2003

# Using Input-Output Analysis to Identify Australia's High Employment Generating Industries

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## Publication Details

This article was originally published as Valadkhani, A, Using Input-Output Analysis to Identify Australia's High Employment Generating Industries, Australian Bulletin of Labour, 29(3), 2003, 199-217.

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**Keywords**

Input-output analysis, Employment, Australia.

**Disciplines**

Business | Social and Behavioral Sciences

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# Using Input-Output Analysis to Identify Australia's High Employment Generating Industries

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*JEL* classification numbers: C67, D57, and J21.
Key words: Input-output analysis, Employment, Australia.

## 1. Introduction[*]

Persistent unemployment and underemployment continue to pervade Australia and many other OECD countries. With the exception of four months in the year 2000, Figure 1 shows that overall the unemployment rate in Australia was higher than the aggregate OECD countries from February 1990 to January 2002 (the shaded area). Mitchell and Mosler (2002, p.243) argue that the Australian economy has not generated "enough jobs in the last 25 years to match the growth of the labour force". Although Figure 1 indicates that the rate of unemployment in Australia has been lower than that of the OECD countries since February 2002, a rising level of underemployment is still considered a critical issue (Mitchell and Carlson, 2001). Obsessed with supply side solutions to the high unemployment problem, "the dominant economic theory has, since the mid-1970s, cajoled policy makers to follow policies that have deliberately and persistently deflated their economies under the false impression that the role of policy is to ensure the economy is operating at the natural rate of unemployment" (Mitchell and Muysken, 2002, p.2). Against the background of the preceding discussion the major objective of this paper is to identify the leading employment generating sectors of the Australian economy. Given the rising level of Australia's underemployment and the increasing number of discouraged workers, it is important to identify these sectors because "the unemployed can not find jobs that are not there" (Mitchell, 2001).

Many economists have undertaken extensive research on various aspects of Australia's unemployment problem. Le and Miller (2000) present a wide-ranging summary of these studies. Despite a vast literature exploring many aspects of the problem, including aggregate studies of how economies generate jobs, there has been

[*] I wish to acknowledge Professor Peter B. Dixon, two anonymous referees, and Professor Keith

little comprehensive research undertaken on the determination of high employment generating industries. Some studies focus on a specific industry in isolation and therefore ignore the inter-industry employment generating mechanisms that may be important. See for example Smith and Hagan (1993).

**[Figure 1 about here]**

Therefore, it is of paramount importance to identify high employment generating industries particularly in times of high unemployment. In other words, if rising and persistent unemployment is deemed to be an important socioeconomic phenomenon, one of the solutions would be to stimulate economic activity in high employment generating industries.

In the literature there are a number of ways that input-output (IO) techniques can be used to measure the significance of a sector in terms of its contribution to output and employment. Sharma, Leung and Nakamoto (1999) have classified these procedures into three broad categories: final demand-based; output-based; and hypothetical extraction (shut-down) of an industry. Each approach has its own limitations (see Sharma, Leung and Nakamoto, 1999). Given the purpose of this analysis, the third approach is more appropriate and will be used in this paper. Jensen and West (1985) have provided a theoretical framework for the third approach, which underpins the measurement of the significance of an industry in terms of output, employment and value added. Furthermore, West (1993) in his IO software package (GRIMP) has included an option enabling practitioners to measure the industrial significance at both national and regional levels using the shut-down of industry approach.

Hancock for their useful comments on a previous draft of this paper. The usual caveat applies.

By adopting a similar approach, which is referred to as "loss of the industry" or "shut-down of industry", Groenewold, Hagger and Madden (1993), *inter alia*, have employed a 58-industry IO model of the (Australian) State of Tasmania to measure the direct and indirect contributions of various sectors to regional employment.

In this paper, using a more aggregated version of the 1996-97 IO table, the sectoral employment multipliers and elasticities are calculated to identify high employment generating industries with their corresponding final demand cost requirements. However, the linkage and multiplier approaches, which are widely used in the literature, could mislead decision-makers about the identification of the key sectors because the sectoral ranking based on employment linkages may identify relatively small industries as very important, or large-sized sectors as unimportant (Mattas and Shrestha, 1991). Therefore, to incorporate information on the relative size of an industry and its capacity to expand, sectoral employment elasticities will be calculated. In other words, the resulting sectoral ranking provides a rough guide representing both the relative size of an industry and its capacity for possible expansion. The rankings and empirical analysis undertaken in this study shed some light on the sectoral potential in relation to the creation of jobs in the economy.

The rest of the paper proceeds as follows. Section 2 briefly discusses the concept, applications and the limitations of IO models. This section also presents a succinct theoretical discussion of the "loss of the industry" or "shut-down of industry" approach to measure the direct and indirect contribution of the tradeable sectors to employment. "Tradeable" in this context refers to sectors subject to international trade. In addition, this section explains how the sectoral employment multipliers and elasticities are computed. Section 3 uses the latest IO table (1996-97) to calculate the sectoral direct and indirect contribution to total employment as well as the sectoral employment multipliers and elasticities. Based on the empirical results and rankings, this section also discusses the major policy implications of the study. Section 4 provides some concluding remarks. .

