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Demographic-economic modelling in the Wollongong statistical district

Reetu Dhawan
University of Wollongong

DEMOGRAPHIC - ECONOMIC MODELLING

IN THE

WOLLONGONG STATISTICAL DISTRICT

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REETU DHAWAN

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ABSTRACT

The objectives of this study are to apply a new demographic-economic input-output model to the Wollongong Statistical District and to carry out sensitivity analysis on this new demographic-economic model.

The multipliers of the new demographic-economic model (considered as a static closed model) are compared with the traditional model (static semi-closed model) for the Wollongong region. The study finds that the static closed model calculates multipliers which are smaller than those calculated by the static semi-closed model. Thus, the study concludes that the demographic-economic model enhances the performance of the traditional input-output models specially in economies experiencing rapid economic and demographic changes, through calculating realistic output multipliers.

The study also finds that the new demographic-economic model is more sensitive to changes or errors in the coefficients than the traditional model. Thus it is important to weigh the benefits of realistic multipliers against the cost of having a model which is more sensitive to errors.

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INTRODUCTION

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INTRODUCTION

The economic impact of either adding or deleting an economic activity in a region has long been of special interest to people living in the region and to policy makers. With unemployment in Australia recently reaching record post-war levels, the importance of identifying the economic impacts associated with the introduction or removal of an employment source has been considerably increased.

A number of techniques have been developed for assessing regional economic impacts. These techniques are:

(1) Economic base models;
(2) Keynesian multiplier models;
(3) Regional econometric models;
(4) Regional input-output models.

This study concentrates on regional input-output models, which are an extension of the application of the input-output model at the national level that was pioneered by Leontief (1936). Regional input-output models have enjoyed a rapid rise to prominence and are now generally acknowledged as the most powerful and comprehensive models available to the regional analysts. The importance of regional input-output analysis is summarised by Conway (1977) who describes input-output models as:

> "the most operational regional economic forecasting and planning tools of a general equilibrium nature". [Conway (1977; pp. 177)].

Recognising this importance, this study is concerned with the development and application of regional input-output models. In particular, this study is concerned with

improving the usefulness of input-output models for regional impact analysis, specially in economies experiencing rapid change.

The way planning studies have been undertaken for non-metropolitan areas is for a group of economists to prepare regional economic projections and for demographers to undertake population projections. These exercises were largely carried out independently. However, it became evident that such an approach was likely to generate substantial problems in terms of the reliability of the end product. In particular, the problems became quite severe when unemployment deepened in western economies in the late seventies and the eighties. Regional economists who were predicting a severe downturn in regions whose basic industries were threatened by the decrease in commodity prices and other factors, found that regional economies were either growing or not declining as quickly as predicted. It became apparent that demographic factors had an important bearing on the activity levels of regional economies. The economists previous models had excluded from their models people who were not part of the workforce. However, as the number of unemployed (and the associated transfer payments) increased and migration of the aged intensified, regional economies were being supported by people who were not part of the workforce. This forced regional economists to reconsider their modelling approach and thus demographic-economic modelling was born. Regional economists started to specifically model how demographic variables were affecting regional economies, or what could be called demographic/economic interface.

The Wollongong Statistical District was experiencing the same problems as studies showed that standard input-output models tended to overstate the impacts of a decline in a region. For example, early forecasts of the impact of the downturn in the steel industry in Wollongong, based on input-output models were very pessimistic. The main problem was that it was not acknowledged that a large number of those who

found themselves unemployed would remain in the region and maintain reasonably high levels of expenditure. That is, the forecasts based on traditional input-output models exaggerated the consumption-induced impacts of the downturn.

Thus, the aim of this study is to apply a new input-output model to the Wollongong Statistical District. The new model, called the DECON model was developed by Mangan and Phibbs (1988). The DECON model is an application and an extension of demographic-economic (hereafter known as demo-economic) model which arose out of the dissatisfaction with the performance of the earlier style of input-output model in modelling the Wollongong economy and the unique conditions facing the Wollongong economy.

The DECON model was applied to the Wollongong region because of several changes which occurred in the region between 1981 and 1986. The main changes which occurred were:

- large number of job losses among unskilled and semi-skilled male workers and female textile workers.

- outward migration of families, normally associated with the job losses mentioned above.

- an aging of Wollongong's population with an increasing percentage of retired persons.

- significant increase in part-time, service based and mainly female jobs.

The speed and extent of these changes in the region are such to bring into question the capacity of standard techniques to correctly model the regional impacts. More specifically, the experience of Wollongong has shown the need to modify existing input-output analysis:

(i) to incorporate the role of the non-workforce population.

(ii) to correctly monitor the movement of the whole region's population rather than just the workforce.

(iii) to adjust raw workforce data to reflect the job status and occupational shifts.

The DECON model is the result of the improvements which were built into the traditional input-output table to overcome these limitations. The DECON model is built in such a way as to add two new industries to the traditional input-output model. The two new industries are the unemployed industry and the population industry. The unemployed industry treats the unemployed as a separate industry and specifically models their consumption. The population industry allows the specific calculation of the population multipliers which measure the flow-on population change due to a shift in economic activity in a particular sector. These procedures will lead to the demo-economic multipliers (called type IV multipliers) being smaller than the traditional multipliers (called type II multipliers).

In addition to the improvements in multiplier accuracy, the DECON model allows the regional analyst to assess the impact of demographic changes in their region. That is, the DECON model has been extended to take account of migration.

The DECON model also overcomes the traditional problem of modelling labour supply by using full-time job equivalence data rather than absolute job numbers.

This study extends beyond the application of the DECON model to the Wollongong region. Sensitivity analysis is carried out on the DECON model to determine the extent of the sensitivity of the Wollongong table to changes in coefficients due to the demo-economic factors.

Given the cause, development and nature of the new demo-economic (DECON) model, the question then arises as to how the DECON model is applied to the Wollongong region, the

effect the demo-economic factors have on the Wollongong economy and the sensitivity of the DECON model to changes in the coefficients of the Wollongong table. The following chapter reviews the literature of input-output analysis. Chapter three discusses the input-output method of measuring economic impact and a review is presented of its application to the Wollongong region which lead to demo-economic modelling in the region. Emergence of demo-economic modelling which served as a starting point of the DECON model is provided in chapter four. A description of the methodology of the demo-economic (DECON) model used for impact assessment is given in chapter five and the results presented in chapter six. Chapter six also provides the results of the sensitivity analysis done on the DECON model. The major contributions and implications of this study are presented in the final concluding chapter.

CHAPTER TWO

GENERAL INPUT-OUTPUT ANALYSIS

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Input-output analysis has been available to economists since the work of Leontief in 1936. However, it has only been used as a tool of regional analysis for the last 25 years and has experienced an acceleration of activity during the last decade. The first development was the recognition of the social accounting value of the input-output table and the incorporation of the table into the national accounts of most nations. The other development has been the use of input-output table as a database for the study of economic structure and to identify the structural characteristics of national or regional economies.

2.1 THE STRUCTURE OF THE INPUT-OUTPUT MATRIX

The input-output model estimates the change in inputs required to service any given change in output. An input-output table (also termed as a transactions table or an input-output flow table) records the production and the disposal of the products of an economic system for a particular period.

The core of input-output economics is the transactions matrix which represents the economy to be studied in terms of aggregated industrial or commodity groups or sectors. The transactions matrix summarizes the inter-sector flows in a given period and is conventionally presented in tabular form such as in Table 2.1. The transactions matrix traces out the transactions in money terms between the sectors for a given year.

TABLE 2.1: Generalized Transactions Matrix

		Intermediate Demand (Sales)			Final Demand		
	Outputs → / Inputs ↓	Intermediate Sector			Household Consumption	Other Final Demand	Total Output
Intermediate Inputs (Purchases)		(Quadrant I)			(Quadrant II)		
		1	2	3			
	1	X_{11}	X_{12}	X_{13}	Y_{11}	Y_{12}	X_1
	2	X_{21}	X_{22}	X_{23}	Y_{21}	Y_{22}	X_2
	3	X_{31}	X_{32}	X_{33}	Y_{31}	Y_{32}	X_3
Primary Inputs		(Quadrant III)			(Quadrant IV)		
	Households	P_{11}	P_{12}	P_{13}	-	-	P_1
	Other Primary Inputs	P_{21}	P_{22}	P_{23}	-	-	P_2
	Total Inputs	X_1	X_2	X_3	Y_1	Y_2	

where

Xj denotes total output of sector j.

Xij denotes direct purchase of output from sector i by sector j as intermediate requirements in sector j's production activity (i.e. domestically produced raw materials).

Yij denotes final demand of type j for output of sector i.

Pij denotes direct purchase of primary inputs required for sector j's production activity (labour cost, consumption of capital, operating surplus, imported raw materials).

PjYi appropriate totals.

Note: Quadrant IV is shown as a null matrix since it does not contain any transactions here.

The rows of an input-output matrix show the disposition or disposal of the output of each sector, that is each row indicates the money value of sales from one sector to another and to the final demand. From Table 2.1, firms in sector 1 sell X_{11} of their output to firms in the same sector, X_{12} to firms in sector 2 and X_{13} to firms in sector 3, Y_{11} to household consumers as final users and Y_{12} to other final demand sources.

Each column shows the purchases of inputs which each sector makes from other sectors, i.e. it shows the purchasing patterns of sectors. For example, firms in sector 3 purchase X_{13} from firms in sector 1, X_{23} from firms in sector 2 and X_{33} from firms in the same sector, P_{13} from primary inputs in the form of household labour (via wages, salaries, etc.) and P_{23} in the form of other primary inputs.

2.2 THE FOUR QUADRANTS

Table 2.1 shows that an input-output matrix is defined in four quadrants. These quadrants are:

1. Intermediate
2. Final Demand
3. Primary Inputs
4. Primary Inputs-to-Final Demand

A distinction is made between the endogenous quadrants (intermediate demands and intermediate inputs) and exogenous quadrants (final demand and primary inputs).

2.2.1 The Intermediate Quadrant

This quadrant shows the flow of transactions between the industrial sectors defined for the study, and provides the analytical core of input-output impact analysis. An essential feature of the transactions matrix is that in

quadrant I, there must be the same number of rows as there are columns. That is, quadrant I must always be a square matrix. The same restriction is not imposed on any other quadrants and in practice the number of rows and columns in other quadrants are seldom equal.

2.2.2 The Final Demand Quadrant

The second quadrant indicates sales by each sector to final demand or more precisely, it records the disposal of output of each sector to destinations other than as inputs to other sectors in the economy, that is to the final use of goods and services as far as the economy is concerned.

The final demand quadrant typically includes household consumption, exports, capital formation, government expenditure and changes in stocks.

The final demand vectors have a special significance in the input-output matrix in that the level of activity in the final demand vectors are considered to be exogenous, autonomous or independent of the production system (intermediate sectors). Final demand is also considered important because many of the changes which occur in sector production levels do so following a change in one of the final demand vectors.

2.2.3 The Primary Inputs Quadrant

This quadrant shown as quadrant III in Table 2.1 lists inputs into each intermediate sector which originate outside the production system, that is, they are not purchased from firms within the local economy. Normally included in this quadrant are rows for components of value added (wages and salaries, indirect taxes, gross operating surplus including depreciation) and imports of goods and services from outside the economy.

2.2.4 The Primary Inputs-To-Final Demand Quadrant

The last quadrant shows those transactions which directly link the final demand and primary inputs quadrant without transmission through the intermediate quadrant. This quadrant includes the value of imported goods consumed by households, capital formation, government and exports.

The input-output matrix provides a descriptive "concise snapshot" of an economy at a point in time. It is essentially a system of double-entry bookkeeping. Within each industry in the processing sector, all of the receipts from sales are paid out for goods and services purchased from other industries or sectors. Since the output of each sector is shown to be an input in some other, the double-entry bookkeeping of the input-output table reveals "the fabric of our economy, woven together by the flow of trade which ultimately links each branch and industry to all others". [Leontief (1986; pp.5)].

2.3 THE TRANSACTIONS MATRIX

The transactions matrix is represented by a series of equations such as:-

$$\begin{aligned} X_1 &= X_{11} + X_{12} + X_{13} + Y_{11} + Y_{12} \\ X_2 &= X_{21} + X_{22} + X_{23} + Y_{21} + Y_{22} \\ X_3 &= X_{31} + X_{32} + X_{33} + Y_{31} + Y_{32} \end{aligned} \qquad \ldots(2.1)$$

It is assumed that the amount of sector 1's output purchased by sectors 1, 2 and 3 is a stable function of the latters' output, thus:

$$a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + Y_{11} + Y_{12} = X_1 \qquad \ldots(2.2)$$

where $a_{11} = \dfrac{X_{11}}{X_1}$; $a_{12} = \dfrac{X_{12}}{X_2}$; $a_{13} = \dfrac{X_{13}}{X_3}$

or in general ...(2.3)

$$aij = \frac{Xij}{Xj}$$

where i represents the (ith) row address and
j the (jth) column address in which the coefficient is located.

The aij's are referred to as direct input coefficients or technical coefficients. Writing the relationship between these elements in matrix form where the matrix operation represents a set of equations, then the result is:

$$AX + Y = X \quad \text{or} \quad Y = X-AX \qquad ...(2.4)$$

where A is a square matrix of direct input coefficients.
X is a column vector of gross output.
Y is a column vector of final demand.

Equation (2.4) can be rewritten as

$$(I-A)X = Y \qquad ...(2.5)$$

where

I is the identity matrix. [Identity matrix is a matrix which has one's in every diagonal cell and zero's everywhere else].

From equation (2.5), we can express gross output as a function of final demand:

$$X = (I-A)^{-1} Y \qquad ...(2.6)$$

where $(I-A)^{-1}$ is the inverse of matrix (I-A).

Equation (2.6) can be rewritten as

$$X = ZY \text{ where } Z = (I-A)^{-1} \qquad ...(2.7)$$

The matrix $(I-A)^{-1}$ is called the inverse matrix or more precisely the static open Leontief inverse. Each element Zij calculates the direct and indirect output required from sector j to produce one unit of output of sector i sold to final demand.

It is further assumed that primary inputs are required in fixed proportions to total output in each sector, so we can write:

$$P_{11} X_1 + P_{12} X_2 + P_{13} X_3 = P_1$$
$$P_{21} X_1 + P_{22} X_2 + P_{23} X_3 = P_2 \qquad \ldots(2.8)$$

From the total output requirements in equation (2.6), total primary input requirements are calculated by premultiplying the inverse $[(I-A)^{-1}]$ by a matrix of primary input coefficients:

$$P = PX \qquad \ldots(2.9)$$
$$= P\,(I-A)^{-1}\,Y \qquad \ldots(2.10)$$

The inverse matrix may be multiplied by a size and composition of final demand, in order to obtain the level of gross output and primary inputs for each sector. This then enables us to measure the total impact on the economy of any exogenous disturbances to final demand.

2.4 OPEN AND CLOSED MODELS

Input-output models can be "closed" with respect to certain elements of the matrix. When all sectors are considered as being both consumers and producers the system is represented by a so called "closed" model. Closure of the model involves the transfer of a particular item from the exogenous portions of the matrix (Quadrants II, III and IV) to the endogenous section of the matrix, Quadrant I. This implies that the transferred item is related to the level of economic activity in each sector, not to external influences.

The most common closure in input-output models is with respect to households. In open input-output models, household consumption is located as a column vector in the final demand portion of the table, and wages, salaries and other household income is included in the primary inputs quadrant. Closure of input-output models with respect to household will result in incorporation of the household row and column into the endogenous matrix. One way of closing the model is by assuming that the households constitute an industry whose output is labour and whose inputs are consumption goods.

2.5 LINKAGE EFFECTS

In input-output analysis, it is possible to calculate forward and backward linkage effects. These two mechanisms operate to induce the establishment of new industries and to further economic development. First, the output-utilization or forward linkage effects, that is,

> "every activity that does not by its nature cater exclusively to final demands, will induce attempts to utilize its outputs as inputs in some new activities". [Hirshman (1958; pp.100)].

While it is acknowledged that the establishment of an industry in a locality is usually a result of some pre-existing demand, Hirschman (1958) argues that the establishment of the industry in itself may help to induce demand. This is because of attempts by the producers of the goods to promote its use and hence to encourage further industrial development.

Forward linkage effects can be measured by considering elements of the ith row of the Leontief inverse which indicate the extent to which sector i provides services directly and indirectly to support activities of each of the other sectors. According to Hirschman, the measure of

forward linkage serves as a "mental experiment", as the forward linkage multipliers represent only potential forward linkage effects as they assume that the industry in question was the first to locate and that all other activities developed after its establishment and as a result of its existence. This may not be true in many cases, as an industry which shows a high degree of interdependence may infact have been the last industry to locate in the region.

Secondly, the input-provision, derived demand, or backward linkage effects, that is,

> "every nonprimary economic activity, will induce attempts to supply, through domestic production, the inputs needed in that activity". [Hirschman (1958; pp.100)].

A measure of backward linkage for any sector can be obtained by considering elements of the jth column of the Leontief inverse matrix, which estimate the direct and indirect output required by each sector, row i, by an increase in final demand in sector j.

2.6 MULTIPLIERS

Multipliers can also be calculated using input-output analysis. Input-output multipliers measure the response to an increase of one dollar in sales to final demand by a sector. The major categories of impact are in terms of output, employment and income increases as follows:

The first round effect refers to the effect of purchases by the sector providing the additional dollar of output. The elements of the direct coefficient matrix show the case of the output multiplier. First round income effects are calculated by multiplying the first round output effects by the appropriate household income coefficients. The total first round income effect is given by:

$$\sum_i a_{ij} h_i$$

and the disaggregated income effects of the extent to which household income increases in each sector due to the first round output effects is given by individuals $a_{ij}h_i$. First round employment effects are calculated in the same manner using the employment coefficient e_i in the place of the household coefficient h_i.

Second and subsequent round effects, also known as industrial support effects, refer as "successive waves" of output increases occurring in the economy to provide industrial support as a response to the original dollar increase in sales to final demand. The term excludes any increase caused by increased household consumption. Output effects are calculated from the open inverse $Z = (I-A)^{-1}$ as a measure of industrial response to the first round effects. The industrial support output requirements are calculated as the elements of the columns of the inverse Z, less the initial dollar stimulus and the first round effects. The industrial support income effects are defined consistently with the output effects multiplied by the household income coefficients. The industrial support employment effects are calculated by multiplying the output effects by the employment coefficients. Industrial support and the first round effects are together termed the production-induced effects.

The consumption-induced effect is defined as that induced by increased household income associated with the original dollar stimulus in output. The consumption induced output effects are calculated in disaggregated form as the difference between the corresponding elements of the open and closed inverse.

Appendix A looks at the coefficients and the multipliers in input-output analysis using the GRIT (Generation of Regional Input-Output Table) package in detail.

CHAPTER THREE

INPUT-OUTPUT METHOD OF MEASURING REGIONAL ECONOMIC IMPACT

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The following two sections look at the conceptual and technical problems of input-output analysis which must be borne in mind when interpreting the result derived from input-output analysis. Section 3.3 looks at the more recent problems associated with regional input-output modelling. The last section concentrates on input-output modelling in Wollongong and the movement towards demographic-economic (demo-economic) modelling to overcome some of the problems associated with traditional regional modelling.

3.1 CONCEPTUAL PROBLEMS AND LIMITATIONS OF INPUT-OUTPUT ANALYSIS

The major conceptual problems of input-output analysis stem from the assumptions which underlie its structure. The static input-output system in its simplest form is founded on three assumptions. The first assumption requires that each sector should produce a single output with a single input structure and no substitution should exist between the outputs of different sectors. The second assumption requires that the inputs into each sector are simple proportions only of the level of output of that sector, that is the amount of each kind of input absorbed by a particular sector goes up or down in direct proportion to the increase or decrease in that sector's total output. The third assumption is that the total effect of carrying out production in several sectors is the sum of the separate effects.

The first assumption is known as the homogeneity assumption and it requires that all products of a single sector should either be perfect substitutes for one another or they should be produced strictly in fixed proportions; each sector should have a single input structure; and that there should be no substitution between the products of

different sectors. This means that the same product or a close substitute should not be included in two different sectors.

One of the problems that exists is that these assumptions are not always compatible and indeed are sometimes contradictory. One example is that of wool and synthetic fibres. They are close substitutes in consumption, hence in order to comply with the "no-substitution" assumption they should be combined in the same sector. But both wool and synthetic fibres have completely different input structures, and if combined the principle of a "single input structure" is violated. Therefore, in each case a decision has to be made by the analysts of what to include in each sector. According to O'Connor and Henry (1975), each case must be considered on its own merits but generally the rule is that if a choice such as this has to be made, it is best to preserve the single-input structure rather than any other.

The assumption of linear input functions means constant returns to scale and no substitution between inputs, that is, the total effect of production is the sum of the separate effects, which rules out external economies and diseconomies. Pleeter (1980) goes as far as saying that the linear production function for each industry rules out the possibility of economies of scale altogether, which leads to troubles for regional analysis. For instance urbanization and localization economies should be accounted for in regional analysis. Urbanization economies are external economies that occur when firms in different industries locate at one locality and a corresponding urban infrastructure is built to service them. Localization arises from the location of many plants in the same industry in close proximity to each other since many ancillary firms will also locate around such an agglomeration and provide specialized services at lower costs. The existence of both these economies means that while the coefficients may be accurate at the point in time for which they were estimated,

changes may occur in the actual relations between sectors over time making assumptions of constant coefficient inaccurate and wrong.

Also, since technical coefficients of the interindustry transactions matrix are assumed to be constant, difficulty arises for technological change and productivity adjustments to be represented in the system. Innovations will lead to changes in production techniques and trading patterns (substitution among inputs), but the assumption of fixed coefficients does not recognize these events.

Coefficients, in the short run will not be affected by technical change. However, in the long run according to Almon (1966), either some assumptions about the nature of technical change must be made or a dynamic model must be constructed. There are two methods which have been used in the past to take account of changes in technological and trading patterns. The first one involves the assumption that regional coefficients change at the rate equal to national increments. A second method involves researchers judgement to future technical change. A well known method, RAS method takes into account technical changes in input-output matrices. The RAS method uses new row and column totals for the later year and alters the coefficient of an old input-output matrix according to a mathematical rule to obtain an updated, consistent input-output matrix.

The input-output models are usually static and not dynamic, as dynamic features are difficult to incorporate in the model. Complex behavioural relationships governing capital formation by businesses and housing purchases by consumers are typically calculated outside the model and forecast values introduced as exogenous components of final demand. The exogenous components may then be included as part of an impact analysis by incorporating these final demand columns into the interindustry transactions matrix and taking the inverse of the augmented matrix.

Another problem in input-output models is the change in regional structure, such as the introduction of a brand new industry. This leads to an additional row and an additional column to the input-output table and the recalculation of a number of new coefficients. If the new industry is introduced sometime after the estimation of the table then there may be serious difficulties in updating the other coefficients without a new survey, which requires more time and results in higher costs.

3.2 SURVEY VERSUS NON-SURVEY METHODS FOR DERIVING INPUT-OUTPUT MATRICES

Central to the recent debates in regional economics is the improvement of the operational efficiency of the technique(s) used in input-output analysis when preparing a transactions matrix for a particular region. The necessity to have a regional matrix as up-to-date as possible has been emphasized in statements such as the following:

> "...a more parsimonious approach to input-output data gathering might result in the production of tables more frequently, thereby increasing their utility in the provision of regional impact accounting framework". [Hewings and Janson (1980; pp.852)], and

> "...the greatest single need in input-output analysis today is a reliable method of rapidly and accurately updating transactions table" and "all published input-output data are outdated at birth". [Garlick (1984; pp.3)].

Consequently, much relatively recent input-output research is concerned with developing methods of constructing and updating regional matrices and multipliers.

3.2.1 Preparation Of An Input-Output Matrix

Preparation of an input-output transactions matrix means, in effect, attempting to account in a disaggregated form for virtually all of the transactions which occur in an economy in a given time period. This is a major undertaking in terms of the sheer volume of information required for the data-ravenous table, and the detailed treatment of these data, demands a massive input from the analysts. Analysts faced with the task of preparing sub-state regional matrices are usually seriously disadvantaged both with respect to data availability and access to research resources.

There are basically two distinct approaches to regional input-output models, and consequently two sets of technical problems: an input-output matrix may be constructed by census or "survey" methods, or by "borrowing" coefficients from other input-output matrices. The latter is referred to as a "non-survey" method. The clear distinction between the survey and non-survey method is that the former determines the elements of the transactions matrix from collections of primary data by various survey methods, and the latter attempts to derive these elements from other (usually national) matrices by various modification techniques. The other alternative method is the hybrid (partial survey) approach which has become the most popular in recent years.

3.2.2 Survey Methods

The construction of survey based input-output models requires large amounts of resources, which is not only a time consuming task but also a very costly task. In addition to the cost of data gathering, there is a serious concern of those who use input-output models in applied work in that the table coefficients available to them for the economy that they are studying may reflect data from a much earlier year. For example, the 1977-78 input-output table for Australia was not published until 1983. These time lags reflect the fact

that when establishments in different industries are surveyed for information regarding their purchases of inputs and their sales of output, it takes a great deal of time (and money) to obtain the data, organize the information, and reconcile inconsistencies.

The problem of sampling is also encountered while surveying. The sampling problem is how to determine the total number of firms and the number of firms per industry to be sampled and is best summarized by Boster and Martin (1975) who state that:

> "poorly drawn samples, sampling errors, inadequate or poorly trained field workers, and poorly conceived schedules are among possible sources of error". [Boster and Martin (1975; pp.35)]

Considerable problems could occur if we had to aggregate firms into industries where there is a high degree of diversity among firms. If one views each firm as an industry, then the advantage of the model in assembling and collecting data into a more meaningful category is lost. On the other hand, too much aggregation will result in estimated production functions that have little correspondence with the economy that they are supposed to describe, as well as producing biased forecasts.

In dealing with purchases of firms in a survey method, problems exist in trying to separate current purchases from investment purchases, to the extent that if the two accounts overlap, biases will be introduced into the model.

Imports are conventionally valued in input-output tables as cost-including insurance and freight (c.i.f.), or the landed cost of commodities. However, the classification of imports into two types of categories, namely competitive and non-competitive poses problems for the analysts. In principle, competitive imports are those imports which could be produced within the region in the short run at a

comparable cost. Careful interviews, studies with manufacturers, engineers, economists and other experts are needed to obtain this kind of information. But, in practice, the competitive/non-competitive distinction is often drawn on the basis of foreign trade statistics and industrial census data. Even though there are problems in splitting the two categories of imports, treating all imports of one type or the other can lead to severe biases in input-output forecasts.

Finally, after assembling the data, the input-output matrix must balance. That is, sales must equal purchases (including operating surplus) for each sector if the matrix is to have any validity. The input-output matrix based upon a sample will generally not balance after the initial effort. No generally accepted procedure for reconciliation (the process of equating "rows only" and "columns only" coefficients) exists. Reconciliation in the study by Bourgue (1967) was achieved largely on subjective grounds, reinforced by knowledge of data and methodology involved in the preparation of input-output matrices. Differences between rows and columns sums were eliminated by Jensen and McGaurr (1976) by using the RAS method. Miernyk in his study in 1976 attempted to incorporate in explicit terms, the concept of reliability of estimates in input-output reconciliation. A reliability coefficient was calculated for each dual entry for each cell. The reconciliation process began in the cells with the highest combination of sector reliability coefficients and exercised judgements to arrive at the actual cell entries. Therefore, as there has been no agreement on the reconciliation process, it can be said that individual judgement, often in conjunction with industry experts, is the basis for reconciliation. This means that two researchers with exactly the same data may construct two different input-output matrices, and no information is available as to which matrix is correct.

Survey methods have been the most popular and have been followed by most analysts until the late 1970's. However, now the attention has focused on non-survey techniques as the demand has grown for a wider application of the input-output approach in regional and urban planning.

3.2.3 Non-Survey Methods

The survey approach has been too costly in terms of time and resources needed for widespread application to regional planning. Boster and Martin (1972) indicate the cost comparisons between survey and non-survey model constructed for the state of Arizona. They found budget differences of the magnitude of 20:1. The large difference in cost essentially means that in most problem-oriented situations there is no alternative between survey and non-survey input-output models; it is "non-survey or nothing". There are several non-survey techniques available that are based upon adjusting technical coefficients from other input-output matrices. There is no generally agreed method as each method has weak assumptions and limitations which present problems to the analyst using the non-survey method.

Three families of techniques are outlined:

1. The location quotient procedure with three variations:

   (i) purchases-only location quotient;
   (ii) cross-industry location quotient;
   (iii) logarithmic cross-industry location quotient.

2. The commodity-balance or supply-demand pool procedure.

3. An iterative simulation procedure.

The location quotient (LQ) method was developed to help analysts estimate the exports of an area. Location quotient is based on readily available data, it is simple and provides

a convenient starting point. The location quotient is a measure which compares the relative importance in terms of output or employment of an industry in a region to its relative importance in nation or it can be expressed algebraically as:

$$LQ_i = \frac{r_i/R}{n_i/N} \qquad \ldots(3.1)$$

where LQ_i - location quotient for industry i.
r_i - represents the regional output of industry i.
R - the total regional output.
n_i - the national output of industry i.
N - the total national output.

Operationally, the regional coefficients of row i are estimated by multiplying the national coefficient by LQ_i, and apportioning the difference to imports, that is, $k_{ij} = a_{ij} LQ_i$ where $LQ < 1$ and where a_{ij} is the national technical coefficient and k_{ij} is the regional technical coefficient. A $LQ < 1$ means that the region produces less than its share of national output in industry i and imports are therefore required. A $LQ = 1$ means that the region is self-sufficient in industry i and a $LQ > 1$ means that the region exports some of output i.

The location quotient procedure is grossly deficient. There is no guarantee that the residual will exist when $LQ_i > 1$ nor that the local production is inadequate to supply local needs when $LQ_i < 1$. Inter-industry flows into cell ij depend on the size of local purchasing industry j relative to its national counterpart and, in the case of an importing industry, on LQ_i. Success in using the simple location quotient is ensured if the local industry structure closely resembles the national structure; this is a requirement which is seldom ever met.

