UPDATING INPUT-OUTPUT TABLES WITH THE HELP OF A TEMPORAL FUNDAMENTAL ECONOMIC STRUCTURE

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ABSTRACT Economic development is a process of ongoing structural change in which structural linkages that connect core components (the fundamental economic structure or FES) provide a platform on which non-fundamental activities at the periphery of the core can develop. Previous research has concentrated on the spatial characteristics of the fundamental - non-fundamental dichotomy with little regard for temporal adjustments as the economy develops and evolves. This paper revisits previous FES developments and suggests an alternative or complementary view of a dynamic. evolving FES which has a coherent development path. Evidence to support this hypothesis is found by analysing the structural characteristics and changes that have occurred in the Australian economy over the period 1974/5 to 1992/3. This information is used to 'forecast' the 1993/4 national input-output table.

1. INTRODUCTION

In Australia, there has been little research on structural change in a temporal framework at the interindustry level. Although there are a number of macro-econometric models available, these generally do not provide adequate sectoral disaggregation to meaningfully analyse the patterns of industry change over time. Models which do provide significant industry disaggregation are generally comparative static or commercial models which are used either for impact assessment or forecasting of specific industries but are rarely used if at all to analyse structural change in a holistic sense. Little has been done on comparing the interindustry structure of the Australian economy at different points in time; to analyse how this structure has changed or evolved; to determine which industry activities have declined and which activities have emerged as the new growth industries following the recession and micro-economic reform processes instigated by the Government.

Input-output (IO) models provide one avenue for analysing structural change. The IO transactions table disaggregates the economy into sectors or industries, and documents the production and disposal of all goods and services among these sectors over a one year period. It thus forms part of the national accounting system and provides a very detailed picture of the structure of the economy at a given point in time, and a basis for the analysis of intersectoral relationships.

The study of economic structure using input-output has followed several paths. At the simplest level, comparative analysis of the tables can provide information on the temporal changes in relatively simple economic indicators by industry, such as value added, employment, gross output, capital formation, import substitution, exports, wages and salaries, and so on. This can be extended to more sophisticated techniques of analysing industry economic significance and structures. These include traditional multiplier analysis, ordering of sectors, pattern analysis, triangulation, and other holistic measures of connectedness (Hewings *et al*, 1987), linkage and key sector analysis (Rasmussen, 1957; Hirschmann, 1958; West, 1882), industry significance analysis (Groenewold *et al*, 1993), and extraction methods (Strassert, 1968; Dietzenbacher and van der Linden, 1997) to name but a few. More innovative and recent techniques include structural decomposition approaches (Dewhurst, 1993), fields of influence, hierarchical structures and feedback loop analyses (van der Linden *et al*., undated), shift-share (Jensen *et al*, 1990), and minimal flow analysis (Schnabl, 1994).

One offshoot of these studies of economic structure is the interesting concept of fundamental economic structure (FES), first suggested by Jensen, West and Hewings (1988). Rather than focusing attention on the differences between economies, this approach seeks to identify regularities across regions. Those cells which contain transactions flows which are consistently present at predictable levels over a range of economies are termed *fundamental* meaning that category of economic activity is inevitably required in all economies. Those cells which are more region-specific in nature, such as mining or agriculture, and thus less predictable from region to region, comprise the non-fundamental component (NFES).

Previous research has concentrated on the spatial characteristics of the FES-NFES dichotomy with scant regard for temporal adjustments as the economies develop or evolve. This paper considers the possibility of a temporal FES of core components which provides a platform on which non-fundamental economic development at the periphery of the core can proceed. The following section revisits the FES literature to lay the foundation of the subsequent search for evidence of a temporal FES using nine input-output tables for Australia over the period 1974-75 to 1993-94.

2. FUNDAMENTAL ECONOMIC STRUCTURE REVISITED

The earlier work of Jensen *et al* (1987) on taxonomy of economies lays the foundation for the FES concept. Initially, it was envisioned that the FES comprised primarily 'people' related activities, people being the common denominator of all economies. This suggested a *partitioned* approach to identifying the FES. Subsequently, an alternative, though not necessarily incompatible, view referred to as the *tiered* approach was proposed (Jensen *et al*, 1991). Each approach is briefly reviewed in this section. Note that both the partitioned and tiered approaches were envisaged in a spatial context. This paper suggests that a third category may also exist, namely a temporal FES. This is explored further in the next section.

2.1 Partitioned FES

In the partitioned approach, each cell is classified as either fundamental or non-fundamental. This concept was derived from an analysis of input-output tables for the eleven regions of Queensland, ranging from less-developed remote rural regions to a large metropolitan region. The analysis identified regularities and patterns in cell behaviour across these regions. The results (Jensen *et al.*, 1988) indicated that (a) about 75% of the cells were 'predictable' at a 10% significance level based on relationships between the size of the cells and the size of the economy; (b) cell distributions were similar across regions within sectors, mainly in the secondary, services and trade sectors, but less so in mining and primary industries; (c) identifiable patterns of predictable cells occurred encompassing the secondary service-trade interactions, or the urban-type services in the economy. These results based on the Queensland tables were later replicated using sets of regional tables for New South Wales, Victoria and South Australia.

The suggestion of a predictable fundamental structure based on the "less primary - more tertiary" type sectors is consistent with the expectation that urban or people-oriented activities would be the common type of economic activity among regions and in many cases probably the dominant activity. This suggests that the economic core of a regional economy might more appropriately be defined in terms of this ever-present and predictable people-oriented activity rather than the variable-type or economic base activity which supply extra-regional markets. However these structures would also be expected to change over time so that temporal comparisons could be instructive.

