STRUCTURAL CHANGE IN THE QUEENSLAND ECONOMY: AN INTERINDUSTRY ANALYSIS

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This paper attempts a tentative analysis of the structural changes which have occurred in the Queensland economy over the last two decades. An extended form of linkage analysis is used to provide a picture of the changing economic landscape. The data used is a series of input-output tables constructed for the period 1973-4 to 1992-3. The Queensland economy has followed a rapid development path, and continues to grow strongly, yet the evidence suggests that rather than increasing internal complexity, a hollowing out process has begun. The contributing factors appear to be the rapid transition from mainly primary activities to tertiary with the fabricative manufacturing stage largely being overpassed, together with significant - improvements in labour productivity, resulting in a greater level of outsourcing of inputs into the productive system than would otherwise be the case with a well developed manufacturing base. Increased globalisation will speed up the hollowing out process which has significant policy implications for Queensland.

1. INTRODUCTION

Economists have long been intrigued by questions of economic structure. Over time we would expect to observe a process of structural change manifest itself in increasing complexity and increasing levels of economic interdependence. This implies that there is more to observing structural change than macro indicators can provide. Although we have information concerning the inputs and outputs from various productive activities, it is difficult to gauge how the strength and nature of the connectedness of economic structure has changed over time. For this we need to delve into the internal organisation of the economy.

The search for tools to classify and analyse structures invariably involves the concept of 'connectedness', which indicated the extent to which an economy 'churns' and the mechanisms involved in this process. Studies of connectedness thus generally revolve around interindustry models, the most common of these being the input-output model[1]. The input-output model can be viewed as an

[1] There are numerous texts on the theory of input-output. Two highly recommended texts are Miller and Blair (1985) and Bulmer-Thomas (1982).

equilibrium construct at a point in time, and the goal of analysing structural change is to identify how this equilibrium shifts over time.

The study of the tree called economic structure has many branches. At the lowest level, input-output 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. More sophisticated techniques of analysis include traditional multiplier analysis, ordering of sectors, pattern analysis, triangulation, and other holistic measures of connectedness (Hewings, Jensen and West, 1987), inverse sensitivity analysis (West, 1882), and industry significance analysis (Groenewold, *et al.*, 1993), 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.*), shift-share (Jensen, *et al.*, 1990), fundamental economic structure (Jensen, *et al.*, 1991) and minimal flow analysis (Schnabl, 1994).

This paper draws from a branch called linkage and key sector analysis to study the structural evolutionary changes which have occurred in the Queensland State economy over the twenty year period 1973-4 to 1992-3 using a series of five input-output tables. The 1973-4 and 1978-9 tables were constructed by research teams at the University of Queensland and the 1985-6, 1989-0 and 1992-3 tables were constructed by the Queensland Government Statistician's Office. The tables have been aggregated to a common sectoral classification as given in Table 1 and form a consistent accounting framework of basic values with direct allocation of imports.

TABLE 1

INDUSTRY SECTOR CLASSIFICATION

No.	Name	No.	Name
1	Animal Industries	12	Electricity
2	Other Agriculture	13	Gas and Water
3	Forestry and Fishing	14	Building and Construction
4	Coal, Oil and Gas Mining	15	Trade
5	Other Mining	16	Transport
6	Food Manufacturing	17	Communication
7	Wood and Paper Manufacturing	18	Finance and Business Services
8	Machinery, Appliances and Equipment	19	Public Administration and Defence
9	Metals, Metal Products	20	Community Services
10	Non-metallic Mineral Products	21	Recreation and Personal Services
11	Other Manufacturing		

2. OVERVIEW OF THE QUEENSLAND ECONOMY, 1973-4 TO 1992-3

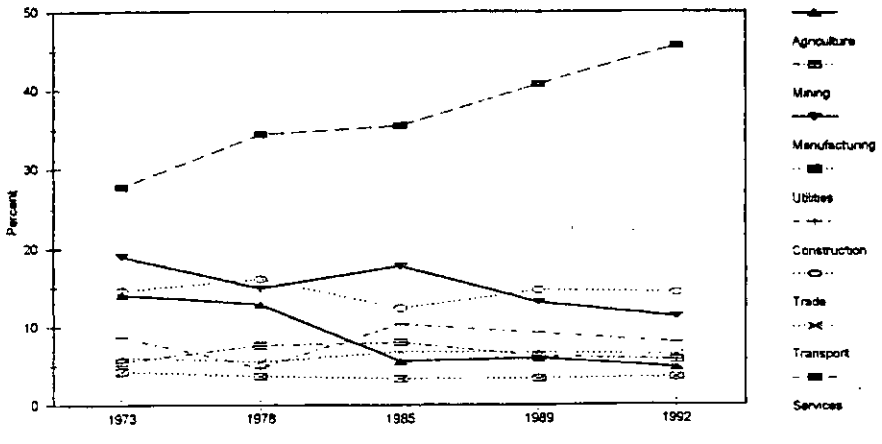
Over the period 1973 to 1992, Queensland experienced rapid economic growth, with Gross State Product increasing approximately 2.5 fold in real terms and employment increasing 1.7 times. Yet we do not have a clear picture of how its economic structure has changed. There are, however, a few clues.

Queensland has traditionally been regarded as a primary/rural economy and it is only in recent years that this label has been aggressively contested. In 1973-4, agricultural production accounted for 14 per cent of Gross State Product. This has gradually decreased, as demonstrated in Figure 1, and in 1992-3 agriculture accounted for less than 5 per cent of Gross State Product, although prolonged drought conditions aggravated the decline. In common with what has been observed in developing economies around the world, there has been a progressive shift from primary and manufacturing to service activities over time. Primary activity, defined here as comprising all Agriculture, Forestry, Fishing and Mining, decreased from 19.6 per cent of Gross State Product in 1973-4 to 10.6 per cent in 1992-3. Manufacturing also experienced a decline from 19 per cent to 11.3 per cent of Gross State Product over the period. Service activities, on the other hand, comprising Communication, Finance, Public Administration, Community Services and Recreation, increased from 27.7 per cent of Gross State Product in 1973-4 to 45.7 per cent in 1992-3. Trade, Transport, Utilities (Electricity, Gas and Water) and Construction activity remained relatively constant over the period.

These trends are also reflected in other economic indicators. Figure 2, for example, shows that employment in the Primary sectors dropped from 13.8 per cent of total State employment in 1973-4 to 9 per cent in 1992-3. Manufacturing from 17.2 per cent to 12.7 per cent, while the Service sectors increased their proportion of total State employment from 31.1 per cent to 42.8 per cent. However, this apparent decline in Primary production is not as simple as it appears on the surface.