Other types of location quotients have been developed to overcome the deficiencies of the simple location quotient. The main variations to the simple location quotient are Charles Tiebout's 1967 suggestion of purchases-only location-quotient; cross-industry location quotient (CILQ) (Schaffer and Chu, 1969), and the logarithmic cross-industry location quotient (LCILQ) (Round, 1972). Purchases-only location quotient recommends that the "summation of total output in the calculation of the quotient for industry i should be carried out only over those industries which make purchases from industry i. However, the impact of this modification upon the results is comparatively slight". [Schaffer and Chu (1969; pp.95)]. Cross-industry location quotient compares the proportion of national output of selling industry i in the region to that for purchasing industry j or:

$$CILQ_{ij} = \frac{r_i/n_i}{R_j/N_j} \qquad \text{...(3.2)}$$

The third type of location quotient, the LCILQ refines the CILQ by taking into consideration the relative size of the region compared to the nation. LCILQ takes the form:

$$LCILQ_{ij} = LQ_i/\log_2 (1 + LQ_j). \qquad \text{...(3.3)}$$

where LQ_i = location quotient of selling industry i.
LQ_j = location quotient of purchasing industry j.

Schaffer and Chu proposed the second non-survey technique, the supply-demand pool (SDP) which is based upon Isard's (1953) derivation of regional commodity balances. The supply-demand pool method relies upon subtracting total regional requirements from total regional output in each industry to obtain a net deficit or surplus. If a deficit is obtained, the implication is that local demand is greater than local supply, and importation of goods and services will be necessary. Hence, the national coefficients of row i have to be reduced. However, if a surplus is obtained for

industry i, then the local supply is sufficient to cover local demand, and the national coefficients may be used in row i of the regional coefficients matrix.

The pool technique was modified by Kokat (1966) and results in a slight change in the procedure allocating insufficient local production. Kokat allocates to each purchasing industry j its share of regional output i available to producers, based on the needs of the purchasing industry itself relative to the needs of all purchasing industries.

The main weakness of the commodity approach and the location quotient approach is that balances are stated in net terms. Thus, the possibilities of accounting for cross-haulage (the import and export, of similar goods by an individual sector) are denied, implying the assumption that within-region trade is maximized. This, in turn, implies that the supply-demand pool technique will tend to overstate sector multipliers. Another limitation of the supply-demand pool and location quotient techniques is that the rows of the region's export sectors cannot be adjusted for imports, that is, the national coefficients will overstate the industries' sales to local processing industries.

An iterative procedure is our final technique in computing input-output matrices by the non-survey method. This technique embodies several of the above devices but employs an iterative procedure to redistribute local sales allocated initially on the national sales pattern. The Regional Input-Output Table (RIOT) Simulator not only assumes that the national production technology applies, but also attempts to distribute local production according to both the national sales pattern and local needs. This procedure differs basically from the supply-demand pool technique in attempting to follow the national sales pattern to distribute local output and in reallocating local sales from one cell to another as necessary to best satisfy local needs. It thus appears to represent the feasible maximum of local trade.

Non-survey methods may prove to be a useful supplement to survey studies. According to Jensen, if there was a consensus in the matter of survey and non-survey approaches in input-output analysis, it would probably be that the survey approach is the most attractive both theoretically and intuitively. However, on practical grounds and cost considerations, non-survey techniques seem to be the more appropriate ones.

3.2.4 Semi-Survey Methods

Some have suggested a hybrid approach as a compromise between the two approaches in order to gain the advantages of both methods and to avoid the main disadvantages.

Richardson (1972) and Cutbush (1973) refer to the possibility of using non-survey techniques to estimate the elements of the initial transactions matrix, but to replace the entries in this matrix relating to a few key or problem industries with survey-based estimates.

The first group of semi-survey technique known as a constrained matrix, refers to adjustments used to estimate a solution matrix, given row and column totals and an input-output matrix which may be taken as providing information with respect to the internal structure of the required matrix. A technique derived by Stone and Leicester, in 1966, known as RAS, derives a matrix A^1 of regional coefficients (a_{ij}) from the national matrix A of technical coefficients. The elements of A^1 has to be consistent with a pair of vector x^1 and y^1 which are vectors of total regional intermediate output and intermediate input, by sector. It was argued by Stone that all determinants of change in input-output coefficients be summed under two headings. One heading being the fabrication (f_i) effect, and the other the substitution (s_j) effect. The former refers to changes in the degree to which intermediate inputs have uniformly increased or decreased in weight in the fabrication of commodity j, and

the latter refers to changes in the degree to which i has uniformly been substituted for or replaced by other intermediate inputs. Validity of this method rests entirely on the empirical evidence. Gretton and Cotterell (1979) defined three more consequences which result in input-output coefficients changing. They are the price effect, imperfect data effect and the concept and definition effect. The price effect is measured by the extent to which changes in relative prices bring about changes in coefficients. The imperfect data effect is measured by the extent to which coefficients change on account of the inclusion of inaccurate estimates in either the base or current period tables and the concept and definition effect is measured by the extent to which coefficients change on account of conceptual and definitional changes.

Su (1970) proposed a technique emphasizing the direct estimation of imports. He came up with the conclusion that the regional coefficients differ from their national equivalents to the extent that some inputs will be imported from other regions, due to the production process being invariant between regions in terms of their input structure. Alternatively, Schaffer (1970) suggested direct estimation of exports. This is the "rows only" approach. Regional firms were surveyed for annual sales and the proportion of sales to purchasers outside the region. This information is then applied to calculate regional coefficients in a similar manner to the commodity balance approach.

A third technique developed by Jensen et al (1976) is termed the Generation of Regional Input-Output Tables (or GRIT) system. GRIT is designed for general use in the production of regional input-output tables from both national input-output tables and other data sources. GRIT is described by Jensen et al as a "variable-inference" non-survey based system, producing hybrid (i.e. a combination of non-survey and survey) input-output tables. GRIT is based on

a combination of non-survey methods, but allows modifications of mechanically produced tables at the discretion of the analysts, to produce more realistic input-output tables.

The GRIT system was developed at a point in time when regional input-output analysts were facing two dilemmas. The basic dilemma faced by input-output analysts was neatly summarized by Miernyk (1976) when he said:

> "The truth is that our capacity to develop highly sophisticated regional models has far outrun our ability to implement them, given the primitive nature of available data and data-gathering techniques".

The necessity of acquiring voluminous amounts of data to undertake such analyses has often hindered their application.

The second dilemma is reflected in apparent conflict between the statements that "there is still no substitute for a good survey-based study" and that it is "non-survey or nothing".

This second dilemma is whether a survey method should be used where time lags and cost are the major disadvantages, but accurate results are guaranteed; or should a non-survey method be used which produces matrices of apparently a lower degree of accuracy. The GRIT system is a response, taken in the context of the two dilemmas facing regional analysts. GRIT is to provide an operational method, free from "significant error", for regional economic analysis. The distinct advantage lies in non-survey techniques of input-output, in both time and money terms and therefore, selected non-survey techniques form the basis of the GRIT system.

GRIT relies on a series of mechanical steps to produce prototype regional tables from the national table but provides the opportunity at several stages for the insertion of "superior data". The authors found that the GRIT system,

in the final analysis is a "variable-interference" non-survey technique, producing tables known as "hybrid". It is variable-interference to the extent that the operator might exercise discretion regarding the amount of superior data from survey or other exogenous sources, to be inserted into the tables. This feature directly incorporates a trade-off at the discretion of the operator between survey and non-survey sources of coefficients, and consequently a tradeoff between time-and-cost component and the satisfaction of knowing that data has been gathered by the more "respectable" survey methods. The GRIT methodological sequence is expressed in fifteen steps which is arranged in five phases as summarized in Table 3.1.

Other techniques are the regional weights and aggregation techniques which account for the differences in industry mix in the region vis-a-vis the nation. Mandeville (1975) advocates the use of "representative" regional input-output coefficients, by "borrowing" selected coefficients from survey-based matrices already constructed for a similar region.

3.2.5 Evaluation of Non-Survey Methods

The non-survey methods provide advantages over the survey methods in term of time and cost but have a disadvantage in that they are not as accurate as survey-based methods. Most of the techniques have not been subjected to rigorous evaluation until now. The evaluation literature is restricted largely to the location quotient, commodity balance and constrained matrix techniques.

Schaffer and Chu (1969) compared simulated input-output matrices with a Washington survey based matrix and computed Chi-square statistics for each column of matrices. The authors found that the best results, in terms of simulating acceptable coefficients, were obtained with the simple location quotient followed (in rough order) by the cross-

Table 3.1: The GRIT Methodological Sequence

Step No.	
	Phase I: Adjustments to National Table
1	Start with national input-output table. (109-sector table with direct allocation of all imports, basic values, net of intrasectoral transactions).
2	Adjustment of national table for price levels and updating.
3	Adjustment for international trade.
	Phase II: Adjustment for Regional Imports
	(steps 4-14 apply to each region for which input-output tables are required).
4	Calculation of non-competitive imports.
5	Calculation of competitive imports.
	Phase III: Definition of Regional Sectors
6	Insertion of disaggregated superior data.
7	Aggregation of sectors.
8	Insertion of aggregated superior data.
	Phase IV: Derivation of Prototype Transactions Table
9	Derivation of initial transactions tables.
10	Manual or iterative adjustments to initial tables to derive prototype tables.
11	Aggregation if uniform tables are required.
12	Derivation of inverses and multipliers for prototype tables.
	Phase V: Derivation Of Final Transactions Tables
13	Final superior data insertions and other adjustments.
14	Derivation of final transactions tables.
15	Derivation of inverses and multipliers for final tables.

Source: Jensen, et al (1979); pp.56.

industry location quotient, regional input-output simulation compared and in every case the non-survey based multipliers overestimated those derived from the survey matrix. The best estimates were those resulting from the application of the simple location quotient technique.

Czamanski and Malizia (1969) used the 1958 national input-output matrix of the U.S., and regional estimates of gross sector outputs and vectors of the intermediate output and inputs, and had applied the RAS method to generate a 1963 regional matrix for the State of Washington. The authors examined the quality of results obtained in respect of individual sectors and found the largest errors were manifest in the primary sectors and also in sectors in which the region specialized. As a result, it was suggested by Czamanski and Malizia to exclude tertiary sectors through aggregation and instead use field surveys in order to obtain input-output coefficients for primary industry and industry in which the region is specialized.

Smith and Morrison (1974) tested a number of non-survey methods such as simple location quotient, purchases-only location quotient, cross-industry location quotient, logarithmic cross-industry location quotient, supply-demand pool and RAS. The simulated matrices and multipliers were compared with the survey-based equivalent.

In terms of matrix comparisons, the authors found that the RAS technique gave far superior results to the other reduction methods followed by the simple location quotient, purchases-only location quotient, supply-demand pool, and finally the logarithmic cross-industry location quotient and the cross-industry location quotient. Type I and Type II income multipliers were calculated and compared with those from the survey matrix. Again, the best results were obtained from the RAS method and then followed by cross-industry location quotient.

Morrison and Smith's (1974) results showed that the RAS approach, supplemented by survey or exogenous data, can provide greatly improved and perhaps superior data. However, Malizia and Bond (1974) found large and theoretically unsystematic coefficient errors, and along with Miernyk, recommended against the use of RAS for adjusting input-output coefficients.

3.2.6 Summary

In summary, there appears to be little or no agreement at all as to which technique, if any, is satisfactory for manipulating national matrices in order to generate multipliers. Many location quotient techniques have been devised but none of them seem to have improved from the simple location quotient. The RAS method, according to Morrison and Smith (1974), can provide greatly improved and superior data as long as it is supplemented by survey or other exogenous data.

A GRIT-type model is considered a preferred alternative, but the final specifications of the model depend on the amount of data that needs to be acquired by survey. It is considered that the amount of survey work necessary depends on a number of factors, including:

- the amount of available published data;
- the type of region being examined;
- the number and type of industries being analyzed.

A modification of the GRIT method was used for the derivation of the input-output matrix of the Wollongong Statistical District by Guest, Mangan and Robinson which was subsequently used for analysis in the present study. Therefore, the problems of non-survey methods must be borne in mind when interpreting the results derived from it.

3.3 PROBLEMS OF REGIONAL INPUT-OUTPUT MODELLING

Regional input-output models have been by far the most popular regional economic models over the last decade. However, traditional input-output analysis is deficient in some respects which leads to the estimation of unrealistic impact forecasts. The main problems being the following:

1. The treatment of consumption effects; that is, only consumption of workers were considered. The traditional input-output model simply treated workers as another sector who received wages and then used these wages to consume the necessary "raw" materials to continue as an "industry". Thus, to measure the impact that the consumption of unemployed household would have on the regional economies was not quite possible. Similarly, the impact of the aged (economically inactive households) was not traditionally considered.

2. When examining the consumption of workers, the traditional model only included the market expenditure of workers, that is, as stated by Phibbs (1987) "unless there is a money transaction, their consumption is considered to have no impact on the regional economy. However, a large part of the service sector is operated in the public sector, and hence is not dependent on cash flows. Rather, the size of this sector is influenced by the size of the population, or in other words it is 'population-driven'" [Phibbs (1987; pp.5)]. Also, in most economies, there exists a non-monetary household economy based upon work provided by family members or mutual "barter" trading of services among members of the community. While this form of non-market economy is difficult to quantify, its importance is likely to be directly related to economic recession and the presence of this kind of phenomenon only strengthens the role of population-driven economic factors.

3. Data problems arise in most empirical studies. These problems are associated either with access (where the researcher is constrained by confidentially or other privacy restrictions) or from data impurities within the primary source.

4. Specification of the labour supply input. In many cases the employment data listed in the tables refers only to absolute job numbers irrespective of significant differences in job-status among the workers. These job status differences refer to the normal distinction between full-time and part-time and also to the differences in hours worked among those classified as part-time. In other words, all jobs are not homogeneous. Therefore, the labour supply aspect of the workforce should be modelled.

It is important to note here that the static nature of input-output analysis is not good for the rapid change that the economy may be experiencing.

To overcome the above problems of standard input-output analysis (related specifically to the hybrid approach) regional economists developed an alternative form of model, generally referred to as a demo-economic model, to which we now turn our attention.

3.4 INPUT-OUTPUT MODELLING IN WOLLONGONG, AND THE MOVEMENT TOWARDS DEMO-ECONOMIC MODELLING

Mangan and Guest in 1983 used standard input-output analysis to predict job losses in Wollongong following the restructuring of the steel industry. The authors predicted in 1983 that the decline in steel production and employment would produce a total additional job loss of 7900 between 1983 and 1985. However, Sandercock and Mesler in 1986 indicated that actual job losses (to 1986) were in order of 5000 (including coal workers). The Wollongong economy had proven more resilient than expected and while increased

government expenditure, tourist growth and a partial recovery in the steel industry had contributed to this recovery, it appears likely that of the estimates of the economic impact of steel industry restructuring by Mangan and Guest were exaggerated because of the methodology they used.

This exaggerated result highlighted one particular deficiency in input-output analysis, namely the treatment of consumption spending. In particular, the failure to specify the consumption of the non-workforce population and the impact they have on the economy. Recent work has shown the tendency for standard input-output multipliers to overstate the negative consumption effects of economic downturn. This has led to some concern over the accuracy of the standard input-output techniques in formulating economic policy prescriptions, as the unemployed workers, through social security payments, continue to support fixed consumption expenditure. What is then needed is to "produce quantitatively more accurate estimates of the impact of economic recession, is to incorporate into the derived coefficients of an input-output table, the effect of the consumption safety net provided by social security payments and dissaving". [Mangan and Phibbs (1987; pp.114)].

This was done by the authors by taking Table 3.2 which shows the comparison between the expenditure by those households whose main income is unemployment or sickness benefits with the expenditure patterns of those households whose incomes approximate more closely of those of displaced steel workers.

Looking at Table 3.2, the first column lists the expenditure of wage and salary earners while the second column lists the expenditure of the unemployed households. The last column expresses the expenditure of the unemployed households as a percentage of wage and salary household expenditure. The last column has been modified for the consumption effects. The result here has been artifically changed, it is an approximation which has been incorporated into the model.

Table 3.2: <u>Consumption Expenditure of Wage and Salary Earners and the Unemployed (1984; dollars)</u>

Description	4th Decline W & SH.H	All Unemployed H.H	Col(2)/Col(1) * 100
	$	$	%
1. Housing costs	53.48	44.43	83.1
2. Fuel and power	10.78	9.13	84.7
3. Food	73.44	56.15	76.4
4. Alcohol	12.88	6.83	53.0
5. Tobacco	7.24	7.64	105.5
6. Clothing & footwear	20.55	12.15	59.1
7. H/hold furn. & equip.	28.81	15.74	54.6
8. H/hold services	15.20	11.16	73.4
9. Medical expenses	14.39	4.93	34.3
10. Transport	60.73	41.11	76.7
11. Recreation	47.42	18.55	39.1
12. Personal care	6.69	3.80	56.8
13. Misc. commod. & serv.	22.81	17.69	77.6
Total	374.42	249.22	66.6
Weekly H.H. Income	436.53	177.62	40.7

<u>Source</u>: Mangan and Phibbs (1987); pp.114.

The results show that fixed expenditure will be reduced but by smaller amounts than other categories. [For example, sausages will be substituted for chops]. Expenditure on variable consumption items has dropped between 50% and 75% of the former level. The exception being recreation, where the decrease is even more marked. There has been an increase in tobacco expenditure, and to a lesser extent, alcohol expenditure (stress related goods), but there has been a decrease in health care, because of the availability of free health care for the unemployed. Table 3.2 also shows that the propensity to consume of unemployed sector is greater

than 1 (dissavings). This acts to limit the consumption - induced impacts of an increase in unemployed, at least in the short run.

The employment multipliers were also calculated and the results are shown in Table 3.3. The authors took column (4) of consumption, but they really had to look at the differences between the two methods, which lead to the calculation of type 2A multipliers. Type 2A multipliers represent the ratio of direct, indirect and induced income to direct income from each sector. The implication of the reduction of type 2A multiplier of 0.72 from 2.5 to 1.78 are quite significant. More importantly, the job loss predictions from this modified multiplier yields results far more in keeping with what actually occurred. That is, from the original steel industry prediction of job losses of 7,900, the modified model predicted job losses of 5,600, which is much closer to the true case.

Table 3.3: Steel Sector Employment Multipliers

	(1) Initial	(2) First	(3) Industrial	(4) Consumption	(5) Total	(6) Type 2A
Standard employment multiplier	0.0092	0.0044	0.0016	0.0079	0.0231	2.52
Employment multiplier (a)	0.0092	0.0044	0.0016	0.0067	0.0219	2.40
Modified employment multiplier	0.0092	0.0044	0.0016	0.0012	0.0164	1.78

(a) using consumption coefficients of the unemployed.

Source: Mangan and Phibbs (1987); pp.115.

Therefore, for realistic forecasts of economic impact, a specific demographic component needs to be incorporated. The traditional input-output approaches ignored the fact that to

some extent regions are population driven. That is, the full effects of economic decline in a region will only occur if displaced workers along with their families leave the region. If they stay, the safety provided by social security, government spending and family support tends to produce impacts that are smaller than those predicted by traditional regional analysis. The failure by Mangan and Guest to incorporate the role played by the social security payments in offsetting the consumption impacts of the unemployed, were responsible for a large part for the exaggerated job loss estimates. Therefore, it is necessary to differentiate between workers who lose their jobs and remain in the region and those who emigrate. This led to demo-economic modelling in Wollongong.

CHAPTER FOUR

EMERGENCE OF DEMOGRAPHIC-ECONOMIC MODELLING

CHAPTER FOUR

EMERGENCE OF DEMOGRAPHIC-ECONOMIC MODELLING

In order to overcome the problems associated with regional input-output modelling (outlined in the previous chapter) and to achieve sensible forecasting results using input-output analysis, it is necessary to consider the integration of demographic and economic analysis and forecasting. Traditionally, planning studies for non-metropolitan areas were undertaken by economists who prepared regional economic projections and the demographers undertook population projections. These exercises were mainly carried out independently. However, it became evident that such an approach was likely to generate substantial problems in terms of reliability of the end product. Yet the integration process itself also presents problems. For example, problems of (i) those relating to the economic-demographic link, or the effect that the economy has on population (known as interface 1); and (ii) those relating to demographic-economic link, the effect that the population has on the economy (known as interface 2). The economic-demographic link is mediated through migration and through changes in economic activity rates, headship rates and other demographic characteristics that can be reasonably expected to be influenced by economic factors; while the demographic-economic link is mediated through personal consumption.

The two most important facets of the linkage problem (and evidence tends to support this) - involve accurate modelling of migration in the economic-demographic link and some explicit treatment of the effects of unemployment on personal consumption in the demographic-economic articulation.

Here the concentration will mainly be on assessing regional impacts, that is, the deomgraphic-economic (demo-economic) model. This is consistent with recent trends in

regional modelling, where attempts to model demographic and economic variables simultaneously have been widespread. One can only agree with Schinnar (1976) who states:

> "There is abundant evidence pointing to the fact that demographic variations have been induced by manipulations or movements in economic variables, and conversely, that demographic changes have important feedback effects on economic matters". [Schinnar (1976; pp.455)].

Madden and Batey (1980) built a demo-economic model after identifying an inconsistency concerning unemployment in traditional input-output analysis. This inconsistency is explained in the following terms:

> "For forecasting purposes, the derivation of household consumption vector...relies on an exogeneous forecast of household numbers, and some assumptions about the unemployment rate of the population making up those households. The consumption must then be incorporated into a final demand vector, which is premultiplied by the Leontief inverse. From these gross outputs labour demand figures may be obtained by means of coefficients relating employment to gross output. Labour supply is made up of the economically active members of the households whose consumption was incorporated into the final demand vector used to generate the forecast. Comparison of labour demand with labour supply yields an unemployment rate which is equal to the assumed (input) rate only by chance". [Batey and Madden (1981; 1067)].

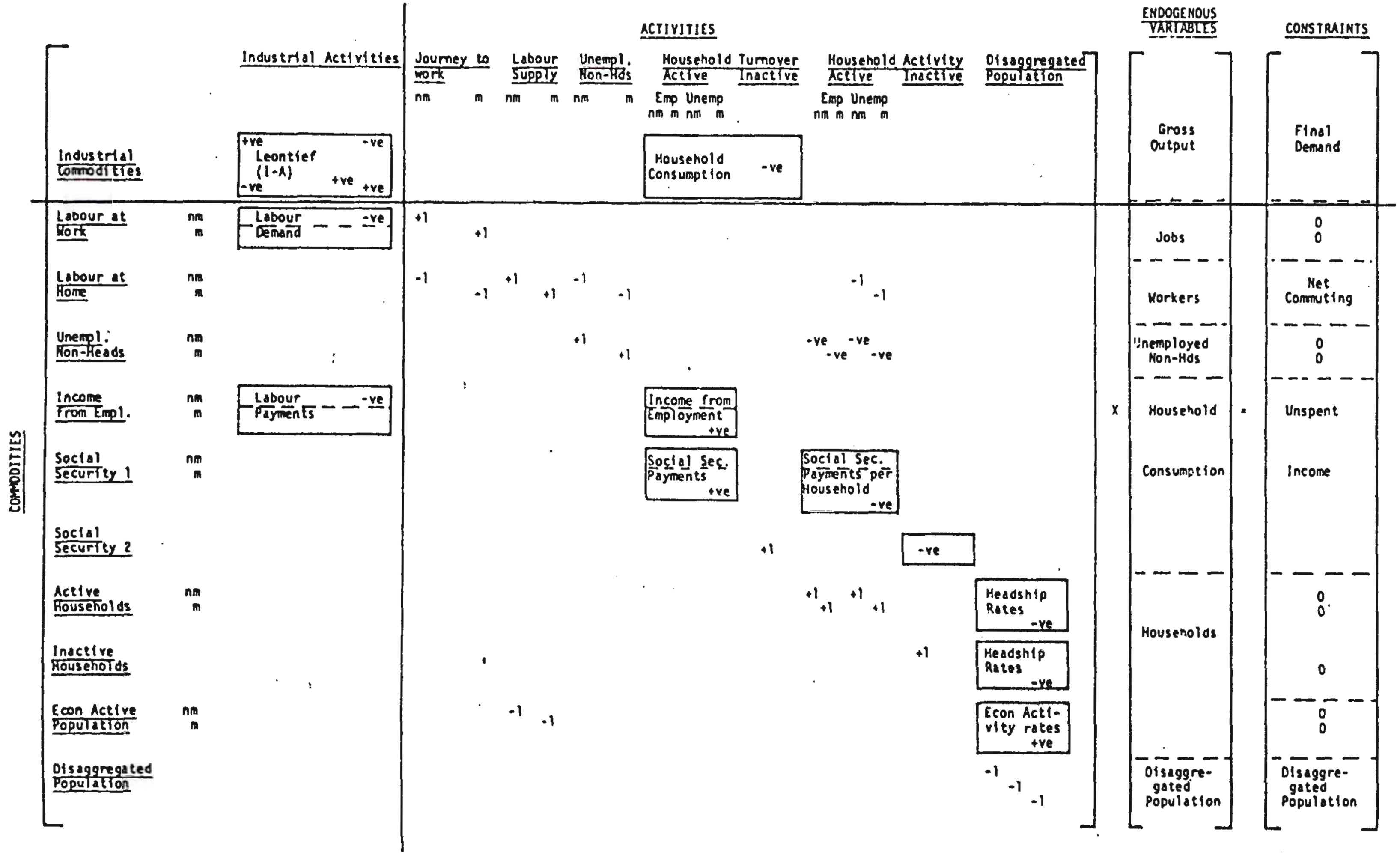
This can be explained in detail by looking at the activity-commodity framework.

4.1 ACTIVITY-COMMODITY FRAMEWORK

The problem of achieving consistent forecasts of population, unemployment and economic activity can be tackled effectively by setting individual forecasting models within a single, overall framework, described by Batey and Madden (1980) as an activity-commodity framework. An activity-commodity framework consists of a set of simultaneous linear equations. The variables are activities and the coefficients of the equations are derived by dividing inputs to and outputs from activities by the level of activity. For example, a particular industrial sector might be said to consume a certain number of workers (that is, they work in that sector). The appropriate coefficient might be obtained by dividing the number of workers in that sector by the gross output of the sector.

Figure 4.1 shows an activity-commodity framework: This framework is essentially an extended input-output model and has an advantage that the demographic-economic system can be represented explicitly. The framework is characterized by a series of interrelated activities each consuming and producing one or more commodities. These activity vectors are grouped in matrix form, with commodities as rows and activities as columns. Each activity has an activity level which measures how much of an activity is utilised. The activity levels in the matrix of coefficient may be expressed in different units within the same framework. Coefficients are given negative signs if they represent consumption of a commodity by an activity and a positive sign if they represent production of a commodity by an activity. The matrix of coefficients is used to premultiply a column vector containing the activity levels, the result being set equal to a column vector of constraints. These constraints allow restrictions to be placed upon the level of consumption and production of commodities, and also enable exogenous inputs to be entered into the framework.

Figure 4.1: A Typical Activity-Commodity Framework



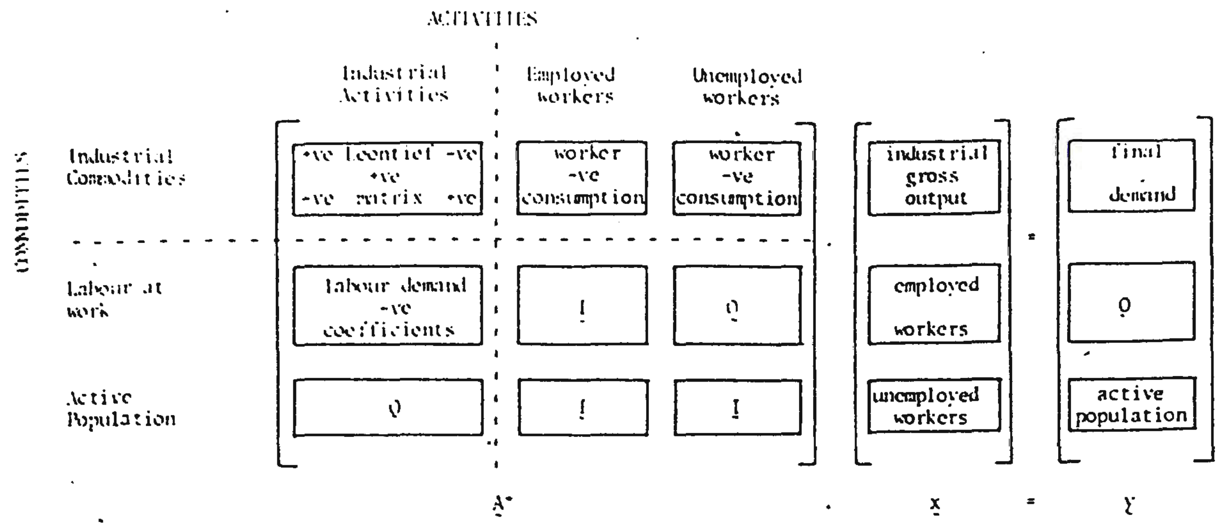
Source: Madden and Batey (1983); pp.148.

The matrix of coefficients is square, as the number of activities represented in the framework is equivalent to the number of commodities. That is, the framework will yield a determinate solution (expressed as a vector of activity levels) in response to changes introduced via the constraints vector.

Figure 4.1 includes Leontief's (I-A) submatrix, which describes the interrelationships between industrial activities and commodities. The activity levels associated with these industrial activities are the gross outputs of the industrial sectors, and the corresponding constraints on the industrial commodities are final demand.

From Figure 4.1, we can see that household consumption is represented as a series of column vectors - with several types of households being separately identified. Figure 4.2 illustrates the consistent personal consumption coefficients for employed workers and unemployed workers. If it is assumed that there are two corresponding sources of personal income - income from employment and income derived from social security payments to unemployed workers - and that all other sources can be ignored, we have a basis for a procedure which allows the regional effect of the social security payments to be isolated. Such payments can be regarded as "injections" of consumer spending within the local economy, as they tend to originate from state or national government outside the study region. In declining regions they may represent the only income of a substantial proportion of the workforce. Therefore, it is important to be able to measure the direct, indirect and induced effects which this income has upon industrial output and the overall level of employment.

Figure 4.2: The Personal Consumption Framework



Source: Batey and Madden (1983); pp.317.

Most forms of input-output model differ from this personal consumption framework in that they either ignore unemployment completely or make a prior assumption that it accounts for a fixed and small proportion of the workforce. This implies that when industries hire or lay off workers, as a response to change in gross output, those workers experience an absolute shift in consumption. Thus, in the previous models, as long as the workers remain unemployed, their consumption had no measurable impact on the local economy. As a result, the activity-commodity framework results in an automatic adjustment to the weighting given to the various types of household activity in order to be consistent with the activity levels of unemployment. Given an exogenous input of demographic variables, the framework enables the split between employed and unemployed heads of household to be calculated, and thus ensures labour demand, unemployment, and household consumption are mutually consistent. The distinction is also made between workers and heads of household according to their occupational skills: manual (m) and non-manual(nm). It includes headship rates coefficients, so that the treatment of households and of labour supply is endogenous, rather than a separate exercise outside the framework.