A subsequent review of these studies, in which each cell can only be classified as belonging to either fundamental or non-fundamental categories, raised the possibility that the partitioned approach could be a special case of a more general concept of FES. This was termed the tiered FES approach.

2.2 Tiered FES

The tiered approach is based on the notion that the input-output table can be decomposed into two separate tables, one of which can be regarded as fundamental (FES) and the other non-fundamental (NFES). The fundamental tier should be 'predictable' within any economic system in the sense that each region can be expected to exhibit an FES tier. The NFES tier will not be predictable within the economic system but will reflect those aspects of economic activity which are region specific.

The implication of this approach is that each cell of the table can be regarded as consisting of two components, one of which is fundamental or predictable in some endogenous sense and the other which is determined by exogenous or 'random' factors. The former could be considered to be determined by "internally-oriented" paths (Jensen, 1981) which originate within the region, and the latter by "externally-oriented" reaction paths where market and institutional forces external to the region initiate economic impulses affecting directly and indirectly the levels of some economic activities within the region. For example, geographically-oriented activities, such as extractive and agricultural industries or perhaps extra-regional tourism in which the region has locational advantages, would be regarded as directly sourced externally-oriented reaction paths. Indirectly sourced externally-oriented reaction paths include local complementary activities which provide inputs to the extractive and agricultural industries. Urban-oriented activities, on the other hand, through the provision of goods and services for the purposes of personal consumption, including law and order, education, health and so on, will generally not be directly related to the externally-oriented activities (although some households will be indirectly dependent on these industries).

This implies that the fundamental component of the local economy largely comprises activities which are predictable or constant from region to region and do not depend to a large extent on the non-fundamental activities. This in turn implies that personal consumption expenditure patterns per capita, taking into account transport costs and imports, are basically similar across regions (the fundamental component) although there will be other personal expenditures which arise from region specific characteristics (the non-fundamental component).

As the FES/NFES structure should be consistent with the theory of input-output, it is logical that the internally and externally-oriented reaction paths will impact on the regional economy through the elements of final demand. This essentially means that final demand **F** can be decomposed into fundamental and non-fundamental components:

$$\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1} [\mathbf{F}_F + \mathbf{F}_N] \tag{1}$$

where **X** is an $n \times 1$ vector of industry production levels and **A** is the $n \times n$ direct requirements or input coefficient matrix. The subscripts F and N denote fundamental and non-fundamental categories respectively.

Final demand can be disaggregated into a number of separate activities ($\mathbf{F}_1$, $\mathbf{F}_2$, $\mathbf{F}_m$), representing household consumption, final expenditure by government, capital expenditure, exports and so on. Thus, equation (1) can be further decomposed into

$$\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1} [(\mathbf{F}_{F1} + \mathbf{F}_{N1}) + (\mathbf{F}_{F2} + \mathbf{F}_{N2}) + \ldots + (\mathbf{F}_{Fm} + \mathbf{F}_{Nm})] \tag{2}$$

In this way, it is possible to attribute a level of **X** to any one final demand or combination of final demand elements. For example, the level of output attributable to the final demand $\mathbf{F}_{Fi}$ is

$$\mathbf{X}_{Fi} = (\mathbf{I} - \mathbf{A})^{-1} \mathbf{F}_{Fi} \tag{3}$$

with FES tier corresponding to final demand category i ($\forall \; i = 1 \ldots m$)

$$\mathbf{T}_{Fi} = \mathbf{A} \; \hat{\mathbf{X}}_{Fi} = \mathbf{A} \; \mathbf{diag}\{(\mathbf{I} - \mathbf{A})^{-1} \mathbf{F}_{Fi}\} \tag{4a}$$

where the ^ denotes a diagonal matrix. The corresponding non-fundamental tier would be

$$\mathbf{T}_{Ni} = \mathbf{A} \; \hat{\mathbf{X}}_{Ni} = \mathbf{A} \; \mathbf{diag}\{(\mathbf{I} - \mathbf{A})^{-1} \mathbf{F}_{Ni}\} \tag{4b}$$

Summing the various layers gives the total FES and NFES tiers:

$$\mathbf{T}_F = \sum_{i=1}^{m} \mathbf{T}_{Fi} \quad (5a)$$

$$\mathbf{T}_N = \sum_{i=1}^{m} \mathbf{T}_{Ni} \quad (5b)$$

which in turn sum to the total transactions table **T**.

This structure assumes that the **A** matrix of input coefficients is the same for different categories of final demand. This is the conventional approach under the assumption of sector homogeneity, i.e. if an industry is producing a single commodity, it presumably cannot differentiate which inputs go into the production of the locally consumed output and those inputs which are used to produce that quantity which is exported. The more aggregated the table, the less comfortable this assumption sits, and there is a strong argument for working at the commodity level if attempting this FES/NFES breakdown. Alternatively, one could assign different **A** sub-matrices to different categories of final demand. The two tiers may then be defined as:

$$\mathbf{T}_{Fi} = \mathbf{A}_{Fi}\,\hat{\mathbf{X}}_{Fi} = \mathbf{A}_{Fi}\ \mathbf{diag}\,\{(\mathbf{I} - \mathbf{A}_{Fi})^{-1}\,\mathbf{F}_{Fi}\} \quad (6a)$$

$$\mathbf{T}_{Ni} = \mathbf{A}_{Ni}\,\hat{\mathbf{X}}_{Ni} = \mathbf{A}_{Ni}\ \mathbf{diag}\,\{(\mathbf{I} - \mathbf{A}_{Ni})^{-1}\,\mathbf{F}_{Ni}\} \quad (6b)$$

In this case $\mathbf{T}_{Fi}$ + $\mathbf{T}_{Ni}$ will not necessarily equal **T**, and some balancing or synergistic term will be necessary. Alternatively, if an average of the $\mathbf{A}_{Fi}$ matrices is considered appropriate, the FES tier could be calculated from

$$\mathbf{T}_F = \mathbf{A}\,\hat{\mathbf{X}}_F = \mathbf{A}\ \mathbf{diag}\,\{(\mathbf{I} - \mathbf{A})^{-1}\,\mathbf{F}_F\} \quad (7)$$

The NFES tier can then be estimated by subtraction from **T**.

