

FACTORS AFFECTING THE GROWTH OF
MANUFACTURING IN THE AUSTRALIAN STATES
OVER THE SEVENTIES

by

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This thesis arises from a continuing interest in regional and urban economics which began with my studies at the University of Melbourne. Given the dearth of studies on State economic growth in Australia, it seemed appropriate to undertake a thesis analysing the factors affecting manufacturing growth in the States, especially over the turbulent period of the 1970s.

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I declare that this work has been compiled wholly by myself except where explicit recognition of other studies has been made. Moreover, this study is not substantially the same as any other that I have submitted previously for any other degree at any other University or College.

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CHAPTER 1: INTRODUCTION

THE RELATIONSHIP BETWEEN MANUFACTURING GROWTH AND TOTAL ECONOMIC GROWTH

Very few studies of economic growth in the Australian States are available and most rely upon a simple shift-and-share model. Further, these studies usually confine themselves to looking only at employment change. This thesis moves past this and presents two other possible interpretations of the major factors affecting State manufacturing growth.

One possible reason why this approach has not been followed in the past is that the necessary data has not been readily available. One of the main accomplishments of this study has been the compilation of a consistent data set for manufacturing in each Australian State at the manufacturing sub-division level. Collecting the data involved a great deal of time and effort. As well as the size of the task involved, adjustments had to be made to account for differences in the definitions of various series and for changes in the coverage of the data set over the time period being examined. Adjustments were also made to convert the data from current to constant values.

The data set covers wages and salaries paid, value added, fixed capital expenditure, capital stock and average employment in real terms annually for the period 1968-69 to 1980-81. This

time period was chosen as 1968-69 was the first year of the Australian Bureau of Statistics integrated economic census which enabled consistent data at an acceptable level of disaggregation to be gathered across the States and for Australia. At the time this study began, 1980-81 was the most recent year for which data was available.

This period, the 1970's, has been one of dramatic change for all nations with the onset of persistently high unemployment and inflation from the mid-seventies. As such, and since it is recent, the seventies represent an important period.

The preoccupation of the thesis with manufacturing is less easily explained. After all, the manufacturing sector in 1981 employed only 17.7 per cent¹ of the Australian workforce and its share has been declining for several decades.

A study of manufacturing growth over any period would be of interest for its own sake simply because the manufacturing sector employs people both directly and indirectly. A study of manufacturing growth in the 1970s, however, is more interesting as the sector shed labour, while employment in the Australian economy increased. But as Table 1.1 shows, this pattern is not replicated in each of the States. In Queensland and Western Australia manufacturing employment increased. These different patterns suggest either that different factors are at work in each State or that similar factors are working differently in

the States. This suggests that an inquiry into manufacturing growth at the State level rather than the national level is justified.

TABLE 1.1

TOTAL AND MANUFACTURING EMPLOYMENT CHANGE
BY STATE AND AUSTRALIA:
1968-69 to 1980-81 (persons)

State	Total Employment	Manufacturing Employment
NSW	+ 237,000	- 64,520
VIC	+ 193,000	- 32,829
QLD	+ 185,00	+ 8,519
SA	+ 47,400	- 6,074
WA	+ 137,200	+ 8,174
TAS	+ 8,300	- 3,855
AUST	+ 869,400 ^a	- 90,585 ^b

a Includes Northern Territory and the Australian Capital Territory.

b Comprises six States only. Excludes the Northern Territory and the Australian Capital Territory.

The manufacturing sector has also been seen by some theorists as a major source of growth and income differentials between regions. Land based activities such as agriculture or mineral exploitation are necessarily tied to particular areas. Given identical production technology in all areas, climatic and geological factors largely explain why, for example, some areas have a larger and more profitable wheat growing industry than others or why those areas which possess resources with a fast growing demand (such as oil or uranium) grow faster than others. No elegant economic theories are necessary here. It is when one considers manufacturing activity that puzzles arise. Kaldor (1970) has argued that the prevailing regional distribution of income both within and between nations is largely explained by the unequal development of manufacturing industry across regions. High income areas are those with a highly developed manufacturing industry and vice versa.

This explanation, however, ignores the services sector, which is by far the largest sector in the economy, providing over 70 per cent of total employment. It is possible to argue that employment and activity in the services sector is more a consequence of the level of population and income levels in a region than a cause of variations in economic activity. If this were so, and if income differentials between regions were not great, then the share of employment in service industries would be fairly constant across regions. As can be seen from Table 1.2, which shows the distribution of total employment in each State by broad industry group, this appears to be the case.

TABLE 1.2
STRUCTURE OF EMPLOYMENT BY INDUSTRY AND STATE: 1981 (per cent)

INDUSTRY	AREA	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUSTRALIA
A. AGRICULTURE		4.9	5.4	8.1	7.7	7.9	7.6	4.0	0.7	6.0
B. MINING		1.4	0.3	2.0	0.8	4.0	2.5	4.6	0.2	1.4
C. MANUFACTURING		18.5	22.2	13.0	19.0	12.5	15.3	4.6	3.6	17.7
D. ELECTRICITY, GAS WATER		2.1	2.2	1.6	1.9	1.7	2.7	1.9	0.7	2.0
E. CONSTRUCTION		6.2	5.6	7.5	5.5	7.5	6.4	9.2	5.0	6.3
F. WHOLESALE, RETAIL		17.3	17.0	18.4	18.2	17.8	17.1	11.9	12.9	17.4
G. TRANSPORT, STORAGE		5.5	4.7	6.1	4.5	5.6	4.8	4.8	2.7	5.2
H. COMMUNICATION		2.0	2.0	2.2	1.9	1.8	2.0	1.8	1.6	2.0
I. FINANCE ETC		9.6	8.0	7.9	7.0	8.5	6.3	5.5	7.6	8.4
J. PUBLIC ADMIN & DEFENCE		5.1	5.1	5.7	4.9	4.3	5.2	12.9	32.5	5.6
K. COMMUNITY SERVICES		13.9	14.8	13.8	17.5	16.3	17.4	19.5	22.3	14.9
L. RECREATION, PERSONAL SERVICES		5.6	4.5	5.5	5.1	5.3	6.0	5.9	5.9	5.2
M & N. OTHER		7.8	8.1	8.1	6.3	6.8	6.6	13.5	4.3	7.7
TOTAL		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: 1981 Census

Those industries that can be classified as services (groups C to L) display a fairly constant share of total State employment, except in the Australian Capital Territory, which provides services of a particular kind to the whole of Australia.

This regularity is further supported at higher levels of spatial disaggregation, as can be seen from Table 1:3 which shows the distribution of employment by industry in the capital city and the rest of State areas for each State and for Australia. It should not be surprising that a higher proportion of employment in the rest of State areas occurs in the primary industries nor that manufacturing takes a higher share in the State capitals. In Tasmania this pattern does not hold partly because of its decentralised population and employment pattern and partly due to its reliance on manufacturing activities, such as wood and paper products, that are closely linked to the processing of primary products.

As with the State distribution figures, there is a fairly constant proportion of total employment accounted for by most industries within the services sector. The Finance and Wholesale and retail industries are the exceptions as they are more highly represented in each of the capitals. In the case of the Finance industry this may be due to a need to locate near the head offices of major businesses and near communications systems that require large populations to keep them viable. In the case of wholesale and retail this may be due to the ability of the Wholesale industry to serve large areas from central

TABLE 1.3
STRUCTURE OF EMPLOYMENT BY INDUSTRY AND REGION: 1981 (per cent)

INDUSTRY	NSW		VIC		QLD		SA		WA		TAS		NT	ACT	AUSTRALIA
	Sydney	Other	Melbourne	Other	Brisbane	Other	Adelaide	Other	Perth	Other	Hobart	Other			
A. AGRICULTURE	0.75	12.72	0.81	17.56	1.06	14.11	1.10	24.41	1.76	22.07	1.51	11.83	3.98	0.70	6.03
B. MINING	0.43	3.17	0.19	0.65	0.72	3.15	0.48	1.45	1.23	10.34	0.19	4.14	4.60	0.18	1.41
C. MANUFACTURING	20.29	15.03	25.01	14.81	16.22	10.33	20.66	14.75	14.95	6.83	12.97	16.95	4.63	3.61	17.71
D. ELECTRICITY, GAS WATER	1.97	2.30	1.83	3.35	1.74	1.51	1.79	2.03	1.59	2.03	3.08	2.48	1.87	0.71	2.00
E. CONSTRUCTION	5.85	6.97	5.25	6.55	7.01	8.00	5.67	4.93	7.81	6.91	7.08	5.99	9.20	5.04	6.33
F. WHOLESALE, RETAIL	18.27	15.49	17.70	15.10	20.34	16.74	19.63	14.72	20.07	12.64	17.93	16.47	11.92	12.87	17.38
G. TRANSPORT, STORAGE	5.89	4.91	5.01	3.87	6.11	6.06	4.34	4.86	5.64	5.44	4.07	5.28	4.75	2.73	5.24
H. COMMUNICATION	2.20	1.73	2.09	1.66	2.55	1.84	2.00	1.60	1.97	1.33	2.75	1.47	1.80	1.59	1.99
I. FINANCE ETC	11.69	5.76	9.40	4.38	10.00	6.04	8.44	3.39	10.60	3.72	8.64	4.72	5.52	7.55	8.45
J. PUBLIC ADMIN & DEFENCE	5.24	4.87	5.28	4.60	6.49	5.04	5.58	2.99	4.83	3.12	7.95	3.29	12.92	32.49	5.62
K. COMMUNITY SERVICES	14.29	13.14	14.94	14.60	16.20	11.68	19.33	12.70	18.13	11.99	20.94	14.93	19.50	22.35	14.93
L. RECREATION, PERSONAL SERVICES	5.47	5.71	4.50	4.55	5.03	5.95	5.27	4.50	5.56	4.86	7.45	4.99	5.89	5.90	5.23
M & N. OTHER	7.67	8.19	8.00	8.32	6.52	9.56	5.70	7.65	5.84	8.74	5.43	7.46	13.42	4.29	7.68
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: 1981 Census

locations. No matter the location, however, the Wholesale and retail industry is an important, with employment shares always above 10 and often above 15 per cent of total employment. In some regions its employment share is greater than that of manufacturing.