The activity-commodity framework can also be looked at in the following way:

The framework is structured such that the matrix of coefficients is post - multiplied by a vector of endogenous variables or activities and set equal to a vector of constraints, as described above. Formally we write as:

$$A^* X = b \qquad \ldots(4.1)$$

where

A^* is the matrix of coefficients.

X is the vector of activity levels.

b is the vector of constraints.

A typical equation from this framework, referring to the active households non-manual (nm) row would be:

$$X_{n+12} + X_{n+14} - hr_1x_1 - hr_2x_2 - hr_3x_3 = 0 \qquad \ldots(4.2)$$

where

X_{n+12} is the number of active employed non-manual households.

X_{n+14} is the number of active unemployed non-manual households.

hr_n is the headship rate of the nth population cohort x_n.

We have a Leontief (I-A) matrix in the matrix A^*, and have a dissaggregated set of consumption vectors such that the equation

$$(I - A)X_i - H_cX_h = d \qquad \ldots(4.3)$$

is satisfied where

H_c is the matrix of consumption vectors.
X_i is the subset of industrial activities.
X_h is the subset of household turnover activities.

Now, the system can be solved by one of the two methods. If a rectangular system is assumed, in which the number of activities is not equal to the number of commodities, we can select an objective function from our variable set and minimize or maximize subject to equation (4.1). If the framework is square, we can solve through

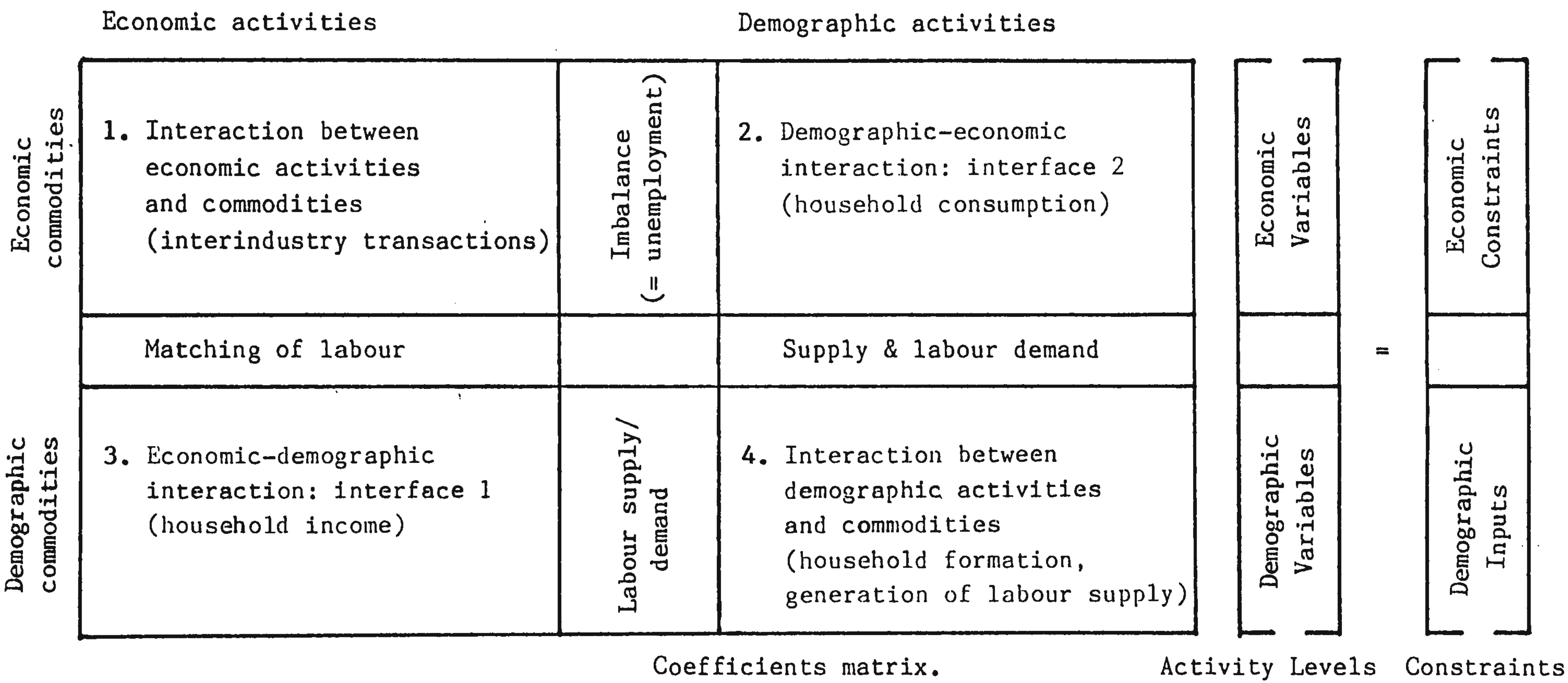
$$X = (A^*)^{-1} b \qquad \text{...(4.4)}$$

noting that by carrying out this inversion a Leontief - type inverse is embedded within $(A^*)^{-1}$.

Therefore, by defining and solving a framework of this kind, it is possible to distribute simultaneously the population into employed and unemployed households, in this case adding inactive households as well as breaking down active households into two types, manual and non-manual. Since the equation system itself is inherently consistent, inconsistencies in the treatment of unemployment do not arise. The solution of the equations by matrix inversion in a way combines the simultaneous and the simulation approaches to the problems of the demographic-economic interface.

Figure 4.3 gives us a summary of the principal demographic and economic relationships embodied in the forecasting framework which is obtained by partitioning the matrix of coefficients into four quadrants. We find the Leontief (I-A) matrix containing the relationship between economic activities and commodities in quadrant 1. Quadrant 2 represents demographic-economic interaction which contains the household consumption coefficients. Interaction between demographic activities and commodities (for example,

Figure 4.3: <u>The Basic Structure of the Demographic-Economic Forecasting Framework</u>



Source: Batey and Madden (1981); pp.1070.

household formation) is shown in quadrant 3. Quadrant 4, contains labour demand coefficients relating employment to industrial gross output.

Population enters the demographic-economic system through the constraints vector b along with changes in final demand not due to household consumption. A defect in the present system is its failure to treat migration inside the A* matrix, which must be rectified. When the activity-commodity framework is used as a forecasting device, there exists a problem concerning the static nature of the headship rates, economic activity rates, and input-output coefficients. To solve this problem, a dynamic input-output relationship is needed.

4.2 DEMOGRAPHIC-ECONOMIC ANALYSIS

The activity-commodity framework is suitable as an aid to regional impact analysis, where quick results are needed. The activity-commodity framework is solved by inverting its matrix of coefficients. This solution method yields a determinate solution expressed as a vector of demographic and economic activity levels, and this has much in common with the inversion of a matrix of technical inter-industry coefficients in a Leontief model. The set of entries in the activity-commodity framework inverse represents the effects of changes in the constraints (final demand and demographic variables) vector on the variables of a consistent forecasting system. Within this consistent inverse, we find a set of entries which are directly comparable with those of a conventional Leontief inverse, and from which it is possible to construct multipliers which relate to those of an input-output model.

4.2.1 Impact Multipliers and Household Sector

In a household-exogenous input-output model, the income multipliers represent the ratio of direct and indirect income changes to direct income changes, for each individual industrial sector, and are generally known as type I multipliers. They ignore the income/consumption second round onwards effects of households. Household-endogenous models, in which the inverse is enlarged to include wages paid to labour and household consumption, give rise to type II multipliers. Type II multipliers represent the ratio of direct, indirect, and induced income to direct income for each sector. Type II multipliers treat the household sector as an industry whose inputs are consumption goods and whose output is labour.

Both type I and type II multipliers suffer from the restriction that only one pattern of household is adopted. That is, the relationship between consumption and income assumes a homogeneous population of households with an average consumption propensity. Therefore, only one pattern of household consumption is represented, as households are confined to a single row and column in the model. This is clearly an unrealistic assumption since there are a variety of households exhibiting different consumption patterns. Incomes of households will vary as the households enter (or leave) the region.

Therefore, to create homogeneous expenditure and earnings categories in household-endogenous model, we adopt a disaggregated household sector. Disaggregation in the past has taken many forms. Miernyk distinguished households according to previous residence of their principal workers and developed a so called type III income multiplier. A more ambitious approach was suggested by Miyazawa (1976) which involved the disaggregation of existing wage earners' expenditure by the income group of the wage recipient.

Third approach to disaggregation, is by looking at the consistent activity-commodity framework. Here a distinction is made between the consumption patterns of households with an employed head and those with an unemployed head. Batey and Madden (1981) derived a type IV (demo-economic) income multiplier. Here, changes in income and consumption are not treated as being immediately related to one another as type II models do. This consistent framework recognises that, a decrease in wages to labour do not mean identical decreases in household consumption. Even if the household income falls, or is removed completely by redundancy, households do not necessarily spend correspondingly less, or disappear altogether from the system. The government provides social security, which takes the place of income from employment, and consumption is affected in different ways.

Type IV multipliers are calculated in the same manner as type I multipliers, the only difference being that instead of using entries from Leontief inverse, interindustry entries from the inverse of the consistent framework is substituted. The type IV multiplier for a given sector j is given as:

$$\sum_{i=1}^{n} b_{11}^{ij} h^{i}_{r}/h^{j}_{r}$$

where

n is the number of industrial sectors.

b_{11}^{ij} is any given entry in column j of the interindustry quadrant of the consistent inverse.

h^i_r, h^j_r are entries for sector i and j in a row vector of income from employment coefficients.

By incorporating differential consumption vectors in consistent frameworks, it is possible to identify the ratio between direct, indirect, and consistent induced income and direct income for each industrial sector. According to Batey

and Madden (1981), the type IV multipliers (demo-economic multipliers) will be smaller than the traditional type II multipliers since:

> "consumption is treated as an increment - so that people moving into employment from unemployment increase their consumption by a margin rather than by the amount they are newly receiving as income (ignoring savings), and vice versa - we can expect type IV multipliers to be smaller than type II multipliers, but nevertheless larger than the type I multipliers which ignore induced effects altogether". [Batey and Madden (1981; pp.1072-73)].

Apart from the consistent income multipliers consistent production multipliers and employment multipliers can also be obtained.

4.2.2 Relationship Between Multipliers

There is a consistent relationship between type I and type II multipliers [see Bradley and Gander (1969) for proof]. We noted above that type IV multiplier lies between type I and type II multipliers. Type IV and type II multipliers are both derived from household-endogenous models, and so each multiplier embodies an induced income effect, as well as direct and indirect effects. Any difference in the size of the two multipliers for a given sector will be due entirely to differences in the magnitude of the induced effect, since the two models are identical in their treatment of interindustry relationships.

Type II model and type IV model differ considerably in terms of complexity of the induced effect. Madden and Batey (1983) summarize the differences between the two models:

"The type II model incorporates a relatively simple mechanism. An increase in the gross output leads to an increase in the wages bill, suggesting that new workers are moving into employment. These new workers are assumed to have previously been outside the local economy, and neither to have received income nor to have consumed goods and services produced within the local economy. The increased wages bill is subsequently translated into household consumption.

The type IV model, on the other hand, contains a more sophisticated mechanism. A gross output increase is translated into an employment increase and this can mean a change in household mix and therefore a change in household consumption. This will not always be the case, however. Not every new job will go to a head of household, and yet only if a head of household becomes employed will there be a shift from unemployed head to employed head and a consequent increase in household consumption.

Once the shift in household categories has taken place, we find that a certain number of households are consuming at a higher rate, because they have moved from the unemployed household consumption rate to that for employed head households. We can see, therefore, that the increase in household consumption in the type IV case is due to a marginal shift from one category of consumption to another, rather than the absolute change (from no consumption to some consumption) implied by the type II model". [Madden and Batey (1983; pp.157)].

This section can be concluded by saying that the intersectoral variations in the ratio between type II and type IV induced effects are entirely due to variations in sectoral wage rates.

4.3 EMPIRICAL EVIDENCE

Table 4.1 shows the extent to which the employment multiplier effects are exaggerated by models which actually ignore unemployment benefits. Comparing the multisector multipliers in (a) with those in (b), we obtain a 1.288 ratio for manual workers and a 1.401 ratio for non-manual workers, suggesting the model over-states multiplier effects by 30-40%.

Table 4.1 also shows the distributional impact of social security payments. It can be seen, that 58% of the impact of removing social security payments is felt by non-manual workers and only 42% by manual workers.

Table 4.1: Inter-Relational Employment Multipliers for Manual (m) and Non-Manual (nm) Workers

		Unit Change in m	Unit Change in nm
(a) With no social security payments			
	Effect upon nm	0.2423	1.2646
	m	1.1734	0.1936
	Multisector Employment Multiplier	1.4157	1.4582
(b) With full social security payments			
	Effect upon nm	0.0575	1.0223
	m	1.0414	0.0183
	Multisector Employment Multiplier	1.0989	1.0406
(c) Distributional impact of social security payments [(a) subtracted from (b)]			
	Effect upon nm Social Security	-0.1848 (58%)	-0.2423 (58%)
	Payments upon m	-0.1320 (42%)	-0.1753 (42%)
	Difference in multisector employment multipliers	-0.3168	-0.4176

Source: Batey and Madden (1983); pp.326.

Table 4.2 shows that the social security injections into the economy have produced higher levels of industrial gross output and employment, and corresponding reductions in unemployment. Overall figures indicate that without social security payments in Merseyside in 1980, the unemployment rate would have been 51% higher, and the gross output of the Merseyside economy 7% lower. Non-manual unemployment is most affected by social security payments, "reflecting the greater preponderance of non-manual employment in those industrial sectors experiencing the greatest influence from personal consumption". [Batey and Madden (1983; pp. 325)].

We now look at the importance that social security would have in the economy if there was a 15% contraction across the board in industrial final demand, with no change in population results. The results are shown in Table 4.3, from which it can be seen that the contribution made by social security to the economy is substantially greater than the previous example. 12½% of industrial gross output here is due to social security - related consumption, with consumption - related industrial sectors such as distribution showing very high levels of gross output due to social security (26.5% here).

The overall unemployment rate without social security in the system would be 43% higher, with the greater proportion of this change occurring in the non-manual sector. Social security payment made to the unemployed in declining areas will play an increasing part in determining their industrial outputs. Changes in social security rates will have considerable effects on changes in unemployment in such areas.

A distinction is now made between social security payments to the unemployed, and those made to the old people in the form of pensions. Table 4.4 presents the same range of selected activity levels with pension-related consumption as the only non-wage consumption in the system. Here, more than average proportions of the gross output of industries geared to old persons' consumption being due to pension-related consumption.

Table 4.2: Selected Activity Levels of Merseyside 1:
(a) with no social security payments.
(b) with full social security payments.

Activity	(a)	(b)	Proportion of (b) due to social security
Textiles	648332	654160	0.0089
Chemicals	1578107	1589932	0.0074
Vehicles	735167	736637	0.0020
Transport	1554769	1633083	0.0480
Port	1474155	1480843	0.0045
Distribution	6035872	7226398	0.1647
All Industry	32983822	35552578	0.0723
Unemployed, nm	41526	18265	0.5601 *
Unemployed, m	76174	59395	0.2203 *
Employed, nm	274067	297328	0.0782
Employed, m	318180	334959	0.0501
Inactive Households	69189	69189	0
Unemployment Rates (%)			
nm	13.16	5.79	
m	19.31	15.06	
Overall	16.58	10.94	

The final demand/constraints vector used in these computations was estimated to produce accurate representation of this Merseyside demographic-economic system for 1980 at 1971 prices. Gross outputs are measured in hundreds of pounds sterling.

* reduction in unemployment.

Source: Batey and Madden (1983); pp.325.

Table 4.3: Selected Activity Levels for Merseyside 2:
(a) with no social security payments.
(b) with social security payments.

Activity	(a)	(b)	Proportion of (b) due to social security payments
Textiles	551083	550180	0.0162
Chemicals	1341391	1359905	0.0136
Vehicles	624892	627206	0.0036
Transport	1321554	1449258	0.0881
Port	1253032	1263386	0.0081
Distribution	5130491	6982302	0.2652
All industry	28036249	32041865	0.1250
Unemployed, nm	82636	46424	0.4382*
Unemployed, m	123901	97838	0.2103*
Employed, nm	232957	269169	0.1345
Employed, m	270453	296516	0.0878
Inactive households	69189	69189	0
Unemployment Rates (%)			
nm	26.18	14.71	
m	31.41	24.80	
Overall	29.09	20.32	

The final demand vector used in these computations was 0.85 of the vector used in Table 4.2. Demographic constraints are not altered.

* reduction in unemployment.

Source: Batey and Madden (1983); pp.326.

Table 4.4: Selected Activity Levels for Merseyside 3: (a) with pension payments included as the only form of non-wage income.

Activity	(a)	Proportion of (a) due to pensions
Textiles	650168	0.0035
Chemicals	1582752	0.0029
Vehicles	735735	0.0007
Transport	1581676	0.0170
Port	1476890	0.0019
Distribution	6498124	0.0711
All industry	33997825	0.0298
Unemployed, nm	32367	0.2206*
Unemployed, m	69463	0.0881*
Employed, nm	283226	0.0323
Employed, m	324891	0.0207
Inactive households	69189	0
Unemployment Rates (%)		
nm	10.26	
m	17.61	
Overall	14.34	

* reduction in unemployment.

Source: **Batey and Madden (1983); pp.327.**

A declining economy causes out-migration to occur, and usually this migration is skewed towards the younger age groups. This leads to the population structure being skewed towards the older age groups. As old people have a high social security component in their consumption, and do not have high activity rates, the results show that old populations generally have beneficial effects upon the unemployment rates in the Merseyside economy, as we might expect, in any economy. According to Batey and Madden (1983) the results indicated that the effect of the 60+ population's consumption on economic output and hence labour demand is

less than the activity rate of the 60+ population. Therefore, any large decrease in the activity rates in the 60+ population would have the effect of causing increases in old people to reduce unemployment.

Increased longevity and falling birth rates will keep skewing the population towards the old, and that the personal consumption of the old will become an increasingly important factor affecting the continued economic buoyancy of declining spatial areas of developed areas. Batey and Madden (1983) point out that "linking the sensitivity of industries in these depressed areas to old persons' consumption with their responses to changes in unemployment benefit rates, we can note the clear duty of central government administrators to consider very carefully the economic and demographic-economic effects of any proposed decrease in such benefits". [Batey and Madden (1983; pp.328)].

4.4 SUMMARY

Madden and Batey built a demo-economic model around an activity-commodity framework after they identified an inconsistency concerning unemployment in traditional input-output models. The thrust of Madden and Batey's approach is to remove the inconsistency concerning unemployment by specifically including household consumption coefficients for unemployed households. More specifically, as Phibbs (1984) points out:

> "Madden and Batey combine the traditional input-output matrix with disaggregated household consumption functions, a sub-model showing the interaction between demographic activities and commodities (e.g. household formation) and a submodel relating employment to industrial output". [Phibbs (1984; pp.192)].

Madden and Batey take the descriptive equation from each of these quadrants and place them into a square matrix. These set of simultaneous equations are solved by the usual method of inverting the matrix of coefficients. This process generates multipliers, called type IV multipliers which are interpreted in the traditional manner. The type IV multipliers are smaller than the traditional type II multipliers but larger than the type I multipliers.

Confirmation of the importance of integrated modelling of demographic-economic change was provided by giving an empirical evidence of Merseyside. It was shown that a

> "substantial proportion of Merseyside's employment is dependent upon the injection of social security income from outside the region and that non-manual jobs are more sensitive to changes in the provision of this income than manual jobs. We also demonstrated that changes in age structure, involving a shift towards older population, are likely to have significant repercussions upon the levels of local employment and unemployment". [Batey and Madden (1983; pp.328)].

This work represents the important advance on traditional input-output modelling because of its ability to generate realistic multipliers. The explicit modelling of the unemployment sector assumes added significance as unemployment in Western economies including Australia (and specially the Wollongong region) continues to rise. However, the model does have a number of problems in terms of modelling the impacts under any condition but specially under Australian conditions.

4.5 PROBLEMS OF DEMO-ECONOMIC MODEL

The problems of the demo-economic model are threefold. Firstly, the model is data "hungry", necessitating a large amount of information in addition to the normal requirements of input-output model. Phibbs (1984) comments about this as follows:

> "from a practical viewpoint, the model involves the use of many variables and parameters for which, owing to the paucity of disaggregate demogaphic and economic data commonly available at the regional level, pertinent data is not always available". [Phibbs (1984; pp.193)].

Secondly, the model appears to lack flexibility in relation to the number of jobs that are taken by the unemployed people. Specification of the number of unemployed people in each sector who will enter the workforce is needed before the model is solved by inversion. However, the size of the flow-on impacts could influence this number. For example if the flow-on effects are large, there might not be a sufficient number of suitable unemployed people to meet the pre-inversion target, for some sectors.

Thirdly, this model has not resolved the inconsistencies associated with traditional regional input-output models, revealed in the previous chapter. For example, when the consumption of workers were examined, the traditional model only included the market expenditure of workers. The model implies that unless there is a money transaction, their consumption is considered to have no impact on the regional economy. However, a significant part of the service sector is operated in the public sector, and therefore is not dependent on cash flows. In fact, the size of this section is "population-driven" (i.e. the sector is influenced by the size of the population). In addition, a "barter" service amongst community members exists. Thus, according to Mangan and Phibbs (1988):

"Whilst this form of non-market economy is difficult to quantify its importance is directly related to economic recession and the presence of this kind of phenomenon only further strengthens the role of population-driven economic factors [Mangan and Phibbs (1988; pp.9)].

The last two problems can be solved by extending Batey and Madden's model by bringing in additional rows and columns of the demo-economic factors. This is explained in the next section which concentrates on a study by Phibbs of the Broken Hill area.

4.6 BROKEN HILL STUDY

Phibbs adopted one of Madden and Batey's model to form the demo-economic "engine" of the Rural Settlements Project Demographic-Economic Model (RUSEPDEM). Concentration will be on the multipliers, but they will be smaller than traditional input-output multipliers since they acknowledge the impact of the unemployed. A model done by Phibbs is shown in Table 4.5, which shows the "invertible" part of the demo-economic model. The model shows the economic structure of Broken Hill. The time period was between 1971 and 1976. It is during this period that Broken Hill suffered a sharp downturn in the mining industry. Employment in the mining sector was also decreasing by over 800 jobs. Therefore, Broken Hill was ideal for examining the impacts of the decrease in employment.

The model shown in Table 4.5 differs from the Madden and Batey's model in several ways:

1. This model allows jobs to be taken by school leavers or residents not receiving transfer payments (example, wives or husbands of existing workers), compared to the Batey model which allocated jobs to either in-migrants or to the unemployed.

Table 4.5: Demo-Economic Model for Broken Hill 1971

:TOR	1	2	3	4	5	6	7	8	9	10	11	12	13	*14	*15	*16
:iculture	0.0370	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0006	0.0000	0.00	0.0120
ing	0.0009	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000
ufacturin	0.0105	0.0038	0.0562	0.0024	0.0559	0.0067	0.0338	0.0020	0.0059	0.0011	0.0121	0.0207	0.0000	0.0000	0.06	0.0000
:ctricity	0.01/2	0.0803	0.0226	0.2085	0.0559	0.0142	0.0143	0.0064	0.0242	0.0316	0.0445	0.0699	0.0100	0.0000	0.06	0.2000
istruction	0.0044	0.0066	0.0064	0.0187	0.0033	0.0073	0.1147	0.0062	0.0073	0.0373	0.0310	0.0112	0.0070	0.0000	0.00	0.1400
ide	0.0298	0.0009	0.0606	0.0180	0.0535	0.0620	0.0583	0.0102	0.0127	0.0049	0.0159	0.0261	0.1890	0.0000	0.05	3.7800
ns & Stor	0.0166	0.0016	0.0402	0.0117	0.0349	0.0188	0.0122	0.0171	0.0063	0.0112	0.0197	0.0125	0.0150	0.0000	0.03	0.3000
municatio	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0086	0.0151	0.0000	0.0012	0.0099	0.0000	0.00	0.1980
nance	0.0001	0.0000	0.0062	0.0007	0.0108	0.0547	0.0011	0.0009	0.0413	0.0277	0.0006	0.0141	0.0651	0.0000	0.01	1.3020
Admin.	0.0010	0.0001	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0001	0.0001	0.0002	0.0021	0.0000	0.00	0.0420
unity Se	0.0038	0.0010	0.0001	0.0000	0.0000	0.0001	0.0012	0.0000	0.0023	0.0019	0.0007	0.0027	0.0000	0.2625	0.00	0.0000
:ertainmen	0.0004	0.0005	0.0028	0.0020	0.0001	0.0042	0.0020	0.0001	0.0266	0.0079	0.0027	0.0201	0.0000	0.0000	0.00	0.0000
old row	0.0360	0.3260	0.2972	0.2540	0.3120	0.4083	0.5530	0.5954	0.4230	0.6500	0.6490	0.3974	0.0000	0.0000	0.00	0.0000
). change	0.1199	0.1427	0.1627	0.0968	0.2133	0.3422	0.2581	0.2430	0.1544	0.3845	0.5276	0.4320	0.0000	0.0000	0.00	0.0000
:ll constr	0.0480	0.0602	0.0687	0.0409	0.0901	0.1445	0.1090	0.1026	0.0652	0.1624	0.2228	0.1824	0.0000	0.0300	0.00	0.0000
:mployed	0.0027	0.0032	0.0036	0.0022	0.0047	0.0076	0.0057	0.0054	0.0034	0.0085	0.0117	0.0096	0.0000	0.0000	0.00	0.0000
ment coeff	0.0533	0.0634	0.0723	0.0430	0.0948	0.1521	0.1147	0.1080	0.0686	0.1709	0.2345	0.1920	0.0000	0.2100	Based on Census data	
						(1.25 = increase in Service emp. 71-76 based on State trends)								1.2500		
	0.0500 (i.e. the proportion that lose their jobs and stay in the region, and receive social security payments)															
ncy ratio	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000			
construct tor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000		
	0.0500 (i.e. proportion who lose their jobs, stay in the region but do not receive Social Security payments)															

* column 14 = consumption per head of non market services

* column 15 = consumption, per dwelling built, of goods and labour

* column 16 = consumption, per unemployed "worker"

population change coefficient = employment coefficient*(1-rho-ess)*dependancy ratio

dwelling construction coefficient = employment coefficient*(1-rho-ess)*dwelling construction

unemployed coefficient = employment coefficient * rho

Source: Phibbs (1987); pp.13.

2. The population impact of a change in employment is measured and a consumption column is used to estimate the impact of this population change on output and employment in the non-market services and the subsequent multiplier effect. The consumption column is marked consumption per head of non-market services.

3. Phibbs also attempted to estimate the impact of the population change on the residential construction sector, by adding an extra row and column; measuring consumption of goods and services per dwelling. The coefficients of this part are only rough estimates.

The model is used to estimate the total economic impact of the exogenous changes in the Broken Hill economy, or the changes that were not simply the reactions to other economic change. These changes, as seen from Table 4.6 (the inverted matrix), include:

- the loss of 831 jobs in the mining sector.
- a 25% increase in service sector (i.e. Public Administration and Community Services) based on state-wide trends).

The model predicts that given changes in exogenous employment will generate as loss of 860 jobs. The model is a reasonably accurate model of real world situation, as the census estimates the change in employment to be in the order of 880 jobs.

Now this improved multiplier model is placed into a comprehensive demo-economic model. Figure 4.4 shows the structure. The RUSEPDEM will generate accurate multipliers which can be applied to changes in basic activities in a region or what we call exogenous changes. Phibbs (1987) points out that:

Table 4.6: Closed Inverse and Modelling of Final Demand Changes - Broken Hill 71-76

SECTOR	1	2	3	4	5	6	7	8	9	10	11	12	13	*14	*15	*16
1. Agriculture	1.0385	0.0002	0.0010	0.0002	0.0003	0.0003	0.0005	0.0004	0.0003	0.0005	0.0006	0.0004	0.0007	0.0001	0.0001	0.0144
2. Mining	0.0000	1.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3. Manufacturin	0.0188	0.0134	1.0735	0.0135	0.0747	0.0272	0.0610	0.0173	0.0190	0.0250	0.0412	0.0450	0.0082	0.0108	0.0648	0.1635
4. Electricity	0.0346	0.1212	0.0568	1.2843	0.1013	0.0572	0.0659	0.0406	0.0602	0.0875	0.1093	0.1316	0.0299	0.0287	0.0813	0.5977
5. Construction	0.0109	0.0167	0.0222	0.0333	1.0201	0.0239	0.1332	0.0214	0.0200	0.0568	0.0532	0.0291	0.0156	0.0140	0.0126	0.3124
6. Trade	0.0516	0.0868	0.1616	0.1087	0.1576	1.1786	0.2234	0.1547	0.1294	0.1718	0.1787	0.1369	0.2386	0.0469	0.0879	4.7730
7. Trans & Stor	0.0245	0.0164	0.0607	0.0292	0.0570	0.0432	1.0446	0.0400	0.0257	0.0421	0.0536	0.0391	0.0267	0.0141	0.0443	0.5338
8. Communicatio	0.0005	0.0040	0.0043	0.0039	0.0043	0.0053	0.0070	1.0067	0.0143	0.0227	0.0068	0.0057	0.0121	0.0018	0.0012	0.2423
9. Finance	0.0074	0.0313	0.0439	0.0333	0.0492	0.1005	0.0625	0.0548	1.0866	0.0895	0.0588	0.0538	0.0921	0.0154	0.0238	1.8417
10. Pub Admin...	0.0011	0.0009	0.0011	0.0008	0.0009	0.0010	0.0014	0.0013	0.0013	1.0016	0.0015	0.0011	0.0024	0.0004	0.0002	0.0484
11. Community Se	0.0533	0.0627	0.0817	0.0570	0.0974	0.1379	0.1252	0.1007	0.0790	0.1563	1.1979	0.1667	0.0357	0.3144	0.0207	0.7137
12. Entertainmen	0.0012	0.0022	0.0054	0.0043	0.0029	0.0085	0.0055	0.0028	0.0305	0.0120	0.0062	1.0235	0.0038	0.0016	0.0016	0.0758
13. H/Hold row	0.1291	0.4683	0.5170	0.4567	0.5504	0.6743	0.8603	0.7973	0.6266	0.9495	0.9690	0.6752	1.1995	0.2544	0.1292	3.9904
14. Pop. change	0.1876	0.2343	0.3096	0.2166	0.3699	0.5231	0.4712	0.3825	0.2907	0.5865	0.7497	0.6235	0.1348	-1.1968	0.0783	2.6950
15. Dwell constr	0.0764	0.0989	0.1307	0.0915	0.1562	0.2209	0.1989	0.1615	0.1227	0.2476	0.3165	0.2632	0.0569	0.0831	1.0330	-1.1379
16. Unemployed	-0.0042	-0.0052	-0.0069	-0.0048	-0.0082	-0.0116	-0.0105	-0.0085	-0.0065	-0.0130	-0.0167	-0.0139	-0.0030	-0.0044	-0.0017	0.9401
Output Multipliers	1.2425	1.3561	1.5122	1.5685	1.5658	1.5834	1.7302	1.4407	1.4663	1.6659	1.7077	1.6328				
Employment Multipliers	1.5645	1.6424	1.9035	2.2390	1.7340	1.5286	1.8256	1.5742	1.8833	1.5253	1.4208	1.4432				
FINAL DEMAND CHANGES 76-71		-831								55	296					
FLOW-ON IMPACTS		-534								29	125					
NET IMPACT							-860									
ACTUAL IMPACT (BASED ON CENSUS DATA)							-880									

Source: Phibbs (1987); pp.14.