In practice, it is difficult to see how these separate **A** sub-matrices could be estimated. Ideally, it should be approached from a survey-based point of view. However, it may be possible to utilise hybrid-based methods. For example, the FES tier could possibly constitute the mechanical component and the NFES tier the superior data component. Another possibility is the use of regression analysis applied to a series of IO tables to estimate the predictable component $\mathbf{T}_F$ and the non-predictable or random component $\mathbf{T}_N$. This is the approach taken in section 3 below.

An obvious extension of this approach is to convert the transactions tiers into other variables such as value added, income or employment. This would enable analysis of structural characteristics in terms of, for example, employment which may be advantageous to policy makers.

2.3 Spatial versus Temporal FES

The discussion and analysis of the FES in the literature has so far been mainly confined to a spatial dimension. Using a similar definition to that used in the spatial analyses, the FES in a temporal framework can be regarded as that component of the economy which is 'predictable' over time. However, this definition implies a wider range of activities would be included in the FES; activities not predictable across regions may be predictable within a given region over time, depending on the time span under consideration. While not necessarily restricted to urban-type activities, we would expect private consumption related activities to contribute a large proportion of the total FES. In other words, the FES is envisaged to comprise the economic core of the region upon which the non-fundamental component of region-specific activities can develop. The evolution and development of the economy as it passes through the so-called primary-secondary-tertiary phases of growth (e.g. Fisher, 1939; Clark, 1940) should occur mainly at the periphery of the core. There is clear evidence of this transformation in the Australian economy as primary industries are in decline relative to the more technologically advanced service activities.

The notion of a spatio-temporal FES was first mooted by Jensen *et al* (1987). They noted that empirical evidence from the Queensland experiments suggests that the FES evolves in predictable ways. Whilst economies may have different mixes of firms in sectors, reflecting the presence of regional comparative advantage and other traditional location factors, the underlying hierarchical structure of flows may be similar. As economies grow and develop, this underlying structure will change in predictable ways even if the proportions of total activity accounted for by each sector are not the same.

As the NFES passes through the various development phases, this will have repercussions on the host FES. The FES in turn will embrace the strengthening interactions of the NFES - FES elements, resulting in a strengthening bonded mass of increasing density. As the NFES development path evolves, so too will the periphery of the FES, but will still rest on the stable core of fundamental activities. Thus over time as the economy develops, the FES will undergo its own evolutionary change. The unknown factor in this hypothesis is the existence of the fundamental core. This hypothesis is tested in the following section.

3. EVIDENCE OF TEMPORAL FES

Australia is in the fortunate position of having a series of reliable national IO tables produced by the Australian Bureau of Statistics. In this section, nine tables constructed for the years 1974-75, 1977-78, 1978-79, 1980-81, 1983-84, 1986-87, 1989-90, 1992-93 and 1993-94 are used. The tables vary in sector classification from 108 to 113 sectors and are expressed in industry by industry form with direct allocation of competing imports. The tables were aggregated to a consistent level of 31 sectors for comparison purposes. The sector classification is given in Table 1.

Table 1. Input-Output Sector Classification

Number	Name
1	Sheep
2	Meat Cattle
3	Milk Cattle and Pigs
4	Cereal Grains
5	Other Agriculture
6	Forestry and Logging
7	Fishing and Hunting
8	Coal, Oil and Gas Mining
9	Other Mining
10	Food Manufacturing
11	Textiles, Clothing and Footwear
12	Wood and Paper Manufacturing
13	Chemicals, Coal and Petroleum Products
14	Non-metallic Mineral Products
15	Metals, Metal Products
16	Machinery, Appliances and Equipment
17	Miscellaneous Manufacturing
18	Electricity
19	Gas and Water
20	Residential Building
21	Other Building and Construction
22	Trade
23	Rail Transport
24	Other Transport
25	Communication
26	Finance and Business Services
27	Ownership of Dwellings
28	Public Administration
29	Defence
30	Community Services
31	Recreation and Personal Services