## 2. Methodology

Prior to presenting the theoretical framework of this paper, it is useful to provide a brief discussion of the structure, concept and applications of input-output analysis. Basically IO models are final demand driven planning tools, which are designed to examine the inter-relationships among the productive sectors of an economy. Wassily Leontief (1936) is a pioneer of input-output analysis and in 1973 he was awarded the Nobel Prize in economics. IO techniques use an input-out table or matrix, which exhibits the flow of goods and services among industries. In its four quadrants the IO table describes the complex process of production, the use of goods and services, and the way in which income and value added are generated within various sectors of an economy. One can view an IO system as a simplified representation of the production side of an economy, where the set of producers of similar goods and services forms a homogeneous industry. Furthermore, input-output analysis is a useful technique for tracing resources and products in an economy.

An IO system adopts a linear Leontief production function, which assumes proportionality between inputs and outputs of an industry with no economies of scale. This means that the proportion of inputs used in the production process are insensitive to the level of production. For instance, if 100 cars require 10 tons of steel, 200 cars will require 20 tons of steel. Within this system each industry requires different inputs to produce its output, with these inputs procured from other domestic industries or from suppliers of non-domestically produced inputs (intermediate imports). Input-output analysis demonstrates how industries are linked together through supplying inputs for the output of the economy.

For example, let us consider the production of automobiles. We know that various raw materials such as steel, electronic gadgets, plastic, glass etc., are needed to manufacture cars. These raw materials that have a direct use in the production process are referred to as direct inputs in IO terminology. However, if one moves up the supply chain, he/she can realise that several other raw materials go into the production of these direct inputs, for instance steel production requires water, iron ore, coal, electricity, etc. These raw materials not directly used in the production of cars are known as indirect inputs. If the price of iron ore increases substantially or the employees of Australia's coal mines all go on strike for a month, how can these hypothetical events impact on (a) the number of cars produced, (b) the amount of electricity produced, (c) the price of electricity, and (d) the number of job losses in the automobile industry. Input-output analysis is one of the few available tools to answer these types of questions in a systematic way (Stilwell *et al.*, 2000). One can also use IO techniques to assess the relative significance of a sector in terms of its impact on output, incomes, and employment by distinguishing the direct effect occurring within the sector and that spreading to other sectors that it is known as flow-on or indirect effect.

In an IO matrix, the structure of an economy can be shown by the transaction flows across various sectors (say agriculture, manufacturing and services). The rows of the IO table represent the industries that a particular industry sells its final output to (as intermediate inputs to those industries), and down the columns are the industries a given industry buys its required intermediate inputs from. All these intermediate transactions are recorded in the first quadrant (intermediate quadrant) of an IO table.

The intermediate quadrant is referred to as the heart of the IO matrix (Jensen and West, 1985). An IO system is closed by adding three other quadrants to it. These are: (1) the final demand quadrant, which shows the sectoral distribution of household expenditure, government consumption, fixed capital formation, and exports (*i.e.* the destination of sales that do not go to other sectors as intermediate inputs); (2) the primary inputs quadrant, where the sectoral distribution of wages, operating surplus, value added, indirect taxes, subsidies and non-competitive imports are usually shown; and (3) the primary-input-to-final demand quadrant which presents the value of various primary inputs directly linked to the final demand.

IO techniques have many applications such as economic impact analysis (*i.e.* measuring the impact of a change in the sectoral final demand on the production, income, value added or employment of economic sectors), measuring various backward and forward linkage indices, employment creation, income distribution, analysing the effective rate of protection, project appraisal, cost-benefit analysis, regional planning, energy analysis, and price-quantity relationships. For example, Valadkhani and Mitchell (2002) have recently employed a modified IO model to measure the impact of change in petrol prices on inflation and household expenditures in Australia. In all of these applications one needs to calculate Leontief multipliers. For a detailed account of the theory and applications of input-output analysis see (O'Connor and Henry, 1975, Bulmer-Thomas, 1982 and Miller and Blair, 1985).

The direct or tangible importance of an industry in terms of output or employment can easily be measured by its level of output or the number of people working in the sector. However, the indirect contribution of an industry to either total output or employment is not simply observable unless the multiplier and flow-on effects are taken into account. The share of a particular industry in total employment reveals only the direct contribution of a particular industry and this naive measure overlooks the number of jobs generated indirectly in other sectors as a result of stimulating economic activity in the industry concerned.

If a sector is divorced from other industries (*i.e.* with few backward linkages) and its output is mainly exported overseas with few domestic intermediate uses, it can then be argued that its indirect contribution to aggregate employment would be small and inconsequential. As a result, the total contribution (direct and indirect) of this sector to total output or employment would be similar in magnitude to its direct contribution. On the other hand, if a sector is well integrated with other industries in the economy with high and evenly distributed linkages, then the shut-down of this industry will have severe adverse repercussions on the other sectors of the economy in terms of output and job losses. Even if we substitute the domestically produced inputs of this sector with an equal amount of the homogeneous imported inputs, due to the inter-relationship among sectors, the significance of an industry is beyond its own output or employment share in the economy.

