3. METHODOLOGY: INPUT-OUTPUT ANALYSIS

The term 'economic impact' has come to include the class, size and distribution of effects of economic activity. An economic activity creates impacts in terms of output (value of production), household income, and employment. The size of these impacts and how they are distributed - in the regional, state or national economy - is the subject of economic impact analysis.

Economic impact analysis focused, for example, on a regional economy, traces through the linkages in that economy to quantify the impact of a growth or decline in economic activity on the levels of output of a growth or decline in economic activity, on the levels of output in the remainder of the regional economy, on the level of household income throughout the regional economy, and on the number of jobs created in that economy. The analysis is undertaken using a technique introduced in section 1 termed 'input-output analysis'. Using input-output analysis, the impacts throughout the economy of an increase or decrease in output from a particular economic activity may be estimated.

Input-output analysis is a technique which traces the inputs and outputs of an industry throughout a defined economy. The economy is described for the analysis by a matrix with a row and column representing each industry sector. To make the technique manageable, the large number of industries in an economy are grouped into a smaller number of 'sectors'. The input-output table thus constructed is a matrix showing a 'snapshot' of transactions within an economy at a given time. The matrix can be manipulated to provide information in the form of 'multipliers' from which impacts may be calculated.

3.1 Matrix manipulation

The initial setting out of information in a matrix is important. The sectors within an economy are arranged so that the sales to other sectors (inputs) are shown down a column. The sectors make up the 'endogenous' part of the table, as shown below in Figure 3.

The sales to 'final demand', which includes personal consumption, investment, some government expenditure and imports, (Jensen, 1979) are shown as a column or columns.

The 'primary inputs' in production, are shown as rows and include depreciation, indirect taxes, wages and salaries (to householders), gross operating surplus, imports and other value-added items (Jensen, 1979), Final demand and primary inputs are 'exogenous' parts of the table.

Figure 3. A simplified input-output table.

SELLING SECTORS	PURCHASING SECTORS					
	Fishing	Tourism	Mining	Household Consumption	Other Final Demand	Total Output
Fishing	20	10	30	10	30	100
Tourism	10					
Mining	30					
	(Endogenous sectors)			(Exogenous sectors)		
H'sehold	30					
Other Primary Inputs	10					
	(Exogenous sectors)					
Total Input	100					

One aspect of the exogenous sectors, household payments and consumption, may be included with the endogenous part of the table if it is wished to measure the impacts induced by household consumption. (secondary spending of wages and salaries received).

A brief description of matrix manipulation follows. For a full description of the mathematics of the matrix manipulation, see Morison et al., (1982).

The 'multipliers' produced by matrix manipulation are the key information from input-output analysis. A range of multipliers which describe various elements of impacts and their causes are produced.

The first step undertaken in manipulating the input-output table by matrix algebra is to produce a technical coefficients table by dividing values in the column vector by the total column value. The 'First Round' multiplier is found by summing the technical coefficients in the endogenous part of the table (the industry sectors). This multiplier describes the own sector impact of a $1 change in output in that sector.

When the endogenous part of the table is inverted using matrix algebra, 'Industrial Support' multipliers are produced. These measure the 'second and subsequent round effects as successive waves of output increases occur in the economy to provide industrial support as a response to the $1 increase in output' (West et al., 1979).

The original technical coefficients table is then 'closed' with respect to households by including the household vectors with the endogenous sector and again inverting the matrix. The multipliers for 'Consumption Induced' effects are produced in the same way as industrial support multipliers and describe the effects of successive waves of household spending.

The above manipulations provide three types of output multipliers which, when added together, give the 'Flow-On' effect of an initial $1 increase or decrease in expenditure. That initial effect is termed the 'Direct' multiplier (always having a value of $1 for output effects) and together with the Flow-On multiplier makes up the 'Total' multiplier.

Income and employment effects are derived similarly by multiplying the technical coefficients table and then the open and closed inverted tables by household income and employment coefficient vectors respectively.

This explanation of multipliers will take on more meaning when the results of analysis of Reef-based activities are described in the next section of this report, but first the means of incorporating data on Reef-based activities into input-output tables is described.