These regularities and arguments suggest that manufacturing activity may be an important factor in regional growth. As such, and because of the lack of any such study for the Australian States, the preoccupation with manufacturing growth is justifiable. Furthermore, this approach has a precursor in the study by Dixon and Thirlwall (1975) which examined manufacturing growth in regions of the United Kingdom.

This thesis has seven chapters. Following these introductory remarks chapter two reviews several theories of regional economic growth, distinguishing mainly between the demand and the supply oriented models. Chapter three describes the main trends in the data and presents summary measures of State specialisation in manufacturing and the location patterns of manufacturing industries. Chapter four tests a structuralist explanation of manufacturing growth in the States by using a modified shift and share approach. Chapter five presents a neoclassical, supply side explanation of manufacturing growth in the States by using a production function analysis of economic growth. Chapter six briefly presents a demand oriented explanation of manufacturing growth in the States and Chapter seven summarises and concludes the study.

9.

NOTES TO CHAPTER 1

1. 1981 Census

CHAPTER 2: THEORIES OF REGIONAL GROWTH

2.1 Introduction

Growth theory is one of the most contentious subjects in economics. With the addition of a spatial aspect the arguments become wider and the possible explanations more numerous. This chapter reviews the major contributions to regional growth theory.

Several surveys of regional growth theory are available. These include Brown (1969), Brown and Burrows (1977), Richardson (1973 and 1978), Edwards (1981) and Miernyk (1979). It is tempting to classify the competing theories on the basis of whether they expect regional per capita real incomes to converge or diverge with the convergent category containing those theories that predict the eventual equilisation of real income between regions¹ and those in the divergent category predicting real income growth in those regions favoured by an initial economic or locational advantage to grow at the expense of the less favoured, leading to a divergence in income levels between regions. Such a classification, however, misrepresents some of the theories. As will be shown below, two of the more important models can explain either occurrence.

The theories discussed in this chapter are designed to describe total economic growth whereas the thesis itself is

confined to the manufacturing sector. The previous chapter introduced the thesis by placing manufacturing growth in the context of total State growth, pointing to the importance of manufacturing activity in economic growth. In this sense, then, the theories reviewed here can point to factors that are important in explaining manufacturing growth in the States.

This chapter is in five parts. Following this introduction, section two examines those theories that rely mainly or totally upon a demand oriented explanation of economic growth. Section three turns to supply oriented models. Section four briefly draws attention to political and social explanations of regional growth. Section five concludes the chapter by looking at the application of these theories in Australia.

2.2 Demand Oriented Theories

There are basically two demand oriented theories of regional economic growth. Export base is the simpler, relying on a single multiplier to describe economic growth in a region. The other demand oriented explanation, the export led theory, appears to take off where the export base model stops by explicitly considering several factors omitted in the simpler model.

The export base model is oriented to a total regional economy and cannot be confined solely to manufacturing. It would not be meaningful, for example, to calculate an export base multiplier for the manufacturing sector only as the concepts and mechanisms involved require the participation of each sector in the economy. It may be possible to parameterise an export led equation for the manufacturing sector but again, this appears doubtful. The important point to draw from these models is that a demand oriented explanation of regional growth is one possibility and, as such, it will be examined in relation to the States of Australia in a later chapter.

2.2.(a) Export Base

The earliest explanations of regional growth relied heavily upon the export sector. It was argued that as a region possesses only a small economy, little demand for the region's production can be generated within the region itself, so demand in other regions must be tapped through exports in order to increase income. This simple notion, not unique to regional economics as it parallels the idea of vent a for surplus in international economies, was popularised by Andrews (1953) in a series of articles where he argued that any region is dependent upon exports for its output and income levels. Given this dependence, the export base multiplier was developed. The multiplier assumes that the degree of dependence a region places upon its export sector is constant and is estimated as:

$$K = \frac{\text{total employment in a region}}{\text{employment in the export sector of the region}}$$

If, for example, a region has an export base multiplier of 2.0, then every job in the export sector generates another somewhere else in the economy. The non-export sector is seen to exist purely to service the export sector and the regional population the export sector supports and, as such, the non-export sector may be considered unproductive in the sense that it does not contribute to regional growth.

Export base multipliers have been used in various studies but their most extensive use is by Bolton (1966) who studied the impact of defence purchases on regional growth within the United States.

The theory behind export base is very simple but it must be remembered that the aim of any theory is to bring the role of major elements into focus so that their effect upon a system can be examined. Theories become less enlightening and more distracting either when they direct attention to factors which are not of major importance or simplify explanations so much that other important factors are ignored. Export base theory rightly focuses attention upon an important factor in regional economies. Regions are noted for their openness. The lack of barriers to commodity and factor movements between regions and their common currency encourages interregional trade. Simplicity, whilst export base's greatest strength, may be its

greatest weakness as it draws attention away from several other factors which are important in explaining regional growth.

Export base theory assumes that growth is determined solely by external stimuli. This either ignores the role of internal factors or suggests that internal factors are important only in so far as they contribute to the export sector. For example, the possibility of import substitution raising regional incomes is ignored. Capacity constraints within a region are not considered and interregional feedbacks are ignored. Further, the multiplier uses average rather than marginal concepts and presupposes a consistent relationship over time.

Lewis (1972) points out that the export base multiplier implicitly assumes a price elasticity of demand for commodities and labour of zero and an infinitely elastic labour supply function. This results from ignoring several factors. By ignoring the role of prices in changing the demand for the exported goods and the role of wages in attracting labour into the workforce, the first two elasticity assumptions arise. By ignoring any possibility of capacity constraints, the second arises.

Lewis also questions the causal relationship proposed by export base theory suggesting that the development and growth of an export sector is more likely to be the result, rather than the cause, of economic growth. Without growth in the supply of resources or advances in technology, sustained long run growth .

is not possible. Further, if we assume that industries are attracted to regions where input supplies are ample it should be expected that regional growth would allow these industries to expand till they start to export. Export base theory proposes exactly the opposite relationship. Essentially this is the basis of any argument between supply oriented and a demand oriented approaches to economic growth.

These problems reflect in the practical weaknesses of the multiplier. Isard (1960) showed the export base multiplier to be unstable over time and highly sensitive to the choice of regional boundaries.

Calculating the multiplier itself is problematic. Isserman (1980) examined the various methods of identifying the export sector of a region and found that whilst the ranking of these methods remained stable over time² no one method could be shown to give an accurate measure of export employment. This is quite important as Lewis (1976) used several of these methods in calculating export base multipliers and found, not surprisingly, significant variation between the resulting multiplier estimates. Romanoff (1974) examined the export columns of several input-output tables and found that the sum of the small export levels of many industries that would normally fall into the non-export sector represents a significant export aggregate. Consequently, normal methods of identifying the export sector may lead to overestimating the multiplier.

Richardson (1973), in his review of regional growth theory, claimed that the very serious shortcomings of export base theory were such that it should not warrant any attention except for the fact that export base notions still crop up repeatedly, especially in econometric models. Such is the case in Australia. In a joint study by the Victorian and South Australian governments (see South Australian Government 1978) into an area bordering their States, export base multipliers were used.

Does export base tell us anything useful about regional economic growth? It would be difficult to argue that exports are not important to regional growth. As such export base theory may give some useful clues. The implicit assumptions of this approach may, however, mean that too much stress is placed upon exports. Some theorists have examined the role of exports in regional economic growth in other ways and have developed an export-led rather than the restricted export base explanation of regional growth. It is to this explanation that we now turn.

2.2(b) Export Led Models

Kaldor (1970) has noted the importance of exports in relation to growth but suggested extending the simple export base specification to include regional efficiency, capital accumulation and returns to scale. Kaldor displays some degree of scepticism as to the value of resource endowment (supply

side) theories of regional growth and the value of incorporating transport costs into regional growth theory. Many of the criticisms of resource endowment theories of growth will be raised in the next section so they will not be discussed here. It is sufficient to say, at this time, that Kaldor's work is heavily influenced by the Keynesian school.

Kaldor claims that location theory is not sufficiently developed to explain the distribution of economic activity. If transport costs alone are considered then only the location of those industries where transport costs are a significant proportion of total costs is explained. As such Kaldor's work is not one designed to explain growth in a spatial setting. The locational consequences of economic growth evolve from the theories he follows.