For example, suppose that sector 1 in an IO system is to be shut-down. What output and job-loss would result? How do we measure the output and employment losses in other industries? The indirect magnitude of this "loss of the industry" on total output produced in the economy can be evaluated by summing the output loss in all the industries (excluding sector 1) of the economy. The industrial significance of a sector such as sector 1 in terms of its total contribution to output ($S_1^Q$) is thus measured by the following relation:

$$S_1^Q = \overbrace{x_1}^{\text{direct effect}} + \overbrace{\sum_{i=2}^{n} \Delta x_i}^{\text{indirect effects}} \qquad (1)$$

Where $x_i$ denotes output in sector i. Since the employment to output ratio is given for each sector in an IO table, the overall significance and contribution of an industry to total employment ($S^E$) can also be calculated by assuming that the sectoral employment ratios are fixed. As can be seen, in order to calculate ($S^E$) for the tradeable sectors, $S^Q$ first needs to be computed. The theoretical framework underpinning the measurement of indirect contribution of a tradeable industry to total output is presented in the Appendix. It should be noted that all of the sectors in an economy cannot be shut-down. Obviously one cannot shutdown non-tradable sectors such as Government Administration & Defence; Construction; Electricity, Gas & Water, etc. Therefore, it is assumed that only the tradeable sectors can be subjected to this hypothetical closure.

Before presenting the empirical results, it is important to highlight a number of limitations and uncertainties inherent in the use of input-output analysis for forecasting and policy analysis. These limitations are mainly associated with a number of restrictive assumptions. Some of these assumptions are briefly discussed below.

First, IO models assume a linear production function (or fixed technical coefficients) for each industry, ruling out the possibilities of economies of scale, externalities and substitutions among inputs. These models assume linearity in the cyclical impact, meaning that the economy responds exactly in the same way in a boom phase as it does in a recession. For instance, let us assume that an IO table was compiled in a recession year (say 1990) and the analyst wants to use this table to model activity in a peak economic year (say 1995). Under these circumstances, the labor-to-output ratio (obtained from a recession year) tends to be excessive because firms are usually unwilling to lay off workers when they know an economic boom is on its way. This linearity assumption embedded in IO models does not recognise the importance of major asymmetries that exist over the business cycle: what "goes down does not necessarily go up".

Second, in IO models and the Keynesian models it is also assumed that the economy operates with spare capacity and that there always exists un- and/or under-utilised resources and labour force in the sectors identified as providing high employment to accommodate the multiplier effects. In other words, supply effects in IO models are virtually ignored, suggesting that the supply curve is perfectly elastic. For example, if government expenditure in a given year increases say by 10 per cent, based on this assumption it is possible to meet the extra demand by the present production capacity. However, if many resources are close to full-utilisation, the multiplier effects will ignore or mask (negative) displacement effects (*i.e.* employees need to move from one industry to another industry if final demand is increased). Therefore, high positive multiplier effects can include hidden opportunity costs and substitution effects which IO models are not capable of capturing. In view of this fact it would be useful to compare and contrast the sectoral capacity utilisation rate and the sectoral employment elasticity, but it is beyond the scope of the present study to be involved in the computation of the capacity utilisation rate in various sectors of the economy. Additional future research on this issue would be of value.

Third, IO models generate the values of endogenous variables (*e.g* output, income, value added employment, and prices), but only for an initial equilibrium and a new equilibrium after shocks are imposed. In other words, input-output analysis does not convey information on the dynamic adjustment process and only provides a snapshot of the structural characteristics of the economy. Of course one can incorporate capital stock matrices into static IO models to generate dynamic models but there is no capital stock matrix available for the Australian 1996-97 IO table. Therefore, the IO model used in this paper involves comparative statics and as such the reported results should be considered with caution.

Fourth, in IO models it is assumed that the endogenous reaction (in terms of absolute value) of the sectoral output or employment to a shut-down (or a negative one unit shock) is exactly the same as the response that would accompany an expansion (proxied by a positive one unit shock). In other words, unlike the real world situation if the final demand in a given year increases (say by 10 per cent), the resulting change in output and employment in other sectors (in terms of absolute value) would be exactly the same as a 10 per cent decrease in the final demand of that sector.

For a detailed discussion of the limitations of IO techniques see Rose and Miernyk (1989). More recently, computable general equilibrium (CGE) models and social accounting matrices (SAM) have provided newer IO based models which address some of the inherent problems outlined above (See *e.g*. Rose, 1995). It should be noted that the restrictive assumptions in IO analysis make generalisations difficult and the results obtained from this study less accurate but the findings are, to some extent, indicative of the forces at work. Barna (1961, p.3) argues that IO techniques are developed to represent "a great simplification of theoretical models but a considerable elaboration and refinement of statistical data, to the point where theory and empirical implementation meet".