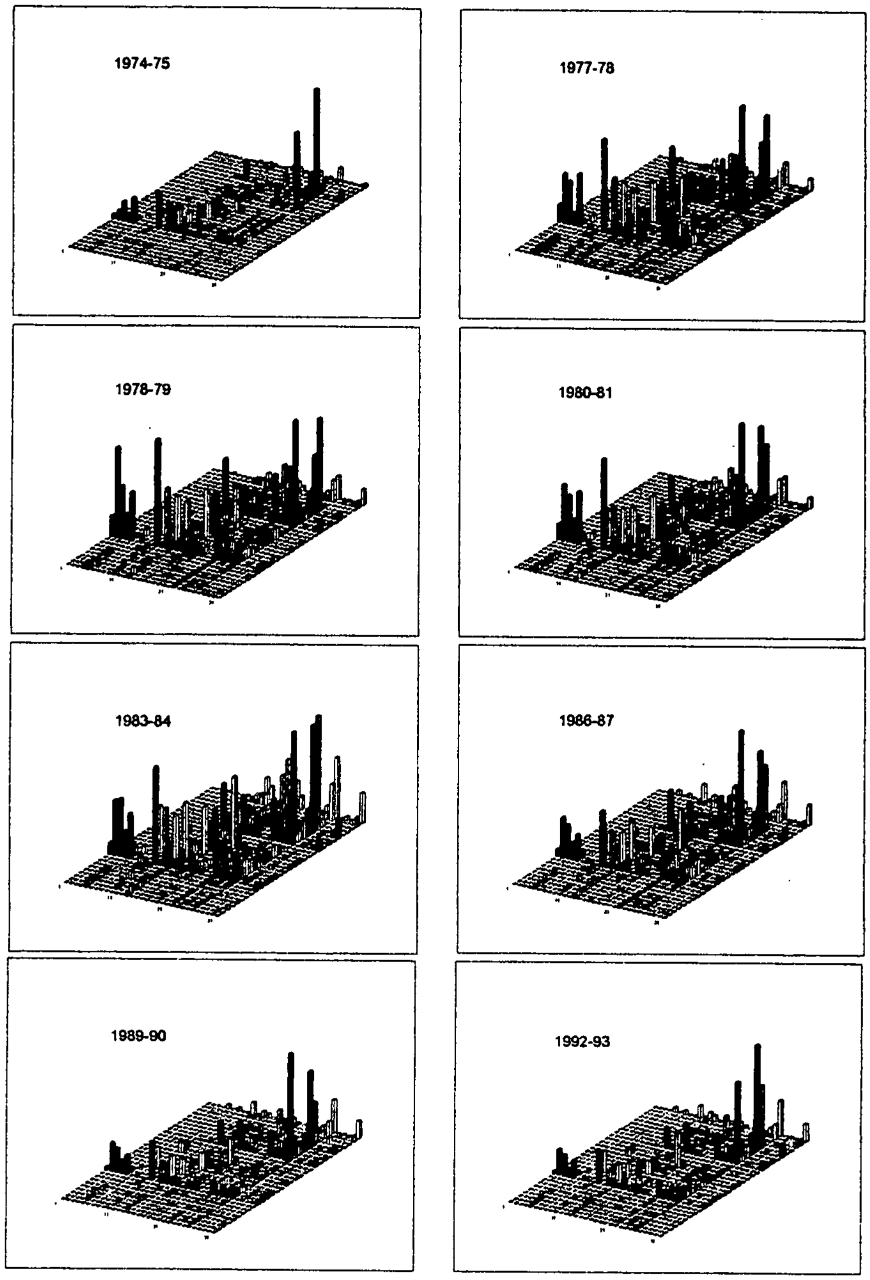

Figure 1. Private Consumption Expenditure Tiers. Australia 1974-75 to 1992-93

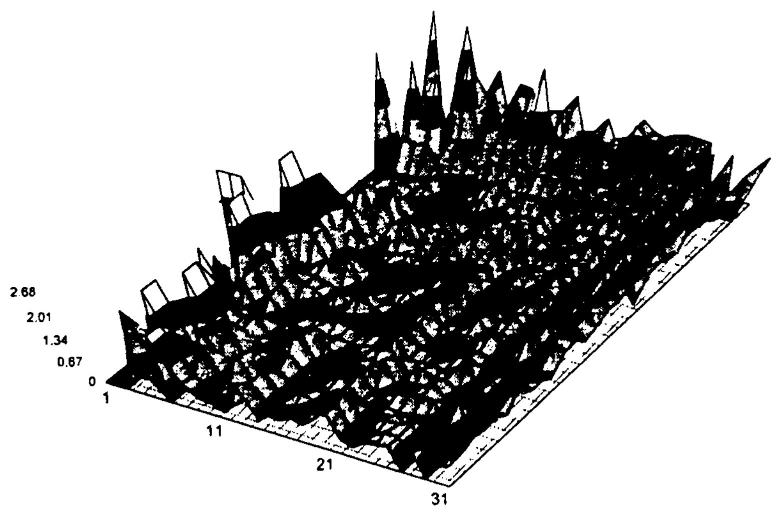

Figure 2. Private Consumption Expenditure Variability Landscape, Australia 1974-75 to 1992-93

Each table contains seven categories of final demand: (1) Private Consumption Expenditure, (2) Final Government Consumption Expenditure, (3) Private Capital Expenditure, (4) Public Enterprise Capital Expenditure, (5) Government Capital Expenditure, (6) Change in Stocks, and (7) Exports.

In the search for evidence of the FES, attention is focussed on the first eight tables. If the FES can be shown to exist, then it should be possible to use this information to predict the ninth table. Depending on how closely the predicted table compares with the true table, this would provide more conclusive evidence of the existence of a fundamental structure.

If the assumption that the FES is based largely on urban/personal consumption related activities is correct, then it is most likely to be evidenced in the tier corresponding to private consumption expenditure as defined in equation (4a), i.e.

$$\mathbf{T}_{PC} = \mathbf{A}\ \hat{\mathbf{X}}_{PC} = \mathbf{A}\ \mathbf{diag}\{(\mathbf{I} - \mathbf{A})^{-1}\ \mathbf{F}_{PC}\} \qquad (8)$$

The tiers corresponding to private consumption expenditure in the eight IO tables 1974-75 to 1992-93 are shown in Figure 1. It can be seen that there is a set of common elements in the expenditures across the sample period, which are predominantly based on Trade and Finance and to a lesser extent, Food Manufacturing and other manufacturing activity such as Textiles, Clothing and Footwear. Electricity, Transport, Community Services, Recreation and Ownership of Dwellings also feature predominantly. Expenditure levels were relatively high during the late 1970s and early 1980s but went into decline by the late 1980s as the economic downturn started to take effect. However, it is also possible to discern changes in the expenditure distributions from period to period. For example, there has been strong growth in Recreation and Finance whereas Food Manufacturing and most other manufacturing activities have declined.

