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Keywords
Input-output analysis, Employment, OECD.

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ABSTRACT

The objective of this paper is to identify high employment industries in Australia, Japan and the U.S using input-output (IO) analysis. It is found that (1) the high and low employment generating industries in 1980 and/or 1990 are almost the same as those in 1997. Thus on a relative basis, there is no evidence that high employment generating industries have changed since 1980; and (2) the high and low employment generating industries are very similar across these three countries. Four of the consistently high employment generating industries in these countries are Food, Beverage and Tobacco; Chemicals, Petroleum, Coal, Rubber & Non-Metallic Minerals; Basic Metals/Fabricated Products; and Electricity, Gas and Water, with the first three industries being part of manufacturing.

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

I. INTRODUCTION

Persistent unemployment and underemployment continue to pervade Australia and many other OECD countries. For example, 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". A rising level of underemployment and casualisation of the workforce are now considered as critical issues..

Against the background of these stylized facts, the major objective of this paper is to identify the leading employment generating sectors in three countries which have shown some common characteristics in this respect. Given the rising level of underemployment and the increasing number of discouraged workers, it is important to identify these sectors, particularly in times of high employment. 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. The rankings and empirical analysis undertaken in this study shed some light on the sectoral potential in relation to the creation of jobs in these three economies.

The rest of the paper proceeds as follows. Section II briefly discusses the theoretical framework of the paper. Section III describes the sources of the IO tables which have been utilised to identify high employment generating industries. Section IV enlists the high employment generating industries in Australia, Japan and the U.S and how they have changed through time from 1980 to 1997. Section V provides some concluding remarks.

II. THE THEORETICAL FRAMEWORK

Given the objective of this paper, as a starting point let us begin with the following relation:

$$\mathbf{(I - A)x = f} \qquad (1)$$

where **A** is the (n x n) matrix of current price, domestic input-output coefficients, based on the direct allocation of imports; **x** is the (n x 1) column vector of sectoral gross outputs; and **f** is the (n x 1) column vector of the sectoral final demands.

Then the solution vector of sectoral gross outputs, **x**, can be written as

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} = \mathbf{Gf} \qquad (2)$$

where $\mathbf{G} = (\mathbf{I}-\mathbf{A})^{-1}$ is the inverse of the Leontief matrix.

Employment multipliers are usually used to identify high employment generating industries. The employment multiplier for sector j is defined as:

$$E_j^m = \sum_{i=1}^{n} \lambda_i g_{ij} \qquad (3)$$

where g_{ij} is the ij^{th} element of the Leontief inverse matrix, and λ_i (i = 1,2,…n) denotes the direct labour coefficient per unit of gross output i.

An employment multiplier can be interpreted as the impact on employment if final demand in sector j increases by one unit (*e.g.* one million US dollars, one billion Japanese Yen or a million Australian dollars). This measure is not unit free and if meaningful time series or cross-country comparisons are to be made, one needs to find a unit free index because the IO tables are expressed in current prices and different countries have different currencies.[1] It should also be noted that 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, we use the Type I ratio which overcomes the problem of the units of measurement. The type I employment multiplier for sector j is defined as follows:

$$T_{\mathrm{j}}^{\mathrm{E}} = \sum_{i=1}^{n} \left(\lambda_i g_{ij}\right) / \lambda_j \qquad (4)$$

This means that for each additional person directly employed in sector j, a further T_j^E are employed in the economy due to the multiplier and flow-on effects of sector j. For a detailed, technical discussion of this issue see Diamond (1975) and West (1993). This measure is independent of units of measurement and thus can be compared across countries and over time.[2] Employment multipliers reveal the overall stimulus to employment from backward linkages arising from the expansion of a particular sector, but not the sectors that experience the increase in employment.

III. THE DATA

Consistent IO data for the three countries based on direct and indirect allocations and constant and current prices are available from the OECD under the ISIC rev2 classification from 1970-90. The OECD (1998) STAN database has an employment series back to 1970 for Japan and the USA under ISIC rev 3, but there are a number of industries for which data are unavailable for both countries.[3] Consequently the study commences with the 1980 IO tables for Japan and the USA. While Australia generated IO tables for 1977-78, no complementary employment data are available. Consequently the 1989 and 1996-97 Australian IO tables were utilised.