"The model will also generate estimates of the number of economic in-migrants and/or outmigrants, which provides the basis for estimating the level of economic migration. This economic analysis is supplemented by the demographic model. In this module, a base population is survived in the traditional manner using the cohort model, and then an estimate made of what could be called non-economic migration. The economic impact of this non-economic migration is calculated by estimating their consumption patterns and then feeding this information into the multiplier model (called a feedback loop in Figure 4.5), via what economists call changes in final demand. The total population growth over the projection period (say 5 years) is then estimated. The final result is an employment and population forecast for the region". [Phibbs (1987; pp.9)].

The data required for such a model are:

1. major elements of the multiplier model which are available for existing input-output table of regions in N.S.W.

(ii) ABS household expenditure survey provides the consumption data for unemployed households and inactive households.

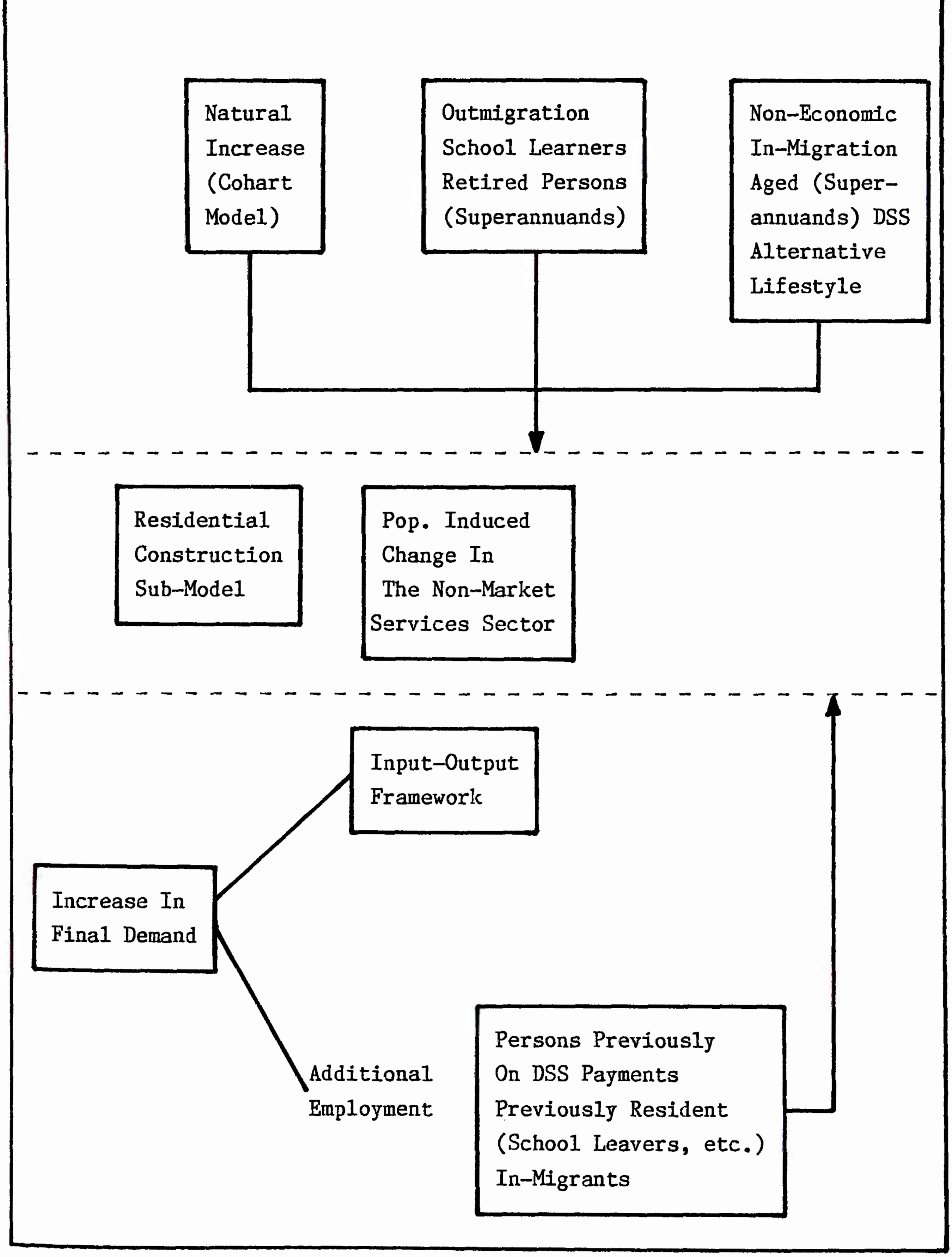
(iii) The proportion of jobs going to existing unemployed in a region are estimated using a skills matching process based on CES data and Census data, on skill level by sector.

The task of the case studies will be to estimate where consumption takes place.

Therefore, demo-economic model allows more realistic forecasts, and helps us answer questions like - "How does this town work?" and "What are the main forces driving demographic and economic change in this town?".

This model was the starting point for our next chapter, the DECON model.

Figure 4.4: A Comprehensive Demo-Economic Model



Source: Phibbs (1987); pp.12.

CHAPTER FIVE

THE DECON MODEL - DEMO-ECONOMIC INPUT-OUTPUT MODELLING

CHAPTER FIVE

THE DECON MODEL - DEMO-ECONOMIC INPUT-OUTPUT MODELLING

The DECON model resulted from a study undertaken into the Wollongong region by Mangan and Phibbs. Their study, which was commissioned by the Federal Government, arose out of the dissatisfaction with the performance of the earlier GRIT (Generation of Regional Input-Output Tables) - style input-output model in modelling the Wollongong economy and the unique conditions facing the Wollongong economy.

5.1 THE MODEL

The DECON model represents both an application and an extension of demo-economic modelling. It is an application because it uses a non-survey approach to model the Wollongong economy; and it is an extension as it brings in the consumption of other groups and calculates the population multipliers. That is, the DECON Model is built in such a way as to add two new "industries" to the traditional input-output table.

The first industry is the unemployed. The unemployed model treats the unemployed as a separate industry, and specifically models their consumption (which was traditionally ignored). This allows the model to estimate the impact of the downturn in the economy by examining the difference in consumption between the employed and the unemployed. The consumption impacts will be based on this difference rather than the total consumption of the employed. This procedure leads to smaller employment multipliers in regions where at least some of the unemployed remain living in the region. As part of the component of the model, it is necessary to estimate the proportion of people losing their jobs who will remain in the region and live on social security payments or other income.

The second industry is the population industry. The point that some economists underestimate, is that growth in employment in some sectors is specifically linked to the population growth. These sectors are what could be called "non-market" sectors, since they are not based on traditional exchange of money, and include Public Administration and Community Services. The population model acknowledges that change in these sectors is related to population change, and not economic change in other sectors of the economy. The introduction of the population industry allows the specific calculation of population multipliers, which measure the flow-on population change due to a shift in economic activity in a particular sector.

The DECON model has also been extended to allow the regional analysts to assess the impact of demographic changes in their regions, such as migration. The Wollongong region, like many coastal regions, has experienced large increases in aged migration and people on social security payments, especially pensioners. They have an impact on the economy through their consumption of market goods and their use of services. This impact is modelled by estimating their level of consumption of goods and services, and then adding this to the Final Demand part of the model. This model, therefore, provides a realistic economic change and also models the economic implication of demographic changes.

The DECON Model is applied to the Wollongong region which has most of the features which cause problems in input-output modelling.

5.2 THE WOLLONGONG ECONOMY

Since the early 1980's, the Wollongong Statistical District has encountered problems of economic adjustment similar to the problems which faced the Australian economy as a whole but to a much greater intensity. For example, the contraction of the economic importance of manufacturing,

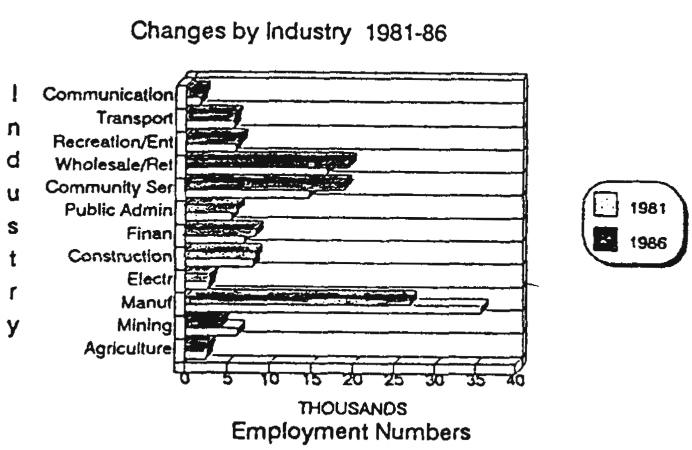
especially a reduction in the demand prices received for exports of raw materials such as coal. Wollongong became particularly susceptible to these changes because of its narrow economic base.

Demo-economic modelling is needed for the Wollongong region because of several factors which interacted over the period 1981-1986:

1. Large scale full-time job loss among unskilled and semi-skilled male workers and smaller, yet still significant full-time job loss among female textile workers.

   In 1982/83 7,000 steel workers were retrenched and by 1987 12,600 steel workers remained of the workforce of 21,000 in 1981. Similarly, in coal, from a workforce of 8,000 less than 6,000 remain. The changing nature of the Wollongong workforce can be seen from a consideration of the data shown in Table 5.1 and Figure 5.1.

Figure 5.1: Employment in the Illawarra



Source: Mangan and Phibbs (1988); pp.3.

Table 5.1: Intercensal Employment Changes in the Wollongong Statistical District by Percent (1981-1986)

Industry	Males	Female	Persons
Agriculture	3.76	12.50	6.30
Mining	-32.06	10.13	-31.52
Manufacturing	-26.71	-12.02	-24.67
Electricity	1.74	46.59	4.60
Construction	1.75	23.43	3.96
Wholesale/Retail	20.35	11.07	15.87
Transport	-1.42	22.39	1.08
Communication	16.20	13.41	15.37
Finance/Property	21.14	21.01	21.07
Public Administration	-2.73	59.04	10.54
Community Services	25.20	30.95	28.85
Recreation/Entertainment	17.85	8.31	12.00
Not included above	-40.49	-73.76	-58.13

Source: Mangan and Phibbs (1988); pp.3.

2. Outward migration of families, normally associated with the job-losses mentioned above and due to the decrease in the number of people employed.

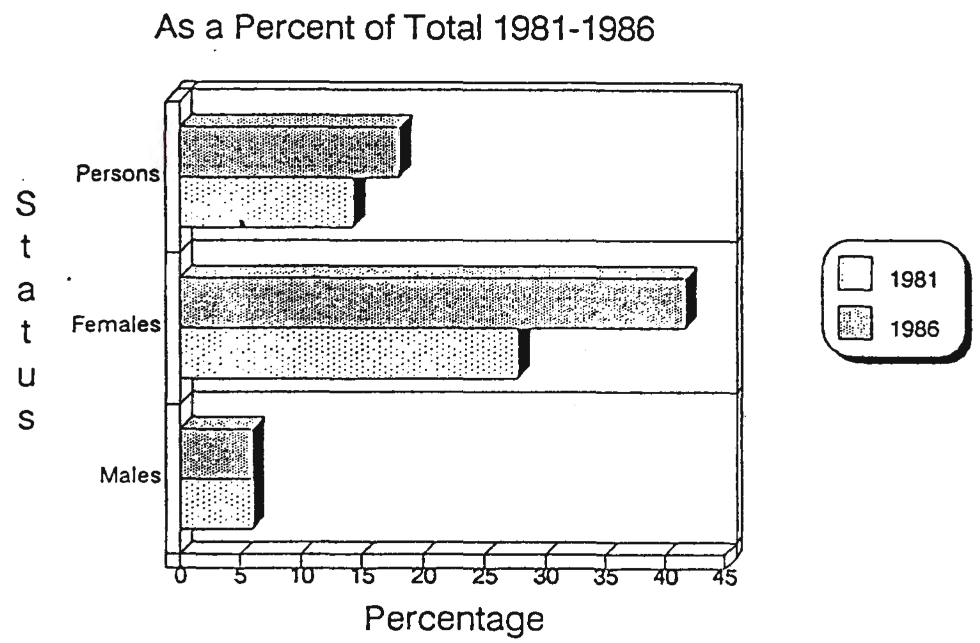
Between 1981/86, the absolute number in employment in the Wollongong Statistical District fell by 4.1% compared with a fall for the state as a whole of 0.6%.

3. Significant increase in part-time, service based and mainly female jobs.

Part-time employment increased from 14.3% in November 1983 to 18.07% in November 1986 as can be seen from Figure 5.2. The main beneficiaries being females, for whom part-time employment as a percentage of the

total employment rose from 27.7% in November 1981 to 41.6% in November 1986. On the other hand, the part-time share of total male employment in the region actually fell over the same period by 0.3%. This increasing importance of part-time work brings into serious question the value of using unadjusted (total) employment numbers as a means of modelling labour supply.

Figure 5.2: Part-Time Employment in the Illawarra



Source: Mangan and Phibbs (1988); pp.4.

4. High levels of regional infrastructural building, government financed 1984/85.

5. Large scale development of the retail industry through private (but government assisted) finance.

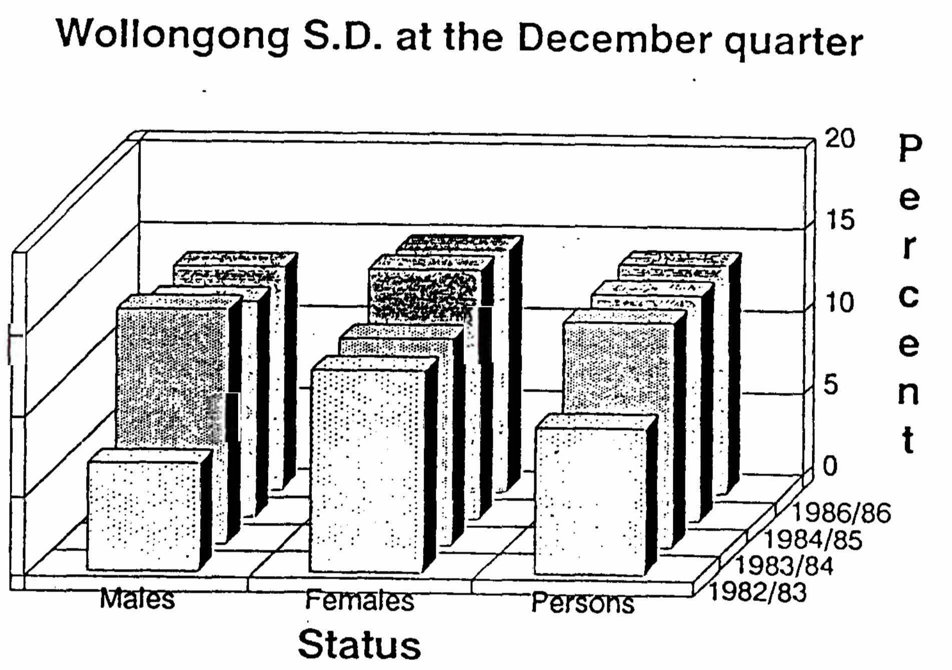
6. An aging of the Wollongong population with an increasing percentage of retired persons.

7. Significant amounts of social security injection in the form of unemployment benefits, child support schemes, aged and war service pensions.

8. A distribution of unemployed that produced significant differences in entitlements among the unemployed.

Registered unemployment averaged 14% in Wollongong Statistical District (see Figure 5.3) over the period compared with a state wide average of 8.8%. This distribution of unemployment is heavily skewed towards youth. In 1986, 42% of all unemployed were under 24 years of age and the unemployment rate of those 15-19 years was 30%-35%.

Figure 5.3: Unemployment Rates



Source: Mangan and Phibbs (1988); pp.5.

9. A mild recovery in which part-time tertiary sector jobs were prominent.

These factors show that significant and rapid changes have occurred in the Wollongong region which brings into question the capacity of standard techniques to correctly model the resulting regional impacts. Demo-economic modelling is needed for the Wollongong region as the "rapid workforce contraction occurring in the Wollongong key industries has meant that not only has the region found re-adjustment difficult but also that the traditional means of economic evaluation has been found wanting in correctly monitoring the net impacts these changes are having on the region". [Mangan and Phibbs (1988; pp.6)].

That is, simple input-output analysis has difficulty in coping with economies experiencing rapid economic changes. This was explained in an earlier chapter which looked at the recession in the Wollongong region. It was found that the traditional input-output analysis has a tendency to overestimate economic impacts. Earlier forecasts of the impact of the downturn in the steel industry was very pessimistic. The main problem was that it was not acknowledged that a large number of those who found themselves unemployed would remain in the region, and maintain reasonable levels of expenditure. The full effects of economic decline only occurs if the displaced workers and their families leave the region. When they stay, the safety net of social security, government spending and family support tends to produce impacts that are smaller than those predicted by traditional regional analysis. That is, the forecasts based on traditional input-output models exaggerate the consumption induced impacts of the downturn.

Therefore, we can say that the "experience of Wollongong has indicated the need to modify existing input-output analysis to incorporate the role of non-workforce populations and social security payments. Moreover it becomes important to correctly monitor the movement of the whole region's population rather than just the workforce, and finally, it becomes essential to adjust raw workforce data to reflect the

job status and occupational shifts and the income distribution aspects inherent in these shift". [Mangan and Phibbs (1988; pp.6)].

5.3 CONSTRUCTING THE MODEL

It is assumed here that the traditional input-output table exists for a region under examination. [The first input-output table for Wollongong was built in 1983 by Guest, Mangan and Robinson. They built the table within the GRIT technique with extensive usage of location quotient adjustment of the 1977-78 Australian input-output table. Since then the Wollongong input-output table has been updated regularly. The coefficients of the Wollongong Statistical District input-output table form the basis of this economic projection model and this table forms the starting point for the DECON Model]. The input-output table is then imported into the demo-economic worksheet. Then, it is essential to add the additional rows and columns reflecting the demo-economic framework. The number of new measurements which have to be obtained are outlined below:

1. Estimating Rho - proportion of employees who remain in the region after they lose their jobs.
2. The Population Impacts.
3. Estimating Ess - proportion of employed who are not eligible for social security beneifts when they lose their job.
4. The Unemployed Coefficient Column.
5. Estimating Full Time Job Equivalents.

5.3.1 Estimating Rho

One of the problems concerning the traditional input-output analysis is the incorporation of the consumption spending of the unemployed into the analysis. The full income impact of a job loss in a region is felt only where

the job-loss results in the former employee leaving the region or where the person becomes unemployed and is not eligible for social security payments. Therefore, it is necessary to dissaggregate job losses and to categorize the resultant unemployed into groups indicative of their likely effect upon regional consumption. There seem to be three specific groups which are listed below in descending order of importance in terms of regional income impact:

(i) Those who become unemployed and leave the region after some time delay.

The worker who leaves the region, particularly if the family moves as well are of greater importance in that not only is their earned income lost to the region, but also any transfer payments that family members, such as children may have been receiving.

(ii) Those who become unemployed, stay in the region but are ineligible for social security payments.

(iii) Those who become unemployed, stay in the region and are eligible for social security benefits.

The rho coefficient is concerned with estimating the relative importance of these options to the total number of job losses. To estimate rho, it is necessary to estimate outward migration flows of displaced workers by industry. No ABS data is available for this type of movement, therefore regional planners have to independently estimate the rho coefficients. The best source of information is provided by Union and Employer groups. The other method to estimate rho, is to consult the personnel records of the significant firms in the industry. Rho will only generate significant changes in multiplier values for sectors experiencing significant job loss and within any one region this is unlikely to concern a large number of sectors.

5.3.2 The Population Impacts

To estimate the magnitude of population change and its resultant impacts, it is necessary to estimate two main parameters. The first one involves making estimates of the level per head of population of non-market services. Secondly, the estimates of the number of dependents by the industry is needed. The procedure for estimating the two variables for the Wollongong region is explained in Appendix B.

5.3.3 Estimating Ess

This measures the proportion of employed who are not eligible for social security benefits when they lose their job. People in this category are workers whose partner are also working. For example, when married males lose their jobs, they are not eligible for unemployment benefits if their wives are also working, and same goes for married females.

Ess for the study of Wollongong is as follows:

$$E_j = F_{mj} * 0.05 + M_{mj} * 0.30$$

where

E_j = Ess for sector j.
F_{mj} = Number of married female workers in sector j.
M_{mj} = Number of married male workers in sector j.

Ess was calculated this way because in the Wollongong Statistical District, less than 5% of working women had partners who were either unemployed or not in the workforce. About 46% of married males had working partners (most were part-time), therefore male partners could still be eligible for benefits if they lose their jobs. It is also possible for both partners to lose their jobs in times of deep recession and hence both will receive social security. This

has the impact of decreasing the value of ess in a severe regional downturn. Hence, it was decided by Mangan and Phibbs to only assume, in the study, that two-thirds of the married males with working partners will be excluded from benefits, or 0.66 * 0.44 = 0.30.

5.3.4 The Unemployment Coefficient Column

Workers who lose their jobs, particularly those with access to social security payments will continue to support fixed consumption. That is, workers who lose their jobs do not cease to be economic agents.

The sector unemployed coefficients are calculated using the following formula:

$$U_j = H_j * R_j * U_b$$

where

U_j = Coefficient in the unemployment column for sector j.

H_j = Household consumption coefficient for sector j.

R_j = Ratio of unemployed to employed consumption.

U_b = Annual employment benefits.

The formula for the coefficient of trade sector:

$$U_t = H_t * R_t$$

where

U_t = Coefficient in the unemployment column for trade sector.

H_t = Household consumption coefficient for the trade sector.

R_t = Ratio of annual average unemployment benefits to average annual wage and salaries.

This column measures consumption per worker [which is conceptually different from the traditional input-output consumption column].

5.3.5 Estimating Full Time Job Equivalents

In traditional input-output models, employment data listed in the tables refer only to absolute job numbers irrespective of significant differences in job-status among the workforce. These job status differences refer not only to the normal distinction between full-time and part-time but also considerable differences in hours worked among those classified as part-time. Therefore, full time job equivalent data (FTE's) was used. Procedurally, this involved adjusting part-time employment numbers by a total hours worked per week index to reduce the number in this category to FTE's.

The results derived from the use of FTE's place new light upon the recession in Wollongong over 1982/83 and subsequent recovery in 1984/85. "The jobs lost in 1982/83 were largely full-time and large numbers of those gained in later period were part-time. The use of FTE's has the effect of accentuating the recession relative to recovery. Moreover, if most of the full-time jobs lost were male and most of the part-time work was female, there may also be some equity and income distributional aspects uncovered in that full-time work, particularly if manufacturing was likely to be the prime source of family income whilst the part-time work often is a supplement to the main income. The net result of the changes that have occurred in Wollongong have been to worsen regional income inequalities". [Mangan and Phibbs (1988; pp.19)].

5.3.6 Calculating Multipliers

Multipliers are estimated using a traditional input-output approach. The coefficient matrix is first estimated by importing the traditional input-output model and then importing it into a demo-economic table. Then the matrix including the household, population and unemployed sector is subtracted from the identity matrix, and the resultant matrix inverted.

Formulas for calculating multipliers:

(i) Output multipliers:

$$O_j = \sum_{i=1}^{n} b_{ij}$$

where

O_j = Output multiplier for sector j.
b_{ij} = Coefficients of the inverse matrix.
n = Number of industry sectors.

(ii) Employment multipliers:

$$E_j = b_{ej}/a_{ej}$$

where

E_j = Employment multiplier for sector j.
b_{ej} = Coefficient of the inverse matrix in the unemployment row and the jth column.
a_{ej} = Coefficient of the direct coefficients matrix in the unemployment row and the jth column.

(iii) Population multipliers:

$$P_j = b_{pj}/a_{pj}$$

where

P_j = Population multiplier for sector j.

b_{pj} = Coefficient of the inverse matrix in the population row and the jth column.

a_{pj} = Coefficient of the direct coefficients matrix in the population row and the jth column.

5.4 FRAMEWORK OF THE MODEL

The DECON model as mentioned earlier, requires the calculation of additional rows and columns. The additional rows required are rho, ess and family size, while the additional columns to be filled in are population and unemployed. This framework as it would appear in the DECON model is presented below.

Figure 5.4 The DECON Row and Column Framework

	Population	Unemployed
rho		
ess		
family size		

rho = proportion of employees who remain in the region after they lose their job.

ess = proportion of employed who are not eligible for social security benefits when they lose their job (i.e. people with working spouses).

family size = average size of family.

population = population driven column.

unemployed = unemployment column, measuring consumption per worker.

Source: By Author.

The above rows and columns allow the calculation of the three DECON multipliers: (i) output
(ii) employment
(iii) population

The DECON model has also been extended to take account of migration. A significant proportion of people who migrate are pensioners and their impact is modelled by estimating their level of consumption of goods and services, and then adding this to the final demand component. [In economic terms, "the impact for example of a large inflow of aged persons wishing to retire is the same as an increase in regional exports".]. The final demand framework in terms of employment and population impacts of the DECON model is shown below in Figure 5.5. It is important to note that in the final demand analysis, only the data for initial employment change is needed. This data along with the multipliers, rho and family size data will complete the employment impacts and the population impacts.

Figure 5.5 The Final Demand Analysis Framework

EMPLOYMENT IMPACTS: Initial Employment Change		
Flow-Ons	=	initial emp. change * (emp. multiplier - 1)
Total Employment Change	=	initial emp. change + flow-ons
POPULATION IMPACTS:		
Initial Population Impact	=	initial emp. change * (1-rho) * family size
Flow-Ons	=	initial pop. impact * (pop. multiplier - 1)
Total Population Change	=	initial pop. change + flow-ons

Source: By Author.

This framework shows the effect that an initial job loss would have on the economy. The initial job loss will result in flow-on job losses and shows the number of people that will leave the region as a result of further jobs being lost. A DECON users manual is presented in Appendix D, which shows the framework in considerable detail.

5.5 EXAMPLE OF THE MODEL

The model is Table 5.2 shows a simple model for the region of Regionville. The main parameters of this example include:

Rho: The proportion of people who remain in the region after they lose their job. For example, in sector where the rho value is 0.8 means that 80 percent of people who lose their job, remain in the region.

Ess: The proportion of people who would be ineligible for unemployment benefits if they lost their jobs. A figure of 0.23 in industry 1 means 23 percent of people who lose their jobs in industry 1 do not receive unemployment benefits.

Family Size: The average family size by industry sector.

Population Coefficient: employment coefficient * (1-rho) * family size.

Unemployment coefficient: - rho (1-ess) * employment coefficient.

The multipliers are derived by an inversion of the 6 x 6 matrix. The multipliers show that a loss of 100 jobs in the secondary sector would generate the loss of further 124 flows-on jobs [(2.24 - 1) * 100], and that the loss of the 100 jobs would mean 84 people would initially leave the region (i.e. 100 * (1-0.6) * 2.1] and that 147 would eventually leave as a result of further jobs being lost [i.e. (84 * (1.75 - 1)) + 84 = 147].

Table 5.2: A Simple Example of the Demo-Economic Model for Regionville

REGIONVILLE DEMO-ECONOMIC MODEL

	1"	2"	3"	4"	Pop.	Unempl.
PRIMARY"	0.1237	0.1034	0.0366	0.125	0.17	1.4
SECONDARY"	0.0698	0.0658	0.1463	0.22	0.11	2.1
TERTIARY"	0.0233	0.1379	0.0679	0.415	0.26	3.5
HOUSEHOLD"	0.2315	0.276	0.1567	0		
Population	0.00609	0.00819	0.00855	0		
Unemployed	-0.0081	-0.0042	-0.0074	0		
EMP.COEF"	0.01325	0.00975	0.01475			
rho	0.8	0.6	0.8			
ess	0.23	0.27	0.37			
family size	2.3	2.1	2.9			

IDENTITY MATRIX FOLLOWS

1	0	0	0	0	0
0	1	0	0	0	0
0	0	1	0	0	0
0	0	0	1	0	0
0	0	0	0	1	0
0	0	0	0	0	1

I-A MATRIX FOLLOWS

PRIMARY"	0.8763	-0.1034	-0.0366	-0.125	-0.17	-1.4
SECONDARY"	-0.0698	0.9342	-0.1463	-0.22	-0.11	-2.1
TERTIARY"	-0.0233	-0.1379	0.9321	-0.415	-0.26	-3.5
HOUSEHOLD"	-0.2315	-0.276	-0.1567	1	0	0
Population	-0.0060	-0.0081	-0.0085	0	1	0
Unemployed	0.00816	0.00427	0.00743	0	0	1

INVERSE MATRIX FOLLOWS

PRIMARY"	1.20241	0.20980	0.10287	0.23914	0.25423	2.48401
SECONDARY"	0.17455	1.22538	0.23773	0.39006	0.22627	3.64974
TERTIARY"	0.17165	0.35135	1.19711	0.59555	0.37908	5.16808
HOUSEHOLD"	0.35343	0.44183	0.27701	1.25634	0.18070	2.39221
Population	0.01022	0.01432	0.01281	0.00974	1.00664	0.08924
Unemployed	-0.0118	-0.0095	-0.0107	-0.0080	-0.0058	0.92571

MULTIPLIERS :	1"	2"	3"
output	1.54862	1.78654	1.53772
employment	1.45008	2.23800	1.44662
population	1.67790	1.74853	1.49799

FINAL DEMAND ANALYSIS
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EMPLOYMENT IMPACTS			
INITIAL EMPLOYMENT CHANGE	0	100	0
FLOW-ONS	0	123.800	0
TOTAL EMPLOYMENT CHANGE	0	223.800	0
POPULATION IMPACTS			
INITIAL POPULATION IMPACT	0	84	0
FLOW-ONS	0	62.8772	0
TOTAL POPULATION CHANGE	0	146.877	0

Source: Mangan and Phibbs (1988); pp.12.