3.2 Creating Reef-based sectors

Input-output tables were available for the regions of Queensland and these tables included Reef-based activities aggregated into other sectors. In order to look at Reef-based activities separately it was necessary to split these off into separate sectors. As there was no information available on the size of Reef-based sectors, it was necessary to collect primary data to build row and column vectors for each Reef-based sector. The data in the Reef-based sector was than subtracted from the regional sector in which it originally appeared, to avoid double counting, for example, commercial fishing data was subtracted from the 'Forestry, fishing, hunting' sector.

Data required to be collected from primary sources included the items on which expenditure was made and the location and value of purchases. Where sales were relevant, as in the case of commercial fishing, the location of sales was also recorded.

Information had to be gathered on exports and imports to the region and on employment in the Reef-based sectors. Data requirements were high. Data were gathered by mail questionnaires of recreational fishermen, campers, charter boat operators and some island resorts. Personal interviews were conducted with commercial fishermen, resort operators, research institutions and a proportion of recreational fishermen and charter boat owners. Where possible with commercial operators, profit and loss statements were used as a data source supplemented by questions on location of purchase. Further details of data gathering are included in McGinnity (1981) and in Driml et al. (1982).

The data gathered required further manipulation to construct row and column vectors. The input-output tables are in 'basic' values which means that retail markups, imports and indirect taxes must be deducted from the amount paid for a particular item and allocated to the correct sectors. For instance, in the case of processed food purchases by an island resort: some food will be imported into the region and expenditure on that food is allocated to the 'Imports'; some food will have been purchased from local retailers and wholesalers, in which case the sales markup is allocated to the 'Trade' sector; and the remaining expenditure is allocated to the local 'Food manufacturing' sector.

In the case of Reef-based activities there are some non-commercial activities - recreational fishing, camping, research - which do not have outputs measured in dollar terms like conventional industries.

The commercial fishing sector presented a case where, for various reasons, recorded input was higher than output. In these cases, total output was set equal to total input (expenditure).

It is usual in setting up an input-output table to adjust total input to equal measured total output (by making adjustment to the 'value added' row).

3.3 Comments on the method

An input-output table records transactions for one year. The data collected for economic analysis of Reef-based sectors were available in their most current form for different years for different activities and regions and attempts have been made to standardise data for comparison. For each region, internal standardisation was undertaken to ensure that all the data collected plus the base input-output table were for the same year. The analysis for the Cairns Region was for the 1979/80 year, the analysis for the Mackay Region was for the 1980/81 year and the analysis for the Townsville and Rockhampton Regions was for the 1978/79 year.

The fact that data vary across three financial years raises questions about comparability. As multipliers are proportional measures, the size of multipliers will not be changed as much as gross measures are changed due to inflation, however some small reduction in comparability does occur. It is worth noting that analysis for the Townsville and Rockhampton Regions was also undertaken (but not reported) for the 1979/80 year and in most cases, multipliers were the same as those for 1978/79, and in no instance was the variation great. Standardisation within a table (as was undertaken) is a more important requirement to establish accurate relativities between output, income and employment measures, provided the range of time over which data were collected for different regions is not great.

Input-output analysis is a technique which has been under constant development for a number of decades. Although fairly widely used both in Australia and overseas, it has limitations. As the basis of the technique is the matrix describing an economy in simplified terms, this presents a static, aggregated, linear, description of an economy. The results of analysis reflect those limitations and must be interpreted accordingly.

The static nature of the table would not be a problem if new tables could be compiled regularly. However, the large amount of data required makes compilation time-consuming and costly. The latest tables available for Australia at the time of the analysis were for the 1978/79 financial year (Australian Bureau of Statistics, 1980). It was only in 1982 that 1978/79 tables became available for Queensland regions (Morison, et al., 1982). Where economies experience significant structural change the accuracy of dated tables is placed in doubt.

Aggregation in tables refers to two dimensions: aggregation on the economy level, and aggregation on the sectoral level. At the economy level the tables produced for Queensland regions are constructed from tables produced for Australia. It is possible to construct regional tables by reducing the Australian tables by a suitable quotient. Jensen et al. (1979) developed 'augmented' tables for Queensland regions by reducing Australian tables and inserting what regional data were available.