## 3. Empirical Results and Policy Implications

In this paper the latest IO table (1996-97) of the Australian economy, in which competing imports are directly allocated in the third quadrant of the table, is used to generate empirical results. This 106-sector table has been compiled on the basis of the

*System of National Accounts 1993*, which is the latest international standard of national accounting, including IO Tables (Australian Bureau of Statistics, ABS, 2001, Cat. 5209). All transactions recorded in the table are expressed at basic prices and in millions of Australian dollars. However, the table has been aggregated into 35 industries according to an IO industry classification and these 35 sectors are then grouped into two major categories: 18 tradeable and 17 non-tradeable industries. Only tradeable industries can be shut-down and at each stage only one industry is removed from the IO system.

The direct or tangible importance of the 18 tradeable industries in terms of employment is shown in column (1) of Table 1. Using the theoretical framework discussed in the Appendix, one will also be able to quantify the indirect contribution of a particular industry to aggregate employment ($S^E$ ).

For instance, as seen from Table 1, with a hypothetical shut down of Meat and Dairy Products (but keeping other tradeable and non-tradeable industries in the system), it seems that only 62450 people, who are directly involved in this industry, will lose their jobs. However, due to sectoral multiplier and flow-on effects, the closure of this industry will bring about a total loss of 285225 jobs in the other 34 sectors indirectly. In this example, the indirect contribution of Meat and Dairy Products to aggregate employment turned out to be greater than its direct contribution. Due to a very high indirect contribution of certain industries to total employment such as the Meat and Dairy industry in the context of Australia and Canada, and the steel industry in the US case, these sectors are highly protected. Therefore, the indirect contribution of a sector to aggregate employment can explain the existence of a relatively high effective rate of assistance in these industries.

**[Table 1 about here]**

It is stated that the "gain from trade liberalisation since 1986-87 has provided the average Australian family with more than $1000 extra per year" (Department of Foreign Affairs and Trade, DFAT, 2000, p.iv). But this gain should be balanced against the number of job losses and the associated unemployment costs on society. Later in this section (Table 3) the annual sectoral final demand requirement of creating one full-time job is presented in the economy using the sectoral employment multipliers.

Another example relates to the importance of the Petroleum and Coal Products sector. It is naive to argue that the closure of Petroleum and Coal Products results in the loss of only 7500 jobs. From Table 1 it is evident that if this seemingly "small sector" is shut-down, over 60000 people in other sectors of the economy will be unemployed due to the flow-on effects, yielding an indirect-to-direct ratio of over 8. On the basis of the total contribution of each sector to total employment, a sectoral ranking has also been performed in the last column of Table 1. Given the total sectoral contribution to employment (Column 3 in Table 1), the top five important tradable industries, based on this criterion, are as follows: Agriculture, Hunting and Trapping; Other Machinery and Equipment; Other Food Products; Meat and Dairy Products; and Paper, Printing and Publishing.

Although the manufacturing industries play a substantial role in employment generating activities in the economy, the growth of employment in most of the manufacturing industries has been negative since 1974. Using the OECD (1998) database, the annual average growth rates of employment in manufacturing over the three periods of 1974-84, 1984-94, and 1974-94 were approximately –1.9 per cent, –0.4 per cent, and –1.2 per cent, respectively.

Table 2 shows the breakdown of employment and corresponding annual average growth rates for major manufacturing sub-sectors in 1974, 1984 and 1994. A cursory look at Table 2 reveals that employment in the majority of manufacturing industries has demonstrated a general downward trend since 1974. During the period 1974-94, the employment growth in all manufacturing industries was negative except for the three sectors Wood and Wood Products; Paper, Printing and Publishing; and Petroleum and Coal Products. Even these three sectors demonstrated a lackluster average growth of approximately 0.2 per cent per annum.

**[Table 2 about here]**

Since the prospect of future employment opportunities in manufacturing is not very rosy, in the rest of this paper I will examine the sectoral employment potential in the non-manufacturing sectors. To this end, the 1996-97 IO table has been further aggregated from 35 industries into 17 industries according to the IO industry classification codes specified in ABS (2001, Cat. 5209). More specifically in this aggregation the manufacturing sub-industries form a single industry.

Equations (7) and (9) in the Appendix are utilised to calculate the sectoral employment multipliers and elasticities, respectively. Table 3 presents the sectoral employment multipliers and elasticities as well as a number of relevant sectoral indices for these 17 industries. Based on information presented in Table 3, the major findings are highlighted below.

**[Table 3 about here]**

First, the Sectoral employment multipliers vary from 11.2 in mining to 34.3 in education. On the basis of the magnitude of the sectoral multipliers, one can calculate the cost of creating a full time job in the economy. For example in order to create an additional job in the economy, the final demand in the Mining industry needs to be augmented by A$89127 pa, whereas in the context of the Education sector this figure is as low as A$29172 (See Table 3).

Second, the sectoral employment elasticities also exhibit a wide degree of variability. For example a 10 per cent increase in manufacturing final demand can lead to a 2.42 per cent expansion in aggregate employment. While manufacturing possesses the highest employment elasticity (0.242), the elasticity for the Electricity, Gas and Water sector is the lowest (0.014). Note that the latter has a low backward linkage and a high forward linkage.