FIGURE 1

PERCENTAGE SHARES OF GROSS STATE PRODUCT

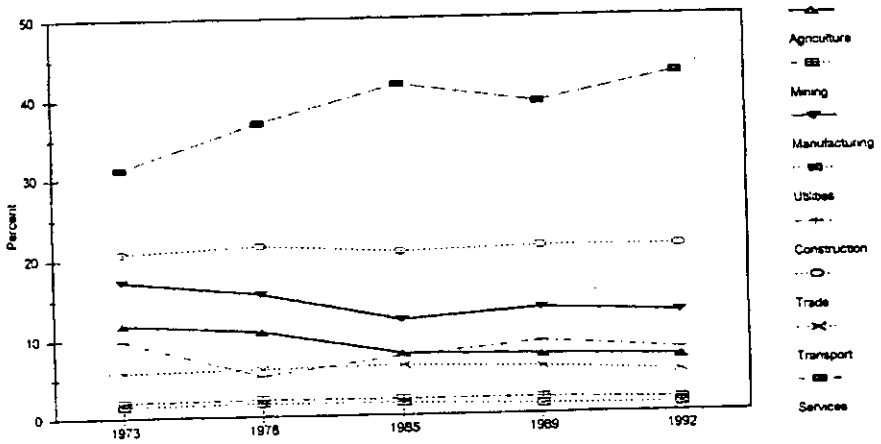


While Agriculture has certainly suffered significant losses, from 11.8 per cent to 7.2 per cent, this has been offset to some degree by Mining, in particular Coal which is a major export commodity for the State. As a proportion of foreign State exports, coal exports increased from 14 per cent in 1973-4 to 37 per cent in 1992-3, compared with the decrease from 22.3 per cent to 7.7 per cent for agricultural products.

While some might argue that these figures show that Queensland is a good example of successful economic development of an economy which has little in the way of a comparative advantage in traditional manufacturing industries, the question remains, has the growth of the Queensland economy been associated with growth in the complexity and durability of its structure? The former should manifest itself in growing numbers of structural linkages and internal trading interactions. The durability of the process of economic development should also manifest itself in an increase in structural linkages which connect 'core' components in a bonded, or interdependent, manner, providing a platform upon which further economic development on the periphery of the economy can proceed. Traditional analysis of sector shares does not provide this information. It simply provides an indication of trends. To answer these questions, we need to delve deeper into the internal workings of the economy. Linkages and key sector analysis provides one avenue which attempts to catch a glimpse of this inner sanctum.

FIGURE 2

PERCENTAGE SHARES OF EMPLOYMENT



3. STRUCTURAL LINKAGES AND KEY SECTORS

The concept of key sectors is generally regarded as initially being conceived with the work of Rasmussen (1956) and Hirschman (1958). Central to the concept of key sectors is the notion of backward and forward linkages. The aim of linkage analysis is to measure the potential stimulus to other activities from investment in any sector, and to identify those sectors which create an above average stimulus to the rest of the economy.

In an n-sector economy at time t, the backward linkage index for sector j is defined as

$$L_{jt} = \frac{n \sum_i b_{ijt}}{\sum_i \sum_j b_{ijt}} \tag{1}$$

where $[b_{ijt}] = B_t = (I - A_t)^{-1}$ and $\mathrm{At} = [\alpha_{ijt}/X_{jt}]$ is the input coefficient matrix, where x_{ijt} is the value of goods and services purchased from industry i in order to produce a total value of production in sector j of X_{jt} in time period t. B is termed the input inverse, or Leontief inverse. The numerator in L_{jt} is essentially an output multiplier and denotes the average stimulus imparted to other sectors by a unit's worth of demand for sector j's output. In order to make comparisons between sectors, a normalisation procedure is carried out by dividing by the average stimulus to the whole economy when all sectors' final demands are increased by unity. If $L_j > 1$, investment in sector j yields above average multiplier effects, while if $L_j < 1$, investment in sector j produces below average backward linkages.

These linkages can be disaggregated across the n input sectoral components as

$$L_{ijt} = \frac{n b_{ijt}}{\sum_i \sum_j b_{ijt}} \tag{2}$$

where $L_{jt} = \sum_i L_{ijt}$, which provides information on the distributional effects of the initial investment stimulus across the n sectors in the economy. A useful dichotomy of disaggregated linkage effects is the *self* and *non-self* contributions. In the former, changes in output can be traced to intrasectoral changes within the industry itself, while in the latter the changes impact on other sectors. The self linkage component is thus defined as

$$L_{jt}(S) = \frac{n b_{ijt}}{\sum_i \sum_j b_{ijt}} \tag{3}$$

which includes the initial unit investment, and non-self component as

$$L_{jt}(N) = \frac{n\sum_{i \neq j} b_{ijt}}{\sum_i \sum_j b_{ijt}} \tag{4}$$

and where $L_j = L_j(S) + L_j(N)$.

Selecting sectors with a high index on its own is insufficient for planning purposes, since only one or two sectors may stand to gain from the stimulus. Ideally, we require any stimulus to sector j to spread as widely as possible throughout the economy. A measure of this backward spread is the coefficient of variation

$$CV_{jt} = \frac{\sqrt{\frac{1}{n-1}\sum_i (b_{ijt} - \frac{1}{n}\sum_i b_{ijt})^2}}{\frac{1}{n}\sum_i b_{ijt}} \tag{5}$$

Normalising gives the backward spread index

$$V_{jt} = \frac{nCV_{jt}}{\sum_j CV_{jt}} \tag{6}$$

A low V_j means that investment in sector j would stimulate a large number of other sectors, while a high V_j indicates the stimulus would only have localised effects. A *key* backward sector is defined as one which has both a high backward linkage index and a low spread index.

Backward linkages only provide part of the story. Backward linkages provide information on the effects of investment in a given industry on upstream activities in a demand driven sense, i.e. through increased demands for other sector inputs. But what about downstream activities? The increased output in sector j may alleviate bottlenecks to supply to other industries which can in turn increase production, or alternatively all the increased output may be exported. To measure the effect of investment in sector j on these downstream activities, forward linkages and spread effects can be calculated.

The basic idea of forward linkages is to trace the output increases which occur or might occur in using industries when there is a change in the sector supplying inputs, in contrast to backward linkages which trace the output increases which occur in supplying industries when there is a change in the sector using its products as inputs. The forward linkage index for sector i at time t is defined as

$$\vec{L}_{it} = n \frac{\sum_j \vec{b}_{ijt}}{\sum_i \sum_j \vec{b}_{ijt}} \tag{7}$$

where $\left[\vec{b}_{ijt}\right] = \vec{B}_t = \left(I - \vec{A}_t\right)^{-1}$

and $\vec{A}_t = \left[\vec{\alpha}_{ijt}\right] = \left[x_{ijt} / X_{it}\right]$

is the output coefficient matrix at time t, calculated by dividing the transactions flows by total outputs. $\vec{B}$ is the output inverse, as defined in the supply-side model. Disaggregated forward linkages can be constructed in a similar manner to the disaggregated backward linkages.

The forward linkages are now defined in terms of input multipliers, which measure the effect on total output of all sectors associated with a unit change in the primary inputs of sector i. For example, we may want to decide where to place an additional investment in primary factors (labour or capital) so that it would be most beneficial to the total economy, in terms of potential for supporting expanded output.

The forward spread index is given by

$$\vec{V}_{it} = n \frac{\vec{CV}_{it}}{\sum_i \vec{CV}_{it}} \tag{8}$$

where

$$\vec{CV}_{it} = \frac{\sqrt{\frac{1}{n-1}\sum_j \left(\vec{b}_{ijt} - \frac{1}{n}\sum_j \vec{b}_{ijt}\right)^2}}{\frac{1}{n}\sum_j \vec{b}_{ijt}} \tag{9}$$

To provide a balanced picture of the significance of a sector on the economy wide picture, both backward and forward linkages need to be considered. It makes sense to define a *key* sector as one which exhibits both high backward and forward linkage indexes and low bakcward and forward spread indexes.