The 1997 IO tables for Japan and the USA are based on ISIC rev3, while the Australian table for (1996-97) is based on the ANZSIC classification obtained from Australian Bureau of Statistics, ABS, 2001). Current price IO tables are utilised, because the IO tables for all countries are not available at constant prices for 1980, 1990 and 1997. As noted, even with constant price IO tables, comparisons are limited by the need to take account of exchange rates.

While structural change in the three countries has involved both the shift to service based activities and the emergence of new industries, which is reflected in the use of ISIC rev3, rather than ISIC rev2, it is decided to facilitate comparisons by collapsing both classifications to a common 17 sector classification, which is shown in the Appendix. The STAN database is also classified under ISIC rev3, so that the employment data can be readily reconciled with the IO tables for Japan and the USA. Quarterly ABS employment data by industry are available under the ANZSIC classification from 1984. This can be readily collapsed into the common 17 sector classification. West's GRIMP software package (West, 1993) is used to undertake the IO calculations.

IV. EMPIRICAL RESULTS

Table 1 shows the computed Type I employment multipliers for Australia, Japan and the US in 1980, 1990 and 1997. For example in 1997 each additional job created in the Australian Food, Beverages and Tobacco industry would create 3.75 extra jobs in the economy. To provide a clearer picture, the 17 industries are classified into the 6 top employment generating industries, 5 medium employment generating industries and 6 low employment generating industries. The results are presented in Table 2.

Table 1. Sectoral employment type I multipliers for Australia, Japan and the USA

New Code	Sector	Australia		Japan			USA		
		1989	1997	1980	1990	1997	1982	1990	1997
1	Agriculture, forestry & fishing	1.43	1.50	1.86	1.73	1.63	2.66	2.36	2.12
2	Mining & quarrying	2.26	3.06	2.45	1.59	1.69	1.99	2.29	2.48
3	Food, beverages & tobacco	3.46	3.75	2.80	2.53	2.08	3.84	3.74	3.72
4	TCF & leather	1.65	1.66	1.98	1.81	1.61	2.05	1.88	1.94
5	Wood & paper products, furniture	2.53	2.23	2.41	2.17	1.84	2.12	2.19	1.94
6	Chemicals, petroleum, coal, rubber & non-metallic minerals	2.56	2.46	3.36	3.13	2.36	3.04	2.82	2.77
7	Basic Metals/Fabricated Products	2.37	2.31	3.53	2.77	2.32	2.31	2.29	2.26
8	Machinery & equipment	1.85	1.89	2.41	2.67	2.27	2.20	2.19	2.39
9	Other Manufacturing nec	1.13	1.53	1.29	1.29	1.34	1.46	1.39	1.75
10	Electricity, gas & water	2.02	2.30	2.79	2.37	2.16	3.62	2.53	2.64
11	Construction	1.69	1.57	1.92	1.87	1.54	2.38	2.04	1.94
12	Wholesale retail, restaurants etc	1.28	1.42	1.42	1.37	1.34	1.26	1.26	1.29
13	Transport & storage	1.57	1.85	1.59	1.70	1.34	1.84	1.67	1.70
14	Communication services	1.41	1.69	1.33	1.39	1.53	1.24	1.21	1.75
15	Finance & insurance	1.48	1.54	1.34	1.41	1.32	1.72	1.72	1.83
16	Property & bus services	1.54	1.80	1.67	1.80	1.76	1.52	1.53	1.48
17	Community, Social & Personal Services	1.19	1.23	1.51	1.22	1.21	1.16	1.19	1.16

Source: OECD IO tables for all countries, except Australia (ABS, 2001) and OECD DSTI (STAN industrial database) 2001 (annual) for the USA and Japan. AUSSTATS quarterly employment data by ANZSIC (annual average) for Australia.

