc., so that only expenditure patterns of groups sharing these characteristics with the employees in Shetland need be considered. Secondly, these camps provided considerable on-base facilities such as accommodation, catering, shops, entertainment, services, etc., and this is very similar to the type of facilities to be offered in the Firth Construction camp of the Sullom Voe complex, where most immigrant construction workers will reside, so that on-base versus off-base expenditure behaviour may be similar in both cases.

In summary, it is argued that although the occupations in the RAF camps in Kinloss and Lossiemouth and in the oil-related Construction works in Shetland are entirely different, certain characteristics of the employment (i.e. away from centres of population, considerable on-base facilities), and of certain groups of employees (temporary, non-resident), are

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21. See Mackay, A.G., Invergordon Working Paper No. 24.
22. Greenwood, D. and Short, J. (1973).

sufficiently similar to warrant the assumption that expenditure behaviour for equivalent groups will be similar in both cases. The Greenwood and Short studies were therefore the main data sources in estimating construction workers' expenditures; however where possible independent checks were attempted: e.g. by asking publicans, hoteliers, etc. how much their trade had increased as a result of spending by oil construction workers.

Based on conversations with the oil operating companies, and the Shetland Island Council, the following Greenwood-Short (G.S.) category of employee was taken as being reasonably representative of oil-related construction employees in Shetland: non-local, single (or unaccompanied married) male, camp resident. From Greenwood and Short's study, the expenditure pattern for this type of employees was as given in Table III.6.

Table III.6 Expenditure pattern of 'construction-equivalent' personnel

Commodity Group	% of total (average of Kinloss & Lossiemouth) Expenditure
Food	12.01
Housing	3.71
Fuel & Light	0.82
Clothing & Footwear	9.78
Transport	10.71
Tobacco & Drink	26.40
Furniture	0.41
Other Durable Household	1.11
Medical	4.68
Entertainment	5.84
Other Services	2.62
Savings	21.86
	100

The proportions in Table III.6 relate to the total disposition of Personal Disposable Income (PDI) regardless of the geographical location of the expenditure. However, for use in the Input-Output study expenditures in the local community must be separated from those made on camp or outside Shetland since only the former have significant repercussions on the local economy. G.S. divide total expenditure on each commodity group among six geographical areas: (a) on base, (b) within 3 miles, (c) in main local shopping area, (d) in other local shops, (e) in main regional centre, (f) elsewhere. This geographical breakdown, of course, relates to the Moray area, and the locational proximity of various shopping facilities to the Firth camp in Shetland need not be similar. In facts, based on knowledge of the service and shopping facilities location in Shetland, supplemented by discussion with local businessmen, the following general adjustments were made:

1. In Shetland, the category 'within 3 miles' was included in 'on base'.
2. In Shetland, it was assumed the categories 'main local shopping area' and 'other local shops' were expenditures in Shetland, outwith camps.
3. The categories 'main regional centre' and 'elsewhere' were assumed to represent expenditure outwith Shetland.

Some further particular adjustments were made e.g. not all expenditure 'within 3 miles' of the Firth camp on tobacco and drink was assumed to be made on base, since there is a hotel in nearby Brae which is frequented by the camp workers. The final geographical breakdown, based on adjusted G.S. data, is given in Table III.7.

Table III.7 Breakdown of each commodity group expenditure by Geographical Location

Commodity Group	% Expenditure by Locality		
	On Base	Shetland	Elsewhere
Food	66.6	30.0	3.4
Housing	100	-	-
Fuel & Light	100	-	-
Clothing & Footwear	13.4	43.6	43.0
Transport	-	74.2	25.8
Tobacco & Drink	50.0	42.9	7.1
Furniture	8.9	63.1	28.0
Other Durables	18.3	63.4	18.3
Medical & Personal	47.4	48.7	3.9
Entertainment	51.9	31.9	16.2
Other Services	40.6	50.8	8.6
Saving	29.5	12.6	57.9

Combined with Table III.6, the above figures easily permit the estimation of the proportions of total expenditure made in Shetland by each commodity group, and the results are not reproduced here.

The final adjustments required were to convert the above expenditure data, given in commodity groups at purchasers prices, to a form suitable for incorporation in the Input-Output study, i.e. basically in industry groups in producer's prices. Fortunately the Household expenditure data for the 1971 transactions table had been collected in a form very similar to G.S.'s (both being based on Family Expenditure Survey groupings) and a detailed conversion had been undertaken then; hence the conversion of the above data presented few problems.