Kaldor's main concern is to explain the reasons for a continued income differential between regions - whether they be nations or areas within a national economy. Further, he asks why these differentials have arisen only in recent history. Quoting a study by Kuznets, Kaldor states that wide differences in the wealth of rich and poor nations are comparatively recent in origin when compared to the length of recorded history. While the income differentials between regions within nations were not as great as between nations, Kaldor considers that many of the same processes are at work. These trends are often called cumulative causation processes and are described at the international level by Myrdal (1957). A work, in the similar

poetic vien, that describes these processes at the regional level is Friedmann (1966).

Kaldor considers that many of the elements of cumulative causation are, in fact, only the result of increasing returns to scale within industry. This is not a small point as the implications of increasing returns to scale for economic theory are quite dramatic, as Kaldor (1972) suggests. To incorporate increasing returns into his analysis Kaldor called upon Verdoorn's law, which states that there is a strong positive correlation between the growth of productivity and the scale of activity.

Kaldor also utilised the concept of the efficiency wage, which is the money wage divided by regional productivity, to extend export base. Linked with the Verdoorn relationship, this has the effect of making industries in regions with large scale production not only more efficient (compared to those with small scale production) initially but also more capable of attaining high growth rates because they hold a competitive edge over other regions and so they are in a better position to export. Growth, then, is the result of an exogenous factor (demand for exports) and an endogenous factor (the movement in the efficiency wage).

In regions, however, these processes are further complicated by labour migration. Migration helps to keep the money wage in different industries and regions fairly constant.

If industry wages are fixed between regions, then the cumulative causation processes are strengthened as money wages in low productivity regions cannot fall below the norm. In Australia, the presence of a centralised wage fixing system reinforces and may institutionalise this.

In regions, these cumulatively divergent processes can be overcome by several factors. First, and a most popular argument by students of urban growth, is the possibility of diseconomies of agglomeration reducing growth in large regions. While the effects of congestion, pollution, housing shortages and other agglomeration diseconomies may occur in a large and growing region, these are external costs to individual industries. Industry in these regions then do not have the effects of these diseconomies adequately built into their own cost and wage structures so the growth reducing effect of these diseconomies would be less than they first appear.

Growth brings with it not only diseconomies but also economies of agglomeration. Business may benefit through the proximity to customers, suppliers, various amenities and a large pool of labour. These benefits may aid business and so lead to further growth.

Regions are also subordinate to a nation and so have largely common taxes, currency and government services. Whenever conditions in a region deteriorate, extra government services in terms of unemployment relief and other social .

security payments are made available and taxation collections decrease. This means that there is a form of inbuilt fiscal stabilizer between regions which serves to ensure that income differentials do not grow too wide.

The basic ideas in Kaldor's work have been reiterated in part or in full by several writers. Biehl (1982) analyzed the determinants of regional income disparities in terms of regional development potential, which was seen to be closely connected to the amount and quality of resources available in a region, and to its ability to export. Biehl's concept of regional development potential parallels that of the efficiency wage because of the common concern with the quality (or 'productivity') of a region's resources. Simply put, Biehl sees the regional problem consisting of attracting a sufficiently large part of world demand in order to fully utilize its existing resources.

Anderson (1970) drew attention to the possibilities for economic modelling of regions when exports are stressed. Whilst primarily concerned with export base models, Anderson suggested that when an export base formulation is used, data requirements for a model can be substantially reduced because all models can be expressed in their reduced form. As the major influences on a regional economy are seen to be exogenous, particularly when exports are considered, an adequate model of a regional economy could be made using only reduced form equations, so reducing data requirements and estimation problems. In some sense, this

possibility has been taken up by Dixon and Thirlwall (1975) who suggest an export led model of regional growth which incorporates many of the ideas put forward by Kaldor.

To begin, the model looks similar to export base, relating the growth of output in a region to the rate of growth of exports. That is:

$$g_t = a (x_t) \quad (2.2)$$

where g_t is the rate of growth of output in period t ;
 x_t is the rate of growth of exports in period t ;
 and a is the constant elasticity of output growth with respect to export growth.

Export growth is assumed to be affected by internal and external factors. In commenting on export base theories, Lewis (1972) mentioned the implicitly assumed elasticities of the export base multiplier. The approach adopted here corrects at least some of these problems by making their values explicit. The export demand function takes the form:

$$x_t = b(p_{dt}) + c(p_{ft}) + d(z_t) \quad (2.3)$$

where p_{dt} is the rate of change in the domestic region's export prices in period t ;
 z_t is the rate of growth in national income in period t ;
 b is the price elasticity of demand for the domestic region's exports;

c is the cross elasticity of demand for exports between the domestic and regions;
and d is the income elasticity of demand for exports.

The export demand function establishes z_t and p_{ft} as exogenous variables to the domestic region. Only the domestic region's export price is endogenous and this is assumed to be set by a mark-up condition. Kaldor (1971) also favours this approach saying that the prices of agricultural products are seen to fluctuate according to market conditions (ie whether the product is in glut or shortage) while the prices of manufacturing products (and presumably services) are determined on a contractual basis, justifying a mark-up pricing mechanism. In rate of change terms, the pricing equation becomes³:

$$p_{dt} = w_t - r_t + j_t \quad (2.4)$$

where w_t is the rate of growth of money wages in period t ;
 r_t is the rate of growth of the average product of labour in the export sector in period t ;
and j_t is the rate of change in the mark-up on unit labour costs in period t .

It is also clear from this pricing equation that the efficiency wage concept enters calculations. To close the model a link between growth and exports via prices is provided through the Verdoorn relationship:

$$r_t = r_s + v(g_t) \quad (2.5)$$

where r_a is the rate of autonomous productivity growth;
and v is the Verdoorn coefficient.

Combining equation (2.2) to (2.5), the growth rate of a region becomes (excluding time sub-scripts):

$$g = \frac{a[b(w-r_a + j) + d(z) + c(p_f)]}{1 + bcv} \quad (2.6)$$

Since b is negative (the price elasticity of demand for exports), growth varies positively with v but negatively with w and j . Growth also varies positively with z , b , c , p_f and v . The effect of b is ambiguous as it appears as a multiplicative term in both the numerator and the denominator and is negative.

This model does not necessarily predict income or growth divergence between regions. The Verdoorn coefficient (v) will magnify regional growth rate differences only if there are differences in the other parameters or if v itself varies between regions.

The model assumes that there are plentiful factor supplies and so the region will not be troubled by capacity constraints. This assumption is less troublesome in a regional than a national setting as the lack of institutional barriers between regions means that there can be a free flow of labour and

capital between regions. In lagging or depressed regions, demand can create its own supply by factor migration.⁴ In other words, the assumption of an infinite labour supply elasticity is tenable.

Such a model of regional growth has not been given much attention by the mainstream of the economics profession⁵ which has tended to pay more attention to the role of factor supplies and production functions. Certainly, this approach is an improvement on the crude export base model because it relaxes many of its implicit and restrictive assumptions and because the arguments behind it are stated more formally and cohesively.

2.2(c) Input-Output Models

Input-output models are regularly used in analyzing the effects of an external shock upon a regional economy. These studies abound in Australian regional economics (see the work by Jensen et al (1979)). It is questionable whether input-output models can be considered as growth models or used to obtain analyses of past growth performance. Richardson (1973) includes them in his survey of regional growth theory but the more thorough work by Edwards (1981) does not mention them. Given the frequency of their use in Australia and as the problems they analyse are open to examination by growth theories, a short appraisal of their usefulness in examining growth is included here.

Like export base models, simple input-output models assume no factor constraints and full utilisation of the employed capital and labour supply. Further, input-output models do not allow any substitution effects, assume constant returns to scale and are sensitive to the level of industry aggregation used. Furthermore, input-output models require a large data input. Such data are not normally available so survey or non-survey techniques must be used to generate tables at the regional level. Survey based tables are expensive, tedious and difficult to compile. The non-survey techniques, whilst less time consuming and tedious, will always be plagued by the question of their accuracy.

Input-output tables and models, no matter how they are formed, contain much potentially useful information about commodity flows in regional economies, but it is difficult to see how input-output tables can be useful in explaining economic growth. Essentially, they are descriptive accounts of an economy point in time. Used to form input-output multipliers, they remain descriptive, drawing little upon theory in doing so. They make no attempt to explain whether growth between regions will be convergent or divergent and provide no other explanation of growth other than assuming that some external shock increases demand for the output of a region.

Whilst appearing complex because of their level of disaggregation, simple input-output models are crude in the sense that they cannot incorporate price and substitution

effects. To obtain growth through increasing factor productivity, a central point in the export led model, would require a change in the direct coefficients of the input-output model - something which is assumed to be fixed. There would appear to be some conflict between the export led and input-output models as the first is extrusive while the second is introspective.

One way in which input-output models could be used in assessing factors affecting growth is shown by Carter (1970), who uses input-output tables of the American economy over different time periods to show how the pattern of production has changed. In this way Carter was able to show, to some degree, the extent and type of structural change that had occurred. With the proliferation of input-output tables for regions in Australia, a similar study may be possible for the Australian States over time or on a cross-sectional basis between the States for one time period..

2.3 Supply Oriented Models

Supply oriented models of economic growth have been widely documented and disputed. These theories have been summarised at the national level by various writers (see Hahn and Mathews (1965) and Jones (1976)) and so national versions of the supply oriented neoclassical model will not be described here. A second supply model, although not usually associated with neoclassical theory, is the shift and share model, which will be

discussed only briefly here as it is used in a modified form in a later chapter.