As the distinguishing feature of the FES is that it appears predictable over time, it may be useful to ascertain the variability of the flows in the tier. A measure of this variability is the coefficient of variation. Figure 2 shows the landscape of the coefficient of variation of the cell values associated with household expenditure over the sample period. They range from 0 to 2.65, with a value of zero meaning no change in the value in that cell. This also includes cells that have no flows which, while perhaps not adhering strictly to the spirit of fundamental as being urban-oriented expenditures, nevertheless are predictable and therefore cannot be ignored. The mean value is 0.67.

Those cells which exhibit little variability constitute the core or subsistence private consumption expenditure which does not change very much as the economy develops. They comprise to a large extent basic goods and services which are regarded as necessary for the average household. The more highly variable components of household expenditure, the non-fundamental components, reflect the changing conditions and environment of the economy, and would be affected by changing tastes and general level of economic performance. For example, if the economy enters a recessionary period, household expenditure will be affected at the periphery both in quantity and type of commodities purchased.

Figure 2 shows that animal industries (sheep and cattle) sales, and Ownership of Dwellings and Defence, exhibit almost no variation over the sample period. Many of the Manufacturing to Manufacturing inputs and manufacturing sales to Construction, Trade and Transport have relatively little variation, together with Community Services and Public Administration. Some elements in the Chemical industries sector are highly variable, as are isolated cells within Cereals, Other Agriculture and Forestry, but the variation in these latter three may be due to erratic climatic conditions, particularly the recurring El Nino effects which had devastating impacts on some regions. If we regard values less than the mean coefficient of variation as having relatively low variation, then 53.49 per cent of the flows associated with private consumption expenditure would fall into this category.

A similar analysis can be conducted for the other categories of final demand. For example, part of government and capital expenditure will be fundamental infrastructure and part non-fundamental infrastructure. The differences between the patterns arise from the different expenditure distributions in the respective final demand vectors, but will be dominated to a large extent by the **A** matrices. This implies that, irrespective of the type of final demand expenditure, there is a core component of the Australian economy which will exhibit relatively little variability over time. This core expands or contracts depending on the type of expenditure, for example, government capital expenditure has a marginally smaller fundamental component than private capital expenditure or public capital expenditure, but overall the landscapes are similar in terms of areas with very low variability and very high variability. [West (1997) presents landscape maps for each category of final demand]. It is only at the boundary between the fundamental and non-fundamental

Table 2. Number of Relatively Low Variation and/or Predictable Cells

Category	Number	Percent
Low Variation	237	24.7
Predictable	351	36.5
Low Variation and Predictable	274	28.5
Low Variation and/or Predictable	862	89.7
Not Low Variation or Predictable	99	10.3
Total	961	100.0

Note: Low Variation refers to flows with coefficient of variation less than mean value. Predictable refers to flows which are significant at 10% level.

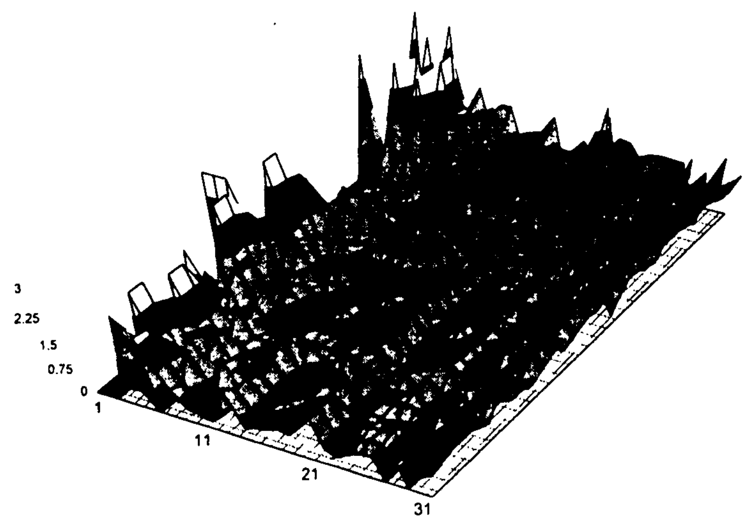

Figure 3. Total Expenditure Variability Landscape. Australia 1974-75 to 1992-93

regions that differentiation becomes fuzzy between the different categories of final demand expenditures.

This suggests that a clearer view of the total fundamental core may be obtained by considering the total flow matrix. As above, an indication of the variability of the flows across time is the coefficient of variation. Figure 3 gives the distribution of the coefficient of variation of each flow over the sample period. They range from 0 to about 2.83, with a mean of 0.752. Again selecting the mean value as a cut-off point, cells with a coefficient of variation less than 0.752 are regarded as having relatively low variation. Overall, 511 cells fall into this category, or 53.17 per cent of the total number of cells in the table. Comparing Figures 2 and 3 indicates a striking similarity between the landscapes. This reinforces the notion that the FES is largely dominated by the **A** matrix and to a lesser extent by the individual elements of final demand. This is due, in part, to changes in things such as supply, technology, relative prices and import substitution, which will all impact on the IO coefficients over time. This in turn will influence the temporal FES, and is one of the reasons why the **A** matrix has to be considered an important factor in addition to the final demand components.