Third, during the period 1985-2000 the average annual employment growth in the following 8 sectors was greater than the total employment growth (2 per cent): Property & Business services (5.9%); Accommodation, Cafes & Restaurants (4.8%); Cultural & Recreational Services (4%); Personal & Other Services (3.1%); Health & Community Services (3%); Construction (2.6%); Retail Trade (2.6%); and Education (2.1%). It is important to recognise that of these 8 fastest growing industries, the following 5 industries are among the first top sectors in terms of the magnitude of the employment elasticity: Retail Trade (0.209); Construction (0.17); Health & Community Services (0.161); Property & Business Services (0.138); and Education (0.12). The share of these five industries, which can be described as key sectors, in total employment is 46 per cent.

Fourth, employment elasticities for the two sectors of Electricity, Gas & Water; and Mining, which had an annual negative employment growth over the period 1985-2000, were as low as 0.014 and 0.037, respectively. In fact Electricity, Gas & Water with an annual average employment growth of -4.9 per cent had the lowest employment elasticity. Overall, it can be concluded that the fastest growing industries in terms of employment are mainly those with relatively higher elasticities and *vice versa*.

The Spearman correlation coefficients have also been calculated between the ranking of sectoral employment elasticities and the ranking of the following three variables: 1) the sectoral distribution of wages and salaries (0.88); b) the sectoral distribution of employment (0.95); and c) the sectoral employment multipliers (0.43). These correlation coefficients, shown in parentheses above, indicate that the overwhelming majority of high employment elasticity industries are, first, large in size in terms of employment and this is due to the use of the sectoral employment as weights in Equation (9); second, among those sectors which contribute to the bulk of the total salaries and wages; and third, do not necessarily have a high employment multiplier. These results indicate that those sectors that generate a large number of jobs are also those that distribute a large amount of wages and salaries, supporting the view that it is possible to design a growth strategy that simultaneously improves employment growth and income distribution. Based on the results reported in Table 3, when unemployment becomes an acute problem, the government can play a more active role in abating the rate of unemployment by stimulating economic activity in those sectors which possess higher employment elasticities.

## 4. Concluding Remarks

Using the latest input-output (IO) table of 1996-97, the high employment generating industries of the Australian economy are identified by two techniques. First, the direct and indirect contribution of tradeable industries to aggregate employment have been measured by using the “loss of the industry” or “shut-down of industry” approach.

Second, the key employment generating sectors of the Australian economy have been identified on the basis of the magnitude of the sectoral employment elasticities.

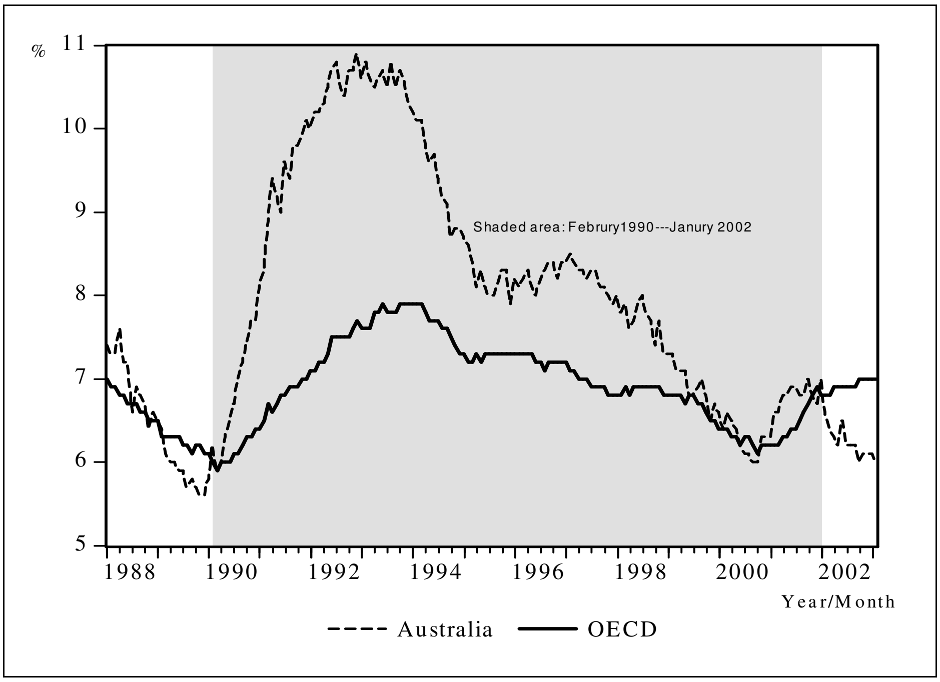
It is found that the manufacturing industries are very important in terms of indirect contribution to total employment in the economy. However, the overwhelming majority of the manufacturing industries have experienced quite low employment growth since late 1970s. Although the aggregated manufacturing sector has the highest employment elasticity of 0.242, the average employment growth for this sector over the period 1985-2000 was as low as 0.1 per cent per annum.