2.3(a) Neoclassical Models

Neoclassical economic models, be they of growth, production, consumption or any market, are characterised by the predominant role of prices and the assumption that producers and consumers organise their behaviour to maximise their wealth. This behaviour is directly applicable to a study of regional growth. Richardson (1978) has provided a general formulation which describes the basis of any neoclassical regional growth theory.

At the heart of these models is a production function. For ease of presentation, and as it is often used in growth studies, a Cobb-Douglas production function constrained to constant returns to scale will be used. In rate of change terms this becomes⁷:

$$y_r = a k_r + (1-a) l_r + t_r \quad (2.7)$$

where y_r is the rate of change in real output in region r ;

k_r is the rate of change in capital stock in region r ;

l_r is the rate of change in labour supply in region r ;

t_r is the rate of Hicks neutral technological change in region r ;

and a is the partial elasticity of output with respect to capital in region r ;
 and $(1-a)$ is the partial elasticity of output with respect to labour in region r .

Within a system of regions, it is assumed that capital and labour are free to move across regional boundaries. In an effort to maximise potential returns, capital and labour are assumed to move in response to differences in the wage and profit rates between regions. The appropriate inter-regional factor flow equations then have the following forms:

$$k_{jr} = f(r_r - r_j) \quad (2.8)$$

$$l_{jr} = f(w_r - w_j) \quad (2.9)$$

where k_{jr} is the net flow of capital from region j into region r divided by capital stock in r ;
 l_{jr} is the net flow of labour from region j into region r divided by the labour supply in region r ;
 r_r is the rate of return on capital in region r ;
 and w_r is the wage rate in region r .

The rate of labour supply growth in a region is equivalent to its natural growth plus any change resulting from migration. That is:

$$l_r = n_r + l_{rj} \quad (2.10)$$

where n_r is the natural rate of population growth in region r .

Capital growth is equivalent to the ratio of the savings rate to the capital-output ratio in a region plus the net effect of inter-regional capital movements.

$$k_r = \frac{s_r}{v_r} + \sum_j k_{rj} \quad (2.11)$$

where s_r is the savings to income ratio in region r ;
and v_r is the capital-output ratio in region r .

Neoclassical growth theory has been used to explain the long term trends towards equalisation in State income levels in America over the period 1880 to 1950. This trend was found in a study by Easterlin (1960).

Convergence in State incomes is a likely result predicted by this simple one sector neoclassical model because of the factor flow equations. Labour moves from low to high wage regions in an attempt to obtain increased income. Capital, likewise, migrates from low return to high return areas. As far as the producer is concerned, the highest rate of return on capital is found in regions where the wage rate is lowest,⁸ so capital tends to flow from high to low wage areas. This is the reverse of the labour flow. As capital accumulates in a region more labour is demanded, increasing the wage rate. At the same time as this capital movement occurs, labour migrates from the low wage region, reducing the labour supply which further increases the wage rate in that region. The effect of these

flows would be to equalise the wage rate and the rate of return on capital between all regions in equilibrium.

These flows have led some to argue that neoclassical models of regional growth predict convergence in regional income but this is not necessarily the case as even this simple model can be used to predict divergent income growth.

In this simple model, a one sector economy is assumed and so capital and output are the same product. Further assume that the marginal product of capital in any region is equal to world or national rate of interest. As a result:

$$M = a \frac{Y}{K} = q \quad (2.12)$$

where M is the marginal product of capital;

$\frac{Y}{K}$ is the average product of capital;

q is the national rate of interest

and a is the partial elasticity of output with respect to capital given in equation (2.7)⁹.

In so far as the world or national interest rate is exogenous, then output and capital must grow at the same rate. If they do not, then the conditions of equation (2.12) will not hold. Placing this restriction into the production function, we obtain:

$$Y_r = k_r = \frac{t_r}{1-a} + n_r \quad (2.13)$$

So the growth rate in a region is equal to a linear combination of the growth of the labour supply and technological change. The per capita income growth rate is found by:

$$Y_r - n_r = \frac{t_r}{1-a} \quad (2.14)$$

Per capita income growth is determined by the rate of technological change. Insofar as technological change varies between regions, there will be a permanent difference between the rate of growth of output between regions leading to a divergence in per capita incomes. This is precisely one of the points made in the previous section when the Verdoorn relationship was discussed.

Even aside from this case, it is not necessary for the per capita incomes of regions to equalise in a neoclassical model if we remove the assumption of homogeneous labour. Nourse (1968) points out that the social mix, skill mix, participation rate, age of workers and property ownership rates may vary between regions. Further a permanent income differential between regions may arise in equilibrium even if technological change is constant across all regions if a labour quality differential is assumed. Batra and Scully (1972) for example use a neoclassical model to explain a twenty per cent wage differential between the north and south of America.

A second possibility for income divergence arises in capital flows. Capital imports to a region are equal to the difference between absorption (ie consumption plus investment) and production¹⁰. The magnitude of capital imports can be determined by comparing the rate of investment with the rate of savings. Assume that savings are proportional to output:

$$S_r = sY_r \quad (2.14)$$

where S_r is the level of savings in region r;
and Y_r is the level of income in region r.

The level of investment is, by definition:

$$I_r = k_r K_r \quad (2.15)$$

where K_r is the initial capital stock in region r;
and k_r is the rate growth of capital stock in region r.

Capital imports occur when regional investment exceeds regional savings (ie $k_r K_r > sY_r$). Since in this model the rates of growth of capital and output must be the same ($k=y$) and the marginal product of capital is equal to the rate of interest (from (2.12)), capital imports occur if the rate of growth of output is greater than the ratio of savings to capital. That is, income diverges if:

$$y > s \frac{q}{a} \quad (2.16)^{11}$$

The greater the rate of growth in a region the more likely it is to import capital. If all regions have similar savings

ratios (ie s) and similar shares of output received by capital (i.e. a), which is tantamount to saying that they have identical production functions, then rapidly growing regions will import capital from slow growth regions.

Differences between regions in the growth of technology and capital have been the main elements in arguments about income divergence. Using the simple neoclassical model, Borts and Stein (1964) set out to examine income growth in regions of the United States. Their primary aim was to test the model itself rather than apply it against the experiences of the regions. They argued that the experiences of the component regions of America provided a more relevant test of the theory than testing it across nations as they are more politically stable and place lower levels of restriction upon trade than do a group of nations.

Borts and Stein, in the end, rejected the simple neoclassical model as it failed to adequately predict the movements of capital and labour in various sub-periods within their total time frame. The failure of the simple neoclassical model should not be taken as conclusive evidence of the inappropriateness of neoclassical theory. The model described so far has been kept uncomplicated deliberately, relying on short chains of reasoning and few factors so that the main features of the neoclassical methodology could be displayed. As such, the study cannot be said to reject an approach based upon relative prices, rates of return and production functions.

Factors that dominate neoclassical models appear in other works that reject the basic neoclassical paradigm. Richardson's (1973) growth theory was reviewed by Borts (1974) who stated that "what started out as an attack on neoclassical growth models winds up as an interesting, potentially testable and useful synthesis of locational variables which might strengthen the neoclassical approach" (p546).

A more extensive neoclassical model is presented by Siebert (1969) who develops a supply side model of regional growth which is restricted by demand considerations. Many elements of the simple model are augmented by societal parameters and transport costs enter the production function. Capital and labour movements respond to more complex factors than simply return differentials. Based upon this model, Siebert states many theorems regarding the causes of differential growth between regions. These theorems are largely addressed to factor mobility between regions. Briefly, Siebert found that the more immobile an internal growth determinant, the greater the difference in regional growth rates and that a differential can exist only if differing factor mobilities prevail. A permanent growth differential presupposes some immobility in at least one factor and, historically, natural resources can be regarded as this factor. Developments that increase factor mobility, such as improvement in the transport system, narrow growth differentials between regions. This, whilst generally true, is not complete. If an autonomous growth factor is inter-regionally immobile, the growth differential will be

higher the more mobile the other growth factors. The immobile autonomous growth factor (eg a resource find) induces the inflow of further growth factors into the region reinforcing the original growth differential by expanding output in this region and reducing possible output in those regions that lose factors through this migration. This is identical to the spread and backwash effects in Myrdal's cumulative causation process.

Richardson's model has been mentioned above. In his approach factor immobility is modelled, in effect, by the use of locational constraints.¹² These involve any peculiarities that restrict the movement of factors between regions. Modelling locational factors involves more than simply incorporating transport costs into factor migration equations. Agglomeration economies at each location are given great weight and incorporated into the analysis. Agglomeration economies, which are meant to measure the locational preferences of consumers and producers are affected by city size (measured by population) and distance to other main population centres. Larger cities are considered to have higher agglomeration economies although diseconomies of very large city size are allowed.

Richardson (1974) and Whitbread (1981) tested various elements of this model. Richardson, in what he considers a crude implementation, found that the spatial and population distribution variables to be significant, drawing the conclusion that non-spatial models are deficient. Whitbread's study of

areas within the EEC also supported convergence. He found that the most important factor in regional growth was growth in the region's parent nation.