5.6 ADVANTAGES AND DISADVANTAGES OF THE DECON MODEL

The advantages of the demo-economic (the DECON model) modelling are:

- the model acknowledges the presence of the unemployed people within the economic system.
- the model uses full time job equivalent data to overcome the serious modelling errors created by using absolute employment numbers.
- it acknowledges the population driven factor.
- is extended to take account of migration.

The major disadvantage of the model is that additional data is required such as the unemployment data, migration data, family size data, data for full-time and part-time work and population forecasts. However, these days most impact studies already include demographic forecasts, therefore in most cases only a minimum additional amount of work is required.

5.7 CONCLUSION

In the demo-economic model (the DECON model), the consumption of the unemployed household is explicitly measured and also a distinction is made between jobs which go to previously unemployed who live in the region, and people who in-migrated into the region. This type of model acknowledges the economic role that the unemployed play in the region, and also acknowledges the importance of demographic variables such as the age and structure of the population and the propensity for inward and outward migration. It is considered that this sort of model is appropriate for modelling the sort of rapid economic change that has occurred in Wollongong in recent years.

CHAPTER SIX

RUNNING AND TESTING THE DECON MODEL

CHAPTER SIX

RUNNING AND TESTING THE DECON MODEL

In this chapter the DECON model is run and tested to determine the reliability of the model. The traditional type II output multipliers (static semi-closed multipliers) and the demo-economic (DECON) type IV output multipliers (static closed multipliers) are compared for the Wollongong region. The DECON model yields multipliers which are smaller than the traditional type II multipliers. Therefore, it is claimed that the traditional type II multipliers tend to overestimate the impact of an economic downturn in the economy and that the DECON model is a much more reliable model and should be used in calculating multipliers.

6.1 WOLLONGONG INPUT-OUTPUT MATRIX

The first input-output matrix for Wollongong was compiled in 1982/83. The matrix was derived from the 108 sector Australian input-output matrix for 1977-1978 using the GRIT method. GRIT stands for "Generation of Regional Input-Output Table" following Jensen et al (1979). It is a method for adjusting national input-output coefficients to reflect the structure of regional activity using location quotients. Application of the method to the Wollongong Statistical District is described in Mangan and Guest (1983). Since then, the Wollongong table has been updated regularly on information gathered from regional surveys.

The DECON study (Mangan and Phibbs (1988)) used a version of the Wollongong input-output matrix, aggregated into a 30 sector matrix plus a household sector in 1986.

6.2 OUTPUT MULTIPLIERS

Both type II and type IV multipliers were calculated by using the same Wollongong input-output coefficients table of 1986. Both multipliers are calculated using the technique of matrix inversion. The difference between the two being that in the calculation of the DECON multipliers (type IV multipliers) the inverted matrix also includes population and the unemployment sectors.

The multipliers were calculated by the author by using the DECON package. As mentioned earlier, the calculation of the DECON multiplier requires additional data. Estimates of rho, ess, family size, population, unemployed and employment coefficients (FTE's) are required. These were taken from Mangan and Phibbs who gathered this data for their study of the Wollongong region.

A detailed worksheet of the data used to generate the multipliers is shown in Appendix C. A copy of this information is also provided on the floppy disk accompanying this volume, in a spreadsheet called Woll.wk1. The DECON user's manual is also provided in Appendix D.

Comparison

Comparison is being made here between the traditional type II multipliers and the demo-economic type IV multipliers. The type II multipliers were calculated by inverting the 31 by 31 Wollongong matrix (includes household) and summing down the first 30 rows of the inverse matrix. The DECON multipliers were calculated by inversion of the 33 by 33 matrix (including household, population and unemployment sectors) and then summing down the first 30 rows of the inverse matrix. The type II multipliers can be considered as static semi-closed multipliers (closed with respect to households). While the type IV multipliers can be seen as static closed multipliers (closed with respect to household, unemployment and population sectors). The multipliers and the percentage differences between the two are presented in Table 6.1.

Table 6.1 Percentage Change in Output Multipliers Between Type II and Type IV Multipliers for the Wollongong Region

Sector No.	Type II	Type IV	% Change
1. Dairy Farming	1.77	1.71	-3.39
2. Other Agriculture	1.78	1.70	-4.49
3. Fishing, Hunting	1.67	1.63	-2.40
4. Coal Mining	1.39	1.38	-0.72
5. Other Mining,Quarrying	1.68	1.65	-1.79
6. Food Manufacturing	1.57	1.54	-1.91
7. Textiles, Clothing	1.23	1.20	-2.44
8. Wood Prod, furniture	1.41	1.37	-2.84
9. Paper, print, publish	1.43	1.40	-2.10
10. Chemicals, Coal Prod.	1.38	1.36	-1.45
11. Clay Prod,Refrectories	1.34	1.31	-2.24
12. Other Non-Metallic Minerals	1.59	1.56	-1.89
13. Basic Iron and Steel	1.41	1.38	-2.13
14. Non-Ferrous Metal Prod	1.29	1.27	-1.55
15. Fabricated Metal Prod.	1.73	1.69	-2.31
16. Transport Equipment	1.45	1.42	-2.07
17. Other Machinery,Equip.	1.33	1.31	-1.50
18. Miscell. Manufacturing	1.47	1.43	-2.72
19. Electricity, Gas	1.44	1.42	-1.39
20. Water, Sewage & Drainage	1.76	1.68	-4.55
21. Residential Building	1.85	1.79	-3.24
22. Other Construction	1.69	1.59	-5.92
23. Trade (Retail)	1.68	1.62	-3.57
24. Transport and Storage	1.46	1.41	-3.42
25. Communications	1.50	1.44	-4.00
26. Finance	1.77	1.72	-2.82
27. Ownership of Dwelling	2.17	2.14	-1.38
28. Public Admin. & Defence	1.44	1.38	-4.17
29. Community Services	1.37	1.33	-2.92
30. Entertainment	1.64	1.60	-2.44
Average			-2.66

Source: Author's calculations with input-output matrix.

Table 6.1 shows that all the type IV multipliers are smaller than the traditional type II multipliers. The greatest reduction in type IV multipliers has been in areas of other construction (5.9%) followed by water, sewerage and drainage (4.6%), other agriculture (4.5%), public administration and defence (4.2%) and communications (4%). Other sectors experienced a reduction in multipliers by less than 4%, with average reduction of the 30 sectors being of the order of 2.66%.

Wollongong depends on iron and steel, coal mining, chemical coal, textiles and clothing and fabricated metal products to generate most of its income and employment. These five industries particularly the steel industry experienced heavy job losses between 1981 and 1986. As can be seen from Table 6.1, the DECON (type IV) multipliers for all these industries are smaller than those from the static semi-closed model. Their percentage differences are:

coal mining	0.72%
iron and steel	2.13%
textiles and clothing	2.44%
chemical coal products	1.45%
fabricated metal products	2.13%

The reason that the type IV multipliers are smaller than the type II multipliers is that the latter method excludes the demographic factors. The type II method ignores the fact that to some extent regions are population driven. That is, the full effects of an economic decline will occur only if the displaced workers and their families leave the region. When they stay, the safety net of social security, government spending and family support produces impacts other than those predicted by traditional regional analysis. As can be seen from the rho data (Table 6.2), which indicates that the majority of workers who lose their jobs remain in the region and at least 75% of those are eligible for social security payments (ess estimates) with textiles and clothing being an exception where 55% of those who lose their jobs are

Table 6.2 Data for Some Demo-Economic Factors

Sector No.	Rho	Ess	Family Size
1. Dairy Farming	0.8	0.38	2.75
2. Other Agriculture	0.8	0.38	2.75
3. Fishing, Hunting	0.8	0.38	2.75
4. Coal Mining	0.6	0.24	3
5. Other Mining,Quarrying	0.8	0.24	3
6. Food Manufacturing	0.8	0.27	2.48
7. Textiles, Clothing	0.8	0.55	2.37
8. Wood Prod, furniture	0.8	0.25	2.53
9. Paper, print, publish	0.8	0.3	2.56
10. Chemicals, Coal Prod.	0.8	0.28	2.7
11. Clay Prod,Refrectories	0.8	0.24	2.43
12. Other Non-Metallic Minerals	0.8	0.24	2.43
13. Basic Iron and Steel	0.77	0.22	2.33
14. Non-Ferrous Metal Prod	0.8	0.22	2.33
15. Fabricated Metal Prod.	0.8	0.25	2.18
16. Transport Equipment	0.8	0.22	2.17
17. Other Machinery,Equip.	0.8	0.24	2.07
18. Miscell. Manufacturing	0.8	0.28	2.11
19. Electricity, Gas	0.8	0.22	2.42
20. Water, Sewage & Drainage	0.8	0.22	2.42
21. Residential Building	0.8	0.26	2.2
22. Other Construction	0.8	0.26	2.4
23. Trade (Retail)	0.8	0.36	2.78
24. Transport and Storage	0.8	0.27	2.64
25. Communications	0.8	0.32	2.5
26. Finance	0.8	0.41	2.42
27. Ownership of Dwelling	0.8	0.31	2.5
28. Public Admin. & Defence	0.8	0.26	2.22
29. Community Services	0.8	0.47	2.48
30. Entertainment	0.8	0.45	2.37

Source: Mangan and Phibbs.

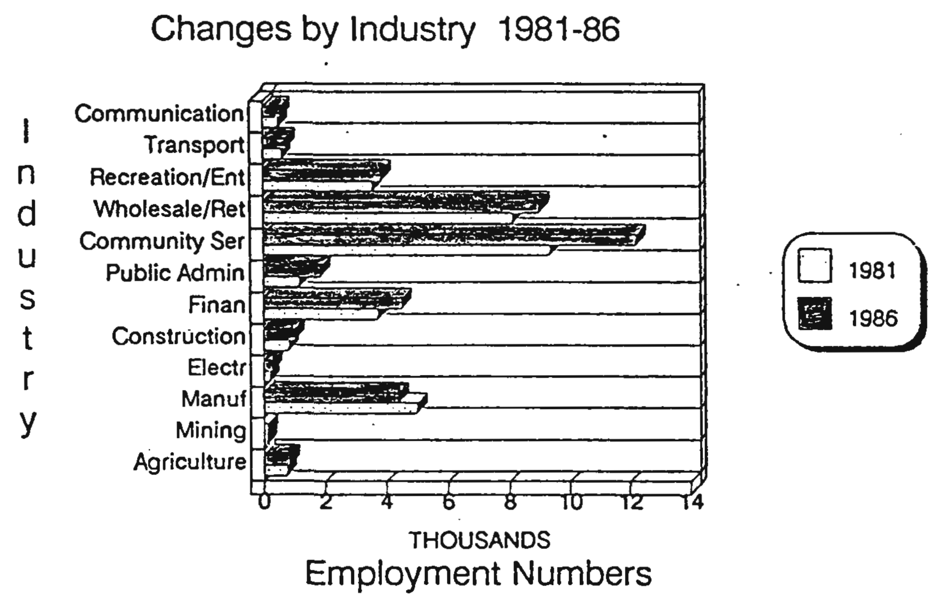
ineligible for social security payments (due to those workers having working spouses). However, for textiles and clothing, 80% do stay in the region and will still be receiving some kind of government support such as child allowance. The type II method is unable to take into account the impacts of expenditure by the unemployed on the economy and thus the results tended to overestimate the true impacts.

The two most important industries in Wollongong are the coal and steel industries. It can be seen that the steel multipliers are down by 2.13%, while the coal multipliers are only down by 0.72% from the original estimates by the type II multiplier method. The difference is due to the fact that 77% of the workers who lose their jobs in the steel industry remain in the region and of those 78% receive social security, while for the coal industry only 60% remain in the region after job loss and of those 76% receive social security payments. As a result, the impact of steel industry restructuring has a higher tendency to be exaggerated since the majority of workers will stay in the region and continue to support a fixed consumption expenditure through the social security they receive. The coal industry also has a higher average family size (3) compared to the steel industry (2.33) and hence workers moving out of the region will take their families with them and no longer have any effect on the economy. The other reason for the large difference in the two most important industries to Wollongong is due to the fact that the government provided assistance to the steel industry in mid-1982. The aim was to promote long term viability through the allocation of resources towards the improvement of international competitiveness, and the evidence certainly indicates that this has been achieved.

The male-dominated industries experienced heavy job losses. On the other hand, the female share of total employment rose from 31% in 1981 to 35% in 1986. Female employment remained heavily segmented in wholesale/retail (females making 46%), finance and property (54%), community

services (64%) and recreation and entertainment (59%). There has also been an increase in female participation in public administration as seen in Figure 6.1.

Figure 6.1 **Female Employment in the Illawarra**



Source: Mangan and Phibbs (1988); pp.4.

This employment of female workers is mainly part-time employment. Thus, it becomes essential to use full-time job equivalents to model labour supply instead of absolute job numbers. It can be seen from the data (Table 6.3) that the employment coefficient (full time job equivalent) for these female-dominated industries are relatively higher than the male-dominated industries due to the fact that these industries gained jobs between 1981 and 1986, most being part-time jobs gained by females.

Table 6.3: Data for Employment Coefficients (Full Time Job Equivalency Data)

Sector No.	Employment Coefficient Adjusted for FTE's
1. Dairy Farming	0.02309
2. Other Agriculture	0.03903
3. Fishing, Hunting	0.01949
4. Coal Mining	0.0073
5. Other Mining,Quarrying	0.00646
6. Food Manufacturing	0.01085
7. Textiles, Clothing	0.02333
8. Wood Prod, furniture	0.0137
9. Paper, print, publish	0.01146
10. Chemicals, Coal Prod.	0.00836
11. Clay Prod,Refrectories	0.01483
12. Other Non-Metallic Minerals	0.00876
13. Basic Iron and Steel	0.00852
14. Non-Ferrous Metal Prod	0.00664
15. Fabricated Metal Prod.	0.01611
16. Transport Equipment	0.00965
17. Other Machinery,Equip.	0.00991
18. Miscell. Manufacturing	0.01607
19. Electricity, Gas	0.0073
20. Water, Sewage & Drainage	0.03147
21. Residential Building	0.02264
22. Other Construction	0.04387
23. Trade (Retail)	0.02728
24. Transport and Storage	0.02191
25. Communications	0.02576
26. Finance	0.01921
27. Ownership of Dwelling	0
28. Public Admin. & Defence	0.02371
29. Community Services	0.02991
30. Entertainment	0.02086

Source: Mangan and Phibbs.

Table 6.1 shows these industries also had type IV multipliers smaller than type II multipliers, as the former took account of full time job equivalents (FTE's). The percentage differences are:

trade (retail)	3.57%
finance	2.82%
public administration and defence	4.17%
community services	2.92%
entertainment	2.44%

The rho estimates for these female-dominated industries are similar to the male dominated industries such as steel, i.e. a majority (80%) of the workers stay in the region after they lose their jobs. However, the ess estimates are much higher (community services, 47% and entertainment, 45%), indicating that the majority of those who lose their jobs are ineligible for social security payments because most of their spouses are also working. These results indicate that the decrease in multipliers is not only due to the expenditure of the unemployed, but also due to the correct modelling of labour supply through using adjusted employment coefficients.

These results echo the claims made in earlier chapters where it was argued that the type IV (demo-economic) multipliers will be smaller than the traditional type II multipliers as the demo-economic model specifically models the unemployed, population and labour supply (using FTE's). It is clear that the failure by the type II method to take into account demo-economic factors gives us exaggerated results for the regional multipliers. It can also be pointed out that the effort, time and cost required to gather the extra information required for DECON multipliers should be balanced against the improvement in reliability, since the decrease in multipliers is not significantly large in many cases. Presentation of the DECON model can be criticized on the grounds that its multipliers are not broken down into initial, consumption and induced impacts although in principle this could be done.

6.3 OTHER MULTIPLIERS

In addition to calculating output multipliers, the DECON model also calculates the employment and population multipliers. These multipliers are shown in Appendix C. The DECON employment multipliers cannot be compared with the type II employment multipliers because of different units. The type II uses unadjusted employment coefficients, while the DECON adjusts the employment coefficients using full-time job equivalents.

The population multipliers are a new development. These multipliers measure the flow-on population changes in a region resulting from an initial population change due to a shift in economic activity in a particular sector.

6.4 EXPLORING THE RELIABILITY OF THE MODEL FURTHER USING THE WOLLONGONG 1981-1986 EXPERIENCE

Some assumptions about changes in final demand in the Wollongong region between the Census period were made to further explore the reliability of the model (Wollongong model). The following were considered to include the main changes in final demand (or the main changes in economic activity which were not the result of the decline at the steelworks, but rather were independent changes) [1].

(i) Public Sector Employment Growth: Changes in community sector employment were exogenously determined, resulting exclusively from increased government spending. However recruitment from the local area was widespread.

(ii) Coal Sector Changes: Changes to the coal industry were also exogenously determined. There was some improvement in productivity but the main cause of job loss in the industry was a loss of overseas orders.

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[1] For full details, see Mangan and Phibbs (1988).

(iii) Public and Private Infrastructure Structure: The recession in Wollongong coinciding with the downturn in manufacturing and mining in 1982/83 was partially offset by large scale private and public capital expenditure during the 1984-86 period.

(iv) Retail: Investment, capital expenditure and resultant decline in escape spending strengthened the infrastructural base of the region and enters the Wollongong economy as a series of short-run injection of exogenous funds into the region and run through the final demand sections of the input-output table.

Using these changes in final demand as inputs, the demo-economic model was run and the results compared with Census estimates. Table 6.4 shows the results.

The unadjusted difference in employment for the Wollongong Statistical District between 1981-1986 was 7126. However, the difference rose to 7381 when allowance was made for the lower level of underenumeration to the 1986 census. When FTE ratios were applied to job changes in the individual sectors, we saw that the sectors that lost jobs tended to have large FTE ratios, while the sectors that gained jobs (retailing and community services) had large numbers of part-time jobs. When we multiplied the change in employment by the various FTE ratios, the number of FTE jobs lost between 1981 and 1986 rose to 8114. The predicted job loss which is estimated at 9959 jobs by using the model is outside the range of the Census figure. However, it is a much closer estimate than that predicted by the traditional model. The population impacts also do not appear to be reasonable. The model suggests that as a result of the downturn, 6875 people will leave the city. The ABS estimate that the net out-migration from the region over the 1981-86 period was 10050. Thus the DECON model needs to be improved and further tested in terms of population and employment changes.

Table 6.4 Running the Wollongong DECON Model 1981-1986

	Coal	Iron/ Steel	Const- ruction	Retail- ing	Public Admin.	Community Services	Total
Initial Employment Change	-2262	-7300	935	1085	873	2621	4048
Initial Employment Change (FTEs)	-2173	-6789	823	803	768	1703	-4865
Employment Flow-ons	-2208	-4043	163	339	220	435	-5094
TOTAL EMPLOYMENT CHANGE	-4381	-10832	986	1142	988	2138	-9959
Initial Population Impact	-2608	-3638	395	446	341	845	-4219
Population Flow-on	-1024	-2200	88	174	125	181	-2656
TOTAL POPULATION CHANGE	-2632	-5838	483	620	466	1026	-6875

Source: Author's Calculations using the DECON Model.

It must be remembered that such an analysis cannot be considered as a complete test of the multiplier model. The DECON package is unable to model all the changes in the economy between 1981 and 1986 that affected employment in the region. Firstly, there could have been numerous changes in Final Demand in the Wollongong economy which are impossible to ascertain because of the large size of the economy. Secondly, changes in employment result from economic changes such as price changes which the DECON model does not take into account. The other point to consider is that Census is resident based and hence measures the number of workers in Wollongong not the number of jobs. Or in other words, changes in the number of Wollongong workers reported at the Census might be the result of changed commuting patterns to Sydney. Another confounding factor is that it is difficult to estimate the exogenous employment changes in the services sector and the estimates in Table 6.4 are based on a number of assumptions.

6.5 SENSITIVITY ANALYSIS ON THE DECON MODEL

Sensitivity analysis is carried out on the Wollongong matrix to determine the sensitivity of the Wollongong DECON matrix to minor coefficient changes or errors. Changes in regional coefficients occur for many reasons. There is usually a time lag from the period for which the latest available published data applies to the time the final table is published. For example, the Wollongong matrix that is being used in this study in 1988 was last updated in 1986. In the meantime some industries may have contracted or expanded relative to other industries, there may have been minor or major structural shifts in the economy, or there may have been technological change which would have caused some coefficients within particular industries to alter. Thus it must be recognized that no regional input-output table can be particularly accurate for the time period the table is used (let alone compiled or updated). Therefore, sensitivity

analysis is important to determine the sensitivity of the results to minor changes or errors in the regional trade coefficients.

Sensitivity analysis was done in this study by using the methodology of West (1982). Tables 6.5, 6.6 and 6.7 show the average output multiplier impact for each sector caused by a 10% change in each intermediate A(I,J) coefficient for the static open model, the static semi-closed model and the static closed model respectively.

In the static open model (Table 6.5), the sensitivity of the average output multiplier for each sector due to 10% change in each intermediate coefficient is generally small with the highest sensitivity occurring in the sectors of fabricated metal (with an average impact of 0.0052%), residential building (0.0050%) and other building (0.0048%).

In the static semi-closed model (Table 6.6), the sensitivity of the multipliers increases relative to the static open model with the highest sensitivity occurring again in the sectors of fabricated metal (0.0058%), residential building (0.0057%) and other building (0.0055%).

In the static closed model (Table 6.7), the sensitivity to errors is at the highest compared to the previous two models. Major sensitivity due to a 10% change in each intermediate coefficient occurs in sectors of ownership of dwelling (with the average output multiplier impact of 0.0134%), dairy farming (0.0098%) and finance (0.0098%). Sensitivity of these three sectors has considerably increased in the closed model compared to other sectors.

The results show that in the static open model, the multipliers are not very sensitive to errors or changes in the Wollongong input-output coefficients. The sensitivity increases when the matrix is semi-closed (closed with respect to household consumption). The sensitivity of the Wollongong matrix further increases when the whole model is closed

Table 6.5: List of the Average Output Multiplier Impact for Each Sector Caused by a 10% Change in Each Intermediate A(I,J) Coefficient in the Static Open Model

SECTOR	1	DAIRYFARMG	AVERAGE IMPACT =	.0028	PERCENT	MULTIPLIER =	1.2471
SECTOR	2	OTHERAGRIC	AVERAGE IMPACT =	.0029	PERCENT	MULTIPLIER =	1.2577
SECTOR	3	FISH&HUNTG	AVERAGE IMPACT =	.0025	PERCENT	MULTIPLIER =	1.2101
SECTOR	4	COALMINING	AVERAGE IMPACT =	.0015	PERCENT	MULTIPLIER =	1.1218
SECTOR	5	OTHRMINING	AVERAGE IMPACT =	.0035	PERCENT	MULTIPLIER =	1.3304
SECTOR	6	FOODMANUFG	AVERAGE IMPACT =	.0034	PERCENT	MULTIPLIER =	1.3162
SECTOR	7	TEXTILEETC	AVERAGE IMPACT =	.0020	PERCENT	MULTIPLIER =	1.1707
SECTOR	8	FURNITURE	AVERAGE IMPACT =	.0020	PERCENT	MULTIPLIER =	1.1641
SECTOR	9	PRINTING	AVERAGE IMPACT =	.0017	PERCENT	MULTIPLIER =	1.1415
SECTOR	10	CHEMICALS	AVERAGE IMPACT =	.0031	PERCENT	MULTIPLIER =	1.2831
SECTOR	11	REFRACTORY	AVERAGE IMPACT =	.0019	PERCENT	MULTIPLIER =	1.1599
SECTOR	12	NONMETMINL	AVERAGE IMPACT =	.0037	PERCENT	MULTIPLIER =	1.3449
SECTOR	13	IRON&STEEL	AVERAGE IMPACT =	.0033	PERCENT	MULTIPLIER =	1.2996
SECTOR	14	NONFERRMET	AVERAGE IMPACT =	.0007	PERCENT	MULTIPLIER =	1.0537
SECTOR	15	FABRICMETL	AVERAGE IMPACT =	.0052	PERCENT	MULTIPLIER =	1.5568
SECTOR	16	TRANSEQUIP	AVERAGE IMPACT =	.0020	PERCENT	MULTIPLIER =	1.2412
SECTOR	17	OTHMACHINS	AVERAGE IMPACT =	.0015	PERCENT	MULTIPLIER =	1.1183
SECTOR	18	MISCMANUFG	AVERAGE IMPACT =	.0028	PERCENT	MULTIPLIER =	1.2424
SECTOR	19	ELECTRIGAS	AVERAGE IMPACT =	.0012	PERCENT	MULTIPLIER =	1.1009
SECTOR	20	WATER&SEWR	AVERAGE IMPACT =	.0029	PERCENT	MULTIPLIER =	1.2511
SECTOR	21	RESIDBUILD	AVERAGE IMPACT =	.0050	PERCENT	MULTIPLIER =	1.5341
SECTOR	22	OTHERBUILD	AVERAGE IMPACT =	.0048	PERCENT	MULTIPLIER =	1.4774
SECTOR	23	COMMERCE	AVERAGE IMPACT =	.0034	PERCENT	MULTIPLIER =	1.3265
SECTOR	24	TRANSPORTS	AVERAGE IMPACT =	.0030	PERCENT	MULTIPLIER =	1.2581
SECTOR	25	COMMUNICAT	AVERAGE IMPACT =	.0013	PERCENT	MULTIPLIER =	1.1088
SECTOR	26	FINANCE	AVERAGE IMPACT =	.0031	PERCENT	MULTIPLIER =	1.2786
SECTOR	27	OWNDWELLNG	AVERAGE IMPACT =	.0034	PERCENT	MULTIPLIER =	1.3042
SECTOR	28	PUBLICADMN	AVERAGE IMPACT =	.0035	PERCENT	MULTIPLIER =	1.3335
SECTOR	29	COMMSERVIC	AVERAGE IMPACT =	.0026	PERCENT	MULTIPLIER =	1.2265
SECTOR	30	ENTERTAINT	AVERAGE IMPACT =	.0031	PERCENT	MULTIPLIER =	1.2845

Source: Author's Calculations.

Table 6.6: <u>**List of the Average Output Multiplier Impact for Each Sector Caused by a 10% Change in Each Intermediate A(I,J) Coefficient in the Static Semi-Closed Model**</u>

SECTOR	1	DAIRYFARMG	AVERAGE IMPACT =	.0036	PERCENT	MULTIPLIER = 1.7665
SECTOR	2	OTHERAGRIC	AVERAGE IMPACT =	.0037	PERCENT	MULTIPLIER = 1.7764
SECTOR	3	FISH&HUNTG	AVERAGE IMPACT =	.0033	PERCENT	MULTIPLIER = 1.6728
SECTOR	4	COALMINING	AVERAGE IMPACT =	.0023	PERCENT	MULTIPLIER = 1.3938
SECTOR	5	OTHRMINING	AVERAGE IMPACT =	.0044	PERCENT	MULTIPLIER = 1.6804
SECTOR	6	FOODMANUFG	AVERAGE IMPACT =	.0043	PERCENT	MULTIPLIER = 1.5715
SECTOR	7	TEXTILEETC	AVERAGE IMPACT =	.0024	PERCENT	MULTIPLIER = 1.2310
SECTOR	8	FURNITURE	AVERAGE IMPACT =	.0028	PERCENT	MULTIPLIER = 1.4073
SECTOR	9	PRINTING	AVERAGE IMPACT =	.0026	PERCENT	MULTIPLIER = 1.4373
SECTOR	10	CHEMICALS	AVERAGE IMPACT =	.0037	PERCENT	MULTIPLIER = 1.3822
SECTOR	11	REFRACTORY	AVERAGE IMPACT =	.0027	PERCENT	MULTIPLIER = 1.3440
SECTOR	12	NONMETMINL	AVERAGE IMPACT =	.0045	PERCENT	MULTIPLIER = 1.5892
SECTOR	13	IRON&STEEL	AVERAGE IMPACT =	.0038	PERCENT	MULTIPLIER = 1.4064
SECTOR	14	NONFERRMET	AVERAGE IMPACT =	.0014	PERCENT	MULTIPLIER = 1.2883
SECTOR	15	FABRICMETL	AVERAGE IMPACT =	.0058	PERCENT	MULTIPLIER = 1.7346
SECTOR	16	TRANSEQUIP	AVERAGE IMPACT =	.0034	PERCENT	MULTIPLIER = 1.4498
SECTOR	17	OTHMACHINS	AVERAGE IMPACT =	.0022	PERCENT	MULTIPLIER = 1.3297
SECTOR	18	MISCMANUFG	AVERAGE IMPACT =	.0035	PERCENT	MULTIPLIER = 1.4722
SECTOR	19	ELECTRIGAS	AVERAGE IMPACT =	.0021	PERCENT	MULTIPLIER = 1.4441
SECTOR	20	WATER&SEWR	AVERAGE IMPACT =	.0037	PERCENT	MULTIPLIER = 1.7582
SECTOR	21	RESIDBUILD	AVERAGE IMPACT =	.0057	PERCENT	MULTIPLIER = 1.8475
SECTOR	22	OTHERBUILD	AVERAGE IMPACT =	.0055	PERCENT	MULTIPLIER = 1.6863
SECTOR	23	COMMERCE	AVERAGE IMPACT =	.0044	PERCENT	MULTIPLIER = 1.6763
SECTOR	24	TRANSPORTS	AVERAGE IMPACT =	.0038	PERCENT	MULTIPLIER = 1.4597
SECTOR	25	COMMUNICAT	AVERAGE IMPACT =	.0023	PERCENT	MULTIPLIER = 1.4983
SECTOR	26	FINANCE	AVERAGE IMPACT =	.0041	PERCENT	MULTIPLIER = 1.7716
SECTOR	27	OWNDWELLNG	AVERAGE IMPACT =	.0043	PERCENT	MULTIPLIER = 2.1686
SECTOR	28	PUBLICADMN	AVERAGE IMPACT =	.0045	PERCENT	MULTIPLIER = 1.4374
SECTOR	29	COMMSERVIC	AVERAGE IMPACT =	.0034	PERCENT	MULTIPLIER = 1.3737
SECTOR	30	ENTERTAINT	AVERAGE IMPACT =	.0040	PERCENT	MULTIPLIER = 1.6446

<u>**Source**</u>: **Author's Calculations.**

Table 6.7: **List of the Average Output Multiplier Impact for Each Sector Caused by a 10% Change in Each Intermediate A(I,J) Coefficient in the Static Closed Model**

SECTOR	1	DAIRYFARMG	AVERAGE IMPACT =	.0098	PERCENT	MULTIPLIER =	1.7143
SECTOR	2	OTHERAGRIC	AVERAGE IMPACT =	.0096	PERCENT	MULTIPLIER =	1.7014
SECTOR	3	FISH&HUNTG	AVERAGE IMPACT =	.0092	PERCENT	MULTIPLIER =	1.6288
SECTOR	4	COALMINING	AVERAGE IMPACT =	.0065	PERCENT	MULTIPLIER =	1.3762
SECTOR	5	OTHRMINING	AVERAGE IMPACT =	.0084	PERCENT	MULTIPLIER =	1.6512
SECTOR	6	FOODMANUFC	AVERAGE IMPACT =	.0071	PERCENT	MULTIPLIER =	1.5371
SECTOR	7	TEXTILEETC	AVERAGE IMPACT =	.0026	PERCENT	MULTIPLIER =	1.2018
SECTOR	8	FURNITURE	AVERAGE IMPACT =	.0060	PERCENT	MULTIPLIER =	1.3722
SECTOR	9	PRINTING	AVERAGE IMPACT =	.0068	PERCENT	MULTIPLIER =	1.4073
SECTOR	10	CHEMICALS	AVERAGE IMPACT =	.0044	PERCENT	MULTIPLIER =	1.3578
SECTOR	11	REFRACTORY	AVERAGE IMPACT =	.0050	PERCENT	MULTIPLIER =	1.3090
SECTOR	12	NONMETMINL	AVERAGE IMPACT =	.0071	PERCENT	MULTIPLIER =	1.5584
SECTOR	13	IRON&STEEL	AVERAGE IMPACT =	.0046	PERCENT	MULTIPLIER =	1.3821
SECTOR	14	NONFERRMET	AVERAGE IMPACT =	.0054	PERCENT	MULTIPLIER =	1.2693
SECTOR	15	FABRICMETL	AVERAGE IMPACT =	.0067	PERCENT	MULTIPLIER =	1.6902
SECTOR	16	TRANSEQUIP	AVERAGE IMPACT =	.0060	PERCENT	MULTIPLIER =	1.4211
SECTOR	17	OTHMACHINS	AVERAGE IMPACT =	.0053	PERCENT	MULTIPLIER =	1.3038
SECTOR	18	MISCMANUFG	AVERAGE IMPACT =	.0062	PERCENT	MULTIPLIER =	1.4341
SECTOR	19	ELECTRIGAS	AVERAGE IMPACT =	.0074	PERCENT	MULTIPLIER =	1.4213
SECTOR	20	WATER&SEWR	AVERAGE IMPACT =	.0095	PERCENT	MULTIPLIER =	1.6809
SECTOR	21	RESIDBUILD	AVERAGE IMPACT =	.0082	PERCENT	MULTIPLIER =	1.7858
SECTOR	22	OTHERBUILD	AVERAGE IMPACT =	.0063	PERCENT	MULTIPLIER =	1.5932
SECTOR	23	COMMERCE	AVERAGE IMPACT =	.0081	PERCENT	MULTIPLIER =	1.6186
SECTOR	24	TRANSPORTS	AVERAGE IMPACT =	.0057	PERCENT	MULTIPLIER =	1.4089
SECTOR	25	COMMUNICAT	AVERAGE IMPACT =	.0077	PERCENT	MULTIPLIER =	1.4442
SECTOR	26	FINANCE	AVERAGE IMPACT =	.0098	PERCENT	MULTIPLIER =	1.7253
SECTOR	27	OWNDWELLNG	AVERAGE IMPACT =	.0134	PERCENT	MULTIPLIER =	2.1371
SECTOR	28	PUBLICADMN	AVERAGE IMPACT =	.0045	PERCENT	MULTIPLIER =	1.3832
SECTOR	29	COMMSERVIC	AVERAGE IMPACT =	.0046	PERCENT	MULTIPLIER =	1.3279
SECTOR	30	ENTERTAINT	AVERAGE IMPACT =	.0082	PERCENT	MULTIPLIER =	1.6019

Source: Author's Calculations.