The breakdown of expenditure in G.S. uses an expenditure ≡ PDI identity. We have estimated above, Gross Income at £4.43 million (average) and £4.98 million (peak). To make the necessary conversion to PDI, we note that G.S. found that the assumed equivalent personnel in their study paid 30% of their Gross Income in statutory payments. Assuming this proportion (which is the highest of a range) applies in Shetland, PDI (average) is £3.10M and PDI (peak) £3.49M.

The local purchases, on an industry basis, by oil-related Construction workers are given in Table III.8.

Table III.8 Local purchases by oil-related Construction Workers

Industry	% of Total Expenditure	Actual Expenditure £'000 (1974) Peak	Average
Distribution	4.21	146.9	130.5
Transport	7.90	275.7	244.9
Professional Services	0.07	2.4	2.2
Communications	0.08	2.8	2.5
Miscellaneous Services	8.85	308.9	274.4

Combined with the local industry expenditures of Table III.5, and multiplied throughout by 0.695 to convert to 1971 prices (see page 218), Table III.8 yields the total annual expenditure made in Shetland as a result of oil-related construction activity. This is given in Table III.9, which forms the Final Demand columns for oil-related construction.

Table III.9 Direct Oil-Related Construction Expenditures (Total)

Shetland Industry	Peak	£000 (1971 prices)	Average (to 1981)
Agriculture	0		0
Fishing	0		0
Quarrying	483.4		429.7
Fish Processing	0		0
Textiles	0		0
Ship Repair	0		0
Other Manufacturing	137.2		122.0
Construction	398.5		354.2
Utilities	65.3		58.1
Transport	452.9		402.5
Communications	93.4		83.1
Distribution	138.7		123.2
Professional Services	1.7		1.5
Other Services	280.0		248.8
Local Government	65.3		58.1
Households	0		0
Totals	2116.4		1881.2

APPENDIX IV: Sample Questionnaires

This appendix includes examples of the types of questionnaire used to collect data for the empirical Input-Output study in the text.

Questionnaire (1) demonstrates the most detailed format employed. This questionnaire was used in interviews only, and only where a high degree of co-operation was forthcoming. To ease the tasks of completion and compilation, the individual purchases listed were varied from industry to industry to reflect the most important inputs in each (as suggested by appropriate Census of Production returns). The example shown is for the Hosiery and Knitwear industry. Simplified variants of this questionnaire were used in 'difficult' firms in manufacturing and in most service industries.

Questionnaire (2) is the type of questionnaire which was used in the postal survey (in this case for Distributive firms).

A brief explanation for requesting certain information is given, and the information asked for is kept to a minimum. Letters of introduction from the University and from Shetland Island Council accompanies each questionnaire, and 'reminders' were went to non-responding firms. It was hoped in this way that response rate could be maximised.

Questionnaire (3) was used in interview situations with oil-related firms, particularly with the Oil Supply Bases on the island.

SHETLAND INPUT-OUTPUT STUDY

CONFIDENTIAL

GENERAL:

1. NAME OF FIRM: ....

2. HOW MANY ESTABLISHMENTS IN SHETLAND ARE INVOLVED IN FIRM?

3. WHAT IS PRINCIPAL PRODUCT OF FIRM?:

4. WHAT OTHER PRODUCTS DOES FIRM PRODUCE? AND, WHAT PERCENTAGE ARE THESE OF TOTAL SALES?

	PRODUCT	PERCENTAGE OF TOTAL SALES
1.		
2.		
3.		

NOTE: In all the following sections, answers should refer only to establishments in Shetland where possible.

EMPLOYMENT ANALYSIS:

PLEASE STATE YEAR TO WHICH REPLIES REFER[1]:

	MONTH	YEAR
FROM:		
TO:		

[1] IF POSSIBLE DETAILS FOR THE CALENDAR YEAR 1971 ARE PREFERRED. IF THIS IS NOT AVAILABLE PLEASE GIVE DETAILS FOR NEAREST CALENDAR OR FINANCIAL YEAR TO IT.