Collect the backward linkage indexes at time t in the n-element row vector L_t, and the forward linkage indexes in the n-element column vector $\vec{L}_t$. Define the Linkage Product Matrix as

$$M_t = \vec{L}_t L_t \tag{10}$$

The elements of M are uniquely associated with each combination of backward and forward linkage indices; large elements will be associated with large backward and forward linkages, and small elements will be associated with small backward and forward linkages. In graph theoretic terms, the matrix depicts an economic landscape of linkages which will highlight the strengths and weaknesses of the economic interactions between sectors.

To completely identify the key sectors, we also need to take into account the spread indices. Noting that the man of the spread indices in unity, an adjusted set of indices symmetric to the original set about unity can be constructed by

$$U_i = 2i^I - V_i \tag{11}$$

and

$$\vec{U}_i = 2i - \vec{V}_i \tag{12}$$

where V_i is the n-element row vector of backward spread indices, $\vec{V}_i$ the n-element colunmn vector of forward spread indices, and i denotes an n-element column vector of ones. Now, unlike V_i and $\vec{V}_i$ which ideally should be small, we want U_j and $\vec{U}_i$ to be large to maximise the spread effects of a stiumulus to sector j. The companion matrix to M, termed the Spread Product Matrix, is now defined as

$$S_i = \vec{U}_i U_i \tag{13}$$

from which Key Sector matrix can be constructed

$$K_i = M_i \times S_i$$

where $\times$ denotes an element by element product.

4. LINKAGE ANALYSIS OF THE QUEENSLAND ECONOMY

The key sector matrix provides a unique insight into the underlying structural core and highlights the key interactions in terms of their contribution to the direct and indirect flow-ons to the rest of the economy. Large elements reflect strong interconnections and indicate sectoral links which form a fundamental bonded core of the economy.

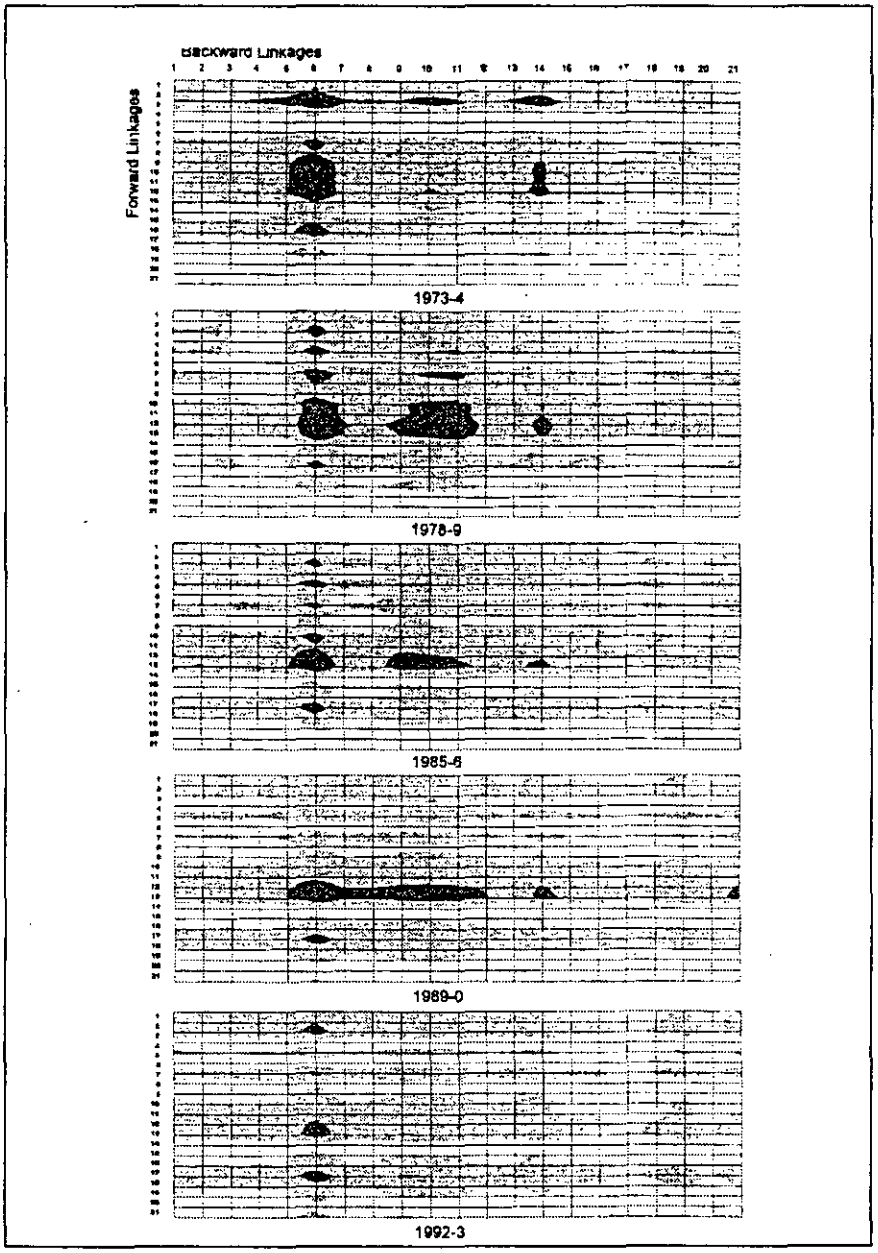
The K matrix exhibits some interesting properties and can be analysed and depicted in a number of ways. For example, all the rows are proportional to each other and similarly for the columns. The matrix can therefore be rank-sorted by both rows and columns to provide a hierarchial picture of key sectors. In this paper, a simpler approach is taken. For the five time periods under consideration, the K matrix is depicted as a contour map which provides a clear visual representation of the similarities and differences in the linkage structure of the Queensland economy over the twenty year time span. These are given in Figure 3.

In each of the maps, darker shading represents stronger linkages. Intersectoral links are defined by the intersection of grid lines with the columns representing backward linkages and the rows forward linkages. Thus, in 1973-4 for example, Food Manufacturing (sector 6) has the strongest backward linkages in terms of direct and indirect inputs into Food Manufacturing, and Forestry and Fishing (sector 3) has the strongest forward linkages in terms of other industry uses, both directly and indirectly, for Forestry and Fishing products. Building and Construction (sector 14) ranks as the second most significant sector in terms of backward linkages in 1973-4.

Over the twenty year time span, Food Manufacturing remains the first ranked key sector for backward linkages. Sectors which have dropped in ranking as backward linkage key sectors include Construction (from 2 to 3), Non-metallic Mineral Products (3 to 5), Other Mining (4 to 12), Machinery (6 to 10) and Coal

FIGURE 3

KEY SECTOR MAPS, QUEENSLAND



Mining (8 to 9). Sectors which have risen in ranking include Other Manufacturing (from 5 to 4), Animal Industries (9 to 6), Public Administration (11 to 7), Metal Products (13 to 2) and Recreation (16 to 8).

It is clear from comparison of the maps in Figure 3 that a thinning process has occurred within the economy, with the contour landscapes appearing less dense over time. This is clearly seen by reference to Table 2 which shows the percentage of key sector indices of value 1 or less increasing from 48.1 per cent in 1973-4 to 53.5 per cent in 1992-3, and the percentage greater than 1 decreasing from 51.9 per cent to 46.5 per cent. The largest key sector index has progressively fallen over the period from 3.708 in 1973-4 to 2.581 in 1992-3.