Table 2. Top, medium and low employment generating industries: Australia, Japan and USA

Industry	Australia	Japan	US	Common Industries
	1980			
Top 6	NA	7, 6, 3, 10, 2 & 8	3, 10, 6, 1, 11 & 7	3, 6, 7, 10
Medium 5	NA	5, 4, 11, 1 & 16	8, 5, 4, 2 & 13	4 & 5
Low 6	NA	13, 17, 12, 15, 14 & 9	15, 16, 9, 12, 14 & 17	9, 12, 14, 15 & 17
	1990			
Top 6	3, 6, 5, 7, 2 & 10	6, 7, 8, 3, 10 & 5	3, 6, 10, 1, 2 & 7	3, 6, 7, 10
Medium 5	8, 11, 4, 13, 16	11, 4, 16, 1 & 13	8, 5, 11, 4 & 15	11 & 13
Low 6	15, 1, 14, 12, 17 & 9	2, 15, 14, 12, 9 & 17	13, 16, 9, 12, 14 & 17	9, 12, 14, 17
	1997			
Top 6	3, 2, 6, 7, 10 & 5	6, 7, 8, 10, 3 & 5	3, 6, 10, 2, 8 & 7	3, 6, 7 & 10
Medium 5	8, 13, 16, 14 & 4	16, 2, 1, 4 & 11	1, 11, 4, 5 & 15	4
Low 6	11, 15, 9, 1, 12 & 17	14, 12, 13, 9, 15 & 17	14, 9, 13, 16, 12 & 17	9, 12 & 17

Source: Table 1.

As can be seen from this Table 2, four of the consistently high employment generating industries in these countries are Food, Beverage and Tobacco (3); Chemicals, Petroleum, Coal, Rubber & Non-Metallic Minerals (6); Basic Metals/Fabricated Products (7); and Electricity, Gas and Water (10), with the first three industries being part of manufacturing. It is interesting to note that the high employment generating industries in 1980 and/or 1990 are almost the same as those in 1997. Thus, given the broad definition of industries, there is no evidence that high employment generating industries have changed since 1980. Likewise the low employment generating industries have not changed markedly since 1980 across the three countries.[4] Except for Other Manufacturing (9), the remainder are service sector industries. However, due to the lack of disaggregated employment data for all the three countries, this analysis does not show changes in new low or new high employment sub-sectors which may have been created or disappeared within a particular sector through time.

From the results in Tables 1 and 2, it seems that the magnitude and sectoral ranking of employment multiplier ratios have not undergone a major change since 1980 at an aggregate level. A correlation coefficient of 0.87 between the US and Australian T^E statistics across industries for 1997 and a correlation coefficient of 0.73 between the US and Japan clearly indicates that the high and low employment generating industries are very similar across countries. Therefore, one can conclude that not only the high and low employment generating industries have not changed through time, but also, on a relative basis, these industries are very similar across these three countries (See also the last column of Table 2).

Table 3 indicates that on average the T^E in the USA is greater than those of Japan and Australia, increasing slightly from 2.02 in 1990 to 2.07 in 1997. The Australian employment multiplier ratio is not only higher than Japan's, but also unlike Japan it has exhibited an upward trend since 1990. One possible explanation is that Japanese industry has been characterised by overmanning which is being addressed as

the country slips deeper into recession. See Bon and Yashiro (1996) for a detailed discussion of the IO analysis of demand-side and supply-side of the Japanese economy.

Table 3. Average employment multiplier ratios for Australia, Japan and the USA

Country	1980	1990	1997
Australia	NA	1.9	2.0
Japan	2.1	1.9	1.7
USA	2.1	2.0	2.1

Source: See Table 1.

IO multiplier analysis has several limitations and the results must be interpreted carefully. For example, multiplier effects tend to ignore or mask displacement effects because many resources could already be fully utilised in the economy. Thus, positive multiplier effects may include hidden opportunity costs and substitution effects. See Valadkhani (2003) for a discussion of IO restrictive assumption in a similar context. Although these restrictive assumptions embedded in an IO system make generalisations difficult, the findings are, to some extent, indicative of the forces at work.

V. SUMMARY

This paper examines high employment industries across three OECD economies (namely Australia, Japan and the U.S), drawing on the intersectoral relationships that are revealed by IO analysis. Despite some major difficulties with obtaining consistent data, some interesting results have been obtained. It is found that not only the high and low employment generating industries have not changes through time, but also, on a relative basis, these industries are very similar across these three countries. It appears that three out of the four highest employment generating industries belong to manufacturing.