(closed with respect to household, population and unemployment sectors). Some sensitivity here is due to the closure of households, however the large part of sensitivity is due to the demographic factors.

Looking closely at the two most important industries, coal and iron and steel, we can see the magnitude of the sensitivity to errors in a static closed model is high compared to the other two models. Table 6.8 shows the results.

Table 6.8: <u>Average Output Multiplier Impact for the Coal and Iron and Steel Sectors Caused by a 10% Change in Each Intermediate A(I,J) Coefficient</u>

Sector	Static Open Model	Static Semi-Closed Model	Static Closed Model
Coal	0.0015%	0.0023%	0.0065%
Iron and Steel	0.0033%	0.0038%	0.0046%

<u>Source</u>: Author's Calculations.

The table shows that the coal industry coefficients are more sensitive to errors in the static closed model compared to the iron and steel industry. However, the steel industry is more sensitive in the static open and static semi-closed model than the coal. Both the coal and iron and steel industries are more sensitive to changes or errors in the static closed model, just like the other sectors in the Wollongong Statistical District.

Therefore, it can be said that even though the demo-economic factors provide us with additional information, they are more sensitive to errors or changes. Thus the benefits of the extra information gained through the demo-economic factors must be weighed against the sensitivity of the multipliers to coefficient errors or changes.

6.6 SUMMARY AND CONCLUSIONS

The DECON study was undertaken after it was realized that earlier modelling work into the effects of manufacturing recession in the Wollongong economy had produced overly pessimistic impact predictions. Studies have shown that the Wollongong economy proved to be far more resilient to economic shock than the conclusions based upon estimates of a standard input-output table had led us to predict. This was due to the tendency of the standard input-output table to ignore the consumption-support effects of the unemployed and the fact that regions in Australia tend to be to some extent population driven, in particular the amount of State and Federal Government funding of services and programmes depends on population size. Both these factors have highlighted the deficiency of the traditional input-output table, in terms of its exclusion of the non-workforce population.

Wollongong, has experienced rapid economic change between 1981 and 1986. There have been changes in both job-status and occupation and sex distribution of the workforce, and in consequence, in the characteristics of the non-workforce population. There has been an increase in female employment, a greatly increased proportion of part-time employment in the workforce, a large number of young (15-19) and older (45+) persons seeking employment.

The following improvements were built into the traditional input-output table to overcome these limitations:

1. The use of full-time job equivalents in preference to absolute job-numbers to more correctly reflect labour supply in the region.

2. The use of the unemployment coefficients to model the consumption spending of the unemployed and the further refinement of the consumption aspects of unemployment by the use of the rho and ess coefficients and family size data.

3. The calculation of population multipliers to specifically allow for the effects of demographic changes on the regional workforce and economy.

The result has been the calculation of output multipliers substantially different from standard multipliers and in the case of Wollongong more closely reflecting actual events in the economy over the last six years. However, the population and employment changes are not reasonable as they do not predict changes close to the Census data, but are a considerable improvement over the traditional input-output model.

The advantage of this new approach, i.e. demo-economic modelling is that it allows the obvious benefits of the simple input-output approach to be retained, while acknowledging the impact of the unemployed on regional economic systems. In addition, this approach addresses the major problems associated with traditional applications of input-output model - that of population-driven factor and modelling labour supply.

In conclusion, the calculation of realistic output multipliers suggests that the model is reliable and is a considerable improvement over the previous simple input-output model used for modelling the Wollongong region. However, the DECON model is more sensitive to errors or

changes in coefficients than the simple model and therefore it is important to weigh up this disadvantage with the benefits of calculating realistic output multipliers.

6.7 AREAS OF FUTURE DEVELOPMENT

The DECON model has concentrated on one sector of the non-workforce population, the unemployed and their families. Other significant (in terms of consumption spending) elements of the non-workforce population such as students and retired people may need to be included in the analysis. This applies particularly to regions such as the Gold Coast where it is arguable that the contribution made by the non-workforce population to the economy is as large as the contribution made by the workforce. It becomes important to model the consumption patterns of the whole population as the aging of Australian population continues to grow. Wollongong has an increasing number of persons that work in Sydney but live in Wollongong. And for the model to be complete, these elements of the economy need to be modelled in a region. Single mothers could also be needed to be modelled. This all requires extra data gathering in areas that do not readily lend themselves to direct estimation. Therefore, it is necessary to balance the benefits of the information gained against the cost of data gathering.

6.8 EVALUATION OF RESULTS

It is appropriate to acknowledge the point stressed by Jensen et al (1978) concerning the evaluation of input-output results:

> "Multipliers cannot be mechanistically applied but require careful interpretation and indeed adjustment in some circumstances if they are to realistically predict real world economic impacts".

The foregoing results must be evaluated in the light of the assumptions upon which the input-output model is based and the economic conditions of the particular economy under consideration (in our case, the Wollongong region).

Input-output assumes constant technology, yet the recent improvements in the technology of Wollongong rail links may cast doubt on this assumption. These improvements include the electrification from Sydney to Wollongong, a new rail link from Maldon to Dombarton and the upgrading of the Moss Vale line. These improvements will increase the efficiency of rail transport and thus will have implications for the input structure of any industries requiring long distance transport.

These improvements in communication links along with the inland transport and the new Port Kembla grain handling facility create the opportunities for a two-way traffic of goods and services by both land and sea transport. This will increase the consignment of import cargoes to Wollongong (Port Kembla) to supply the region and the south and west regions of Sydney. This will further stimulate the development of Wollongong as a merchandising center.

The Wollongong input-output matrix used for the purpose of this study pertains to 1986. The general tendency for industries to become more capital intensive over time means that employment multipliers estimated may be slightly overestimated as automation will displace workers in each sector.

The existence of excess capacity is denied by the linearity assumption. However, the Wollongong economy has experienced a recession in the early 1980's associated with the decline in the steel and coal sectors. This has resulted in industries operating below capacity with the implication that the input-output multipliers estimated above will tend

to overstate the true impacts. However, this does not appear to be a great problem as the Wollongong economy has begun to recover in recent years.

The relevance of the assumption of unlimited capacity constraints differ from industry to industry. However, if major construction operations start to occur in the area, then there would be a large influx of temporary construction workers and could create a local boom in the industry putting pressure on local resources. Again this would imply that the multipliers overestimate the true impacts.

Some influences suggest that the estimated multipliers may in fact understate the true impact of the economy. For instance, the increased potential for agglomeration economies may result in new firms locating within the region which would increase economic activity. These agglomeration economies may be due to overall costs being reduced due to an increased use of infrastructure.

From the foregoing discussion, it can be concluded that the impact multiplier estimates obtained from any input-output model should not be interpreted as fixed and immutable, but rather it must be realised that their is potential for errors in their estimation both in a downward and upward direction, and they will change over time. While recognising these facts, and noting some of the sources of errors in multipliers, it is beyond the scope of this study to analyse them in further detail.

CHAPTER SEVEN

SUMMARY AND CONCLUSIONS

CHAPTER SEVEN

SUMMARY AND CONCLUSIONS

Input-output analysis has proved to be a particularly powerful instrument for applied regional analysis. In Australia the utilisation of input-output for measuring the extent and nature of regional economic impact is now routine, for example, in the assessment of large industrial projects.

One of the main criticisms has been that the snapshot characteristics of the input-output model do not allow it to satisfactorily handle the real problems of future growth and change with any sort of accuracy. Seen in the light of main applications of regional input-output, impact or multiplier analysis, this apparent deficiency of the static model has proved a subject of considerable research aimed at constructing and updating regional input-output multipliers in a way that is cost and time effective. Described either as non-survey or hybrid (partial survey) input-output approaches, these methods, which generally use a national input-output table as a basis, are seen as substitutes for full survey methods of regional table construction. An important finding of the review in chapter three is that no one method can be recommended for all situations. A GRIT type model seems to be the most suitable and is the one used for this study.

Traditional input-output models also produce unrealistic impact forecasts because of several main problems:

(i) The traditional input-output model only considered the consumption of workers. Thus it was not possible to explicitly measure the impact that the consumption of unemployed households would have on the economy.

(ii) The traditional input-output model did not acknowledge that the economy is to some extent population driven.

(iii) The traditional model used absolute job numbers in modelling labour supply which results in serious modelling errors in input-output analysis as the number of part-time jobs continues to increase.

As a result of these problems, standard input-output models tended to overestimate the impacts of decline in regions. Early forecasts of the impact of the downturn in the steel industry in Illawarra, based on static open input-output models, were pessimistic. This was because it was not acknowledged that a large number of those who become unemployed would remain in the region and maintain reasonably high levels of expenditure.

After the weaknesses of the standard models were acknowledged, regional economists developed an alternative model known as a demo-economic model. The demo-economic model was popularised by Madden and Batey (1980) who developed a model around an activity-commodity framework to overcome the inconsistencies of unemployment. However, the activity-commodity framework was unable to model the population-driven factor. Thus Mangan and Phibbs (1988) extended the demo-economic model to overcome the traditional problems and developed a new demo-economic model, called the DECON model.

The DECON model is an application and extension of demo-economic modelling which arose out of the dissatisfaction of the earlier style of modelling in the Wollongong region and the unique conditions facing the Wollongong economy. In the DECON model, the consumption of unemployed households was explicitly measured and also a distinction was made between jobs which go to previously unemployed who live in the region, and people who migrated into the region. This model acknowledges the economic role that the unemployed play in a region and also acknowledges the importance of demographic variables such as the age and sex structure of the population, the relative size of the non-working population and the propensity for inward and outward migration. It is

considered that this sort of model is appropriate for modelling the Wollongong economy because of the rapid changes which occurred in the region between 1981 and 1986.

The demo-economic (DECON) model adds two new industries to the traditional input-output model. The first new industry is the population industry. This model acknowledges that the changes in the non-market sectors is related to population change and not economic change in other sectors of the economy. The introduction of this industry allows the specific calculation of population multipliers which measure the flow-on population changes in a region resulting from an initial population change due to a shift in economic activity in a particular sector.

The second new industry is the unemployed. The model treats the unemployed as a separate industry and specifically models their consumption. This allows the model to estimate the impact of the downturn in the economy by examining the difference between the employed and the unemployed. The major new parameters of this model include:

(i) Rho: the proportion of people who remain in the region after they lose their job.

(ii) Ess: the proportion of people who would be ineligible for unemployment benefits if they lost their job (i.e. people with working spouses).

(iii) Family size: the average family size by industry sector.

The DECON model also allows regional analysts to assess the impact of demographic changes in their regions. For example, pensioners impact can be modelled by estimating their level of consumption of goods and services, and then adding this to a part of the model known as Final Demand.

The DECON model also uses full time job equivalent data to overcome the serious modelling errors created by using absolute job numbers.

This demo-economic model was run and tested for the Wollongong region. Comparison between the traditional type II (static semi-closed) multipliers and the demo-economic type IV (static closed) multipliers were made for the Wollongong region. The results showed that all the type IV multipliers were smaller than the type II multipliers. This was due to the exclusion of the demographic factors from the traditional model. The traditional model ignored the fact that to some extent the Wollongong region (as with any region) is population-driven. That is, most of the workers who lose their jobs remain in the region and through social security payments continue to support fixed consumption expenditure and some percentage of variable consumption depending upon their financial position.

These results indicate that the demo-economic model is far superior to the traditional model as it calculated output multipliers which reflected more closely the actual events in the Wollongong region between 1981 and 1986. However, the employment and population changes predicted by the DECON model were not close to the census estimates indicating the employment and population multipliers are not accurate.

The study went one step further and examined the sensitivity of the static closed model, i.e. the DECON model. Sensitivity was carried out on the static open, static semi-closed (closed with respect to households) and static closed (closed with respect to households, unemployed and population sectors) to show the average impact on each sector multiplier caused by a 10% change in each intermediate A(I,J) coefficient.

The results indicated that the sensitivity to errors is high in the static semi-closed model compared to the static open model. However, sensitivity is the highest in the static closed model.

Therefore, the benefits of realistic multipliers and the extra information gained from the DECON model must be weighed against the cost of data gathering and the high sensitivity of multipliers to errors or changes in the coefficients.

The results obtained in this study are subject to some qualifications, due to the assumptions upon which all input-output models are based and the weaknesses of non-survey input-output table.

The main assumptions of input-output that may be cause for concern are the assumptions of no excess capacity and unlimited capacity constraints. If these assumptions are not appropriate to certain sectors in the Wollongong region, this may result in the multipliers over-estimating the impacts. The assumption of constant technology may also be inaccurate in the face of improvements in the rail link network surrounding the district.

There are difficulties in deriving accurate input-output models using non-survey methods and in trying to evaluate their accuracy. The regional input-output matrix used in this study was derived by the GRIT method. Therefore the problems of non-survey methods outlined in chapter three must be borne in mind when interpreting the results.

Increased potential for agglomeration economies may result in new firms locating within the region which would increase economic activity, and this could understate the estimated impact of the economy.

After considering all the above factors there appears no reason to believe that the multipliers estimated will be either significantly overstated or understated as these affects are likely to counteract each other.

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APPENDICES

APPENDIX A

INPUT-OUTPUT APPLICATIONS AND THE MULTIPLIER ANALYSIS

This section looks at the importance of the coefficients and the multipliers in input-output analysis by using the GRIT (Generation of Regional Input-Output Tables) method. GRIMP (GRIT Impact Programme) package is used to determine the coefficients and the multipliers using the hypothetical economy shown in Table 1.

Table 1: Transactions Table: A Hypothetical Economy, 1987/88, ($'000).

Sector	INDUS 1	INDUS 2	INDUS 3	TOTAL I	H-Hold	GOVT	CAPITAL	EXPORTS	TOTAL F	TOTAL
INDUS 1	2	4	3	9	12	12	7	20	51	60
INDUS 2	1	6	3	10	10	8	6	11	35	45
INDUS 3	2	5	2	9	5	14	9	3	31	40
TOTAL I	5	15	8	28	27	34	22	34	117	145
H-Hold	30	15	11	56	0	0	0	0	0	56
GOVT	6	2	4	12	20	0	0	0	20	32
G.C.S	4	-2	11	13	0	0	0	0	0	13
IMPORTS	15	15	6	36	50	0	7	0	57	93
TOTAL P	55	30	32	117	70	0	7	0	77	194
TOTAL	60	45	40	145	97	34	29	34	194	339
Employ.	200	400	600	1200						

Technical and Interdependence Coefficients

Table 2, the direct technical coefficients (or the A matrix), shows the direct or first order effects of changes in output. That is, technical coefficients is the amount of inputs required from each industry to produce one dollar's worth of the output of a given industry. Technical coefficients are calculated by dividing every item in the quadrants of the transaction's table by the corresponding totals.

Table 2: Direct Coefficients Table: A Hypothetical Economy, 1987/88.

Sector	INDUS 1	INDUS 2	INDUS 3	TOTAL I	H-Hold	GOVT	CAPITAL	EXPORTS	TOTAL F	TOTAL
INDUS 1	0.0333	0.0889	0.0750	0.1972	0.1237	0.3529	0.2414	0.5882	1.3063	1.5035
INDUS 2	0.0167	0.1333	0.0750	0.2250	0.1031	0.2353	0.2069	0.3235	0.8688	1.0938
INDUS 3	0.0333	0.1111	0.0500	0.1944	0.0515	0.4118	0.3103	0.0882	0.8619	1.0563
TOTAL I	0.0833	0.3333	0.2000	0.6167	0.2784	1.0000	0.7586	1.0000	3.0370	3.6536
H-Hold	0.5000	0.3333	0.2750	1.1083	0.0000	0.0000	0.0000	0.0000	0.0000	1.1083
GOVT	0.1000	0.0444	0.1000	0.2444	0.2062	0.0000	0.0000	0.0000	0.2062	0.4506
G.O.S	0.0667	-0.0444	0.2750	0.2972	0.0000	0.0000	0.0000	0.0000	0.0000	0.2972
IMPORTS	0.2500	0.3333	0.1500	0.7333	0.5155	0.0000	0.2414	0.0000	0.7568	1.4902
TOTAL P	0.9167	0.6667	0.8000	2.3833	0.7216	0.0000	0.2414	0.0000	0.9630	3.3464
TOTAL	1.0000	1.0000	1.0000	3.0000	1.0000	1.0000	1.0000	1.0000	4.0000	7.0000
Employ.	3.3333	8.8889	15.0000	27.2222						

Industry 2 will be used to illustrate the meaning of direct technical coefficients.

For each $1 thousand worth of production in industry 2, it requires direct purchases from other industries as follows:-

(i)	purchases by industry 2 from industry 1	88.9
(ii)	purchases by industry 2 from industry 2[(a)]	133.3
(iii)	purchases by industry 2 from industry 3	111.1
	∴ Total direct purchases	333.3

(a) intra-industry purchase

Each one thousand dollars worth of production requires $666.7 worth of primary inputs as well.

This concept can also be illustrated by using the transactions table (Table 1) in the following manner:

If the production of industry 2 is increased by 10%, this will lead to an increase of \$4.5 thousand worth of production. Thus, we have to increase the production of all inputs which are used in the production of industry 2 by 10%.

That is,

\$0.4 thousand worth of additional output of industry 1.
\$0.6 thousand worth of additional output of industry 2.
\$0.5 thousand worth of additional output of industry 3.
\$3.0 thousand worth of additional primary inputs.

\$4.5

Basically, the direct technical coefficient shows direct effects or first order effects of a change in output. Here, we are looking at a \$ thousand in output. This change (increase) in output will lead to change (increase) in inputs.

In addition to these first-round purchases, there will be a series of indirect purchases as waves of second, third and subsequent-round effects make their way throughout the economy. These rounds are summed to obtain a total combined direct and indirect effect. Second round effects can be calculated simply by multiplying the A matrix by itself; i.e. obtaining the A^2 matrix. Similarly, the third round effect can be calculated by obtaining the A^3 matrix and so on. If we sum the matrices A, A^2, A^3,.....A^n, i.e.

$$\sum_{i=1}^{n} A^i$$

we obtain the indirect, or production-induced, effects of a dollar increase in sales to final demand of each sector. The term excludes any increases caused by increased household income.

Output effects are calculated from the open inverse $Z = (I-A)^{-1}$. The Leontief inverse or the interdependence coefficient as it is sometimes called, show that a change in the final demand of the products of one sector causes ramifications through the system which changes not only the outputs of the sector concerned but also those of most or perhaps all the other sectors of the economy. That is, the Leontief's inverse represents total addition to output resulting from additional sales to final demand sector.

Table 3 shows the open inverse matrix of a hypothetical economy. By looking at the columns of the table, we can say that for $1 thousand of final demand for industry 2 output, the:

(i) total output of industry 1 is 0.12.
(ii) total output of industry 2 is 1.17.
(iii) total output of industry 3 is 0.14.

Providing a total of $1.43 on the productive sectors of the economy as a whole.

Table 3: Open Inverse Matrix: A Hypothetical Economy, 1987/88., ($'000).

Sector	INDUS 1	INDUS 2	INDUS 3
INDUS 1	1.04	0.12	0.09
INDUS 2	0.02	1.17	0.09
INDUS 3	0.04	0.14	1.07

It must be remembered here, that for any sector, the output required exceeds final demand because indirect relationships are expressed in the system. The open inverse shows both the direct and indirect effects of increasing final demand for any sector by one unit of value. Therefore, we can say that each entry in Table 3 is a multiplier indicating an expected response to a dollar sales stimulus; the elements of the table are disaggregated output multipliers, showing the relative output effects which can be expected in each sector of the economy.

Consumption - Induced Effects

The consumption-induced effect is defined as that induced by increased household income associated with the original dollar stimulus in output. The inverse of the closed model, shown in Table 4 includes an income multiplier and consumption effects. The consumption-induced effects are calculated in disaggregated form as the difference between the corresponding elements of the open and closed inverse. They are larger than the elements of the open inverse because they include output levels required by local firms to meet the consumption-induced output effects included by closing the model with respect to households. Each element of the closed inverse will be greater than the corresponding element of the open inverse matrix by the amount of the consumption-induced output effects.

Table 4: Closed Inverse Matrix: A Hypothetical Economy, 1987/88., ($'000).

Sector	INDUS 1	INDUS 2	INDUS 3	H-Hold
INDUS 1	1.13	0.20	0.15	0.17
INDUS 2	0.10	1.24	0.15	0.15
INDUS 3	0.09	0.18	1.10	0.09
H-Hold	0.62	0.56	0.43	1.16

Multipliers

Multipliers can also be derived by input-output analysis. A multiplier is a measurement of response to an economic stimulus. In input-output case, the stimulus is normally assumed to be an increase of one dollar in sales to final demand by a sector. The major categories of impact as defined by Jensen et al (1979) are in terms of output, income, and employment.

Output Multipliers: are shown in Table 5. This table shows, for example, that each dollar of output of the industry 2 sector can be expected to result in 33 cents in direct or

first-round output effects in all sectors, 9 cents in industrial support output effects, 20 cents in consumption-induced output effects, giving a total multiplier of 1.62, or a flow on effect of $0.62. The flow-on effect is considered to be the output result of the assumed dollar output stimulus to the regional economy, therefore, depicting the multiplier as a measure of response to a stimulus which can be valued in this case as an additional (an average) dollar of output.

Table 5: Total Output Multipliers: A Hypothetical Economy, 1987/88., ($'000).

SECTOR	INITIAL	FIRST	INDUST	CONS'M	TOTAL	TYPE 1A	TYPE 1B	TYPE 2A	TYPE 2B
INDUS 1	1.00	0.08	0.02	0.22	1.32	1.08	1.10	1.32	0.32
INDUS 2	1.00	0.33	0.09	0.20	1.62	1.33	1.43	1.62	0.62
INDUS 3	1.00	0.20	0.05	0.15	1.40	1.20	1.25	1.40	0.40

Employment Multipliers: are calculated by multiplying the appropriate inverse matrices by the employment coefficients shown in row 11 of Table 2. Employment multipliers are calculated in Table 6 of the hypothetical economy. The multipliers show that each $1000 of output of industry 2 is responsible for 8.89 employees in that sector, 3.15 in the first-round effects, 0.85 employees in industrial support effects, 1.55 employees in the consumption-induced effects, or a total of 14.44 employees with 5.55 due to flow on effects. This produces a flow-on ratio (type 2B) of 0.62, indicating that for each person directly employed in industry 2, a further 0.62 are employed in the economy due to the flow-on effects of industry 2.

Table 6: Total Employment Multipliers: A Hypothetical Economy, 1987/88., ($'000).

SECTOR	INITIAL	FIRST	INDUST	CONS'M	TOTAL	TYPE 1A	TYPE 1B	TYPE 2A	TYPE 2B
INDUS 1	3.33	0.76	0.17	1.71	5.97	1.23	1.28	1.79	0.79
INDUS 2	8.89	3.15	0.85	1.55	14.44	1.35	1.45	1.62	0.62
INDUS 3	15.00	1.67	0.48	1.17	18.32	1.11	1.14	1.22	0.22

Household Income Multipliers: these show the expected impact of an assumed dollar of output of each sector on regional household income. The household income multipliers calculated for a hypothetical economy is shown in Table 7. These multipliers show the income effect of an output change. Each dollar of industry 2 output results in 33 cents in income within the same sector, 12 cents in industries affected by first round purchases, three cents in industries affected by industrial support effects, eight cents affected by consumption induced effects, leading to total income affects of 56 cents per dollar of industry's 2 output, with 23 cents occurring as a result of flow-on output effects in various sectors of the economy.

Table 7: Total Income Multipliers: A Hypothetical Economy, 1987/88., ($'000).

SECTOR	INITIAL	FIRST	INDUST	CONS'M	TOTAL	TYPE 1A	TYPE 1B	TYPE 2A	TYPE 2B
INDUS 1	0.50	0.03	0.01	0.08	0.62	1.06	1.08	1.25	0.25
INDUS 2	0.33	0.12	0.03	0.08	0.56	1.36	1.46	1.69	0.69
INDUS 3	0.28	0.08	0.02	0.06	0.43	1.28	1.35	1.56	0.56

Type I and type II ratios are calculated to establish a relationship between initial or own sector income effects and flow-on income effects. Type I and type II ratios are calculated as follows:

$$\text{Type I Ratio} = \frac{\text{Direct and Indirect (Initial and Final Round and Industrial Support)}}{\text{Initial (own sector) Effect}}$$

$$\text{Type IIA Ratio} = \frac{\text{Total Effect}}{\text{Initial Effect}}$$

$$\text{Type IIB Ratio} = \frac{\text{Flow-on Effects}}{\text{Initial Effects}}$$

A Summary of Input-Output Multipliers

We can list the effects of each (or an additional) $1000 of industry's 2 output as can be seen from Table 8:

(i) own sector effects:

$330 in household income
8.89 in employment

(ii) first round effects:

$330 in output effects
$120 in household income
3.15 in employment

(iii) industrial support effects:

$90 in output effects
$30 in household income
0.85 in employment

(iv) consumption-induced effects:

$200 in output effects
$80 in household income
1.55 in employment

(v) total multiplier effects:

$1620 in output effects
$560 in household income
14.44 in employment

(vi) flow-on effects:

$620 in output effects
$230 in household income
5.55 in employment

Table 8: Output, Income and Employment Multipliers, Hypothetical Economy 1987/88.

	Initial Effect (1)	First Round (Direct) (2)	Industrial Support (Indirect) (3)	Consumption -Induced (4)	Total Multiplier (5)	Flow-on (6)
A. Output Multipliers [(a)]						
1. Industry 1	1.00	0.08	0.02	0.22	1.32	0.32
2. Industry 2	1.00	0.33	0.09	0.20	1.62	0.62
3. Industry 3	1.00	0.20	0.05	0.15	1.40	0.40
B. Income Multipliers [(a)]						
1. Industry 1	0.50	0.03	0.01	0.08	0.62	0.12
2. Industry 2	0.33	0.12	0.03	0.08	0.56	0.23
3. Industry 3	0.28	0.08	0.02	0.06	0.43	0.15
C. Employment Multipliers [(b)]						
1. Industry 1	3.33	0.76	0.17	1.71	5.97	2.64
2. Industry 2	8.89	3.15	0.85	1.55	14.44	5.55
3. Industry 3	15.00	1.67	0.48	1.17	18.32	3.32

(a) Output per dollar of output of each sector

(b) Scaled to represent employees per thousand dollars of output of each sector

A summary of the concept of input-output multipliers is shown in Table 9. Row 2 shows the case if the direct and indirect multiplier developed as an expansion, through several rounds of A matrix, $I + A + A^2 + -- + A^n$, and providing the open inverse. Row 1 provides the same with respect to the A* matrix closed with respect to households. Row 3 shows the consumption-induced effect, calculated as a difference between open and close matrices. Part B is an exact parallel to part A, showing the employment multiplier. Employment multipliers are calculated by the use of employment coefficients as arranged in the form of a row vector $e = [e_1 \; e_2 \; e_3]$ and using matrix multiplication. Part C provides another example of some other nominated effect represented by coefficients C_i, also in row vector form $c = [c_1 \; c_2 \; c_3]$, to calculate a general multiplier.