TABLE 2

KEY SECTOR MATRIX CHARACTERISTICS, QUEENSLAND 1973 – 1992

Interval	Relative Frequency (percent)				
	1973-4	1978-9	1985-6	1989-0	1992-3
>0 - 1	48.1	51.9	51.5	50.6	53.5
>1 - 2	45.4	41.3	43.8	44.9	44.2
>2 - 3	6.3	6.6	4.5	4.5	2.3
>3 - 4	0.2	0.2	0.2	0	0
Maximum	3.708	3.164	3.032	2.955	2.581

This apparent decline in density in a developing economy is not a unique observation. Okazaki (1989) noted a similar phenomenon in the Japanese economy, a procedure he referred to as a "hollowing out" effect. He likened the process to scooping out the inside of a large fruit; the size of the fruit remained the same but its density decreased, an analogy to the loss of flows between sectors within the intermediary part of the economy. Hewings *et al.* (1996) observed a similar trend in the Chicago economy. In essence, the suggested hypothesis in that the evolutionary path of the economy is as described in Figure 4.

Traditional ideas suggest that the growth process is logistic, with a slow initial accumulation of intersectoral flows (Stage I) before a take-off into an accelerated period of growth (Stages II and III). As the economy reaches maturity, the deepening of the interactions slows down (Stage IV); the growth in tertiary activity accompanied by the decline in the manufacturing base sees the economy outsourcing more and more for its material requirements. However, rather than monotonically increasing at a decreasing rate, the internal density begins to decline as the level of dependence on local purchases and sales decreases[2].

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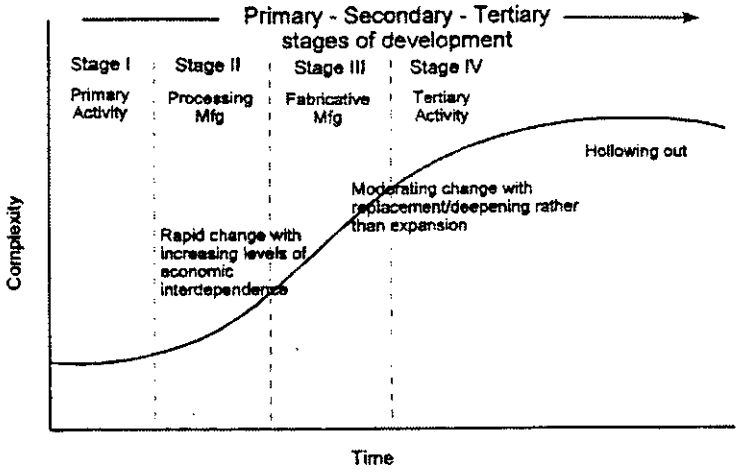
2 Note that Figure 4 does not preclude the possibility of parallel expansion in more than one stage. Rather, it is simply meant to indicate that one type of activity will tend to dominate the other activities.

FIGURE 4

STAGES OF ECONOMIC DEVELOPMENT



The evidence suggests that the transition from Stage I to Stage IV in the case of Queensland has been extremely rapid, that the fabricative manufacturing phase may have been largely bypassed and that we are now in the early stages of tertiary development. This would explain the decrease in density which would normally be associated with growth in the secondary sector.

A more detailed inspection of the linkage and spread indices shows that the service sectors consistently have lower spread indices than manufacturing; in other words, their effects are more localised and not spread as widely across the economy. While the economy may be expanding if measured in gross output figures, the intermediate linkages will continue to weaken as Stage IV becomes the dominant stage. The shift from manufacturing to services will tend to be associated with, and accelerate, a hollowing out of the economy.

Further evidence to support the hollowing out hypothesis in the Queensland economy can be seen in Figure 5 which shows total direct and direct plus indirect requirements coefficients. The curves show a remarkable similarity to the early stages of Figure 4, with accelerated growth occurring between 1978 and 1989 but slowing between 1989 and 1992. Moreover, the direct and indirect requirements are slowing faster than the direct requirements (growth rates of 6.4 per cent, 14.1 per cent and 4.9 per cent respectively for 1978-1985, 1985-1989 and 1989-1992 for direct requirements, compared to 2.3 per cent, 6.5 per cent and 3.1 per cent for direct and indirect requirements), which indicates a definite thinning of the indirect intersectoral core which is a leading indicator of the internal complexity of the economy.

FIGURE 5

TOTAL INTERMEDIATE REQUIREMENTS, QUEENSLAND 1973 – 1992

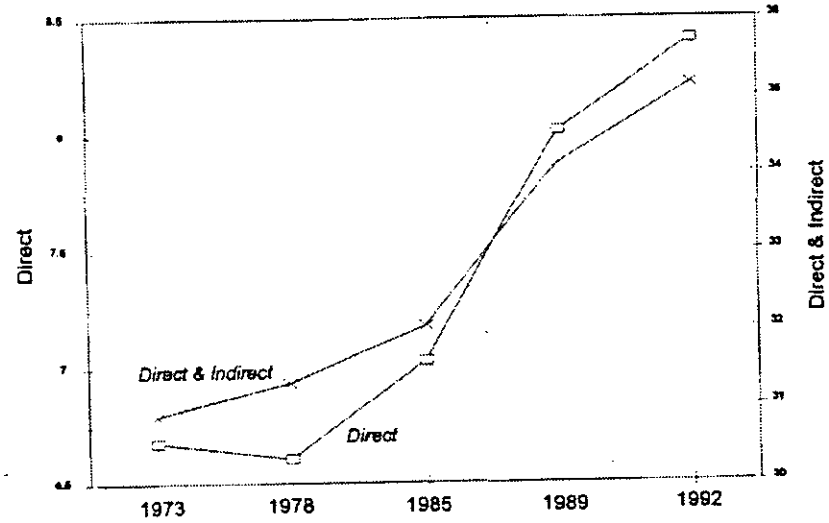


FIGURE 6

CHANGE IN SECTORAL SHARES, QUEENSLAND 1973 – 1992

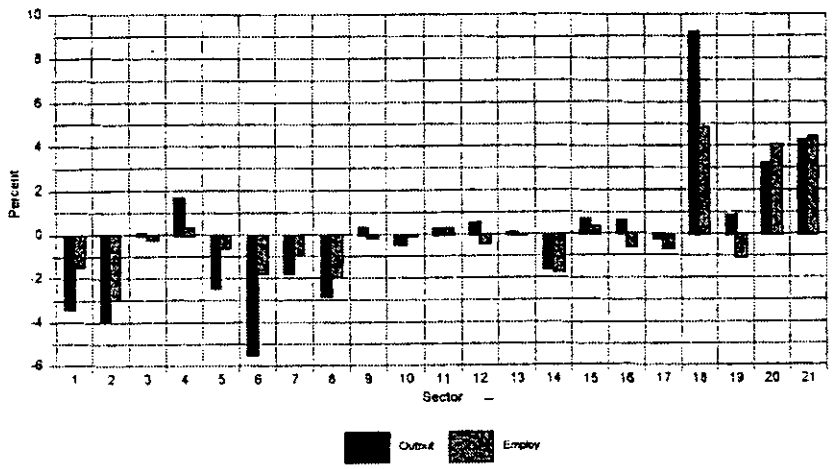


Table 3 gives the sectoral percentage changes in direct and direct plus indirect requirements over the sample period. Except for Other Mining, Food Manufacturing, Wood and Paper Products, Machinery, Construction, Communication and Community Services, all the other sectors' direct and indirect inputs grow at a slower rate than direct inputs. In other words, the backward linkages in these sectors have not kept pace with direct purchases. A similar story can be told with respect to the forward linkages.