It is also found that the following 5 industries are not only the fastest growing (in terms of annual employment growth during the 1985-2000 period) and the largest sectors (in terms of their share in total employment and salary and wages in the year 1996-97) but also possess relatively higher employment elasticities: Retail Trade; Construction; Health & Community Services; Property & Business Services; and Education (See Table 3). It is highly likely that these key industries will play a crucial role in generating employment in the years to come. In other words, it seems that the industries showing positive growth in labour usage also have relatively higher employment elasticities..

It should be borne in mind that IO systems are based on the following assumptions: (1) homogeneity of output; (2) zero rates of substitution between inputs and infinite elasticity of supply of factors of production; (3) fixed proportions between inputs and outputs; (4) absence of economies of scale; (5) linearity in the cyclical impact; and (6) exogeneity of primary inputs and final demand components. Therefore, the model used in this paper cannot capture the importance of major asymmetries that exist over the business cycle and the dynamic and feedback effects on factor prices, the exchange rate, consumption, public expenditure, exports and imports. These restrictive assumptions embedded in an IO system make generalisations difficult and the results obtained from this study less accurate but the findings are, to some extent, indicative of the forces at work.

FIGURE 1

*Standardised unemployment rates (seasonally adjusted) for Australia and total OECD* , January 1988-February 2003




Source: ABS (2003, Table E2).

TABLE 1

*Direct and indirect impacts of hypothetical industry shut-down on total employment by sectors (persons and ranks)*

| Sector | Direct (1) | Indirect (2) | Total (3) | % (1)/(3) | Rank (total) |
|---|---|---|---|---|---|
| Agriculture; hunting and trapping | 355163 | 209789 | 564952 | 62.9 | 1 |
| Forestry and fishing | 22350 | 37476 | 59826 | 37.4 | 18 |
| Meat and dairy products | 62450 | 285225 | 347675 | 18.0 | 4 |
| Other food products | 85288 | 269035 | 354323 | 24.1 | 3 |
| Beverages and tobacco products | 17913 | 107108 | 125021 | 14.3 | 13 |
| Textiles | 34675 | 71991 | 106666 | 32.5 | 15 |
| Clothing and footwear | 62625 | 72078 | 134703 | 46.5 | 12 |
| Wood and wood products | 41900 | 60840 | 102740 | 40.8 | 16 |
| Paper, printing and publishing | 127838 | 191418 | 319256 | 40.0 | 5 |
| Petroleum and coal products | 7500 | 60197 | 67697 | 11.1 | 17 |
| Chemicals | 55225 | 153615 | 208840 | 26.4 | 9 |
| Rubber and plastic products | 41225 | 79157 | 120382 | 34.2 | 14 |
| Non-metallic mineral products | 45563 | 90127 | 135690 | 33.6 | 11 |
| Basic metals and products | 68363 | 191801 | 260164 | 26.3 | 8 |
| Fabricated metal products | 110150 | 164157 | 274307 | 40.2 | 7 |
| Transport equipment | 102462 | 176775 | 279237 | 36.7 | 6 |
| Other machinery and equipment | 138225 | 222637 | 360862 | 38.3 | 2 |
| Miscellaneous manufacturing | 74038 | 86683 | 160721 | 46.1 | 10 |

Source: Author's calculations.

TABLE 2

*Employment composition in major manufacturing industries: 1974, 1984 and 1994 (persons and growth rates)*

| Industry | 1974 | 1984 | 1994 | Annual average growth % | | |
|---|---|---|---|---|---|---|
| | | | | 1974-84 | 1984-94 | 1974-94 |
| Food | 164848 | 150175 | 150845 | -0.9 | 0.0 | -0.4 |
| Beverages and tobacco products | 29369 | 24856 | 20155 | -1.7 | -2.1 | -1.9 |
| Textiles | 72325 | 48738 | 47668 | -3.9 | -0.2 | -2.1 |
| Clothing and footwear | 93130 | 68233 | 60333 | -3.1 | -1.2 | -2.1 |
| Wood and wood products | 105639 | 93998 | 109638 | -1.2 | 1.6 | 0.2 |
| Paper, printing and publishing | 119519 | 119768 | 124000 | 0.0 | 0.3 | 0.2 |
| Petroleum and coal products | 4579 | 6007 | 4790 | 2.8 | -2.2 | 0.2 |
| Chemicals | 111727 | 98111 | 104000 | -1.3 | 0.6 | -0.4 |
| Rubber and plastic products | 50369 | 41046 | 48014 | -2.0 | 1.6 | -0.2 |
| Non-metallic mineral products | 67756 | 50262 | 50000 | -2.9 | -0.1 | -1.5 |
| Basic metals and products | 99119 | 86909 | 62918 | -1.3 | -3.2 | -2.2 |
| Fabricated metal products | 489827 | 379759 | 339633 | -2.5 | -1.1 | -1.8 |
| Transport equipment | 156786 | 125466 | 94765 | -2.2 | -2.8 | -2.5 |
| Other machinery and equipment | 211097 | 148991 | na | -3.4 | na | na |
| Miscellaneous manufacturing | 28741 | 18190 | 22811 | -4.5 | 2.3 | -1.1 |

Source: OECD (1998).