The sector which has the least variable input structure is Food Manufacturing with 81.25 per cent of its intermediate inputs classified with low variability. Other sectors which rank highly in low input variability are Sheep and Meat Cattle, Forestry and Logging, Wood and Paper Manufacturing, Non-metallic Mineral Products, and Other Transport, each of which have two thirds or more of their intermediate inputs in this category. In terms of intermediate sales, Ownership of Dwellings and Defence are dominated by zero cells. In addition, Meat Cattle, Milk Cattle and Pigs, Sheep, Metals and Metal Products, Textiles, Clothing and Footwear, Wood and Paper Manufacturing, Food Manufacturing, Machinery, Appliances and Equipment, and Trade all have two thirds or more of their intermediate outputs classified as having low variability. Communication and Recreational and Personal Services show the highest volatility in both inputs and outputs over the 18 year period.

The primary aspect which characterises the FES is predictability. One possibility for determining the predictable cells is to follow the procedure outlined in Jensen *et al.* (1988) in which transactions flows in each cell were regressed against corresponding sectoral output. In this study, a time trend was also included. These equations were estimated for the first eight tables 1974-5 to 1992-3. At the 5 per cent significance level, 566 or 58.9 per cent of the equations (cells) were significant, while 625 or 65.0 per cent were significant at the 10 per cent level.

Combining both factors, low variability and predictability, gives a picture of the total FES, as shown in Table 2. Of the 961 intermediate cells in the table, 237 (24.7 per cent) were classified as having low variability, 351 (36.5 per cent) as predictable (at the 10 per cent significance level), and 274 (28.5 per cent) as being both low variable and predictable. Thus 862 (89.7 per cent) of the cells can be regarded as having relatively low variability and/or being predictable, comprising the total FES. The remaining cells (99 or 10.3 per cent) are therefore classified as non-fundamental.

Table 3 gives the sectoral breakdown of relatively low variation and/or predictable cells. Sheep, Other Mining, Food Manufacturing, Gas and Water, and Finance and Business Services each have all their inputs classified as fundamental. Metals and Metal Products, Electricity, Gas and Water, Trade, Finance and Business Services, Ownership of Dwellings, and Defence show a similar pattern for their outputs. Figure 4 provides a map of the relatively low variation and predictable cells over the eight tables.

Using these results, we can attempt to predict the intermediate flow matrix of the 1993-94 IO table. Those cells which were predictable at the 10 per cent level were estimated using the corresponding regression equation. Cells which exhibited no variability were simply estimated by this value. In this exercise, cells which are not predictable or constant (the non-fundamental cells) were also estimated using regression equations, even though they were not significant. It was assumed that gross outputs are known, as are primary inputs and final demands. These can generally be estimated from a variety of published data sources. Data on intermediate flows, on the other hand, is rarely available, which explains why numerous mechanical procedures such as location quotients have been suggested in the literature for estimating them.

After the intermediate flow matrix was estimated in this way, the table was balanced to the correct intermediate totals using the biproportional RAS procedure. This provides an estimate of $\mathbf{T}_F$ in equation (7). The predicted 1993-94 table was then compared with the true table, as was the total requirements (direct and indirect) matrix and output multipliers. The results are given in Table 4. The measures of deviation between the estimated and true values used are the mean deviation (MD), mean absolute deviation (MAD), mean percentage error (MPE), mean absolute percentage error (MAPE) and root mean square error (RMSE). While the MPE for the direct requirements matrix (and transactions flow matrix) was quite large (-94.206 per cent), this is reduced to -2.9972 per cent for the total requirements matrix, demonstrating the inbuilt 'error correcting' capability of the IO model to coefficient errors.

Table 5 lists the true and predicted output multipliers. The largest error is 0.024 or 1.78 per cent, with a mean error of 0.0002 or 0.0319 per cent. In all sectors the predicted multiplier values are correct to at least one decimal place and most to two decimal places. As expected, the mean error is positive because of the positive skewness introduced into the multiplier distribution by coefficient errors (West, 1986). These results strongly indicate the existence of a temporal FES, at least in a holistic sense.

Table 3. Number of Relatively Low Variation and/or Predictable Cells by Sector

Sector	Inputs				Outputs			
	Low Variation	Predictable	Low Variation and Predictable	Low Variation and/or Predictable	Low Variation	Predictable	Low Variation and Predictable	Low Variation and/or Predictable
1	10	10	11	31	25	2	0	27
2	9	5	12	26	29	0	1	30
3	9	6	9	24	28	0	1	29
4	10	5	10	25	15	6	3	24
5	6	14	8	28	3	11	9	23
6	15	6	6	27	4	16	6	26
7	7	20	1	28	10	9	3	22
8	8	13	9	30	3	11	5	19
9	9	13	9	31	2	11	8	21
10	6	5	20	31	4	7	17	28
11	7	6	11	24	7	6	16	29
12	6	9	15	30	1	7	21	29
13	4	9	10	23	2	10	17	29
14	7	8	14	29	1	18	7	26
15	7	10	12	29	4	7	20	31
16	8	9	12	29	7	9	14	30
17	6	13	8	27	3	12	15	30

Table 3 (contd). Number of Relatively Low Variation and/or Predictable Cells by Sector

Sector	Inputs				Outputs			
	Low Variation	Predictable	Low Variation and Predictable	Low Variation and/or Predictable	Low Variation	Predictable	Low Variation and Predictable	Low Variation and/or Predictable
18	9	8	5	22	2	14	15	31
19	8	18	5	31	3	15	13	31
20	7	10	12	29	0	28	1	29
21	9	9	11	29	7	7	10	24
22	8	9	10	27	1	10	20	31
23	11	12	4	27	3	9	8	30
24	12	7	9	28	1	11	18	30
25	7	21	0	28	0	26	4	30
26	6	19	6	31	1	19	11	31
27	6	12	6	24	31	0	0	31
28	6	19	4	29	2	22	4	28
29	6	17	4	27	31	0	0	31
30	4	10	15	29	5	12	6	23
31	4	19	6	29	2	26	1	29

Note: Low Variation refers to flows with coefficient of variation less than mean value.
Predictable refers to flows which are significant at 10% level.