TABLE 3

PERCENTAGE CHANGE IN INTERMEDIATE INPUTS AND OUTPUTS, QUEENSLAND 1973 – 1992

Sector	Intermediate Inputs		Intermediate Outputs	
	Direct	Direct & Indirect	Direct	Direct & Indirect
Animal Industries	44.7	15.4	25.5	15.7
Other Agriculture	16.4	9.1	-0.9	6.1
Forestry & Fishing	23.4	10.9	-28.1	-16.3
Coal Mining	23.3	12.8	66.6	14.5
Other Mining	-4.8	3.6	602.3	108.0
Food Mfg	-5.2	5.1	87.8	10.0
Wood,Paper Mfg	4.5	5.9	21.2	11.1
Machinery	0.4	5.9	-39.4	-14.7
Metal Products	57.3	29.0	-25.5	-13.6
Non-metallic Products	15.8	12.0	11.3	5.8
Other Mfg	37.1	18.9	-17.0	-7.0
Electricity	196.6	58.1	20.6	44.2
Gas & Water	8.4	7.7	109.7	65.0
Construction	2.1	6.0	-65.2	-13.0
Trade	29.2	11.0	-34.3	-11.8
Transport	9.8	4.8	-27.0	-9.4
Communication	-2.6	0.0	1792.8	114.2
Finance	66.3	20.8	91.7	32.5
Public Administration	84.1	34.6	91919.7	73.4
Community Services	-17.6	-2.1	28.1	1.6
Recreation	98.6	32.0	968.1	42.8
All Industries	25.8	13.9	28.2	16.4

Disaggregating the sectoral backward linkages into self and non-self components, as given in Table 4, shows that the greatest loss occurs in the self generated component. Only three of the seven sectors which experienced increases in backward linkages also showed an increase in self generated linkages while all experienced an increase in non-self generated components. This implies an increased agglomeration of intraindustry firms within sectors relative to intersectoral flows, but, except for Public Administration and Recreation, all the backward spread effects decrease (Table 6). This contraction of local input sources outweighs the intersectoral diversification, resulting in a thinning of the economic core. A similar pattern emerges with the output linkages in Table 5.

TABLE 4

BACKWARD LINKAGE INDICES, QUEENSLAND

Sector	1973			1992		
	Self	Non-Self	Total	Self	Non-Self	Total
Animal Industries	0.692	0.305	0.996	0.599	0.410	1.010
Other Agriculture	0.759	0.240	0.998	0.651	0.306	0.957
Forestry & Fishing	0.681	0.255	0.935	0.611	0.300	0.911
Coal Mining	0.683	0.307	0.991	0.610	0.371	0.981
Other Mining	0.694	0.377	1.071	0.649	0.326	0.975
Food Mfg	0.728	0.667	1.396	0.679	0.609	1.288
Wood, Paper Mfg	0.789	0.272	1.061	0.664	0.322	0.986
Machinery	0.714	0.311	1.025	0.616	0.337	0.954
Metal Products	0.785	0.249	1.034	0.705	0.467	1.171
Non-metallic Products	0.745	0.380	1.125	0.680	0.427	1.107
Other Mfg	0.755	0.309	1.064	0.675	0.437	1.111
Electricity	0.684	0.173	0.856	1.000	0.189	1.189
Gas & Water	0.681	0.311	0.992	0.600	0.338	0.938
Construction	0.690	0.453	1.143	0.601	0.463	1.064
Trade	0.716	0.175	0.891	0.636	0.233	0.869
Transport	0.700	0.281	0.981	0.642	0.261	0.903
Communication	0.680	0.162	0.842	0.639	0.101	0.740
Finance	0.736	0.137	0.873	0.745	0.181	0.926
Public Administration	0.680	0.296	0.976	0.827	0.325	1.153
Commity Services	0.680	0.181	0.861	0.600	0.140	0.740
Recreation	0.682	0.205	0.887	0.672	0.356	1.028

TABLE 5

FORWARD LINKAGE INDICES, QUEENSLAND

Sector	1973			1992		
	Self	Non-Self	Total	Self	Non-Self	Total
Animal Industries	0.641	0.436	1.076	0.543	0.526	1.069
Other Agriculture	0.703	0.452	1.155	0.590	0.464	1.054
Forestry & Fishing	0.631	0.922	1.552	0.554	0.562	1.116
Coal Mining	0.633	0.146	0.779	0.553	0.213	0.767
Other Mining	0.645	0.099	0.744	0.588	0.741	1.329
Food Mfg	0.675	0.044	0.719	0.615	0.064	0.679
Wood, Paper Mfg	0.731	0.467	1.198	0.602	0.541	1.143
Machinery	0.661	0.355	1.016	0.559	0.186	0.744
Metal Products	0.709	0.584	1.293	0.639	0.320	0.959
Non-metallic Products	0.690	0.658	1.348	0.616	0.609	1.225
Other Mfg	0.699	0.574	1.273	0.612	0.406	1.018
Electricity	0.634	0.641	1.274	0.906	0.673	1.579
Gas & Water	0.631	0.363	0.994	0.544	0.864	1.409
Constructuction	0.639	0.174	0.813	0.545	0.063	0.608
Trade	0.663	0.383	1.047	0.576	0.217	0.793
Transport	0.649	0.565	1.214	0.582	0.363	0.945
Communication	0.630	0.031	0.661	0.579	0.638	1.217
Finance	0.682	0.229	0.911	0.676	0.361	1.037
Public Administration	0.630	0.000	0.630	0.750	0.189	0.939
Community Services	0.630	0.016	0.647	0.544	0.021	0.565
Recreation	0.632	0.024	0.656	0.609	0.196	0.805

TABLE 6

BACKWARD AND FORWARD SPREAD INDICES, QUEENSLAND

Sector	Backward		Forward	
	1973	1992	1973	1992
Animal Industries	0.961	0.870	0.970	0.994
Other Agriculture	1.054	0.998	0.949	0.921
Forestry & Fishing	1.010	0.984	0.627	0.791
Coal Mining	0.951	0.921	1.129	1.093
Other Mining	0.894	0.979	1.210	0.752
Food Mfg	0.753	0.782	1.314	1.371
Wood, Paper Mfg	1.030	0.987	0.852	0.794
Machinery	0.971	0.950	0.896	1.126
Metal Products	1.053	0.902	0.773	1.004
Non-metallic Products	0.914	0.901	0.799	0.887
Other Mfg	0.980	0.892	0.753	0.888
Electricity	1.110	1.245	0.669	0.847
Gas & Water	0.951	0.939	0.872	0.690
Construction	0.835	0.832	1.090	1.357
Trade	1.119	1.086	0.871	1.086
Transport	0.990	1.048	0.731	0.912
Communication	1.122	1.279	1.335	0.719
Finance	1.174	1.187	1.042	0.972
Public Administration	0.964	1.057	1.403	1.201
Community Services	1.096	1.199	1.367	1.461
Recreation	1.066	0.960	1.350	1.137

The shift from primary to secondary to tertiary activity can also be clearly observed in Figure 6. All service sectors except Communication experience growth while all manufacturing sectors except Metal Products and Other Manufacturing decline in their output shares. Figure 7 shows the percentage change in the consumption of services and manufacturing per unit of output for a group of more highly aggregated sectors. In all cases, consumption of services has increased and except for Manufacturing and Trade, consumption of manufactures has decreased. Over all industries, the consumption of services increased by 381.4 per cent and consumption of manufactures decreased by 22.6 per cent over the sample period.