Neoclassical models have been extensively criticised by writers in both the general and regional economics fields. The criticisms made by the Cambridge school have been well documented by Harcourt (1972) and Jones (1976). Perhaps their major criticism concerns the meaning and measurement of capital and technical change. It is suggested that the index number problems in measuring capital are enough to invalidate much of the practical relevance of the theory. If capital cannot be adequately defined or measured then the technological change term in the production function becomes an undefined residual picking up not only autonomous increases in output but also measurement and specification errors. It is this property that led Abramovitz (1956) to call it the coefficient of our ignorance.

Neoclassical formulations of growth theory have also been questioned as to the appropriateness of the mechanisms explaining the flow of labour and capital. Richardson pointed to the role of agglomeration economies and Siebert drew attention to the problems of factor immobility.

Criticism of the labour adjustment mechanism is especially thorough. Individual studies of migration (ie those not contained within growth models) describe various factors.

affecting labour movements. Climate, social ties, length of residence in an area, age and information flows are all important. Economic factors such as differences in wages and the cost of living between regions, whilst significant, are not the sole determinants. Once non-economic stimuli are considered important determinants of migration, labour movements could have either equilibrating or disequilibrating effects.

Some argument has also occurred about whether migration leads to growth or whether growth predetermines migration flows. At best the argument is inconclusive, but statistical tests by Steinnes (1982) challenge the prevailing view in regional economics literature that people (migration) follows jobs (employment growth) and suggests the reverse (ie jobs follow people).

The argument regarding labour migration is understandable given that people react to a variety of factors - both economic and non-economic. Capital movements, however, may not be so affected and generally it is thought that more faith can be placed in the neoclassical explanation of capital movements. Romans (1965) saw capital as being like wheat, flowing between regions in response to market pressures. This would appear even more likely as transport costs on capital can be expected to be quite low. Even given these considerations, capital movements are not seen to respond as expected. Olsen's (1965) study of capital movements between the states of America fails to support the neoclassical model. Various factors impinge on capital

movements. Risk and uncertainty may be high encouraging entrepreneurs to invest at known locations, supporting the initial location structure. Indivisibilities also restrict capital movement. Furthermore, the initial capital stock is largely fixed and immobile. New investment then becomes the major element in capital movements and a substantial part of this takes place within existing corporations which may have previously made location decisions. Further, where management is unsure of conditions elsewhere, subjective and non-economic factors can also affect the location of new investment. One factor that may cause this uncertainty is the distance between the investment opportunity and management. Distance may cause unfamiliarity with the opportunity or a loss of information because of the long transmission lines that would be needed to pass information back to management.

Agglomeration economies have been mentioned already. An important part of agglomeration economies is sometimes taken to be the distribution of cities within the urban hierarchy. One element of the urban hierarchy argument concerns the diffusion of inventions and ideas. It is argued that those cities (and their accompanying outer regions) higher in the hierarchy get the first chance at implementing new technology. This would be explained in a neoclassical model by incorporating a differential technological change parameter between regions.

Hagerstrand (1967) hypothesised that the first adoption in a country of an imported innovation is usually in the capital or

some large city and that the innovation initially spreads by way of the urban heirhacy from the high to the low ranked cities. This idea has been accepted by several writers. Friedmann (1966) appears to consider urban heirhacy to be an important factor in regional growth as he states that growth takes place in a spatial arrangement of activities so regional policy and planning must be based upon a heirhacy of urban centres (p55). Wilson and Maxwell (1982) have studied structural change in regions in Australia between 1971 and 1976 and called upon spatial diffusion of growth as a possible explanation of their results. A study of urban growth by Little and Carter (1979) suggested that the larger the city, the greater the chances of a high growth rate. Von Boverter's (1975) concept of growth waves also appeals to a theory of spatial diffusion. These studies suggest that spatial diffusion is generally accepted. A cautionary note, however, is sounded by McCombie (1982) who tested the effect of the spatial diffusion by incorporating it into equations testing the Verdoorn relationship. McCombie's tests suggested that the spatial diffusion of innovations is not necessarily an important determinant of regional growth.

Each of these elements add to a general theory of regional growth but in their addition, the complexity of the theory increases significantly. The purpose of a model or theory is to simplify a complex problem, pointing to the major elements working within a system. Simplifying matters necessarily means that errors occur, making it easy to point to deficiencies but it could be argued that these deficiencies, were deliberately

inbuilt in order to make the problem accessible. In this sense, some of the criticisms levelled against a neoclassical approach to explaining growth argue points that the model itself does not try to address. Such arguments are not so much criticisms but suggestions for the extension of the analysis. Richardson's and Siebert's work are prime examples of this. It is this flexibility in the neoclassical model that has enabled it to keep its currency. Further, this flexibility suggests that the simple model has focussed attention upon several important influences on economic growth.

2.3(b) A Location Oriented Model

Von Boverter's (1975) model of growth is difficult to catagorise within the supply side/demand side dichotomy as it uses few relationships found in economics, relying in the main on factors more commonly found in studies of industrial location. Because of the common features between Von Boverter's and Richardson's work and because it draws heavily upon a region's location (being 'supplied' with a particular location), it may be called supply oriented.

A major reason for the separate treatment of Von Boverter's model is its treatment of prices. These are seen to play a secondary role in the regional growth process (p.16).

Von Boverter argues that high prices are paid because of high productivities and not because factors initially are scarce. Factors become scarce because they are in great demand by .

industries that expand. Prices, then, are the effect of growth and should not be used to explain it.

Von Boverter's model sees regional growth as being affected by increased factor supplies, technological change, industrial structure and any agglomeration economies that may arise because of a region's size or position in the urban hierarchy. Labour and capital growth mechanisms appear to be similar to the normally accepted formulations with labour growth comprising net migration plus natural increase and investment being a function of regional savings and net capital movements.

The similarities between the Richardson and von Boverter models lie in their use of agglomeration economies and spatial diffusion through the urban hierarchy. Where the two part is in von Boverter's disregard of the price mechanism, leading him to rely more upon locational characteristics than other models.

2.3(c) Industry Structure Models

One element highlighted in von Boverter's model is the industry structure of a region. This is a widely disputed topic in regional growth but it must be said that explanations of regional growth that rely largely upon industry structure have been shown to lack explanatory power.

Shift and share analysis is the most often used method of analyzing regional growth by industry structure. As a modified

shift and share exercise is presented in Chapter 5, discussion of regional structure arguments will be delayed till then.

2.4 Political Economy Approaches

The theories outlined above are taken from the mainstream of economic thought. Examining the mainstream, unfortunately, does not exhaust the possible explanations of regional or national economic growth. There are several examples of studies that use neither the supply oriented nor the demand oriented approaches outlined above. Of particular importance are those studies which adopt a political economy or Marxian approach. Such an approach is explained by Holland (1975 and 1976). Regional problems and growth are seen in the context of a region's dependency upon national events. National events are in turn subordinate to conditions in the world economy. Regional growth and decline must then be addressed in terms of national and global growth and structural change.

In the Australian context, Stilwell (1980) uses an approach similar to Holland's to examine the effects of the recession in the late seventies upon Australia and its regions. Stilwell places the urban and regional problems of Australia in the context of international events, suggesting that these factors dictate conditions in the regions. Of particular interest to Stilwell is the changing international distribution of economic activity, with many low labour cost countries gaining manufacturing activities that would previously have been located

in more developed nations. Such a global redistribution of resources must have a bearing upon the growth of regions in Australia.

Stilwell finds that the spatial impact of the current recession in the late seventies was very unevenly distributed 'with the large industrial cities and centres of Australia being particularly poorly affected. Stilwell identifies the worst hit areas as Newcastle, Sydney, Wollongong, the La Trobe Valley, Melbourne, Geelong, Adelaide, Adelaide and towns in the 'Iron Triangle' of Whyalla, Port Pirie and Port Augusta. In short, the whole of the industrialised south-east. On the other hand, the mineral resources of Queensland and Western Australia placed them in a better position to weather the recession.

Stilwell recommends a series of regional employment programs and policies to improve the spatial mobility of labour as aids to depressed regions in the current recession. Further, Stilwell points out that the politics of Australian federalism has had noticeable spatial effects. Inter-State rivalry has meant that industry has been able to play off one State government against another and so gain the most favourable conditions for their operations.

Stilwell does not place much hope in these policies however as he considers that unemployment has a spatial dimension not primarily because of imbalance in the regional labour markets but "because of the interaction between (i) depressed national

economic conditions and (ii) cities which are characterised by a territorial segmentation of socio-economic groups" (p172).

The centre-periphery model is another that has not been examined in this review. This approach was mentioned in the supply-oriented section by reference to Myrdal (1957). Indeed, Borts and Stein (1964) set out specifically to test Myrdal's model and Siebert (1969) considers this approach to be a special case of a supply oriented model when certain factor immobilities occur. Whereas Myrdal's work was directed towards the international sphere, Friedman (1966) argues a similar approach for regions. As with the Marxian approach, Friedman argues that the openness of regions means that much of their growth is shaped by outside factors. Regional growth therefore becomes an adaptive process. Only by changing the parameters that restrict choice can regions uncover new opportunities and prosper.

These approaches to regional growth have definite merit but will not be examined further as they are not used in either full or abridged form in this thesis.