1. HOW MANY PERSONS ON AVERAGE WORKED IN ANY CAPACITY IN YOUR BUSINESS IN:

a) APRIL - SEPTEMBER OR "SUMMER"

	MALE	FEMALE
FULL-TIME		
PART-TIME		

b) REST OF YEAR

	MALE	FEMALE
FULL-TIME		
PART-TIME		

2. CONSIDER (a) ABOVE: HOW WOULD YOU ALLOCATE THESE PERSONS TO THE FOLLOWING CATEGORIES:

CATEGORY	NO. OF PERSONS
MANAGERIAL & ADMINISTRATIVE	
CLERICAL & SECRETARIAL	
SKILLED MANUAL	
ALL OTHER	

3. DID THE NUMBER OF PERSONS EMPLOYED IN YOUR BUSINESS CHANGE SIGNIFICANTLY BETWEEN 1971 AND 1973?

PLEASE TICK YES

NO

4. IF YES TO 3. DID THE NUMBER INCREASE OR DECREASE AND BY HOW MANY?

	NUMBER
INCREASE	
DECREASE	

5. WOULD YOU AT PRESENT EMPLOY MORE PERSONS IF THESE WERE AVAILABLE:

PLEASE TICK YES

NO

6. WHAT WERE THE TOTAL GROSS EARNINGS (INCLUDING OVERTIME, BONUSES, ETC. BUT BEFORE ANY DEDUCTIONS FOR TAX, NATIONAL INSURANCE, ETC.) PAID TO ALL PERSONS INCLUDING OUTWORKERS WORKING IN YOUR BUSINESS OVER THE YEAR:

	£
1971	
1973	

7. OF THE ABOVE TOTAL GROSS EARNINGS, HOW MUCH WOULD YOU ESTIMATE WAS PAID TO RESIDENTS OF SHETLAND.

PURCHASES ANALYSIS:

1. VALUE OF STOCKS OF MATERIALS, WORK IN PROGRESS, AND UNFINISHED GOODS:

AT BEGINNING OF YEAR

AT END OF YEAR

2. WHAT WERE THE PROFITS OF THE FIRM (BOTH PAID OUT AND RETAINED):

3. OF THE TOTAL PROFITS EARNED BY THE FIRM, PLEASE ESTIMATE HOW MUCH OF THIS WAS PAID TO RESIDENTS OF SHETLAND?

4. COST OF ALL CAPITAL ASSETS PURCHASED:

VALUE OF ALL CAPITAL ASSETS SOLD:

5. ALLOWANCES FOR DEPRECIATION:

6. PLEASE VALUE YOUR BUSINESS'S PURCHASES OF GOODS AND SERVICES ACCORDING TO THE CATEGORIES ON THE ACCOMPANYING SHEET.

PURCHASES DATA

HOSIERY & KNITWEAR INDUSTRY

IF ESTIMATES ARE GIVEN, PLEASE PUT 'e' AFTER FIGURE QUOTED

	AMOUNT PURCHASED	AMOUNT PURCHASED FROM SUPPLIERS ON SHETLAND
	£	£
Cotton yarn	....	....
All man-made yarns	....	....
Spun & Continuous	....	....
Wool Yarn	....	....
Warp knitted fabrics, all materials	....	....
Other knitted fabrics, all materials	....	....
Cotton woven piece goods (other than narrow fabrics)	....	....
Man made fibre woven piece goods	....	....
Fasteners(e.g. zips, buttons, hooks, press studs, etc.)	....	....
Textile narrow fabrics (incl. tapes, braids, ribbons, woven labels, etc.)	....	....
Covered rubber thread	....	....
Elastomeric thread	....	....
Dyestuffs	....	....
Lubricating oils and greases	....	....
Replacement parts	....	....
Hosiery needles	....	....
Other materials used in production (please specify)		
1.	....	....
2.	....	....
3.	....	....

	AMOUNT PURCHASED	AMOUNT PURCHASED FROM SUPPLIERS ON SHETLAND
	£	£
ALL PACKAGING MATERIALS	....	....
GAS, ELECTRICITY & WATER	....	....
COAL & COKE	....	....
ALL LIQUID FUELS	....	....
ALL TRANSPORT COSTS, INCLUDING OWN TRANSPORT	....	....

CURRENT OPERATING EXPENDITURES:	AMOUNT PAID	PER CENT PAID TO SHETLAND SUPPLIERS
	£	£
1. ADVERTISING, MARKET RESEARCH, ETC.	....	....
2. REPAIRS & MAINTENANCE TO BUILDING, PLANT, ETC.	....	....
3. HIRE OF PLANT & MACHINERY	....	....
4. TAX PAYMENTS TO GOVERNMENT	....	....
5. INSURANCE PAYMENTS, FEES, LICENCES, ETC.	....	....
6. POSTAGE, TELEPHONE, ETC.	....	....