This shift has been accompanied by increased outsourcing of inputs, as shown in Figure 8. Only Other Mining (sector 5), Metal Products (sector 9), Communication (sector 17) and Recreation (sector 21) decreased their import usage per unit of output over the twenty year period. Over all industries, the average increase in imports per unit of output was 8.2 per cent between 1973 and 1992. This increased outsourcing is a contributing factor to the hollowing out process.

5. TEMPORAL LINKAGES

The previous discussion has centred around a comparative static analysis. It is also possible to construct temporal linkages, defined as

$$L_j(t) = \frac{n \sum_i \sum_t b_{ijt}}{\sum_i \sum_j \sum_t b_{ijt}} \qquad (15)$$

which measures the average sectoral impact of an investment stimulus across all sectors of the economy over time. Sectors which retain consistently high backward linkages over the sample period will show large temporal linkage indices while those which change rankings over the period or are consistently low will have smaller indices. Similarly, the normalised coefficient of variation of the average total requirements coefficients over time will give $V_j^{(t)}$. Repeating this process for forward linkage and spread effects allows the construction of the temporal key sector matrix $K(t) = M(t) \times S(t)$ in parallel with the static case.

Figure 9 shows the contour map of the temporal key sector matrix over the period 1973 to 1992, and draws together the salient features of the separate maps in Figure 3. As expected, Food Manufacturing (sector 6) remains the first ranked backward linkage sector, while Electricity (sector 12) closely followed by Gas and Water (sector 13) are the highest ranked forward linkage sectors. Metal Products (sector 9), Non-metallic Mineral Products (sector 10), Other Manufacturing (sector 11) and Construction (sector 14) also retain high backward key sector status. Primary activities, Other Mining, Wood and Paper Processing, Metal Products and Non-metallic Mineral Products comprise a significant core of forward linkages, as does Transport and Communication. Interestingly, Coal Mining is not and has never been a key sector, because most of its product is exported without significant processing. While coal earns valuable export income, it contributes little to the economic development (in terms of its economic complexity) of the State. Note also that the service sectors Public Administration, Community Services and Recreation do not have significant key sector status.

It is also of interest to identify what sectors have remained relatively stable over the sample period. This is linked to the notion of the fundamental economic structure (FES), first suggested by Jensen, West and Hewings (1988). Rather than focusing attention on the differences between economies, or the same economy at different points in time, the FES approach seeks to identify regularities across regions and across time.

Initially, it was envisioned that the FES comprised mainly 'people' related activities, people being the common denominator of all economies, but not necessarily restricted to just urban type activities. In a temporal framework, the FES can be regarded as that component of the economy which is predictably stable over time. In other words, it is suggested that the FES comprises the economic core of the region upon which the non-fundamental economic structure (NFES) component of region-specific activities can develop (West, 1997). As the NFES passes through the various development phases, this will have repercussions on the host FES. The FES will in turn embrace the strengthening interactions of the NFES-FES elements, resulting in a strengthening bonded mass. As the NFES development path evolves, so too will the periphery of the FES, but will still rest on the stable core of

FIGURE 7

PERCENTAGE CHANGE IN CONSUMPTION OF SERVICES AND MANUFACTURE PER UNIT OUTPUT, QUEENSLAND 1973 – 1992

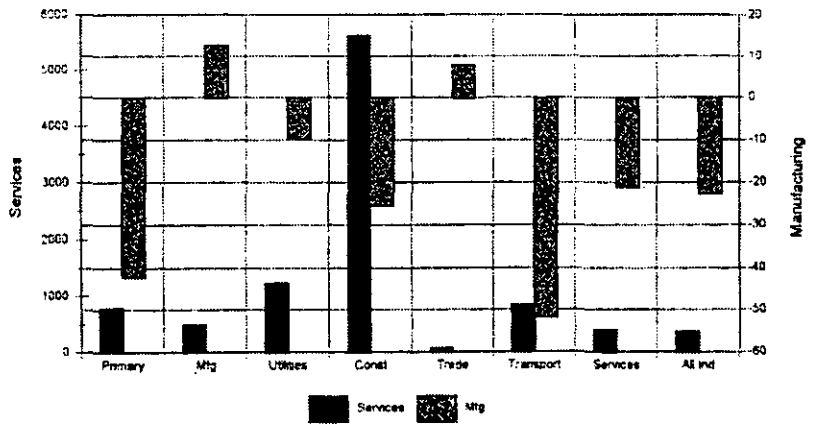


FIGURE 8

PERCENTAGE CHANGE IN IMPORTS PER UNIT OUTPUT, QUEENSLAND 1973 – 1992

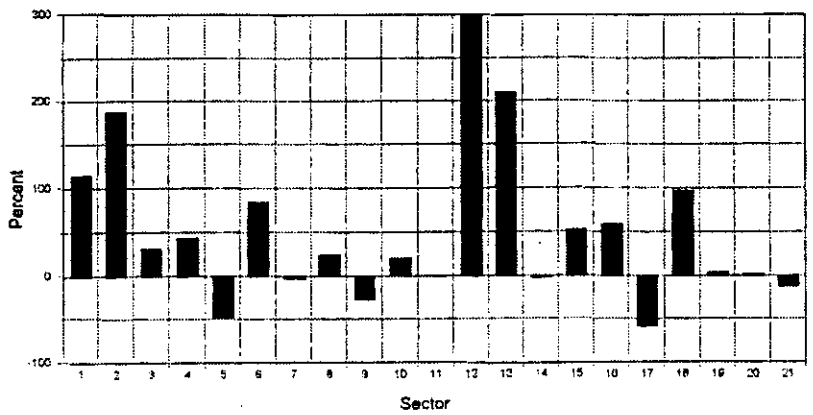


FIGURE 9

TEMPORAL KEY SECTOR MAP, QUEENSLAND 1973 – 1992

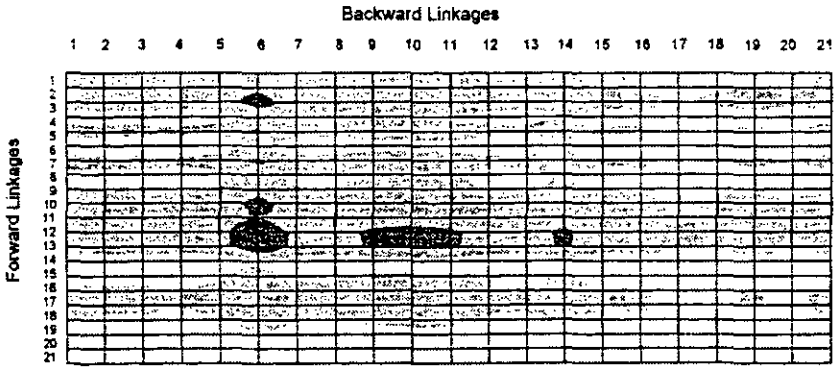
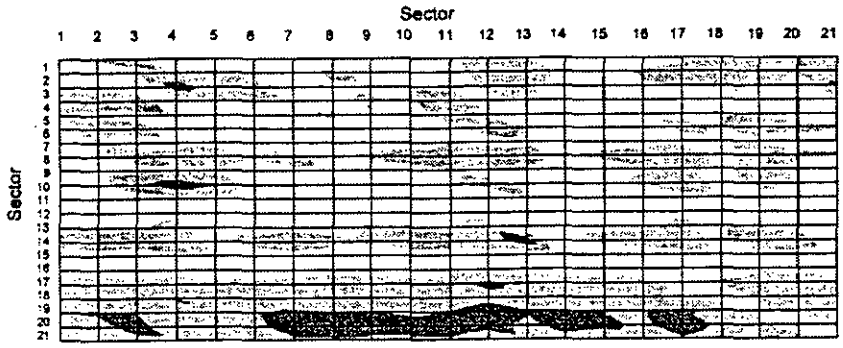


FIGURE 10

TOTAL REQUIREMENTS VARIABILITY, QUEENSLAND 1973 – 1992



fundamental activities. Thus over time as the economy develops, the FES will undergo its own evolutionary modifications.