Appendix. *Concordance for ISIC rev 2 and 3, ANZSIC and 17 sector classification*

ISIC 2	OECD IO, 1970-90	ISIC 3	STAN Database & IO 1997 (Japan & USA)		ANZSIC	New Code
1	Agr, forestry & fishing	01-05	Agr, forestry & fishing	011-42	Agr, forestry & fishing	1
2	Mining & quarrying	10-14	Mining & quarrying	110-52	Mining	2
3	Food, beverages & tobacco	15-16	Food , Beverages & Tobacco	21	Food, bev & tobacco	3
4	Textiles, apparel & leather	17-19	Textiles, Leather & Footwear	22	TCF& leather	4
5	Wood products & furniture	20	Wood & Wood Products & Cork	23	Wood & paper product	5
6	Paper, paper products etc	21-22	Pulp, Paper, Printing etc	24	Print, pub & recorded media	5
7	Industrial chemicals	23-25	Chemical, Rubber, Plastics etc	25	Petrol, coal, chem& related	6
8	Drugs & medicines	26	Other Non-Metallic Mineral Products	26	Non-metal mineral product	6
9	Petroleum & coal products					6
10	Rubber & plastic products					6
11	Non-metallic min products					6
12	Iron & steel	27-28	Basic Metals/Fabricated Products	27	Metal product	7
13	Non-ferrous metals					7
14	Metal products					7
15	Non-electrical machinery	29-33	Machinery & Equipment	28	Machinery & equipment	8
16	Office/comp machinery	34-35	Transport Equipment			8
17	Electrical apparatus, nec					8
18	Radio, TV & communication					8
19	Shipbuilding & repairing					8
20	Other transport					8
21	Motor vehicles					8
22	Aircraft					8
23	Professional goods					8
24	Other manufacturing	36-37	Manufacturing Nec; Recycling	29	Other	9
25	Electricity, gas & water	40-41	Electricity, gas & water supply	361-70	Electricity, gas & water	10
26	Construction	45	Construction	411-25	Construction	11
27	Wholesale & retail trade	50-55	Wholesale, retail: Restaurants etc	451-79	Wholesale trade	12
28	Restaurants & hotels			511-32	Retail trade	12
				571-74	Accomm, cafes etc	12
29	Transport & storage	60-63	Transport & storage	611-70	Transport & storage	13
30	Communication	64	Post and telecommunications	711-12	Communication services	14
31	Finance & insurance	65-67	Financial Intermediation	731-52	Finance & insurance	15
32	Real estate & bus. services	70-74	Real Estate, Renting & Business	771-86	Property & bus services	16
33	CSP services	75-99	CSP Services	811-20	Gov admin & defence	17
34	Government services			841-44	Education	17
35	Other producers			861-72	Health & comm services	17
36	Statistical discrepancy			911-33	Cultural & rec services	17
				951-70	Personal & other services	17

Source: See Table 1.

Note: This table shows the concordance for ISIC rev2 and ISIC rev3. The concordance is approximate because there are differences between ISIC rev2 and rev3 that appear at the four digit level and hence are not apparent at the two digit level.

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[1] If one country was being analysed and the IO tables for the different years were all expressed in constant prices, the employment multiplier formula would be appropriate.

[2] It is acknowledged that these calculations, while unit free, do not provide guidance about the so called *bang for a buck* since the nominal value of the extra output generated by one additional employee in industry j will reflect the productivity of labour, other input costs and the profit margin.

[3] An hours based measure of employment would have been preferred, or at least one that differentiated between part-time and full-time employment, but such data are not available for Japan.

[4] Conway (1977) notes that there are a number of possible causes of changes in the multipliers over time namely: technological change; increasing (or decreasing) benefits from scale of production ("scale economies"); changes in product composition (within industrial sectors) including entirely new products (or loss of products); closure (opening) of entire branches of industries; changes in relative prices; and input substitution as a result of response to price changes or technological change.