2.5 Australian Studies

Few studies or models of Australian regional growth are available. Wilson (1980) provides a descriptive study of Australian growth from settlement to the present followed by an economic geography description of several industries and areas. Donovan (1978) estimated social accounts of the Australian

states for the period 1953/54 to 1965/66 and used the results to perform shift and share and production function analyses of growth in the Australian states. Stilwell (1974) provides a study of regional development in Australia largely for the sixties.

These three studies are concerned with an earlier period and are not in the main designed to address the causes of regional growth. The most recent work of relevance is Stilwell (1981) which was discussed in the previous section.

Most of the regional economics literature in Australia appears to be directed towards describing the spatial organisation of activity, the examination of structural change in the regions and the description of growth in individual States with the most complicated analysis being shift and share studies. Few comparative studies or descriptions of recent growth experiences in the States are available with the works by Donovan (1978) and the New South Wales government (1979) being the exceptions.¹³

Recently it has become necessary to incorporate regional dimensions into economic models of the national economy. The ORANI model has a facility which disaggregates national results to the State level on the assumption that the majority of industries grow at the same rate in each State as in the nation. Some industries are constrained by region specific effects, but this adjustment does not greatly affect the overall

results (see Dixon, Parmenter, Sutton and Vincent (1982) for a more detailed discussion). A further extension of this methodology has allowed disaggregation to the Statistical Division level, only in this case industry is not constrained by region specific factors. (See Industries Assistance Commission, 1981). This method of disaggregation appeals to the industry structure methodology.

The Institute of Applied Economic and Social Research (IAESR) has also started disaggregating the results of the IMP (Institute Multi Purpose) model. While there is little published information about the IMP model (see Brain (1977) or its State module, it appears that State based input-output tables have been linked to the national model in order to calculate the State results (see Gray 1982).

In all, little attention has been paid to the growth of the Australian States¹⁴. There are few descriptive studies and even fewer analytical works.

NOTES TO CHAPTER 2

1. The neoclassical model need not assume real per capita income equalisation between regions as industry mix and occupational mix may vary between regions.
2. The methods Isserman examined were Location Quotients, Minimum Requirements, Regression and Assumption.
3. The mark-up equation when written in levels takes the form

$$P_{dt} = \frac{W_t}{R_t} + J_t$$

where upper case letters represent the levels forms of the variables mentioned in the text in lower case.
4. A good example of this actually happening would be the noticeable labour migration to remote resource development areas in Australia such as Gladstone in Queensland and the Pilbara in Western Australia.
5. Armstrong and Taylor (1978) re-estimated Dixon and Thirlwall's work using later data.
6. Richardson did consider it questionable to include input-output models as models of regional growth.
7. Equations (2.7) to (2.11) are taken from Richardson (1978, p139)

8. This assumes several important points. Specifically it assumes no transport costs, identical production functions between regions, no removal costs, perfect knowledge by the producer and homogenous labour and capital.
9. A partial elasticity is equal to the marginal rate of change divided by the average rate of change of the function with respect to a particular variable.

10. Based on the accounting identity

$$Y = [C + I] + X - M$$

$$M - X = I + C + Y$$

11. To progress from equation (2.14) to equation (2.16)

$$\text{If } S_r = sY_r$$

$$\text{and } I_r = k K_r$$

$$\text{and } M = a \frac{Y}{K} = r$$

$$= \frac{Y}{K} = \frac{r}{a}$$

$$\text{and } k = y$$

and we wish to examine the proposition

$$kK_r > sY_r$$

$$\text{Hence } K = S \frac{Y_r}{K_r}$$

substitution of terms leads to

$$y \searrow s \begin{matrix} r \\ - \\ a \end{matrix}$$

which is equation (2.16)

12. Richardson's model proposes a Cobb-Douglas type production function where

$$y = [a^k + (1-a)l]^b + t$$

where y , k , l , a and t have been previously defined and b is an exponent which reflects increasing, decreasing or constant returns to scale.

This formulation is not standard and the properties of this type of production function are not known. If we assume that b equals 2.0, then the marginal product of capital is

$$\begin{aligned} & \frac{\partial}{\partial k} [(a^k + (1-a)l)^2 + t] \\ &= \frac{\partial}{\partial k} [(a^k)^2 + [(1-a)l]^2 + [2(ak)(1-a)l] + t] \\ &= 2ak + 2a(1-a)l \\ &= 2a[k + (1-a)l] \end{aligned}$$

which is similar to, but not the same as a variable elasticity of substitution (VES) production function.

13. Examples of the current topics of debate in Australia are provided in the compendia edited by Linge (1976), Linge and McKay (1981) and Higgins (1981).

14. Letters sent to Government departments in each State confirm this. Each State was asked if they knew of any descriptive study of manufacturing growth for their State during the 1970s and for information on capital stock estimates. The replies were not encouraging. Western Australia could provide some information on the general state of their economy and the New South Wales government had made a comparative study of the industrial structure of the States. The other four States did not provide even descriptive material.

CHAPTER 3: REGIONAL SPECIALISATION AND MANUFACTURING GROWTH IN
THE AUSTRALIAN STATES

3.1 Introduction

This chapter describes the location pattern of Australian manufacturing and the pattern and degree of specialisation in manufacturing in each State for the years 1968-69, 1974-75 and 1980-81 - the beginning, middle and end points of the period being examined. Apart from using simple measures of the proportional distribution of manufacturing activity across the States, summary measures designed to show the geographic concentration of particular industries and the level and pattern of industrial specialisation in each State are presented.

Interstate differences in the level and pattern of regional and industrial specialisation and structure are important for several reasons. First, as mentioned in the previous chapter, some theories of regional growth place great emphasis upon industrial structure in explaining not only the growth rate of individual regions but also the differences in growth between regions. Second, knowledge of the distribution of manufacturing activity helps us to understand the influence of the individual States on national results and, vice versa, the influence of national economic conditions and policy on individual regions. For example an area heavily dependant upon one industry may be greatly affected by policy decisions affecting that industry. Third, examining the industrial structure of the States is

interesting in its own right. It will be found that some States are microcosms of the national economy whilst others are quite different.

Finally, by studying changes in the industrial structures of the States, some measure of structural change in each State is obtained. Further, these measures may allow some tentative suggestions to be made later concerning future manufacturing growth in the States. If, for example, a State has shown increasing dependence over time on an industry in which either it or the nation as a whole is comparatively inefficient, then the future growth prospects of the State may be gloomy. This is a general statement that will be examined more fully in the next chapter. In specific cases, some States may be peculiarly efficient in an industry, or a part of that industry, in which the nation itself is inefficient.

Following this description, manufacturing growth in each of the States will be examined and compared with each other and with that in Australia as a whole. Further, these growth experiences will be assessed in the light of the location patterns discussed earlier.

It is interesting to note that very little work has been done in describing the location pattern of Australian manufacturing or in describing the growth of manufacturing in the States. The latest study appears to be a paper by the New South Wales Government (undated) which presented several

measures of location patterns in the Australian economy for the period 1959-60 to 1978-79. Donovan (1978) examined the structure of the whole of each State's economy over the period 1953-54 to 1965-66 and used some of the forms of analysis presented in later chapters to assess what were the major contributors to growth in each of the States.

This neglect of information on the States meant that a data base had to be compiled. Because of definitional changes in the data over the period being examined, this required a large degree of manipulation. A full description of the data base and how it was compiled is given in appendix 1.

This chapter is in five parts. Following this introduction, section two examines the location of manufacturing industry and section three presents several measures of manufacturing growth in each of the States. Section four compares parts of each of these two sections and questions the value of one of the measures usually associated with the measurement of regional location and activity. Section five concludes the chapter summarizing the main findings and foreshadowing the following chapters which try to determine the major factors causing the trends found here.

3.2 Manufacturing Location and Regional Specialisation

In this section various measures of industrial location are used to examine the location patterns of individual industries

and the degree of specialisation in each State. Throughout this section employment is used as the enumerator. This is the normal practice when computing these measures as employment data is usually more readily available at regional levels than any other. Further, concern with regional employment and unemployment may justify this approach. In any case, the distribution of value added and employment were compared and found to be similar, suggesting that while the use of one measure may give rise to somewhat different results, the differences would only be slight. There appears to be little value in departing from the accepted procedure of using employment as the indicator of activity.

3.2(a) Measures of Industrial Location

The great majority of manufacturing activity occurs in the two most populous States - New South Wales and Victoria. Table 3.1 shows the percentage distribution of total manufacturing employment by State for the years 1968-69, 1974-75 and 1980-81. Appendix Table A3.1 shows the same figures for each manufacturing sub-division by State.

The dominance of New South Wales and Victoria in all sub-divisions is the most noticeable feature of the two tables. New South Wales and Victoria account for over seventy per cent of total manufacturing employment in each year and the great majority of employment in all manufacturing sub-divisions. In most sub-divisions New South Wales' share is greater than Victoria's and the general ordering of the States

TABLE 3.1

STATE DISTRIBUTION OF EMPLOYMENT IN TOTAL
MANUFACTURING:
1968-69, 1974-75 and 1980-81 (per cent)

State	Year 1968-69	1974-75	1980-81
NSW	40.66	38.66	38.74
VIC	34.59	35.17	33.76
QLD	8.56	8.90	10.00
SA	9.04	9.85	9.31
WA	4.68	5.08	5.83
TAS	2.47	2.34	2.36
AUSTRALIA ^a	100.00	100.00	100.00

a Australia is defined as the six State sum.

remains the same as that for total manufacturing. Exceptions to this rule are the Textiles and Clothing sub-divisions where the Victorian share is greater than that in New South Wales and the heavy concentration in New South Wales of the basic metal products sub-division, reflecting the presence of the iron and steel making plants in Port Kembla and Newcastle.