If we define the temporal FES as those flows which are 'predictably stable' over time, a measure of this variability is the coefficient of variation. Figure 10 gives the distribution of the normalised coefficient of variation of the direct and indirect flows over the sample period. The white area denotes below average variation in the direct and indirect flows between sectors. Based on the above definition, sales by Trade and Transport are the key FES sectors, in common with the notion of the FES comprising people oriented core activities. Electricity and Other Manufacturing are also revealed as being fundamental activities. The block of sectors where most change has occurred over the period are the service sectors, particularly Public Administration and Community Services but including Communication, Finance and Recreation. Comparing these non-fundamental sectors with the key sectors identified previously, it is interesting to note that Recreation is one of the movers and shakers of the economy but has not yet achieved key sector status, unlike Communications, for example, which is both a non-fundamental and key sector. It is in these non-fundamental sectors where much of the change has occurred in the evolutionary process over the twenty year period.

6. THE HOUSEHOLD SECTOR

The preceding analysis has concentrated on all intermediate productive activities of the economy. However it is well recognised that households play an important role in shaping the economic mould. Changing private consumption expenditure patterns provide an insight into the evolutionary path of the economy, both in terms of the self-sustainability of the economy and also in terms of the changing tastes and trends.

It is possible to envisage each intermediate expenditure flow as being split into components, determined by its ultimate final use. For example, some portion of each input into Other Manufacturing will form part of goods sold to households for final consumption, some portion will end up going into goods sold to government, some portion will go into capital stocks, and some will be exported. Thus it is possible to decompose the total requirements flows into expenditure layers, representing their final use. Such a decomposition can be achieved by using the formula

$$T_j = A\,\hat{X}_j = A\,diag\,\{(I - A)^{-1}F_j\}\;;j = 1 \cdots p \qquad (16)$$

where A is the direct input matrix, X_j is a n- element vector of gross outputs associated with meeting final demand expenditures F of category j out of a possible p categories, and where the ^ denoted a diagonal matrix. Summing the various layers gives the total transactions table T:[3]

[3] An alternative interpretation of these layers is that they form a tiered FES structure (Jensen, *et al.*, 1991; West, 1997). In other words, the transactions table can be envisaged as being decomposed into two (or more) separate layers or tables, depending on whether they can be regarded as fundamental or non-fundamental. However this interpretation is not pursued in this paper.

$$T = \sum_j T_j$$

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. An obvious extension of this approach is to transform 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 (West, 1997).

In this paper, the transactions layer corresponding to private household expenditure only is computed. Figure 11 shows the private consumption expenditure direct requirements coefficient landscapes for each of the five years. In 1973-4 the expenditure layer is relatively much flatter than the latter periods with Food Processing (sector 6) the dominant activity. Over time, the landscapes have become more pronounced with Electricity (sector 12) taking over the dominant role. We can also see the progressive emergence of service type activities, in particular Finance (sector 18) and Recreation (sector 21). Other Manufacturing (sector 11) and, of course, Trade (sector 15) have consistently maintained an important role in household expenditure oriented activities.

The results again indicate the gradual shift in economic activity from mainly primary (1973-4) to secondary (1978-9) to tertiary (1992-3). The change in distribution of household expenditure directed production can be clearly seen in Figure 12 which gives the percentage change in total requirements linkages from 1973 to 1992. There was a decrease in backward linkage effects for all manufacturing industries except for Other Manufacturing (sector 11), while service industries Communication (sector 17), Finance (sector 18), Public Administration (sector 19), Recreation (sector 21) and Trade (sector 15) experienced increases. As noted above, utilities (Electricity, Gas and Water) also showed significant increases. The large increase in Communication's forward linkage index indicates how important telecommunications has become to the household sector, not just directly but also indirectly.

A large part of the hollowing out process experienced in the economy can be attributed to the household sector. Consumption induced effects are, generally speaking, the dominant component of interindustry multipliers, and household consumption related production has declined in density at a much faster rate than for the overall Queensland economy. The percentage growth in direct requirements related to household consumption was 24.2 per cent from 1973 to 1992 compared with 25.9 per cent for the overall economy, but only 3.5 per cent in direct and indirect requirements for household consumption related production compared to 13.9 per cent for the overall economy. A contributing factor is the increase in labour productivity, which can be seen from Figures 6 and 13 and Table 7. The substitution of more capital intensive production procedures, especially in sectors which show strong growth in household consumption related production such as Electricity and the Service sectors, has resulted in accelerated outsourcing of inputs which further erodes the economic core.