TABLE 3

*Sectoral employment indicators: Australia, 1996-1997*

| Sector | Sectoral distribution of[a] | | | Employment Multiplier (rank) | Cost of creating a Full time job (A$) | Employment Elasticity (rank) | Annual Average Employment Growth 1985-00[b] (%) |
|---|---|---|---|---|---|---|---|
| | Final demand (%) | Employment (%) | Salary & Wages (%) | | | | |
| Agriculture forestry & fishing | 2.6 | 5.1 | 1.5 | 21.8 (9) | 45954 | 0.043 (13) | 0.4 |
| Mining | 4.3 | 1.2 | 2.3 | 11.2 (17) | 89127 | 0.037 (15) | -1.5 |
| Manufacturing | 17.6 | 14.6 | 14.1 | 18.1 (12) | 55371 | 0.242 (1) | 0.1 |
| Electricity, gas & water | 1.6 | 0.9 | 1.2 | 11.2 (16) | 89103 | 0.014 (17) | -4.9 |
| Construction | 10.7 | 7.4 | 5.4 | 20.9 (10) | 47955 | 0.170 (3) | 2.6 |
| Wholesale trade | 5.4 | 5.8 | 6.5 | 22.0 (7) | 45386 | 0.091 (8) | 0.5 |
| Retail trade | 9.4 | 13.5 | 8.7 | 29.2 (4) | 34189 | 0.209 (2) | 2.6 |
| Accommodation, cafes & restaurants | 3.4 | 4.2 | 2.9 | 24.4 (6) | 41051 | 0.062 (10) | 4.8 |
| Transport & storage | 4.5 | 5.0 | 6.4 | 18.8 (11) | 53189 | 0.065 (9) | 0.9 |
| Communication services | 1.3 | 2.1 | 2.5 | 17.4 (14) | 57382 | 0.018 (16) | 1.1 |
| Finance & insurance | 3.4 | 3.9 | 6.1 | 18.0 (13) | 55435 | 0.047 (12) | 1.2 |
| Property & business services | 13.1 | 9.9 | 12.0 | 13.8 (15) | 72616 | 0.138 (5) | 5.9 |
| Govt administration & defense | 6.1 | 5.5 | 7.4 | 26.5 (5) | 37807 | 0.123 (6) | 0.6 |
| Education | 4.6 | 6.7 | 8.1 | 34.3 (1) | 29172 | 0.120 (7) | 2.1 |
| Health & community services | 6.9 | 8.4 | 9.6 | 30.8 (2) | 32461 | 0.161 (4) | 3.0 |
| Cultural & recreational services | 2.3 | 2.1 | 1.9 | 21.9 (8) | 45577 | 0.039 (14) | 4.0 |
| Personal & other services | 2.6 | 3.7 | 3.4 | 30.0 (3) | 33338 | 0.060 (11) | 3.1 |
| Total | 100 | 100 | 100 | | | | 2.0 |

Sources: a) ABS (2001); b) Based on the ABS Labour Force Statistics Database (ABS, cat. 6203.0) by Industry (ANZSIC Classification); and c) The rest of the table is author's calculations based on the 1996-97 IO table.

## Appendix

Following Jensen and West (1985), Groenewold, Hagger and Madden (1987, 1993), and West (1993) a theoretical model is postulated to measure the indirect sectoral contribution to aggregate output and employment using an IO system. Let's start from the following relation:

$$\mathbf{(I - A)x = f} \tag{2}$$

where:

**A** is the (n x n) technical domestic coefficients;
**x** is the (n x 1) column vector of sectoral gross output; and
**f** is the (n x 1) column vector of the sectoral final demand.

Equation (2) can also be written as follows:

$$\begin{bmatrix} (1-a_{11}) & -a_{12} & -a_{13} & \cdots & -a_{1n} \\ -a_{21} & (1-a_{22}) & -a_{23} & \cdots & -a_{2n} \\ -a_{31} & -a_{32} & (1-a_{33}) & \cdots & -a_{3n} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ -a_{n1} & -a_{n2} & -a_{n3} & \cdots & (1-a_{nn}) \end{bmatrix} \cdot \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} f_1 \\ f_2 \\ f_3 \\ \vdots \\ f_n \end{bmatrix} \tag{3}$$

In order to measure the indirect significance of a particular sector (say sector 1) it is assumed that this sector is "shut-down" and this restriction on the IO system can be imposed in the following manner:

$$\begin{bmatrix} 1 & 0 & 0 & \cdots & 0 \\ 0 & (1-a_{22}) & -a_{23} & \cdots & -a_{2n} \\ 0 & -a_{32} & (1-a_{33}) & \cdots & -a_{3n} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ 0 & -a_{n2} & -a_{n3} & \cdots & (1-a_{nn}) \end{bmatrix} \cdot \begin{bmatrix} x_1^* \\ x_2^* \\ x_3^* \\ \vdots \\ x_n^* \end{bmatrix} = \begin{bmatrix} f_1 \\ f_2 \\ f_3 \\ \vdots \\ f_n \end{bmatrix} \tag{4}$$

However, if sector 1 is removed from the system, the IO table will no longer be balanced. Hence a number of assumptions should be invoked before the indirect output loss can be measured. First, the other n-1 sectors, which used to purchase some intermediate inputs from sector 1, can outsource the required intermediate inputs from abroad through imports. In other words, the loss of output in sector 1 is offset by an equal increase in imports. That is, the intermediate inputs supplied by sector 1 to the other n-1 sectors of the economy are now imported. Second, the shut-down of this sector does not have any effect on the technology of the existing industries, which continue to operate. That is to say, the closure of a particular sector does not change the direct coefficients (input requirements) of the other n-1 sectors. Third, it is also assumed that the distribution of sectoral final demand ($f_2, f_3, \ldots, f_n$) remains unchanged.