SALES ANALYSIS:

1. WHAT WAS THE TOTAL VALUE OF SALES DURING THE PERIOD. (EXCLUDE ANY TRADE DISCOUNTS, REBATES, COMMISSION, ETC. AND ANY TAX PAYMENTS ON GOODS SOLD). £.......

2. ARE THESE VALUED ON AN EX-WORKS OR DELIVERED BASIS:

3. WHAT WAS THE VALUE OF THE INVENTORY OF GOODS ON HAND FOR SALE: £

AT THE BEGINNING OF THE YEAR: ?
AT THE END OF THE YEAR:

4. WHAT PER CENT OF YOUR SALES WOULD YOU ESTIMATE WENT:

a) DIRECT TO SHETLAND HOUSEHOLDS £.......

b) DIRECT TO SHETLAND RETAILERS AND WHOLESALERS £.......

5. HAS THE VALUE OF YOUR SALES CHANGED SIGNIFICANTLY SINCE 1971? YES/NO

6. IF SO, HAS IT INCREASED OR DECREASED? INCREASED/DECREASED

7. BY HOW MUCH? £.......

SHETLAND INPUT-OUTPUT STUDY

CONFIDENTIAL

GENERAL:

I. NAME OF FIRM: ....

2. IS FIRM (a) SHETLAND OWNED
(b) PART OF A LARGER GROUP
(please tick)

EMPLOYMENT ANALYSIS

A clear picture of the pre-oil employment structure in Shetland is necessary if changes in employment brought about by oil or other development are to be estimated.

PLEASE STATE YEAR TO WHICH REPLIES REFER**

	MONTH	YEAR
FROM:		
TO:		

**If possible details for the calendar year 1971 are preferred. if these are not available please give details for nearest calendar or financial year to it.

1. HOW MANY PERSONS WORKED IN ANY CAPACITY IN YOUR BUSINESS ON AVERAGE OVER THE YEAR?

	MALE	FEMALE
FULL-TIME:		
PART-TIME:		

2. HAS YOUR LABOUR FORCE INCREASED OR DECREASED SINCE 1971? YES/NO

IF SO, BY HOW MANY: INCREASED......... DECREASED...........

3. WOULD YOU EMPLOY MORE PERSONS AT PRESENT IF THESE WERE AVAILABLE YES/NO

4. WHAT WERE THE TOTAL GROSS EARNINGS (INCLUDING OVER TIME, BONUSES, ETC,BUT BEFORE DEDUCTIONS FOR TAX, NATIONAL INSURANCE ETC.) PAID TO ALL PERSONS, INCLUDING DIRECTORS, WORKING IN YOUR BUSINESS OVER THE YEAR £............

PURCHASES ANALYSIS:

In this section you are asked to list the value of purchases of certain goods made during the course of your business in 1971(or other year). this information is invaluable in establishing the way in which all local industries depend on one another by buying and selling from each other.

1. ESTIMATES ARE ACCEPTABLE WHERE NECESSARY

	AMOUNT PURCHASED £	AMOUNT PURCHASED FROM SUPPLIERS IN SHETLAND £
Cost of goods for Resale	....	....
Packaging Materials	....	....
Electricity & water	....	....
advertising,printing,etc	....	....
Postage & Telephone	....	....
All other purchases of goods and services	....	....

2. Transport: expenditure on own transport ....

cost of hired transport services ....

3. TOTAL TURNOVER DURING THE YEAR £...........

4. CHANGE IN STOCKS OVER THE YEAR: +£............ or -£...........

SHETLAND INPUT-OUTPUT STUDY CONFIDENTIAL

GENERAL:

1. NAME OF FIRM: . . . .

2. WHEN DID FIRM BEGIN OPERATIONS IN SHETLAND? . . . . .

3. WHAT IS THE PRINCIPAL ACTIVITY OF THE FIRM IN SHETLAND?

EMPLOYMENT ANALYSIS:

NOTE: In this section, and in those following, please give details for the latest calendar year if available. If the firm has not been in operation for a full year in Shetland, please give estimated details for first full year.