FIGURE 11

PRIVATE CONSUMPTION EXPENDITURE LANDSCAPES, QUEENLAND 1973 – 1992

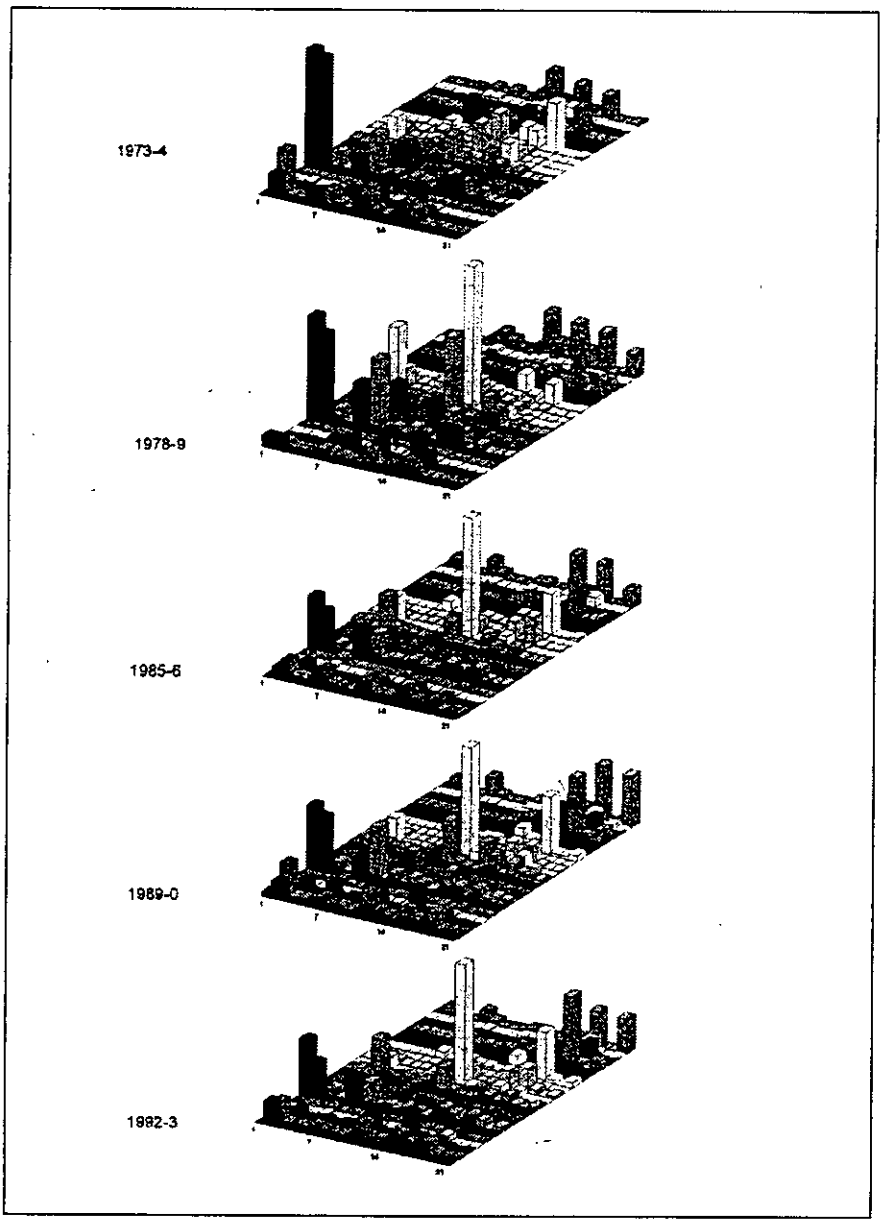


FIGURE 12

PERCENTAGE CHANGE IN DIRECT AND INDIRECT HOUSEHOLD CONSUMPTION LINKAGES, QUEENSLAND 1973 – 1992

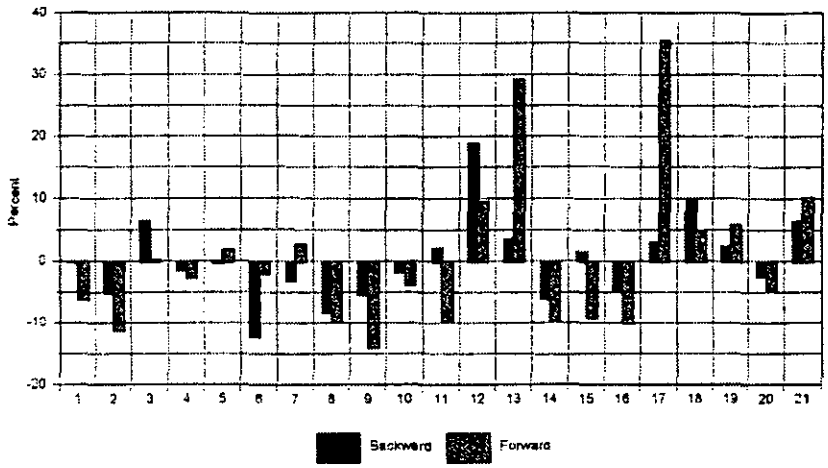


FIGURE 13

LABOUR PRODUCTIVITY ($1989 X 1000), QUEENSLAND 1973 – 1992

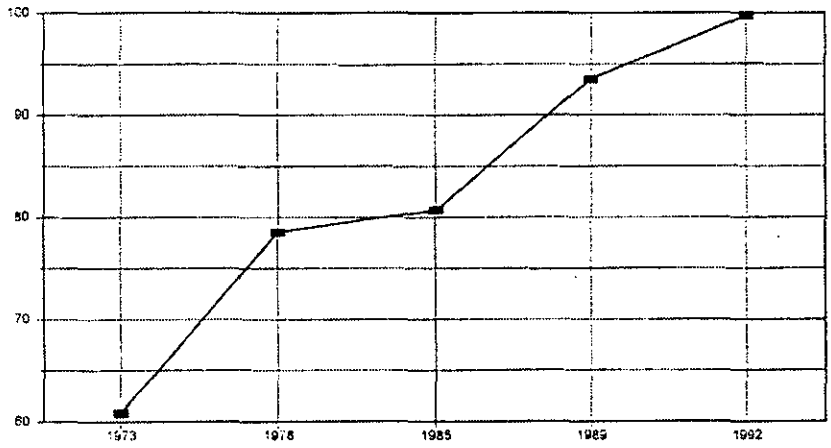


TABLE 7

LABOUR PRODUCTIVITY, QUEENSLAND ($1992M OUTPUT PER EMPLOYEE)

Sector	1973	1992	Average Annual Growth Rate %
Animal Industries	82.7	75.4	-0.5
Other Agriculture	57.3	61.5	0.4
Forestry & Fishing	36.6	111.1	6.0
Coal Mining	319.0	518.3	2.6
Other Mining	186.1	215.9	0.8
Food Mfg	149.2	202.3	1.6
Wood, Paper Mfg	80.0	98.0	1.1
Machinery	83.7	115.6	1.7
Metal Products	109.4	213.6	3.6
Non-metallic Products	135.3	175.3	1.4
Other Mfg	98.9	155.6	2.4
Electricity	135.3	421.3	6.2
Gas & Water	131.8	253.0	3.5
Construction	73.2	125.6	2.9
Trade	35.4	60.7	2.9
Transport	60.4	122.0	3.8
Communication	60.4	129.3	4.1
Finance	89.3	170.4	3.5
Public Administration	39.9	93.0	4.6
Community Services	25.5	53.9	4.0
Recreation	25.5	68.4	5.3
All Industries	64.6	106.1	2.6

4. CONCLUSION

Economic development implies a greater ability to produce a wider range and more complex set of goods and services for both internal and external consumption. One would expect this process to be accompanied by increasing levels of economic interdependence and internal complexity with the tendency for import substitution to occur as the region becomes more self-sufficient. Queensland appears to contradict this widely accepted notion.

The Queensland economy experienced rapid growth during the 1980s, and continues to grow strongly, yet the evidence suggests that rather than increasing internal complexity, a hollowing out process has begun. Hollowing out refers, in this instance, to a reduction in the density of the core structure of the economy as measured by the strength and spread of the intersectoral total (direct and indirect) requirements linkages. The contributing factors appear to be the rapid transition from mainly primary activities to tertiary with the fabricative manufacturing stage largely being overpassed, together with increased industry specialisation and significant improvements in labour productivity, resulting in a greater level of outsourcing of inputs into the productive system than would otherwise be the case with a well developed manufacturing base.

Increased globalisation will speed up the hollowing out process. This has significant policy implications for Queensland. With a more open economy and increased import dependence, Queensland will become more reliant on external sources and markets with their associated advantages and disadvantages, for example access to cheaper manufactured products, but being a predominantly a primary and service economy which is heavily reliant on exports of primary commodities and services such as tourism to gain export income will make the economy more vulnerable to downturns in global economic conditions. It is precisely these types of goods and services which are impacted first in any global downturn. Unfortunately, Queensland has little influence on what happens in the rest of the world, so its options are limited.

The prospects for improving unemployment in the short term are also limited. Based on the past relative gains in labour productivity, there are conceivably greater prospects for further gains in tertiary industries with ongoing improvements in technology. Combined with the hollowing out of the economy which also exerts downward pressure on employment, this makes it more difficult to reduce unemployment levels.

At this point in time, one can only speculate on how long or to what extent the hollowing out process will continue. Will it stabilise when the market reform processes are finally completed, or will it continue its downward spiral? It is difficult to see any major reversal of the process in the short term because once the core is eroded, there is little incentive to reestablish the ways of the past. The nature of a tertiary dominated economy precludes this possibility.

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