An alternative approach is to build tables from the ground up using regional information collected by survey. While this would give a more accurate picture of the regional economy, it is a more costly and complex process. This report combines the two approaches using regional tables developed from the Australian tables and original data on Reef-based sectors collected by surveys at the regional level.

Where industries are aggregated into 'sectors', information can be lost. Aggregation is, however, necessary for practical use of the tables. The table for Australia has 109 sectors while those for Queensland regions have only 19 sectors. With aggregation, the assumption is that all industries within a sector will have the same relationship with other sectors. The reasonableness of this assumption will vary from sector to sector. In the analysis of Reef-based activities the problem has been largely avoided by creating separate sectors for each activity.

The linearity of relationships in the table means that any changes imposed on the economy will be seen to have a constant effect. No account can be taken of economies of scale or threshold levels of operation. Again, this influences the accuracy of results, but if care is taken in considering the scale of operation of the sector or industry being investigated when interpreting the results, the limitation may be largely overcome.

The limitations discussed above do affect the accuracy of the results which will be obtained from input-output analysis. The problems are more evident the smaller (in gross output terms) the sector under investigation. The sectors representing economic activity on the Reef are mostly smaller than others in the 19 sector Queensland regional tables. Jensen (1979) has warned that the results of analysis of the reef-related sectors should be treated with caution and give an 'order of magnitude' result only. 'Order of magnitude' information can be useful - particularly where no indication of economic impact existed previously. Comparison between Reef-related activities is valid where analysis is undertaken using the same regional tables and the same assumptions.

3.4 An input-output table

The input-output table compiled for the Rockhampton Region is shown as an example on the following pages in Table 2. The regional table produced by Morison et al. (1982) for the 1978/79 financial year is augmented by the separation of sectors for Island Resorts (12A), Charter Boats (12B), Island camping (12C), Recreational Fishing (12D), Commercial Fishing (12E) and Research (12F).

Table 2. Rockhampton Region: Transactions table ($ 000).

SECTOR	1	2A	2B	3A	3B	4A	4B	4C	4D	4E	4F	5	6	7
1	10101	0	0	0	0	73008	0	0	0	0	25	0	0	0
2A	11606	3319	34	3	4	82278	0	0	0	0	222	0	0	0
2B	277	0	119	527	8	398	5627	1	10	10	29	130	92	0
3A	0	0	0	8	0	87	0	1	27346	525	5	54788	1	3
3B	9	1	29	1209	1350	126	0	13	4075	3406	381	0	1863	9
4A	3736	328	51	97	71	23543	8	7	64	3	133	8	33	233
4B	4	761	85	731	81	317	5570	125	342	198	32	2	10718	1098
4C	258	311	30	183	112	95	34	2021	60	30	2	90	855	591
4D	50	115	6	587	222	263	92	853	17243	175	110	142	5279	188
4E	0	0	91	165	225	666	137	35	587	4715	3	17	19213	241
4F	971	1107	114	302	131	172	58	25	1068	106	1306	106	139	398
5	5452	4636	23	5758	1159	3915	694	743	16027	1406	330	19652	937	4906
6	988	847	323	572	682	1107	195	231	428	291	53	1978	450	1467
7	6571	7095	1765	1902	983	11319	2627	3537	4668	1306	767	2159	11366	28309
8	7150	3468	695	4416	2461	13861	2366	1474	9078	3464	630	3720	7795	7667
9	28	58	0	2372	1432	1801	672	717	1137	258	129	555	3086	22651
10	92	222	0	103	23	29	0	13	0	0	11	0	0	0
11A	1386	240	4	292	81	70	3	0	14	2	1	10	6	51
11B	261	11	3	337	190	93	96	52	47	10	3	694	15	966
12A	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12B	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12C	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12D	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12E	0	0	0	0	0	4548	0	0	0	0	0	0	0	0
12F	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W & S	90193	88984	2379	56174	6369	49409	18019	22477	30896	5998	1908	26415	40021	147581
G.V.A	82710	96750	9630	141267	14204	8195	10298	16761	42116	6291	1624	80342	35563	88081
IMPORTS	21406	33710	1668	41207	10512	12513	8435	10822	50559	2529	5552	99531	62308	65760
TOTAL	243249	241963	17049	258212	40300	287801	54931	59908	214765	30723	13256	230339	199740	370200
EMPLOY	9401	9275	466	2775	506	4887	2105	2354	2292	670	267	2155	5161	17955

Table 2. Continued.