Table 9: Illustration of Rounds of Multiplier Effects[1]

	Initial Impact ($)		Flow-on Effects: First Round Effect		Second Round Effect		Third Round Effect	...	n^{th} Round Effect		Total (Genera Solutior
A. Output Effects											
1. Closed Model (including households)	I	+	A^*	+	A^{*2}	+	A^{*3}	+ ... +	A^{*n}	=	$(I-A^*)^{-1}$
2. Open Model (excluding households)	I	+	A	+	A^2	+	A^3	+ ... +	A^n	=	$(I-A)^{-1}$
3. Household Consumption Induced Effect (Row 1 less Row 2)	-		A^*-A		$A^{*2}-A^2$	+	$A^{*3}-A^3$	+ ... +	$A^{*n}-A^n$	=	$(I-A^*)^{-1}-(I-A)^{-1}$
B. Employment Effects											
4. Closed Model	eI	+	eA^*	+	eA^{*2}	+	eA^{*3}	+ ... +	eA^{*n}	=	$e(I-A^*)^{-1}$
5. Open Model	eI	+	eA	+	eA^2	+	eA^3	+ ... +	eA^n	=	$e(I-A)^{-1}$
6. Consumption Induced Employment Effect	-		$e(A^*-A)$	+	$e(A^{*2}-A^2)$	+	$e(A^{*3}-A^3)$	+ ... +	$e(A^{*n}-A^n)$	=	$e[(I-A^*)^{-1}-(I-A)^{-1}]$
C. Other Nominated Effects (represented by coefficient c_i)											
7. Closed Model	cI	+	cA^*	+	cA^{*2}	+	cA^{*3}	+ ... +	cA^{*n}	=	$c(I-A^*)^{-1}$
8. Open Model	cI	+	cA	+	cA^2	+	cA^3	+ ... +	cA^n	=	$c(I-A)^{-1}$
9. Consumption Induced Effect of Nominated Factor	-		$c(A^*-A)$		$c(A^{*2}-A^2)$	+	$c(A^{*3}-A^3)$	+ ... +	$c(A^{*n}-A^n)$	=	$c[(I-A^*)^{-1}-(I-A)^{-1}]$

1. The industrial support output effect is defined as $A + A^2 + A^3 + \ldots + A^n$ as shown in Row 2. Similarly these effects in Rows 5 and 8 refer to industrial support employment and "other nominated" factor effects.

Source: Jensen and West (1986); pp.68.

APPENDIX B

THE POPULATION IMPACT PROCEDURE FOR THE WOLLONGONG REGION [1]

In order to estimate the magnitude of population change and its resultant impacts, it is necessary to estimate two main parameters. The first involves making estimates of the level per head of population of non-market services.

The non-market coefficient was estimated using historical data using the following procedure:

- The data on family size (see below) tells us the number of persons likely to be attracted into the region if an additional job is generated and we assume that the vacancy is filled by someone from outside the region. For example, an additional job in the retail sector will generate an additional 2.9 persons;

- Census data were used to estimate the ratio of Service sector jobs per person in the Wollongong Statistical District (0.061). Or in other words, every job in the retail sector will generate an additional 0.176 Service sector jobs, or increase the employment multiplier by about 0.18.

- The entry in the population column was set to 0, and then slowly increased until the necessary increase in the employment multiplier was obtained. This occurred when the coefficient was equal to 0.26.

The second variable that needs to be estimated is the number of dependants by industry sector. This was estimated as follows:

- The ABS cross-tabulated table (No.16 at the 1981 Census, and No. UX0016 at the 1986 Census) - Industry by Age by Marital status for the Illawarra Statistical Division - was used to provide an estimate of marital status by industry sector.

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[1] From Mangan and Phibbs (1988)

- The ABS cross-tabulated table (No.43 1981) - Age Marital Status by sex by family type - for the Illawarra Statistical Division - was used to provide an estimate of the family types of the various marital status categories, for those heads of households in the working age population. For example, those who were never married were mainly head only households, now marrieds were largely head and spouse or head and spouse with dependants. The proportions of each family type for each marital status category were estimated. These are shown in Table 1.

- The Census full format table, Family type by number of persons - was used to estimate the average number of persons in each family type. The results of this exercise are also shown in Table 1.

- Finally, a weighted averaging technique - was used to estimate the family size for each industry sector. The resultant family sizes ranged from 3.0 for the mining sector (which is largely composed of married males) to 2.1 for Other Machinery and Equipment, which has a high proportion of never married amongst its workforce.

TABLE 1

Proportion of each marital status group in each family type

	Never married		Now married		Sep .not div.		Divorced		Widowed		Average
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Family Size
HEADONLY	0.80	0.63	0.01	0.11	0.64	0.22	0.65	0.30	0.7	0.71	1.0
HEAD WITH DEPENDENTS	0.01	0.26	0.00	0.15	0.11	0.54	0.09	0.45	0.04	0.05	2.7
HEAD & SPOUSE	0.04	0.02	0.32	0.33	0.05	0.01	0.05	0.01	0.01	0.00	2.0
HEAD,SPOUSE & DEPENDANTS	0.05	0.01	0.42	0.22	0.06	0.01	0.07	0.01	0.00	0.00	4.1
HEAD & OTHER ADULTS	0.09	0.07	0.00	0.04	0.09	0.12	0.09	0.13	0.17	0.20	2.3
HEAD,OTHER ADULTS & DEPND.	0.00	0.01	0.00	0.03	0.03	0.09	0.02	0.10	0.03	0.03	3.9
HEADSPOUSE & OTHER ADULTS	0.00	0.00	0.13	0.08	0.01	0.00	0.01	0.00	0.00	0.00	3.4
HEAD, SPOUSE, OTHER ADULTS & DEP.	0.01	0.00	0.11	0.04	0.01	0.01	0.02	0.00	0.00	0.00	5.0
TOTAL	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	

APPENDIX C

DIRECT COEFFICIENTS MATRIX

	DAIRY	OTHR AG	FISHING	COAL	OTHER MI	FOOD	TEXTILES
1. DAIRY FARMING	0.00111	0	0	0	0	0.08698	0
2. OTHER AGRICULTURE	0	0	0	0	0	0	0
3. FISHING,HUNTING	0	0	0	0	0	0.01968	0.00005
4. COAL MINING	0	0	0	0.01737	0.00015	0.00027	0
5. OTHER MINING, QUARRYING	0	0.00047	0	0.00227	0.02315	0	0
6. FOOD MANUFACTURING	0.02720	0.00917	0.01292	0.00011	0.00336	0.02394	0.00035
7. TEXTILES, CLOTHING	0.00040	0.00070	0.00493	0.00006	0.00039	0.00085	0.07489
8. WOOD PRODUCTS, FURNITURE	0	0.00023	0.00422	0.00048	0.00027	0.00013	0.00012
9. PAPER, PRINTING, PUBLISHING	0.00010	0.00023	0	0.00007	0.00093	0.00051	0.00078
10. CHEMICALS, COAL PRODUCTS	0.02861	0.05175	0.00587	0.00297	0.00868	0.00071	0.00066
11. CLAY PRODUCTS, REFRECATORIES	0	0	0	0.00003	0.00007	0	0.00001
12. OTHER NON-METALLIC MINERALS	0	0	0	0.00060	0.00101	0.00002	0.00001
13. BASIC IRON & STEEL	0.00010	0.00047	0.00023	0.00112	0.00923	0.00003	0.00007
14. NON-FERROUS METAL PRODUCTS	0.00030	0.00117	0.00070	0.00020	0.00039	0.00001	0.00014
15. FACBRICATED METAL PRODUCTS	0.00020	0.00094	0.00634	0.00491	0.01118	0.00375	0.00096
16. TRANSPORT EQUIPMENT	0	0	0.04793	0.00029	0.00058	0.00046	0.00005
17. OTHER MACHINERY, EQUIPMENT	0.00070	0.00258	0.00869	0.00440	0.01208	0.00040	0.00007
18. MISCELLANEOUS MANUFACTURING	0.00010	0.00023	0.00540	0.00005	0.00148	0.00035	0.00030
19. ELECTRICITY, GAS	0.02376	0.00799	0.00234	0.00899	0.02100	0.01179	0.00593
20. WATER, SEWAGE AND DRAINAGE	0.00879	0.01058	0.00046	0.00074	0.00422	0.00286	0.00025
21. RESIDENTIAL BUILDING	0	0	0	0	0	0	0
22. OTHER CONSTRUCTION	0.00192	0.00305	0	0.00070	0.00539	0.00173	0.00021
23. TRADE (RETAIL)	0.03417	0.04069	0.03829	0.00782	0.04432	0.02550	0.03263
24. TRANSPORT & STORAGE	0.03539	0.02658	0.00704	0.03748	0.03579	0.03805	0.01152
25. COMMUNICATIONS	0.00404	0.00494	0.00140	0.00113	0.00426	0.00224	0.00046
26. FINANCE	0.02012	0.02705	0.01527	0.00580	0.06169	0.02540	0.00853
27. OWNERSHIP OF DWELLINGS	0	0	0	0	0	0	0
28. PUBLIC ADMIN & DEFENCE	0.00091	0.00164	0.00070	0.00051	0.00058	0.00177	0.00032
29. COMMUNITY SERVICES	0.00444	0.00846	0.00164	0.00017	0.00281	0.00050	0.00007
30. ENTERTAINMENT	0.00333	0.00329	0.00093	0.00017	0.00512	0.00263	0.00116
HOUSEHOLD	0.44837	0.44863	0.40531	0.23860	0.25732	0.15150	0.03315
Population	0.01269	0.02146	0.01071	0.00876	0.00387	0.00538	0.01105
Unemployed	-0.0114	-0.0193	-0.0096	-0.0033	-0.0039	-0.0063	-0.0083
employment(FTES)	0.02309	0.03903	0.01949	0.0073	0.00646	0.01085	0.02333
rho	0.8	0.8	0.8	0.6	0.8	0.8	0.5
ess	0.38	0.38	0.38	0.24	0.24	0.27	0.55
family size	2.75	2.75	2.75	3	3	2.48	2.37

DIRECT COEFFICIENTS MATRIX

	WOOD	PAPER	CHEMICAL	CLAY	OTHER NO	STEEL	NON-FER
1. DAIRY FARMING	0	0	0	0	0	0	0
2. OTHER AGRICULTURE	0	0	0	0	0	0	0
3. FISHING,HUNTING	0	0	0	0	0	0	0
4. COAL MINING	0	0	0.00944	0.00007	0	0	0.00001
5. OTHER MINING, QUARRYING	0	0	0	0.03163	0.10684	0	0
6. FOOD MANUFACTURING	0	0	0.00004	0	0	0.00016	0.00005
7. TEXTILES, CLOTHING	0.00056	0.00042	0.00004	0.00001	0.00031	0.00049	0.00005
8. WOOD PRODUCTS, FURNITURE	0.03008	0.00003	0.00016	0.00001	0.00010	0.00014	0.00015
9. PAPER, PRINTING, PUBLISHING	0.00012	0.01489	0.00028	0.00015	0.00014	0.00028	0.00011
10. CHEMICALS, COAL PRODUCTS	0.00006	0.00334	0.05539	0.00017	0.00084	0.00599	0.00188
11. CLAY PRODUCTS, REFRECATORIES	0	0	0	0.00003	0	0.01140	0.00177
12. OTHER NON-METALLIC MINERALS	0	0.00003	0	0	0.00295	0.00059	0.00002
13. BASIC IRON & STEEL	0	0	0.00032	0	0.00017	0.10360	0.00293
14. NON-FERROUS METAL PRODUCTS	0.00012	0	0.00094	0	0	0.00039	0.02415
15. FACBRICATED METAL PRODUCTS	0.00081	0.00038	0.00351	0.00039	0.00168	0.02199	0.00057
16. TRANSPORT EQUIPMENT	0.00031	0.00003	0	0	0	0.00020	0.00006
17. OTHER MACHINERY, EQUIPMENT	0.00056	0.00443	0.00036	0.00140	0.00080	0.00200	0.00016
18. MISCELLANEOUS MANUFACTURING	0.00012	0.00073	0	0.00001	0.00007	0.00008	0.00008
19. ELECTRICITY, GAS	0.00468	0.00468	0.01749	0.02632	0.00551	0.03940	0.00365
20. WATER, SEWAGE AND DRAINAGE	0.00024	0.00042	0.00588	0.00063	0.00649	0.00320	0.00007
21. RESIDENTIAL BUILDING	0	0	0	0	0	0	0
22. OTHER CONSTRUCTION	0.00087	0.00158	0.00098	0.00053	0.00021	0.00999	0.00011
23. TRADE (RETAIL)	0.03658	0.01330	0.02027	0.01847	0.01760	0.00060	0.00245
24. TRANSPORT & STORAGE	0.02771	0.01901	0.08462	0.01800	0.09359	0.02123	0.00545
25. COMMUNICATIONS	0.00305	0.00602	0.00351	0.00341	0.00252	0.00049	0.00023
26. FINANCE	0.02153	0.02985	0.01827	0.02262	0.02459	0.00930	0.00244
27. OWNERSHIP OF DWELLINGS	0	0	0	0	0	0	0
28. PUBLIC ADMIN & DEFENCE	0.00106	0.00105	0.00049	0.00134	0.00129	0.00020	0.00019
29. COMMUNITY SERVICES	0	0.00021	0.00004	0.00007	0.00010	0.00032	0.00000
30. ENTERTAINMENT	0.00249	0.00985	0.00327	0.00223	0.00126	0.00085	0.00019
HOUSEHOLD	0.19595	0.25003	0.04354	0.13511	0.15637	0.05925	0.21610
Population	0.00693	0.00586	0.00451	0.00720	0.00425	0.00456	0.00309
Unemployed	-0.0082	-0.0064	-0.0048	-0.0090	-0.0053	-0.0051	-0.0041
employment(FTES)	0.0137	0.01146	0.00836	0.01483	0.00876	0.00852	0.00664
rho	0.8	0.8	0.8	0.8	0.8	0.77	0.8
ess	0.25	0.3	0.28	0.24	0.24	0.22	0.22
family size	2.53	2.56	2.7	2.43	2.43	2.33	2.33

DIRECT COEFFICIENTS MATRIX

	FABRIC	TRA EQUI	OTHR MA	MISC MA	E & G	WATER	RES BUIL
1. DAIRY FARMING	0	0	0	0	0	0	0
2. OTHER AGRICULTURE	0	0	0	0	0	0	0
3. FISHING,HUNTING	0	0	0	0.00216	0	0.00003	0
4. COAL MINING	0.00001	0.00006	0	0.00237	0.08476	0.00010	0
5. OTHER MINING, QUARRYING	0.00005	0.00006	0	0.07388	0	0.00064	0.00393
6. FOOD MANUFACTURING	0.00001	0.00042	0.00002	0.00021	0	0.00074	0.00041
7. TEXTILES, CLOTHING	0.00098	0.00424	0.00004	0.01479	0.00015	0.00050	0.00063
8. WOOD PRODUCTS, FURNITURE	0.00176	0.00314	0.00082	0.00032	0	0.00091	0.04882
9. PAPER, PRINTING, PUBLISHING	0.00198	0.00137	0.00053	0.00151	0.00001	0.00114	0.00056
10. CHEMICALS, COAL PRODUCTS	0.00186	0.00409	0.00003	0.01998	0.00028	0.01016	0.00238
11. CLAY PRODUCTS, REFRECATORIES	0.00005	0.00003	0.00049	0	0.00001	0.00037	0.05802
12. OTHER NON-METALLIC MINERALS	0.00276	0.00100	0.00038	0.00021	0	0.00303	0.07544
13. BASIC IRON & STEEL	0.19516	0.03702	0.01873	0.00432	0.00005	0.00175	0.01363
14. NON-FERROUS METAL PRODUCTS	0.05199	0.00958	0.01512	0.00270	0	0.00050	0.00492
15. FACBRICATED METAL PRODUCTS	0.08507	0.03974	0.01088	0.00464	0.00004	0.02846	0.03899
16. TRANSPORT EQUIPMENT	0.00007	0.01416	0.00009	0.00010	0	0.00023	0.00013
17. OTHER MACHINERY, EQUIPMENT	0.00389	0.01361	0.01187	0.00064	0.00008	0.01046	0.01123
18. MISCELLANEOUS MANUFACTURING	0.00001	0.00134	0	0.00356	0.00000	0.00040	0.00092
19. ELECTRICITY, GAS	0.01992	0.00479	0.00352	0.00993	0	0.03630	0.00077
20. WATER, SEWAGE AND DRAINAGE	0.00098	0.00048	0.00031	0.00021	0.00004	0	0.00049
21. RESIDENTIAL BUILDING	0	0	0	0	0	0	0
22. OTHER CONSTRUCTION	0.00072	0.00067	0.00032	0.00043	0.00007	0.01506	0.00049
23. TRADE (RETAIL)	0.01853	0.01382	0.01510	0.01717	0.00049	0.01327	0.08001
24. TRANSPORT & STORAGE	0.01320	0.00866	0.00401	0.01047	0.00092	0.00570	0.03772
25. COMMUNICATIONS	0.00269	0.00192	0.00133	0.00194	0.00012	0.00580	0.00070
26. FINANCE	0.02107	0.01984	0.00867	0.01404	0.00216	0.05075	0.03074
27. OWNERSHIP OF DWELLINGS	0	0	0	0	0	0	0
28. PUBLIC ADMIN & DEFENCE	0.00106	0.00115	0.00035	0.00064	0.00003	0.00327	0.00203
29. COMMUNITY SERVICES	0.00005	0.00045	0.00003	0.00043	0	0.00141	0.00055
30. ENTERTAINMENT	0.00231	0.00271	0.00161	0.00237	0.00010	0.00364	0.00127
HOUSEHOLD	0.09471	0.16138	0.18191	0.16990	0.30847	0.43175	0.19943
Population	0.00702	0.00418	0.00410	0.00678	0.00353	0.01523	0.00996
Unemployed	-0.0096	-0.0060	-0.0060	-0.0092	-0.0045	-0.0196	-0.0134
employment(FTES)	0.01611	0.00965	0.00991	0.01607	0.0073	0.03147	0.02264
rho	0.8	0.8	0.8	0.8	0.8	0.8	0.8
ess	0.25	0.22	0.24	0.28	0.22	0.22	0.26
family size	2.18	2.17	2.07	2.11	2.42	2.42	2.2

DIRECT COEFFICIENTS MATRIX

	OTHR CO	TRADE	TRANSPO	COMMUNI	FINANCE	DWELL	PUB ADM
1. DAIRY FARMING	0	0	0	0	0	0	0
2. OTHER AGRICULTURE	0	0	0	0	0	0	0
3. FISHING,HUNTING	0	0	0	0	0.00002	0	0
4. COAL MINING	0.00011	0.00029	0.00049	0.00004	0.00001	0	0.00017
5. OTHER MINING, QUARRYING	0.01268	0.00007	0.00035	0	0.00004	0.00011	0.00006
6. FOOD MANUFACTURING	0.00062	0.00132	0.00062	0.00046	0.00210	0.00001	0.00111
7. TEXTILES, CLOTHING	0.00068	0.00069	0.00228	0.00043	0.00045	0.00004	0.00209
8. WOOD PRODUCTS, FURNITURE	0.01054	0.00159	0.00030	0.00053	0.00007	0.00178	0.00228
9. PAPER, PRINTING, PUBLISHING	0.00054	0.01529	0.00408	0.00133	0.00707	0.00008	0.01127
10. CHEMICALS, COAL PRODUCTS	0.00310	0.00104	0.00761	0.00036	0.00104	0.00145	0.00082
11. CLAY PRODUCTS, REFRECATORIES	0.00630	0.00006	0.00004	0	0.00006	0.00151	0.00006
12. OTHER NON-METALLIC MINERALS	0.05747	0.00079	0.00034	0.00002	0.00016	0.00130	0.00038
13. BASIC IRON & STEEL	0.01910	0.00035	0.00023	0.00009	0.00021	0.00469	0.00236
14. NON-FERROUS METAL PRODUCTS	0.00787	0.00007	0.00001	0.00002	0.00000	0.00125	0.00015
15. FACBRICATED METAL PRODUCTS	0.09224	0.00527	0.00219	0.00213	0.00136	0.00448	0.00758
16. TRANSPORT EQUIPMENT	0.00033	0.00530	0.00911	0.00014	0.00005	0.00001	0.00152
17. OTHER MACHINERY, EQUIPMENT	0.03740	0.00792	0.00240	0.00354	0.00151	0.00137	0.00316
18. MISCELLANEOUS MANUFACTURING	0.00133	0.00124	0.00342	0.00043	0.00025	0.00012	0.00049
19. ELECTRICITY, GAS	0.00192	0.01397	0.00552	0.00223	0.00975	0.00091	0.02422
20. WATER, SEWAGE AND DRAINAGE	0.00162	0.00138	0.00206	0	0.00816	0.04671	0.00290
21. RESIDENTIAL BUILDING	0	0	0	0	0	0.04605	0
22. OTHER CONSTRUCTION	0.00076	0.00292	0.02234	0.00111	0.00339	0.00002	0.01648
23. TRADE (RETAIL)	0.03438	0.04341	0.07059	0.01001	0.02147	0.00346	0.01371
24. TRANSPORT & STORAGE	0.03173	0.01092	0.00901	0.00989	0.00549	0.00145	0.03834
25. COMMUNICATIONS	0.00051	0.02376	0.00904	0.04610	0.02478	0.00012	0.02378
26. FINANCE	0.03104	0.10712	0.03687	0.00868	0.10932	0.11221	0.09957
27. OWNERSHIP OF DWELLINGS	0	0	0	0	0	0	0
28. PUBLIC ADMIN & DEFENCE	0.00174	0.00302	0.00514	0.00169	0.00210	0.00014	0.00015
29. COMMUNITY SERVICES	0.00062	0.00297	0.00145	0.00038	0.00696	0.00006	0.00453
30. ENTERTAINMENT	0.00204	0.00963	0.00393	0.00167	0.01614	0.00000	0.00801
HOUSEHOLD	0.11698	0.24224	0.13334	0.34655	0.38926	0.74157	0.00856
Population	0.02105	0.01516	0.01156	0.01288	0.00929	0	0.01052
Unemployed	-0.0259	-0.0139	-0.0127	-0.0140	-0.0090	0	-0.0140
employment(FTES)	0.04387	0.02728	0.02191	0.02576	0.01921	0	0.02371
rho	0.8	0.9	0.9	0.9	0.9	0.9	0.8
ess	0.26	0.36	0.27	0.32	0.41	0.31	0.26
family size	2.4	2.79	2.64	2.5	2.42	2.5	2.22

DIRECT COEFFICIENTS MATRIX

	TOTAL ALTERNATIVE INCOME ('000 P.A.)				
	COMM SER	ENTERTA	HH	Pop.	Unempl.
1. DAIRY FARMING	0	0	0.00020	0	0.00077
2. OTHER AGRICULTURE	0	0	0	0	0
3. FISHING,HUNTING	0.00004	0	0.00050	0	0.00137
4. COAL MINING	0.00014	0.00024	0.00020	0	0.00078
5. OTHER MINING, QUARRYING	0.00004	0.00045	0	0	0
6. FOOD MANUFACTURING	0.00172	0.00351	0.04174	0	0.13586
7. TEXTILES, CLOTHING	0.00320	0.00468	0.00639	0	0.01670
8. WOOD PRODUCTS, FURNITURE	0.00207	0.00161	0.00292	0	0.01014
9. PAPER, PRINTING, PUBLISHING	0.00711	0.00828	0.00726	0	0.02123
10. CHEMICALS, COAL PRODUCTS	0.00343	0.00354	0.00252	0	0.00560
11. CLAY PRODUCTS, REFRECATORIES	0.00120	0.00219	0.00206	0	0.00379
12. OTHER NON-METALLIC MINERALS	0.00027	0.00099	0.00020	0	0.00786
13. BASIC IRON & STEEL	0.00041	0.00035	0.00010	0	0.00039
14. NON-FERROUS METAL PRODUCTS	0.00003	0.00009	0	0	0
15. FACBRICATED METAL PRODUCTS	0.00385	0.00873	0.00252	0	0.00383
16. TRANSPORT EQUIPMENT	0.00018	0.00046	0.00353	0	0.01329
17. OTHER MACHINERY, EQUIPMENT	0.01020	0.01190	0.00494	0	0.01926
18. MISCELLANEOUS MANUFACTURING	0.00132	0.00095	0.00302	0	0.01179
19. ELECTRICITY, GAS	0.01580	0.03123	0	0	0
20. WATER, SEWAGE AND DRAINAGE	0.00424	0.01216	0	0	0
21. RESIDENTIAL BUILDING	0	0	0	0	0
22. OTHER CONSTRUCTION	0.00623	0.00332	0.00010	0	0.00039
23. TRADE (RETAIL)	0.02141	0.02221	0.15094	0	0.58869
24. TRANSPORT & STORAGE	0.01678	0.00926	0.02994	0	0.14431
25. COMMUNICATIONS	0.01004	0.01124	0.00877	0	0.02907
26. FINANCE	0.05808	0.06264	0.02528	0	0.06632
27. OWNERSHIP OF DWELLINGS	0	0	0.15649	0	0.53184
28. PUBLIC ADMIN & DEFENCE	0.00252	0.00154	0.00258	0	0.01006
29. COMMUNITY SERVICES	0.00380	0.00346	0.04809	0.261	0.09520
30. ENTERTAINMENT	0.00696	0.02317	0.04950	0	0.15889
HOUSEHOLD	0.08166	0.27003	0.06813		
Population	0.01483	0.00988	0		
Unemployed	-0.0126	-0.0091	0		
employment(FTES)	0.02991	0.02086			
rho	0.8	0.8			
ess	0.47	0.45			
family size	2.48	2.37			

INVERSE MATRIX

	DAIRY	OTHR AG	FISHING	COAL	OTHER MI	FOOD	TEXTILES
1. DAIRY FARMING	1.00617	0.00330	0.00351	0.00143	0.00213	0.09070	0.00020
2. OTHER AGRICULTURE	0	1	0	0	0	0	0
3. FISHING,HUNTING	0.00146	0.00105	1.00108	0.00049	0.00070	0.02065	0.00012
4. COAL MINING	0.00331	0.00219	0.00110	1.01898	0.00294	0.00208	0.00071
5. OTHER MINING, QUARRYING	0.00056	0.00104	0.00084	0.00274	1.02445	0.00036	0.00008
6. FOOD MANUFACTURING	0.05666	0.03659	0.03898	0.01565	0.02348	1.04094	0.00222
7. TEXTILES, CLOTHING	0.00588	0.00596	0.01042	0.00301	0.00431	0.00379	1.08141
8. WOOD PRODUCTS, FURNITURE	0.00296	0.00308	0.00714	0.00209	0.00247	0.00170	0.00039
9. PAPER, PRINTING, PUBLISHING	0.00901	0.00893	0.00798	0.00473	0.00805	0.00533	0.00216
10. CHEMICALS, COAL PRODUCTS	0.03395	0.05823	0.00946	0.00522	0.01223	0.00559	0.00118
11. CLAY PRODUCTS, REFRECATORIES	0.00206	0.00200	0.00187	0.00116	0.00170	0.00101	0.00019
12. OTHER NON-METALLIC MINERALS	0.00107	0.00104	0.00087	0.00121	0.00217	0.00065	0.00008
13. BASIC IRON & STEEL	0.00282	0.00345	0.00664	0.00398	0.01580	0.00251	0.00064
14. NON-FERROUS METAL PRODUCTS	0.00107	0.00206	0.00243	0.00095	0.00190	0.00070	0.00030
15. FACBRICATED METAL PRODUCTS	0.00636	0.00725	0.01408	0.00863	0.01794	0.00772	0.00193
16. TRANSPORT EQUIPMENT	0.00408	0.00382	0.05205	0.00260	0.00366	0.00370	0.00058
17. OTHER MACHINERY, EQUIPMENT	0.00722	0.00899	0.01507	0.00797	0.01768	0.00410	0.00088
18. MISCELLANEOUS MANUFACTURING	0.00266	0.00264	0.00768	0.00149	0.00339	0.00180	0.00056
19. ELECTRICITY, GAS	0.03175	0.01626	0.00915	0.01293	0.02861	0.01857	0.00775
20. WATER, SEWAGE AND DRAINAGE	0.01575	0.01737	0.00646	0.00436	0.00966	0.00722	0.00090
21. RESIDENTIAL BUILDING	0.00468	0.00441	0.00420	0.00254	0.00322	0.00220	0.00027
22. OTHER CONSTRUCTION	0.00511	0.00612	0.00217	0.00270	0.00840	0.00416	0.00085
23. TRADE (RETAIL)	0.15035	0.15021	0.14112	0.07133	0.12902	0.08732	0.04412
24. TRANSPORT & STORAGE	0.06494	0.05595	0.03169	0.05275	0.05722	0.05565	0.01447
25. COMMUNICATIONS	0.01833	0.01911	0.01389	0.00844	0.01661	0.01074	0.00279
26. FINANCE	0.08610	0.09217	0.07362	0.03964	0.11868	0.06472	0.01951
27. OWNERSHIP OF DWELLINGS	0.10171	0.09594	0.09122	0.05525	0.07008	0.04797	0.00589
28. PUBLIC ADMIN & DEFENCE	0.00399	0.00458	0.00335	0.00219	0.00300	0.00358	0.00072
29. COMMUNITY SERVICES	0.04353	0.04863	0.03630	0.02157	0.02927	0.02030	0.00640
30. ENTERTAINMENT	0.04060	0.03890	0.03423	0.02011	0.03227	0.02130	0.00422
HOUSEHOLD	0.71117	0.70103	0.63469	0.37587	0.48169	0.34617	0.07301
Population	0.01923	0.02798	0.01624	0.01219	0.00984	0.01077	0.01329
Unemployed	-0.0180	-0.0258	-0.0152	-0.0067	-0.0099	-0.0116	-0.0103