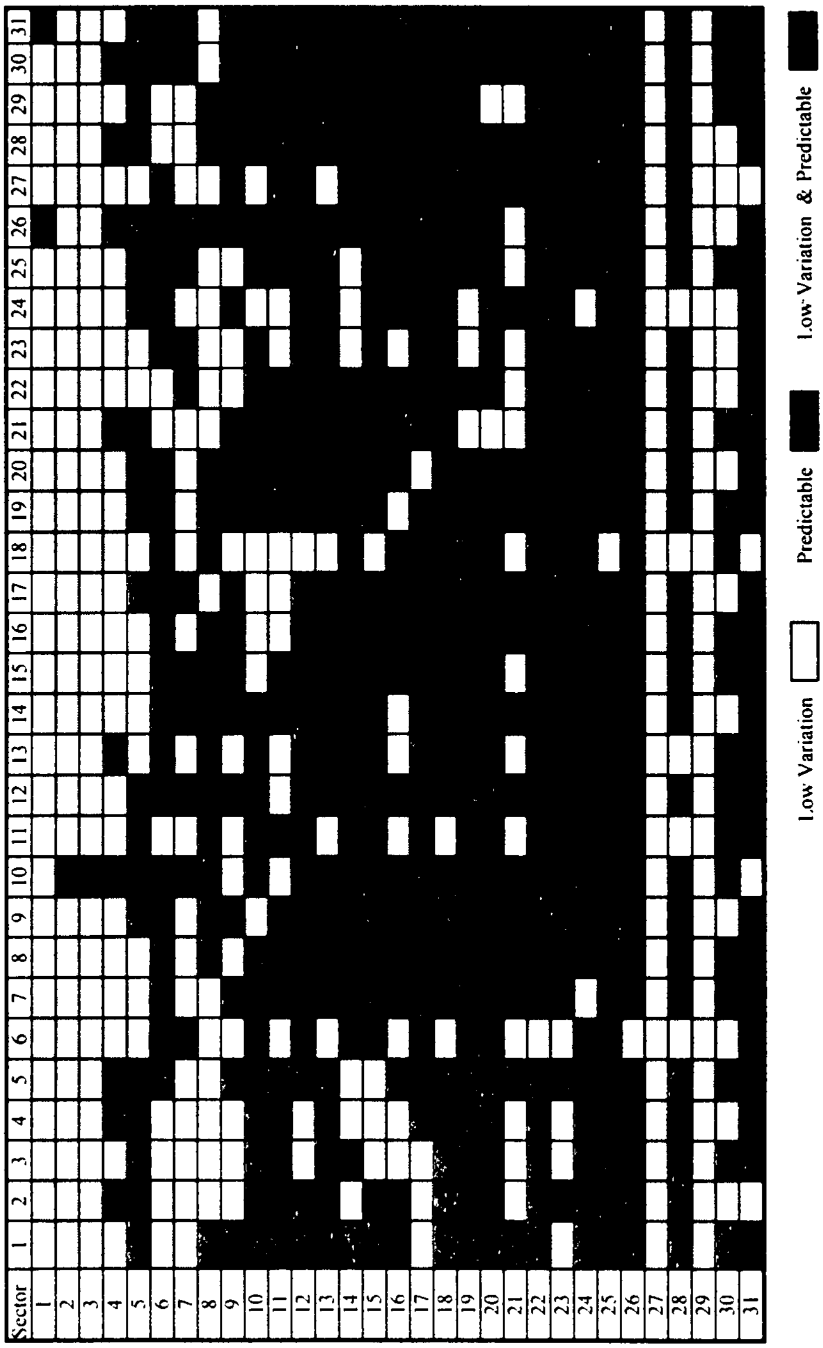

Figure 4. Relatively Low Variation and Predictable Cells. Australia 1974-75 to 1992-93

Table 4. Measures of Deviation Between True and Predicted Matrices and Multipliers with No Superior Data, Australia 1993-94

Variable	MD	MAD	MPE	MAPE	RMSE
Direct Requirements Matrix	0.0000	0.0028	-94.2060	127.3998	0.0075
Total Requirements Matrix	0.0000	0.0033	-2.9972	18.4841	0.0086
Output Multipliers	0.0002	0.0058	0.0319	0.3475	0.0077

MD: Mean Deviation
MAD: Mean Absolute Deviation
MPE: Mean Percentage Error
MAPE: Mean Absolute Percentage Error
RMSE: Root Mean Square Error

In the above case, the entire intermediate flow matrix for the 1993-94 table has been estimated from the eight other tables, based just on the fundamental tier. If the values in those cells which are not constant or predictable are replaced with their true values, so that the predicted flow matrix is made up of the estimated fundamental core cells and true values of the non-fundamental cells, the comparative statistics between this table and the true table are given in Table 6. A comparison of Tables 4 and 6 indicates the results are mixed, but as expected, the errors in the direct requirements and total requirements matrices are smaller with the inclusion of superior data in the non-fundamental cells. In terms of the output multipliers, however, the evidence is less conclusive and, based on a comparison of Tables 5 and 7, there would be little to gain from using limited resources to collect superior data for non-fundamental cells if multiplier estimation were the main goal of the exercise. If, however, the concern was for partitive accuracy, it is clearly a different story and further research is required in this area (see Jensen (1980) for a discussion of the differences between partitive and holistic accuracy).