The second noticeable feature is the change in the distribution of employment between the States. The figures show a marked redistribution of manufacturing employment away from the traditional centres of New South Wales and Victoria towards the resource rich States of Queensland and Western Australia.

This pattern appears similar to the population movements, roughly over the same period, shown by Rowlands (1978) and Hugo (1983). Furthermore, it is interesting to note that nearly all of this adjustment occurred in the first half.

Given the highly concentrated geographic location of Australian manufacturing industry, one may expect that the New South Wales and Victorian experience would follow more closely, or be largely responsible for, the Australian experience. The smaller States may experience quite different growth patterns that are not discernable in the national figures. Whether such different growth patterns did actually occur will be examined in the next section of this chapter.

The generally similar distribution between total manufacturing employment and employment at the industry level suggests that few manufacturing industries display distinct employment location patterns. This is supported by the Coefficient of Location (CL) measures presented in Appendix Table A3.2

To examine changes in the location of industry over time, it is useful to compute the Coefficient of Industrial Redistribution (CIR). This is calculated as:

$$CIR_i = \frac{1}{2} \sum_{s=1}^6 \left| \left(\frac{N_{is}}{N_i} \right)_t - \left(\frac{N_{is}}{N_i} \right)_{t-1} \right|$$

where N_{is} is employment in industry i and State S ;
 and N_i is the total employment in industry i in
 Australia¹.

The CIR ranges between zero and unity. When it is zero, the location pattern of the industry has remained unchanged over time. The greater the coefficient, the more the redistribution.

The CIR for each sub-division is given in Table 3.2. The Transport equipment sub-division shows the greatest redistribution. From the movement of the value for the CL given in Appendix Table A3.2, we can see that the distribution of this industry is moving away from that of manufacturing as a whole. Basic metal products has the next greatest redistribution but its location pattern is becoming more like the aggregate distribution. Textiles and miscellaneous manufacturing follow.

It was noted earlier that most of the redistribution of total manufacturing employment occurred in the first half period. This pattern is repeated at the industry level as nine of the twelve sub-divisions have a greater CIR in the first than in the second half, suggesting that the recession in the second half of the 1970s may have slowed the geographic redistribution of manufacturing activity between the States.

TABLE 3.2
COEFFICIENTS OF INDUSTRIAL REDISTRIBUTION

Year ASIC	1968-69 to 1974-75	1974-75 to 1980-81	1968-69 to 1980-81
21 Food	.0170	.0142	.0258
23 Textiles	.0470	.0293	.0701
24 Clothing	.0335	.0195	.0530
25 Wood	.0397	.0252	.0388
26 Paper	.0190	.0117	.0287
27 Chemicals	.0145	.0104	.0176
28 Non metallic minerals	.0153	.0390	.0487
29 Basic metal products	.0566	.0219	.0744
31 Fabricated metals	.0269	.0383	.0483
32 Transport equipment	.0521	.0469	.0835
33 Other machinery	.0295	.0740	.0574
34 Misc.	.0324	.0322	.0647

The measures presented here, however, do not tell us what kinds of relaxation are occurring. All they can tell us is the comparative amount being made between different sub-divisions and the direction of that redistribution - whether towards or away from the national average. For example, these measures cannot discern whether the Basic metal products industry is declining in one area and growing in several others or whether

the Textiles sub-division is becoming more concentrated in Victoria. To answer these questions separate studies have to be made and measures of the specialisation of industries in different areas examined. The first of these options lies outside the scope of this thesis, but the second is possible, and necessary for a more complete understanding of the manufacturing structure of the Australian States.

3.2(b) Regional Specialisation in Manufacturing

The measures of industrial concentration presented above showed that the Textiles, Clothing and Basic metal products sub-divisions have employment distributions unlike the national average and that the greatest amount of redistribution occurred in the Transport equipment and Basic metal products sub-divisions. In order to describe the pattern of these redistributions, it is necessary to know how the industrial specialisation of each State changed over time. One way of doing this is to examine the proportional distribution of manufacturing employment in each State. These figures are given in Appendix Table A3.3. A better way is to standardise these proportions around those in the nation. This is done by calculating the Employment Location Quotient (ELQ) for each industry in each State. This is calculated as:

$$ELQ_{is} = \frac{N_{is}}{N_s} \bigg/ \frac{N_i}{N}$$

where N_s is total manufacturing employment in State s ;
and N is total manufacturing employment in Australia.

If an industry is of the same importance to a State as it is to the nation, then its ELQ equals unity. If an industry is more important, its ELQ is greater than unity and the State is considered to be specialised in that industry.

The ELQ measures for each State are presented in Table 3.3.

TABLE 3.3
EMPLOYMENT LOCATION QUOTIENTS BY STATE: 1968-69

IND	NSW	VIC	QLD	SA	WA	TAS
21 Food	.83	.91	1.94	.93	1.31	1.42
23 Textiles	.85	1.42	.44	.58	.29	2.63
24 Clothing	.89	1.53	.70	.37	.33	.12
25 Wood	.83	.70	1.79	.95	2.67	2.19
26 Paper	1.00	.97	1.00	.74	1.00	2.31
27 Chemicals	1.19	1.00	.54	.59	1.03	.88
28 Non metallic minerals	1.03	.80	1.29.	.86	1.96	.88
29 Basic metal products	1.59	.35	.44	1.15	.86	1.90
31 Fabricated metals	1.00	.96	1.09	.98	1.40	.54
32 Transport equipment	.78	1.09	1.05	2.00	.64	.35
33 Other machinery	1.16	.99	.52	1.21	.67	.19
34 Misc.	1.04	1.27	.59	.72	.47	.08

TABLE 3.3 (Continued)
EMPLOYMENT LOCATION QUOTIENTS BY STATE: 1974-75

IND	NSW	VIC	QLD	SA	WA	TAS
21 Food	.84	.89	1.87	.95	1.35	1.34
23 Textiles	.80	1.52	.35	.57	.24	2.57
24 Clothing	.87	1.56	.60	.46	.33	.13
25 Wood	.86	.71	1.67	1.15	1.86	2.52
26 Paper	1.01	.96	1.02	.73	1.05	2.37
27 Chemicals	1.27	.97	.59	.46	.93	.90
28 Non metallic minerals	1.05	.79	1.26	.85	1.93	.88
29 Basic metal products	1.55	.38	.67	1.08	1.18	1.58
31 Fabricated metals	.98	.99	1.06	.95	1.38	.58
32 Transport equipment	.72	1.20	.86	1.86	.66	.34
33 Other machinery	1.15	1.02	.62	1.08	.65	.20
34 Misc.	1.04	1.22	.63	.86	.53	.17

TABLE 3.3 (Continued)
EMPLOYMENT LOCATION QUOTIENTS BY STATE: 1980-81

IND	NSW	VIC	QLD	SA	WA	TAS
21 Food	.83	.91	1.77	1.02	1.11	1.36
23 Textiles	.76	1.59	.36	.76	.35	1.99
24 Clothing	.83	1.65	.50	.58	.31	.11
25 Wood	.90	.74	1.57	1.07	1.62	2.03
26 Paper	.99	.99	.90	.82	1.05	2.34
27 Chemicals	1.28	1.00	.50	.53	.88	.75
28 Non metallic minerals	.97	.82	1.44	.85	1.79	.78
29 Basic metal products	1.52	.44	.64	1.07	1.07	1.63
31 Fabricated metals	.99	.96	1.18	.85	1.35	.74
32 Transport equipment	.71	1.32	.90	1.52	.73	.22
33 Other machinery	1.24	.84	.65	1.19	.91	.28
34 Misc.	.99	1.23	.67	.99	.65	.29

The measures of industry location of industry showed the distribution of the Basic metal products sub-division to be furthest from the national average, and for redistribution of its employment to be comparatively high. The ELQ measurements show specialisation in this industry in New South Wales, South Australia and Tasmania, with fairly low representations in the remaining three States in 1968-69. By the middle of the study period, Western Australia had also become specialised in this industry while the ELQs in the remaining States were fairly stable. This agrees with the pattern found earlier that the industry is moving towards the national average of the manufacturing employment distribution.

Another industry noted earlier was the Textiles sub-division. Again, most of the movement appears to occur in only one State. While the ELQ in the mainland States remains fairly stable, Tasmania's falls sharply from 2.63 in 1968-69 to 1.99 in 1980-81. Although the ELQ in Victoria and South Australia rose over the same period, these are not of the same magnitude of the Tasmanian decline.

The largest redistribution of employment noted earlier was in the Transport equipment sub-division. The movement of the ELQs for this sub-division suggest increasing location in Victoria by this industry, away from South Australia and Queensland. Again, this tallies with the movement in the CL

towards an employment distribution different to the national average.

What transpires from this examination of the movement of manufacturing employment is that the major redistributions noted earlier appear to have come about largely through movements in one State. In the case of Basic metal products and Textiles it was changes in employment in one State alone that changed the distribution of manufacturing activity in that sub-division.