INVERSE MATRIX

	WOOD	PAPER	CHEMICAL	CLAY	OTHER NO	STEEL	NON-FER
1. DAIRY FARMING	0.00117	0.00150	0.00043	0.00085	0.00124	0.00048	0.00121
2. OTHER AGRICULTURE	0	0	0	0	0	0	0
3. FISHING,HUNTING	0.00040	0.00052	0.00015	0.00029	0.00042	0.00016	0.00042
4. COAL MINING	0.00087	0.00097	0.01212	0.00275	0.00129	0.00417	0.00071
5. OTHER MINING, QUARRYING	0.00027	0.00038	0.00024	0.03259	0.11008	0.00084	0.00028
6. FOOD MANUFACTURING	0.01285	0.01640	0.00474	0.00931	0.01364	0.00526	0.01328
7. TEXTILES, CLOTHING	0.00311	0.00359	0.00122	0.00184	0.00313	0.00167	0.00248
8. WOOD PRODUCTS, FURNITURE	1.03238	0.00172	0.00077	0.00099	0.00157	0.00087	0.00146
9. PAPER, PRINTING, PUBLISHING	0.00465	1.02027	0.00271	0.00340	0.00511	0.00208	0.00379
10. CHEMICALS, COAL PRODUCTS	0.00176	0.00558	1.06013	0.00172	0.00431	0.00809	0.00348
11. CLAY PRODUCTS, REFRECATORIES	0.00093	0.00119	0.00040	1.00073	0.00100	0.01325	0.00278
12. OTHER NON-METALLIC MINERALS	0.00049	0.00066	0.00039	0.00036	1.00372	0.00158	0.00043
13. BASIC IRON & STEEL	0.00145	0.00167	0.00212	0.00144	0.00355	1.12256	0.00455
14. NON-FERROUS METAL PRODUCTS	0.00052	0.00049	0.00146	0.00032	0.00064	0.00224	1.02507
15. FACBRICATED METAL PRODUCTS	0.00373	0.00383	0.00609	0.00290	0.00668	0.02944	0.00300
16. TRANSPORT EQUIPMENT	0.00235	0.00228	0.00156	0.00142	0.00274	0.00110	0.00173
17. OTHER MACHINERY, EQUIPMENT	0.00371	0.00828	0.00219	0.00404	0.00564	0.00407	0.00283
18. MISCELLANEOUS MANUFACTURING	0.00133	0.00219	0.00074	0.00091	0.00170	0.00061	0.00119
19. ELECTRICITY, GAS	0.00849	0.00902	0.02139	0.02973	0.01242	0.04687	0.00651
20. WATER, SEWAGE AND DRAINAGE	0.00344	0.00449	0.00779	0.00312	0.01051	0.00501	0.00300
21. RESIDENTIAL BUILDING	0.00208	0.00266	0.00073	0.00148	0.00213	0.00081	0.00217
22. OTHER CONSTRUCTION	0.00263	0.00333	0.00375	0.00197	0.00429	0.01231	0.00111
23. TRADE (RETAIL)	0.09069	0.07913	0.04732	0.05737	0.08214	0.02328	0.05381
24. TRANSPORT & STORAGE	0.04041	0.03440	0.09557	0.02765	0.11111	0.03033	0.01730
25. COMMUNICATIONS	0.01065	0.01473	0.00824	0.00907	0.01140	0.00359	0.00581
26. FINANCE	0.05595	0.06886	0.03929	0.04926	0.06941	0.02519	0.02843
27. OWNERSHIP OF DWELLINGS	0.04518	0.05796	0.01594	0.03222	0.04646	0.01768	0.04718
28. PUBLIC ADMIN & DEFENCE	0.00259	0.00280	0.00161	0.00243	0.00329	0.00094	0.00143
29. COMMUNITY SERVICES	0.01835	0.02223	0.00821	0.01415	0.01888	0.00864	0.01688
30. ENTERTAINMENT	0.01968	0.03157	0.01049	0.01475	0.01982	0.00787	0.01690
HOUSEHOLD	0.32903	0.40484	0.12998	0.24571	0.33216	0.14075	0.32323
Population	0.01055	0.00958	0.00786	0.00989	0.00916	0.00732	0.00533
Unemployed	-0.0118	-0.0101	-0.0082	-0.0117	-0.0103	-0.0081	-0.0063

INVERSE MATRIX

	FABRIC	TRA EQUI	OTHR MA	MISC MA	E & G	WATER	RES BUIL
1. DAIRY FARMING	0.00075	0.00105	0.00104	0.00112	0.00180	0.00248	0.00147
2. OTHER AGRICULTURE	0	0	0	0	0	0	0
3. FISHING,HUNTING	0.00026	0.00036	0.00036	0.00255	0.00062	0.00089	0.00050
4. COAL MINING	0.00311	0.00116	0.00074	0.00411	0.08681	0.00422	0.00114
5. OTHER MINING, QUARRYING	0.00073	0.00053	0.00027	0.07618	0.00051	0.00177	0.01463
6. FOOD MANUFACTURING	0.00828	0.01156	0.01144	0.01232	0.01964	0.02719	0.01610
7. TEXTILES, CLOTHING	0.00295	0.00686	0.00220	0.01837	0.00374	0.00556	0.00394
8. WOOD PRODUCTS, FURNITURE	0.00295	0.00453	0.00204	0.00160	0.00197	0.00381	0.05217
9. PAPER, PRINTING, PUBLISHING	0.00529	0.00511	0.00406	0.00552	0.00538	0.00926	0.00709
10. CHEMICALS, COAL PRODUCTS	0.00502	0.00621	0.00152	0.02349	0.00261	0.01393	0.00530
11. CLAY PRODUCTS, REFRECATORIES	0.00354	0.00146	0.00162	0.00095	0.00138	0.00249	0.05949
12. OTHER NON-METALLIC MINERALS	0.00362	0.00160	0.00081	0.00073	0.00064	0.00475	0.07644
13. BASIC IRON & STEEL	0.24049	0.05317	0.02492	0.00814	0.00178	0.01191	0.02682
14. NON-FERROUS METAL PRODUCTS	0.05898	0.01291	0.01663	0.00349	0.00045	0.00317	0.00803
15. FACBRICATED METAL PRODUCTS	1.10109	0.04783	0.01479	0.00851	0.00381	0.03793	0.04762
16. TRANSPORT EQUIPMENT	0.00143	1.01592	0.00161	0.00195	0.00244	0.00359	0.00300
17. OTHER MACHINERY, EQUIPMENT	0.00701	0.01681	1.01460	0.00440	0.00436	0.01694	0.01617
18. MISCELLANEOUS MANUFACTURING	0.00081	0.00234	0.00097	1.00475	0.00163	0.00263	0.00252
19. ELECTRICITY, GAS	0.03439	0.01094	0.00744	0.01559	1.00444	0.04379	0.01065
20. WATER, SEWAGE AND DRAINAGE	0.00407	0.00346	0.00303	0.00357	0.00439	1.00650	0.00532
21. RESIDENTIAL BUILDING	0.00131	0.00180	0.00196	0.00191	0.00323	0.00430	1.00250
22. OTHER CONSTRUCTION	0.00448	0.00240	0.00151	0.00225	0.00143	0.01740	0.00363
23. TRADE (RETAIL)	0.05471	0.05977	0.06028	0.06896	0.07692	0.11728	0.15279
24. TRANSPORT & STORAGE	0.02833	0.02131	0.01491	0.02625	0.02111	0.03127	0.06411
25. COMMUNICATIONS	0.00836	0.00807	0.00659	0.00874	0.00828	0.01916	0.01215
26. FINANCE	0.04934	0.04883	0.03447	0.04846	0.04018	0.11222	0.08559
27. OWNERSHIP OF DWELLINGS	0.02861	0.03917	0.04046	0.04155	0.07016	0.09338	0.05438
28. PUBLIC ADMIN & DEFENCE	0.00225	0.00243	0.00150	0.00200	0.00187	0.00595	0.00439
29. COMMUNITY SERVICES	0.01367	0.01585	0.01539	0.01774	0.02478	0.03899	0.02451
30. ENTERTAINMENT	0.01400	0.01758	0.01639	0.01843	0.02482	0.03819	0.02332
HOUSEHOLD	0.23314	0.28281	0.25784	0.30888	0.47481	0.68438	0.41756
Population	0.01167	0.00753	0.00664	0.01030	0.00728	0.02125	0.01681
Unemployed	-0.0148	-0.0095	-0.0086	-0.0127	-0.0077	-0.0257	-0.0206

INVERSE MATRIX

	OTHR CO	TRADE	TRANSPO	COMMUNI	FINANCE	DWELL	PUB ADM
1. DAIRY FARMING	0.00070	0.00177	0.00091	0.00192	0.00272	0.00472	0.00039
2. OTHER AGRICULTURE	0	0	0	0	0	0	0
3. FISHING,HUNTING	0.00024	0.00060	0.00031	0.00066	0.00095	0.00162	0.00013
4. COAL MINING	0.00113	0.00226	0.00157	0.00081	0.00182	0.00169	0.00266
5. OTHER MINING, QUARRYING	0.01984	0.00065	0.00130	0.00038	0.00063	0.00185	0.00060
6. FOOD MANUFACTURING	0.00779	0.01950	0.01002	0.02100	0.02987	0.05152	0.00444
7. TEXTILES, CLOTHING	0.00253	0.00434	0.00450	0.00432	0.00573	0.00944	0.00321
8. WOOD PRODUCTS, FURNITURE	0.01192	0.00362	0.00168	0.00263	0.00294	0.00929	0.00298
9. PAPER, PRINTING, PUBLISHING	0.00410	0.02240	0.00849	0.00735	0.01627	0.01518	0.01388
10. CHEMICALS, COAL PRODUCTS	0.00540	0.00356	0.00962	0.00268	0.00444	0.00767	0.00206
11. CLAY PRODUCTS, REFRECATORIES	0.00747	0.00144	0.00092	0.00148	0.00208	0.00785	0.00054
12. OTHER NON-METALLIC MINERALS	0.05822	0.00158	0.00198	0.00066	0.00129	0.00666	0.00151
13. BASIC IRON & STEEL	0.04568	0.00398	0.00340	0.00242	0.00319	0.01198	0.00597
14. NON-FERROUS METAL PRODUCTS	0.01442	0.00108	0.00091	0.00067	0.00081	0.00311	0.00107
15. FACBRICATED METAL PRODUCTS	0.10499	0.01047	0.00773	0.00626	0.00752	0.01744	0.01176
16. TRANSPORT EQUIPMENT	0.00180	0.00793	0.01089	0.00278	0.00359	0.00635	0.00240
17. OTHER MACHINERY, EQUIPMENT	0.04079	0.01288	0.00624	0.00803	0.00843	0.01301	0.00545
18. MISCELLANEOUS MANUFACTURING	0.00212	0.00288	0.00438	0.00217	0.00264	0.00447	0.00097
19. ELECTRICITY, GAS	0.01009	0.02053	0.01004	0.00669	0.01785	0.01425	0.02790
20. WATER, SEWAGE AND DRAINAGE	0.00450	0.00662	0.00484	0.00461	0.01549	0.05902	0.00489
21. RESIDENTIAL BUILDING	0.00109	0.00289	0.00148	0.00335	0.00448	0.05448	0.00045
22. OTHER CONSTRUCTION	1.00325	0.00519	0.02387	0.00279	0.00612	0.00460	0.01837
23. TRADE (RETAIL)	0.06947	1.11781	0.11164	0.08983	0.13174	0.20942	0.03187
24. TRANSPORT & STORAGE	0.04750	0.02876	1.02013	0.02810	0.03121	0.04995	0.04365
25. COMMUNICATIONS	0.00695	0.03730	0.01596	1.05738	0.04159	0.02494	0.03052
26. FINANCE	0.06353	0.16393	0.07202	0.05136	1.18135	0.22881	0.12559
27. OWNERSHIP OF DWELLINGS	0.02378	0.06296	0.03213	0.07284	0.09740	1.18302	0.00997
28. PUBLIC ADMIN & DEFENCE	0.00307	0.00524	0.00648	0.00373	0.00509	0.00537	1.00110
29. COMMUNITY SERVICES	0.01773	0.03105	0.01775	0.02945	0.04437	0.06278	0.01406
30. ENTERTAINMENT	0.01288	0.03520	0.01749	0.02790	0.05349	0.06678	0.01462
HOUSEHOLD	0.25771	0.46988	0.26397	0.52762	0.67648	1.20610	0.12507
Population	0.02572	0.02106	0.01593	0.01712	0.01617	0.01049	0.01437
Unemployed	-0.0311	-0.0198	-0.0172	-0.0182	-0.0159	-0.0107	-0.0180

INVERSE MATRIX

	COMM SER	ENTERTA	HH	Pop.	Unempl.
1. DAIRY FARMING	0.00072	0.00211	0.00567	0.00018	0.01756
2. OTHER AGRICULTURE	0	0	0	0	0
3. FISHING,HUNTING	0.00028	0.00069	0.00195	0.00007	0.00574
4. COAL MINING	0.00192	0.00377	0.00146	0.00050	0.00472
5. OTHER MINING, QUARRYING	0.00048	0.00116	0.00094	0.00012	0.00382
6. FOOD MANUFACTURING	0.00803	0.02327	0.06186	0.00209	0.19022
7. TEXTILES, CLOTHING	0.00485	0.00890	0.01111	0.00126	0.02975
8. WOOD PRODUCTS, FURNITURE	0.00293	0.00377	0.00605	0.00076	0.01941
9. PAPER, PRINTING, PUBLISHING	0.01010	0.01506	0.01664	0.00263	0.05008
10. CHEMICALS, COAL PRODUCTS	0.00480	0.00638	0.00623	0.00125	0.01679
11. CLAY PRODUCTS, REFRECATORIES	0.00178	0.00371	0.00425	0.00046	0.01017
12. OTHER NON-METALLIC MINERALS	0.00085	0.00191	0.00191	0.00022	0.01335
13. BASIC IRON & STEEL	0.00268	0.00483	0.00459	0.00070	0.01370
14. NON-FERROUS METAL PRODUCTS	0.00072	0.00136	0.00123	0.00018	0.00370
15. FACBRICATED METAL PRODUCTS	0.00690	0.01459	0.01003	0.00180	0.02696
16. TRANSPORT EQUIPMENT	0.00123	0.00309	0.00749	0.00032	0.02484
17. OTHER MACHINERY, EQUIPMENT	0.01253	0.01710	0.01212	0.00327	0.04092
18. MISCELLANEOUS MANUFACTURING	0.00196	0.00268	0.00509	0.00051	0.01783
19. ELECTRICITY, GAS	0.01929	0.03818	0.01104	0.00503	0.03461
20. WATER, SEWAGE AND DRAINAGE	0.00641	0.01748	0.01334	0.00167	0.04204
21. RESIDENTIAL BUILDING	0.00097	0.00317	0.01020	0.00025	0.03240
22. OTHER CONSTRUCTION	0.00763	0.00558	0.00370	0.00199	0.01249
23. TRADE (RETAIL)	0.04881	0.10174	0.23871	0.01273	0.83773
24. TRANSPORT & STORAGE	0.02395	0.02859	0.05353	0.00625	0.21249
25. COMMUNICATIONS	0.01606	0.02307	0.02479	0.00419	0.07905
26. FINANCE	0.08373	0.11534	0.11535	0.02155	0.35042
27. OWNERSHIP OF DWELLINGS	0.02109	0.06891	0.22159	0.00550	0.70357
28. PUBLIC ADMIN & DEFENCE	0.00349	0.00406	0.00554	0.00091	0.01912
29. COMMUNITY SERVICES	1.01701	0.03120	0.07333	0.26543	0.16460
30. ENTERTAINMENT	0.01650	1.04996	0.07751	0.00430	0.23671
HOUSEHOLD	0.18892	0.49047	1.44584	0.04931	1.19374
Population	0.01900	0.01538	0.00894	1.00469	0.02875
Unemployed	-0.0159	-0.0147	-0.0087	-0.0041	0.97164

MULTIPLIERS

	Output	Employment	Population
1. DAIRY FARMING	1.71430	1.57186	1.51435
2. OTHER AGRICULTURE	1.70141	1.33657	1.30361
3. FISHING,HUNTING	1.62976	1.57591	1.51506
4. COAL MINING	1.37628	2.01600	1.39261
5. OTHER MINING, QUARRYING	1.65117	2.53704	2.53883
6. FOOD MANUFACTURING	1.53718	1.83912	2.00151
7. TEXTILES, CLOTHING	1.20166	1.23733	1.20195
8. WOOD PRODUCTS, FURNITURE	1.37225	1.44190	1.52258
9. PAPER, PRINTING, PUBLISHING	1.40284	1.57929	1.63433
10. CHEMICALS, COAL PRODUCTS	1.35792	1.71632	1.74134
11. CLAY PRODUCTS, REFRECATORIES	1.30917	1.29894	1.37304
12. OTHER NON-METALLIC MINERALS	1.55850	1.94718	2.15377
13. BASIC IRON & STEEL	1.38113	1.59554	1.60467
14. NON-FERROUS METAL PRODUCTS	1.26937	1.54324	1.72570
15. FACBRICATED METAL PRODUCTS	1.68997	1.53197	1.66151
16. TRANSPORT EQUIPMENT	1.42116	1.58869	1.80015
17. OTHER MACHINERY, EQUIPMENT	1.30386	1.43021	1.61581
18. MISCELLANEOUS MANUFACTURING	1.43408	1.37704	1.52000
19. ELECTRICITY, GAS	1.42130	1.71075	2.06246
20. WATER, SEWAGE AND DRAINAGE	1.68105	1.31377	1.39528
21. RESIDENTIAL BUILDING	1.78593	1.53723	1.68797
22. OTHER CONSTRUCTION	1.59312	1.19819	1.22184
23. TRADE (RETAIL)	1.61856	1.42224	1.38866
24. TRANSPORT & STORAGE	1.40881	1.34778	1.37727
25. COMMUNICATIONS	1.44438	1.30448	1.32977
26. FINANCE	1.72525	1.75533	1.73962
27. OWNERSHIP OF DWELLINGS	2.13742	0.00000	0.00000
28. PUBLIC ADMIN & DEFENCE	1.38317	1.28634	1.36523
29. COMMUNITY SERVICES	1.32785	1.25570	1.21371
30. ENTERTAINMENT	1.60180	1.60610	1.55604

APPENDIX D

DECON USERS MANUAL[1]

INTRODUCTION

The DECON model is set in a Lotus 123 template and is designed to be used within a Lotus 123 spreadsheet of version 2.0 or above. Whilst reference is made to some Lotus commands throughout the manual it is expected that users are familiar with the use of the Lotus package for which numerous tutorial software packages and instruction manuals are available. In addition, it is required that the user input a direct coefficients matrix into the DECON model from another Lotus spreadsheet. The preferred means of doing this is to first construct the direct co-efficients matrix in the GRIMP package and import this into Lotus 123. The steps required to achieve this are documented below. Throughout the manual reference is made to the Regionville Demo-Economic table which serves as a simple guide to the procedure.

INTERFACING WITH GRIMP

The DECON model requires the user to input a direct co-efficients matrix from another Lotus spreadsheet. An example of the format for this matrix is shown below in Figure 1 (as would appear in the Lotus spreadsheet).

It is useful, particularly for large tables, to prepare the direct co-efficients matrix using the GRIMP package. The steps required to undertake this are described below.

Figure 1: Direct Co-efficients Table Format

	A	B	C	D	E	F	G	H
1	4	"REGIONVILLE DEMO-ECONOMIC MODEL"						
2		"1"	"2"	"3"	"4"			
3	"PRIMARY"	0.1237	0.1034	0.0366	0.125			
4	"SECONDARY"	0.0698	0.0658	0.1463	0.22			
5	"TERTIARY"	0.0233	0.1379	0.0679	0.415			
6	"HOUSEHOLD"	0.2315	0.276	0.1567	0			
7								
8								
9	"EMP.COEF"	0.01325	0.00975	0.01475				
10								
11								

1 From Mangan and Phibbs (1988).

- After constructing the I-O table in GRIMP consult the main menu within the GRIMP package as shown below in Figure 2.

Figure 2: GRIMP Main Menu

MAIN MENU:	Table	Adjust	Impact	Files	Options	Help	Quit

- Go into table option and select coefficients.
- Once table is in the co-efficients (the co-efficients table should be shown on the screen) form select the print option and print to a disk-file. Enter the name of the file and then ask to check the print options (that is answer "Y" at the prompt) then make the following print option modifications:-

Printed Line Width:	240
Printed Lines Per Page:	100
Total Lines Per Page:	100

- Exit from GRIMP and then use a text editor (normally a word processor such as Microsoft WORD) to remove any formatting lines from the print file. Surround your Title and Sector labels with quotation marks (to signify titles in the Lotus), and delete the totals, final demand and primary inputs rows and columns other than House-hold. If in doubt refer back to Figure 1.
- In the top left hand corner of the file insert the number of sectors in the model including the household sector. In the Regionville table for example, the number of sectors is 4.
- Save this file as a plain ASCII file with a .PRN extension. Check your word processor manual if you do not know how to save file as an ASCII file.
- Load Lotus 123 and import the ASCII file. In Lotus this done by / (to call up the Lotus options), F(to highlight file), I(to import the file) and N (to import numbers).
- Print out the file and check that it is in the same format as Figure 1. Save it as a .wk1 file on lotus on either floppy disk or hard disk.
- The file is now ready for importing into DECON.

RUNNING THE DECON MODEL

Load Lotus 123 and then retrieve the work sheet on the DECON disk called Decon.wk1. For convenience it is probably best to load the DECON disk onto the hard disk and store in the Lotus Directory. The Decon.wk1 file is retrieved by entering / (to access the main Lotus menu), F(to signify that you want file operations) and R(to retrieve the file). You will then see the main DECON Menu as shown below in Figure 3.

Figure 3: Decon Main Menu

OPTIONS	DATA	RUN	PRINT	SAVE	NEW	HELP	EXIT

The options available in this menu are:

1. Options

Data File Directory

Enter the name of the Directory where the data (the Direct Co-efficients Matrix that you have built) is stored. For example if you had stored the table as a .wk1 file in the Lotus directory on drive C the correct entry would be c:\Lotus\. *At this stage the program is not asking for a specific file.* Be sure not to forget to include the back slash before and after the directory name. For those using a floppy disk enter A:\ or B:\.

Output for Printer

Enter y for yes or n for no. Note DECON is set on the n option and as most users will want a print out it is necessary to change this setting. Remember to use lower case.

Output to ASCII File

Enter y for yes or n for no.

The advantage of this option is that output is stored in a file on your disk which can be later used in your wordprocessor.

Output File Directory

Enter the name of the directory to which you wish to send the ASCII file. Don't forget the back slash before and after the directory name.

Printer Set up String

Enter a string here if you want to control your printer. Refer to the Lotus reference manual page 106 for more details.

Printer left Margin

Enter the left margin data as a number between 0 and 240 depending on your output format preferences.

Printer Right Margin

Enter the right margin data a number between 1 and 240.

Press enter to return to the Main Menu.

2. Data

File

This option allows you to load a direct co-efficients matrix into the DECON programme. Make sure that the co-efficients matrix is in the same format as in Figure 1. Before running the Data option use the New option to tell the program the number of sectors in the direct coefficients matrix. Use the cursor key to select the name of the file you want to import.

Edit

This option allows you to edit and add data to the direct co-efficients matrix. There are three options here:

- Row: Edit or add data starting in the Rho row, and proceeding to Ess and Family Size. (See Figure 4).
- Column: Edit or add column data starting in the population driven column and proceeding to the unemployment column. (See Figure 5).
- Demand: Edit or add data to final demand estimates. (See Figure 6).

Please note that the edit facilities here are designed for the demo-economic rows and columns. It is not easy to edit the direct coefficients matrix in Decon and for this reason it is preferable to edit this matrix in a separate Lotus worksheet before you import it into DECON.

Quit

Return to the Main menu.

3. Run

This option inverts the matrix and calculates the multipliers. The output from this option presents the standard output, income and employment options as well as presenting the population multipliers and the population flow-on effects.

4. Print

This option allows the data and results to be printed. There are 5 choices:

- Print the direct co-efficients matrix
- Print the inverse matrix
- Print the final demand and multiplier estimates.
- Print all of the above.
- Quit returns you to the main menu.

Note that whether the above are printed to the printer or to a file depends upon what you had earlier indicated in the options menu.

Figure 4 : The Decon/Lotus Screen in the Row Option. (Using the Regionville Example)

		AA	AB	AC	AD	AE
1		4 REGIONVILLE DEMO-ECONOMIC MODEL				
2						
10			1	2	3	
11	rho		0.8	0.6	0.8	
12	ess		0.23	0.27	0.37	
13	family size		2.3	2.1	2.9	
14						
15	IDENTITY MATRIX FOLLOWS					
16						

5. Save

This option lets you save the model. Enter the name of the file when prompted. Please note that unless you specify a name you will overwrite the original DECON model.

6. New

This option allows the setting of the number of sectors in your direct co-efficients matrix. (Include the household sector but exclude the employment coefficients when calculating this number. Enter the number when prompted.

Figure 5: The Decon/Lotus Screen in the Column Option. (Using the Regionville Example)

		AF	AG
1			
2		Pop.	Unempl.
3	primary	0.17	1.4
4	secondary	0.11	2.1
5	tertiary	0.26	3.5
6	household		

Figure 6: The Decon/Lotus Screen in the Demand Option. (Using the Regionville Example)

(Note: This example assumes that the employment changes in sectors 1, 2, 3 were 0, 100 and 0 respectively)

	AA	AB	AC	AD	AE
	4 REGIONVILLE DEMO-ECONOMIC MODEL				
51		1	2		
52	INITIAL EMPLOYMENT CHANGE		100	0	
53	FLOW-ONS	0	123.800	0	
54	TOTAL EMPLOYMENT CHANGE	0	223.800	0	
55					
56	POPULATION IMPACTS				
57	INITIAL POPULATION IMPACT	0	84	0	
58	FLOW-ONS	0	62.8772	0	
59	TOTAL POPULATION CHANGE	0	146.877	0	
60					
61					
62					

7. Help

This option provides some limited in-program assistance for the user but is not a substitute for the use of this manual.

8. Exit

You are given 4 options here:

- No do not exit, return to previous menu.
- Yes exit to Dos (or OS2).
- System exit to Dos temporarily. This is identical to the System command in Lotus (see page 164 of the Lotus reference manual).
- Ready Mode, leave the menu and go to Lotus Ready Mode.
  Within this mode you can check the DECON data, and change any information using normal LOTUS edit commands. In order to get back to the DECON model enter:

Alt M

Esc

(The Alt key is on the left of your keyboard - you have to hold the Alt key and the M key down at the same time).

Figure 7: The Decon/Lotus Run Output (Using the Regionville Example)

	1"	2"	3"	4"	Pop.	Unempl.
PRIMARY"	0.1237	0.1034	0.0366	0.125	0.17	1.4
SECONDARY"	0.0698	0.0658	0.1463	0.22	0.11	2.1
TERTIARY"	0.0233	0.1379	0.0679	0.415	0.26	3.5
HOUSEHOLD"	0.2315	0.276	0.1567	0		
Population	0.00609	0.00819	0.00855	0		
Unemployed	-0.0081	-0.0042	-0.0074	0		
EMP.COEF"	0.01325	0.00975	0.01475			
rho	0.8	0.6	0.8			
ess	0.23	0.27	0.37			
family size	2.3	2.1	2.9			

IDENTITY MATRIX FOLLOWS

1	0	0	0	0	0
0	1	0	0	0	0
0	0	1	0	0	0
0	0	0	1	0	0
0	0	0	0	1	0
0	0	0	0	0	1

I-A MATRIX FOLLOWS

PRIMARY"	0.8763	-0.1034	-0.0366	-0.125	-0.17	-1.4
SECONDARY"	-0.0698	0.9342	-0.1463	-0.22	-0.11	-2.1
TERTIARY"	-0.0233	-0.1379	0.9321	-0.415	-0.26	-3.5
HOUSEHOLD"	-0.2315	-0.276	-0.1567	1	0	0
Population	-0.0060	-0.0081	-0.0085	0	1	0
Unemployed	0.00816	0.00427	0.00743	0	0	1

INVERSE MATRIX FOLLOWS

PRIMARY"	1.20241	0.20980	0.10287	0.23914	0.25423	2.48401
SECONDARY"	0.17455	1.22538	0.23773	0.39006	0.22627	3.64974
TERTIARY"	0.17165	0.35135	1.19711	0.59555	0.37908	5.16808
HOUSEHOLD"	0.35343	0.44183	0.27701	1.25634	0.18070	2.39221
Population	0.01022	0.01432	0.01281	0.00974	1.00664	0.08924
Unemployed	-0.0118	-0.0095	-0.0107	-0.0080	-0.0058	0.92571

MULTIPLIERS :	1"	2"	3"
output	1.54862	1.78654	1.53772
employment	1.45008	2.23800	1.44662
population	1.67790	1.74853	1.49799

FINAL DEMAND ANALYSIS
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EMPLOYMENT IMPACTS			
INITIAL EMPLOYMENT CHANGE	0	100	0
FLOW-ONS	0	123.800	0
TOTAL EMPLOYMENT CHANGE	0	223.800	0

POPULATION IMPACTS			
INITIAL POPULATION IMPACT	0	84	0
FLOW-ONS	0	62.8772	0
TOTAL POPULATION CHANGE	0	146.877	0

RUNNING DECON - A TUTORIAL

This tutorial assumes that you have a hard disk in your computer configured as the c: drive, although DECON will run quite happily on a twin floppy configuration. <Ent> means hit the Enter key, whilst all the letters in bold letters should be typed in.

1.The first step is to create a separate directory on your hard disk called DECON. You can do this in DOS using the command:

md\decon <Ent>

2.Then copy all the files from the floppy disk into the DECON directory by:

cd\decon <Ent>

copy a:*.*

3.Start up the Lotus program and then set the file directory in Lotus to the DECON directory by entering:

/FDC:\C:DECON

4.Retrieve the DECON spreadsheet template by entering:

FR and then selecting DECON.WK1 from the list.

Please be patient, it will take the file a minute or two to load into your computer.

5.We will now attempt to load the regionville model into the spreadsheet. First we select New off DECON's main menu by entering **N** and then enter **4** <Ent> to indicate the number of rows and columns in our model. Next, we enter **DF** to tell DECON that we want to load a data file, and then select the file Regville.WK1 from the list of files at the top of the screen. The regionville data should then appear on your screen.

6.The next step is to enter the additional data to the traditional regionville I-O table, in order to generate a full demo-economic model. You do this by entering: **ER** in order to add the additional rows of data to the model shown in Figure 5, using the normal method for entering data into Lotus. When you have finished hit the escape key. Next move to the column data by hitting **C** and then entering the data shown in Figure 6. When you have finished hit the escape key. Next move to the column data by hitting **C** and then entering the data shown in the row marked "initial employment change" in Figure 7. When you have finished entering the Final Demand data, hit the escape key and then **Q** for quit twice to return to the main menu.

7.Once you have entered all the information, run the model by selecting the Run option off the main menu by hitting **R** for run.

8.Go to the option submenu by hitting <Ent>, and then change the output to printer flag from n to y. This will cause output to be sent to your printer.

9.Print out all the data be entering **PA** (make sure that your printer is turned on). If you have nominated that output will be sent to an ASCII file (see the Options sub menu), then you will have to nominate the name of the ASCII file. Check that the numbers on your printout match the data in Table 5 of the main report.

9. Leave DECON by entering **EY** and return to DOS.