The above analysis has been undertaken in transactions terms. It is possible to perform similar analyses in terms of other variables which would provide an additional dimension to the identification of the FES sets and the process of structural change. For example, repeating the analysis in employment values would yield insights into relative labour productivity changes. Initial investigations indicate that the changes which have occurred in employment are significantly different from those which have occurred in transactions flows. Overall, employment has been much less variable over the period, with a much larger proportion of cells being classified as fundamental.

Table 5. True and Predicted Output Multipliers with No Superior Data, Australia 1993-94

Sector	True Value	Predicted Value	Deviation	% Deviation
1	1.69	1.69	0.00	0.02
2	1.68	1.69	-0.01	-0.31
3	1.97	1.98	-0.01	-0.43
4	1.74	1.75	-0.01	-0.46
5	1.65	1.64	0.00	0.16
6	1.71	1.72	-0.01	-0.62
7	1.84	1.85	-0.01	-0.61
8	1.36	1.36	0.00	0.06
9	1.79	1.80	0.00	-0.24
10	2.25	2.24	0.00	0.20
11	1.83	1.83	0.00	0.25
12	1.76	1.75	0.00	0.12
13	1.79	1.78	0.01	0.73
14	1.96	1.97	-0.01	-0.50
15	2.09	2.09	0.00	0.09
16	1.79	1.79	0.00	0.07
17	1.85	1.85	0.00	0.09
18	1.38	1.37	0.01	0.41
19	1.35	1.33	0.02	1.78
20	1.91	1.92	-0.01	-0.52
21	1.74	1.76	-0.01	-0.77
22	1.64	1.63	0.00	0.07
23	1.36	1.35	0.01	0.61
24	1.67	1.66	0.01	0.47
25	1.44	1.43	0.00	0.11
26	1.52	1.52	0.00	-0.03
27	1.40	1.39	0.00	0.23
28	1.84	1.85	0.00	-0.15
29	2.02	2.01	0.01	0.42
30	1.32	1.32	0.00	-0.21
31	1.71	1.71	0.00	-0.05

Note: Rounding occurs

Table 6. Measures of Deviation Between True and Predicted Matrices and Multipliers with Superior Data in Non-Fundamental Cells, Australia 1993-94

Variable	MD	MAD	MPE	MAPE	RMSE
Direct Requirements Matrix	0.0000	0.0024	-9.6806	27.4393	0.0067
Total Requirements Matrix	0.0000	0.0029	-1.3464	15.0397	0.0076
Output Multipliers	0.0006	0.0053	0.0574	0.3211	0.0073

MD: Mean Deviation
MAD: Mean Absolute Deviation
MPE: Mean Percentage Error
MAPE: Mean Absolute Percentage Error
RMSE: Root Mean Square Error

4. CONCLUSION

The analysis supports the view that an identifiable temporal economic structure exists in the Australian economy. At the centre is a set of bonded core elements which, within itself, is undergoing a coherent development path. At the same time, at the periphery, non-fundamental activities define the patterns of structural change which are occurring, but which rest on the platform of fundamental core elements and without which could not exist. Furthermore, there is strong evidence to suggest that this structure is holistically predictable within an economy over time.

The notion of a fundamental structure is conceptually attractive and sufficiently general to be implemented across both spatial and temporal dimensions, and provides an additional insight into the characteristics of structural differences and change. The concept lends itself to the theoretical and empirical framework of input-output and should complement other more traditional techniques of analysis. It also provides a useful additional dimension for table construction and projecting/ updating methodologies, complementing the methodologies suggested by West (1981, 1990) and Lahr (1998).

This study is only an exploratory excursion into the existence of a temporal FES, and raises more questions than it answers. For example, whilst the **A** matrix appears dominant, the distributions of final demand components must affect the tiers to some extent. Thus the forecasting procedures may be able to be refined by disaggregating the cell components into their relative contributions to final demand. The use of minimum requirements techniques may also complement the procedures used in this paper. Then there is the question of stability of coefficients. There is much evidence of research done in this area in the literature, albeit from a different viewpoint. This issue has not been addressed in this paper, but expanding the FES concept to encompass stability, variability and predictability would enrich the notion and identification of a fundamental structure.

Table 7. True and Predicted Output Multipliers with Superior Data in Non-Fundamental Cells, Australia 1993-94

Sector	True Value	Predicted Value	Deviation	%Deviation
1	1.69	1.68	0.00	0.17
2	1.68	1.69	-0.01	-0.37
3	1.97	1.98	-0.01	-0.29
4	1.74	1.75	0.00	-0.21
5	1.65	1.64	0.00	0.15
6	1.71	1.71	0.00	-0.03
7	1.84	1.85	-0.01	-0.66
8	1.36	1.36	0.00	-0.04
9	1.79	1.80	0.00	-0.19
10	2.25	2.24	0.00	0.21
11	1.83	1.83	0.00	0.24
12	1.76	1.75	0.00	0.19
13	1.79	1.78	0.01	0.57
14	1.96	1.97	-0.01	-0.56
15	2.09	2.09	0.00	0.08
16	1.79	1.79	0.00	0.10
17	1.85	1.85	0.00	0.02
18	1.38	1.37	0.01	0.63
19	1.35	1.33	0.02	1.69
20	1.91	1.92	-0.01	-0.55
21	1.74	1.76	-0.01	-0.79
22	1.64	1.63	0.00	0.06
23	1.36	1.35	0.01	0.59
24	1.67	1.66	0.01	0.42
25	1.44	1.43	0.00	0.13
26	1.52	1.52	0.00	-0.03
27	1.40	1.39	0.00	0.24
28	1.84	1.85	0.00	-0.18
29	2.02	2.01	0.01	0.37
30	1.32	1.32	0.00	-0.18
31	1.71	1.71	0.00	0.00

Note: Rounding occurs

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