SECTOR	8	9	10	11A	11B	12A	12B	12C	12D	12E	12F	H-H	O.F.D	EXPORTS	TOTAL
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1601150	2432490
2A	0	7	33	13	185	0	0	0	0	0	0	10101	0	134158	241963
2B	272	0	2	0	46	0	0	0	0	0	0	522	7081	1898	17049
3A	5	0	1	43	3	0	0	0	0	0	0	0	8960	166448	258212
3B	27	0	0	7	14	0	0	0	0	0	0	0	2801	24980	54931
4A	15	116	71	167	230	174	25	14	0	117	2	6444	0	194111	287801
4B	697	242	562	1617	917	12	0	0	0	0	1	6129	1882	22808	54931
4C	4106	42	48	67	9	317	73	0	8	633	6	10275	11092	28560	59908
4D	79	9	72	121	233	0	0	0	0	25	0	2075	4094	182732	214765
4E	112	3	8	66	133	1	0	0	0	0	0	0	1162	3143	30723
4F	519	78	70	1338	113	254	0	1	0	11	2	647	223	3997	13256
5	3581	4259	1438	5605	11675	6	0	0	0	60	0	17559	37391	83127	230339
6	18725	1236	1763	3778	309	1045	0	0	0	0	0	15868	147405	0	199741
7	11180	2346	420	3977	2431	125	55	27	2664	389	0	58106	201071	3038	370203
8	3378	2567	2025	5416	2194	444	29	1	0	155	4	15590	122174	1836	224058
9	1138	9821	2658	337	4516	236	59	0	263	218	3	65874	29190	1513	150772
10	0	49	10	34	32	29	36	0	195	42	0	7457	59515	0	67892
11A	187	473	149	137	348	5	0	0	13	2	0	42609	139878	12860	198821
11B	160	3491	364	377	3322	78	0	2	0	0	0	119064	10112	3784	143532
12A	0	0	0	0	0	0	0	1	0	0	4	2048	1	7207	9261
12B	0	0	0	0	0	0	0	69	0	0	0	232	0	754	1055
12C	0	0	0	0	0	0	0	0	0	0	0	138	0	122	260
12D	0	0	0	0	0	0	0	0	0	0	0	8108	0	0	8108
12E	0	0	0	427	0	28	6	0	279	0	0	672	0	3017	8977
12F	0	0	0	0	0	0	0	0	0	0	0	1	0	67	68
W & S	104362	52657	48831	138641	61327	1702	252	0	0	4418	29	0	0	0	999042
O.V.A.	18937	64181	1420	22995	45033	1018	224	7	1252	600	12	161058	0	0	950569
IMPORTS	56575	9143	7946	13657	10460	3787	296	138	3434	2307	5	283836	0	0	767096
TOTAL	224055	150720	67891	198820	143530	9261	1055	260	8108	8977	68	892413	784032	1040275	0
EMPLOY	8359	5006	4170	11834	5187	189	28	0	0	416	8				

1 Animal Industries
2A Other Agriculture
2B Forstry, Hunting
3A Coal, Crude petroleum Mining
3B Other Mining
4A Food manufacturing
4B Wood and Paper manufacturing
4C machinery, appliances
4D Metals, metal Products
4E Non-metallic minerals
4F Other manufacturing
5 Electricity, etc.
6 Building Construction
7 Trade
8 Transport, Communication
9 Finance
10 Public Administration
11A Community Service
11B Entertainment
12A Island Resorts
12B Charter Boats
12C Island Camping
12D Recreational Fishing
12E Commercial Fishing
12F Research
12G Day Trips
W&S Wages and Salaries
OVA Other Value Added
H-H Households
OFD Other Final Demands
Employ Number employed