From an IO table one knows the total output produced by sector 1 before its shut-down ($x_1$), and also the final demand in the other n-1 sectors. Therefore, Equation (3) can be rewritten in such a way that only pre-determined variables appear on the right hand side. That is:

$$\begin{bmatrix} 1 & -a_{12} & -a_{13} & \cdots & -a_{1n} \\ 0 & (1-a_{22}) & -a_{23} & \cdots & -a_{2n} \\ 0 & -a_{32} & (1-a_{33}) & \cdots & -a_{3n} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ 0 & -a_{n2} & -a_{n3} & \cdots & (1-a_{nn}) \end{bmatrix} \cdot \begin{bmatrix} f_1 \\ x_2 \\ x_3 \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} (1-a_{11})x_1 \\ f_2 + a_{21}x_1 \\ f_3 + a_{31}x_1 \\ \vdots \\ f_n + a_{n1}x_1 \end{bmatrix} \tag{5}$$

According to Equation (5), the other n-1 sectors now import their required inputs from abroad rather than purchasing them from sector 1. Relation (5) can be used to calculate the output loss ($\Delta x_i$) as a result of the hypothetical removal of any specific sector from the IO system.

As mentioned earlier since $x_1$ or initial output in sector 1 is known and also $\Delta f_2 = \Delta f_3 = \Delta f_4 = \ldots = \Delta f_n = 0$, one can use Relation (5) to compute the changes in sectoral output ($\Delta x_i$) as follows:

$$\begin{bmatrix} \Delta f_1 \\ \Delta x_2 \\ \Delta x_3 \\ \vdots \\ \Delta x_n \end{bmatrix} = \begin{bmatrix} 1 & -a_{12} & -a_{13} & \cdots & -a_{1n} \\ 0 & (1-a_{22}) & -a_{23} & \cdots & -a_{2n} \\ 0 & -a_{32} & (1-a_{33}) & \cdots & -a_{3n} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ 0 & -a_{n2} & -a_{n3} & \cdots & (1-a_{nn}) \end{bmatrix}^{-1} \cdot \begin{bmatrix} (1-a_{11})x_1 \\ f_2 + a_{21}x_1 \\ f_3 + a_{31}x_1 \\ \vdots \\ f_n + a_{n1}x_1 \end{bmatrix} \tag{6}$$

Now Equations (1) and (6) can be employed to calculate the industrial significance of sector 1 in terms of total contribution to output ($S_1^Q$) and consequently if the fixity of the sectoral employment-output ratios is accepted, one will also be able compute $S_1^E$. The same computation process can be utilised to measure the total significance or contribution ($S_i^E$) of each and every tradeable sector.

In the rest of this Appendix a brief discussion of the theoretical and computational foundations of the sectoral multipliers and elasticities is presented. For a detailed discussion of these issues see Mattas and Shrestha (1991); and Jensen and West (1986).

The employment multiplier can be interpreted as the impact on the aggregate employment if the final demand in sector j increases by one unit. The employment multiplier for sector j is defined as follows:

$$E_j^m = \sum_{i=1}^{n} \left( l_i / x_i \right) b_{ij} \tag{7}$$

where

$l_i$ and $x_i$ denote the employment (number of persons) and output in sector i, respectively,

$b_{ij}$ is the i, j$^{th}$ element of the closed Leontief inverse matrix (***B***), and

$n$ stands for the number of sectors.

As discussed earlier neither multipliers nor linkages consider the relative size and expansion capacity of an industry. High multiplier or backward linkage indices may identify relatively small industries as being important, or large-sized sectors as unimportant. Therefore, following Mattas and Shrestha (1991), the sectoral employment elasticities are utilised to identify high employment generating industries.

An employment elasticity measures the percentage change in aggregate employment in the economy resulting from a one per cent change in the final demand of a given sector. Thus the employment elasticity for sector j is defined as:

$$E_j^e = \frac{\partial L}{\partial f_j} \cdot \frac{f_j}{L} \tag{8}$$

where

$L$ is equal to total employment in the economy,
$f_j$ is final demand in sector i, and
$\frac{\partial L}{\partial f_j}$ is the employment multiplier for sector j.

More specifically using Equation (7) this formula can be written as:

$$E_j^e = \left[ \sum_{i=1}^{n} \left( l_i / x_i \right) b_{ij} \right] \cdot \frac{f_j}{L} \tag{9}$$

In this study Equations (7) and (9) will be used to calculate the sectoral employment multipliers and elasticities, respectively.

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