1. PLEASE STATE YEAR TO WHICH REPLIES REFER:

	MONTH	YEAR
FROM:		
TO:		

2. HOW MANY PERSONS WORKED IN ANY CAPACITY IN YOUR BUSINESS IN SHETLAND ON AVERAGE DURING THE YEAR:

	MALE	FEMALE
FULL-TIME:		
PART-TIME:		

3. HOW WOULD YOU ALLOCATE THE ABOVE PERSONS TO THE FOLLOWING CATEGORIES:

CATEGORY	NO. OF PERSONS
MANAGERIAL & ADMINISTRATIVE	
CLERICAL & SECRETARIAL	
SKILLED MANUAL	
ALL OTHER	

4. HOW MANY OF THE PERSONS EMPLOYED IN YOUR BUSINESS WERE RESIDENT IN SHETLAND BEFORE YOUR BUSINESS ARRIVED:

5. DO YOU EXPECT THE LABOUR FORCE OF YOUR FIRM IN SHETLAND TO CHANGE OVER THE NEXT FEW YEARS YES/NO. IF SO, COULD YOU ESTIMATE ITS EXPECTED PERMANENT LEVEL:

6. WHAT WERE THE TOTAL GROSS EARNINGS (INCLUDING OVERTIME, BONUSES, ETC. BUT BEFORE ANY DEDUCTIONS FOR TAX, NATIONAL INSURANCE, ETC.) PAID TO ALL PERSONS WORKING IN YOUR BUSINESS IN SHETLAND OVER THE YEAR:

£ ....

7. OF THE ABOVE GROSS EARNINGS, HOW MUCH WOULD YOU ESTIMATE WAS PAID TO PERSONS WHOSE FAMILY HOMES ARE IN SHETLAND?

SHETLAND INPUT-OUTPUT STUDY CONFIDENTIAL

PURCHASES ANALYSIS

NOTE: In this section as before please give details for the latest/ first full year.

1. WHAT WAS THE TOTAL COST OF CONSTRUCTING ANY FACILITIES (INCL. OFFICE BUILDINGS, WAREHOUSES, ETC.) REQUIRED FOR YOUR OPERATIONS IN SHETLAND:

£.............

2. OF THE ABOVE TOTAL, HOW MUCH WAS TENDERED TO SHETLAND BASED FIRMS:

£.............

3. THE FOLLOWING IS A LIST OF SOME OF THE PURCHASES YOU MAY MAKE IN THE COURSE OF YOUR BUSINESS. COULD YOU GIVE THE VALUE OF SUCH PURCHASES IN EACH CATEGORY:

CATEGORY	TOTAL AMOUNT PURCHASED*	AMOUNT PURCHASED FROM SHETLAND* SUPPLIERS
	£	£
1. Specialised oilfield equipment	....	....
2. Food stores	....	....
3. Ship chandelry	....	....
4. Stationary, printing etc.	....	....
5. Repairs, etc.	....	....
6. liquid fuels	....	....
7. Plant hire	....	....
8. Road haulage services	....	....

* IF ESTIMATES ARE GIVEN, PLEASE PUT 'E' AFTER FIGURE QUOTED

PURCHASES ANALYSIS

3(Contd.)

CATEGORY	TOTAL AMOUNT PURCHASED*	AMOUNT PURCHASED FROM SHETLAND* SUPPLIERS
	£	£
Air/Sea transport	....	....
Small tools, clothing, cleaning materials, etc.	....	....
Guest house/Hotel accomod.	....	....
Telephone, post	....	....
electricity & water	....	....
Car/Taxi hire	....	....
Laundry Services	....	....
Secretarial Services	....	....
Banking & insurance Services	....	....
Agency Services(travel, estate, employment, etc.)	....	....
Catering Services	....	....
Any other purchases	....	....

* IF ESTIMATES ARE GIVEN, PLEASE PUT 'E' AFTER FIGURE QUOTED

SHETLAND INPUT-OUTPUT STUDY CONFIDENTIAL

SALES ANALYSIS

1. WHAT WAS THE TOTAL VALUE OF SALES OF GOODS AND SERVICES MADE BY YOUR SHETLAND OPERATIONS OVER THE YEAR:

£...........

2. OF THE ABOVE SALES FIGURE, HOW MUCH, IF ANY, WAS MADE TO LOCAL SHETLAND FIRMS:

£...........

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