While the ELQ gives a measure of State specialisation in individual industries, it does not give any idea of overall State specialisation. This is given by the Coefficient of Regional Specialisation (CRS) for each State, which is presented in Appendix Table A3.4. As would be expected from their large shares of total manufacturing activity, New South Wales and Victoria are always depicted as the least specialised States.

A summary measure of the changes in regional specialisation by each State is provided by the Coefficient of Regional Redistribution (CRR) which is calculated as:

$$CIR_S = \frac{1}{2} \sum_i \left| \left(\frac{N_{is}}{N_S} \right)_t - \left(\frac{N_{is}}{N_S} \right)_{t-1} \right|$$

The coefficient has the same properties as the other measures used above and is presented in Table 3.4. Examining

Tables 3.4 and A3.4, it is apparent that each of the smaller States became less specialised over the period while New South Wales and Victoria moved away from the national average. South Australia began as more specialised than Victoria but ended less so. New South Wales and Western Australia experienced the greatest redistribution of their manufacturing employment.

TABLE 3.4
COEFFICIENTS OF REGIONAL REDISTRIBUTION
BY STATE

Period State	1968-69 to 1974-75	1975-75 to 1980-81	1968-69 to 1980-81
NSW	.0796	.0368	.1038
VIC	.0517	.0503	.0859
QLD	.0637	.0406	.0663
SA	.0401	.0613	.0888
WA	.0731	.0532	.0973
TAS	.0473	.0693	.0874

Again it should be noticed that four of the six States experienced greater adjustment in the first half of the period, supporting the observation made earlier that the recession in the latter half of the 1970s may have slowed regional adjustment between the States.

The various changes in the distribution of manufacturing activity described in this section suggest that there has been noticeable variation in the growth of manufacturing industries between the States. It is to these measurements that we now turn.

3.3 Manufacturing Growth In the Australian States

The previous section noted some redistribution in manufacturing activity suggesting differential growth rates between the States in total and in particular industries. In this section the actual growth of the States is examined and compared. Where possible, the movements are related to the locational distribution measures given in the previous section. To place their growth in perspective however, it is first necessary to examine the history of manufacturing growth in Australia over the 1970s.

3.3(a) Manufacturing Growth in Australia

In this section Australian figures will be used to set the scene for examining the growth of the States. These results will be used as a benchmark for comparison between the States. Growth in the States occurs in the context of national events as each of the States exists under trade, monetary, legal and budgetary conditions determined largely by a Commonwealth Government. Consequently the use of national results as a benchmark appears sensible.

During the 1970s nearly all countries have experienced traumatic changes in their growth rates. These global conditions have also affected Australia. Along with many other nations, Australia has, since the mid seventies, experienced high unemployment and inflation simultaneously. Total economic growth has been slow compared to the post-war years and, at times, has approached zero. In the manufacturing sector the story is even worse as the effects of increased import competition, low levels of domestic and export demand and structural change have lead to a loss of 90,585 jobs over the period 1968-69 to 1980-81² at an average rate of 0.63 per cent each year.

Table 3.5 shows the annual average rate of employment growth in each Australian manufacturing sub-division in the period 1968-69 to 1980-81 and its two half periods. Total manufacturing employment declined in both halves with the greatest loss in the second.

The heaviest employment losses occurred in the Other machinery and Clothing sub-divisions where 35,043 and 41,842 jobs respectively were lost. A further 21,220 jobs were lost in the Textiles sub-division. Employment declines in these three sub-divisions accounted for 108.3 per cent of total job loss in manufacturing whilst accounting for just under 30 per cent of manufacturing employment in 1968-69.

TABLE 3.5
 AVERAGE ANNUAL RATE OF EMPLOYMENT GROWTH BY
 MANUFACTURING SUB-DIVISION - AUSTRALIA:
 1968-69 to 1974-75, 1974-75 to 1980-81
 and 1968-69 to 1980-81 (per cent)

IND	Period	1968-69 to 1968-69	1975-75 to 1980-81	1968-69 to 1980-81
21	Food	1.22	-1.16	.03
23	Textiles	-5.00	-2.54	-3.77
24	Clothing	-4.92	-2.23	-3.57
25	Wood	-.32	.50	.09
26	Paper	.49	-.02	.23
27	Chemicals	.22	-1.13	-.46
28	Non metallic minerals	.30	-1.90	-.80
29	Basic metal products	1.66	-.28	.69
31	Fabricated metals	-.03	.55	.26
32	Transport equipment	.52	-2.25	-.87
33	Other machinery	.73	-4.21	-1.74
34	Misc.	1.35	-.89	.23
TOTAL		-.02	-1.25	-.63

The results in table 3.5 clearly show two episodes in growth with the first half being rather fortunate compared to the second when ten sub-divisions shed labour compared to four in the first.

It is against this background that the particular experiences of the Australian States will be examined.

3.3(b) Manufacturing Employment Changes In the Australian States

Employment growth in the manufacturing sector varied greatly between the States. Table 3.6 shows the annual average rate of employment growth by sub-division by State and for Australia between 1968-69 and 1980-81.

Only Western Australia and Queensland experienced manufacturing employment growth over this period. All other States, with the exception of South Australia, shed labour at a rate greater than the national average. As an indication of the degree of variability in the growth performances of the States, it is interesting to note that only in the Textiles sub-division does growth in all States have the same sign.

The results for New South Wales are striking as eleven of its twelve sub-divisions reduced employment and that sub-division where employment did increase (i.e., Wood products) was not one in which it specialises. Only about half of the specialist industries in each State increased employment. Of the twenty-seven specialist industries in all States, thirteen had positive growth. However, if the growth rate of specialist industries is compared to the corresponding industry growth rates

TABLE 3.6
 AVERAGE ANNUAL RATE OF EMPLOYMENT GROWTH BY
 MANUFACTURING SUB-DIVISION BY STATE
 AND AUSTRALIA: 1968-69
 to 1980-81 (per cent)

IND	NSW	VIC	QLD	SA	WA	TAS	AUST
21 Food	-.37	-.17	.60*	1.09*	.36*	-.73	.03
23 Textiles	-5.09	-3.03*	-4.13	-1.29	-.48	-6.50*	-3.77
24 Clothing	-4.62	-3.10*	-5.03	.34	-2.24	-4.14	-3.57
25 Wood	.32	.45	.35*	1.34*	-2.30*	-.94*	.09
26 Paper	-.31	.21	.72	1.27	2.42*	-.08*	.23
27 Chemicals	-.28*	-.70	.38	-1.07	-.08	-2.23	-.46
28 Non metallic minerals	-1.72	-.83	1.46*	-.64	.22*	-2.22	-.80
29 Basic metal products	-.14*	2.26	5.05	.34*	4.29*	-1.01*	.69
31 Fabricated metals	-.30	.07	2.31*	-.72	1.75*	2.57	.26
32 Transport equipment	-2.02	.57*	-.78	-2.90*	1.97	-5.21	-.87
33 Other machinery	-1.56*	-3.29	1.43	-1.62*	2.63	1.04	-1.74
34 Misc.	-.61	-.24*	2.59	3.19	4.58	10.16	.23
TOTAL	-1.14	-.67	.64	-.47	1.06	-1.12	-.63

* indicates sub-division with an ELQ greater than unity.

at the national level, only nine are found to grow less quickly, suggesting that the specialist industries in each State fared comparatively well over the period.

Results for the two half periods are presented in Table 3.7 which shows the annual average rate of growth of manufacturing employment in each State. In the first half, four States increased employment with New South Wales and Tasmania being the exceptions. In the second half, only Queensland and Western Australia grew. The results for South Australia are interesting as it had the highest growth rate in the first half but the lowest growth rate in the second half.

TABLE 3.7
AVERAGE ANNUAL RATE OF TOTAL MANUFACTURING
EMPLOYMENT GROWTH BY STATE AND AUSTRALIA FOR
FULL AND HALF PERIODS (per cent)

	1968-69 to 1974-75	1974-75 to 1980-81	1968-69 to 1980-81
NSW	-.84	-1.44	-1.14
VIC	.25	-1.59	-.67
QLD	.64	.63	.64
SA	1.42	-2.35	-.47
WA	1.22	.90	1.06
TAS	-.95	-1.31	-1.12
AUSTRALIA	.02	-1.25	-.63

In brief, Queensland and Western Australia have done comparatively well over the 1970s while Tasmania and New South Wales have done poorly. South Australia's results suggest that the recession of the second half of the 1970s had severe effects there despite the good showing in the first half.

3.3(c) Value Added In State Manufacturing

Real value added and employment follow much the same trends across the States.

Table 3.8 shows the annual average rate of real value added growth by sub-division and by State and for Australia over the

TABLE 3.8
AVERAGE ANNUAL RATE OF REAL VALUE
ADDED GROWTH BY MANUFACTURING SUB-DIVISION
BY STATE AND AUSTRALIA:
1968-69 to 1980-81 (per cent)

IND	NSW	VIC	QLD	SA	WA	TAS	AUST
21 Food	3.01	2.48	4.17*	4.07*	3.80*	2.39*	3.17
23 Textiles	-.23	.14*	-.35	-3.77	-2.84	-2.02*	.14
24 Clothing	-.21	1.42*	.36	5.99	-2.12	4.09	1.01
25 Wood	1.32	.91	1.82*	1.68*	.87*	2.53*	1.35
26 Paper	2.45	2.80	2.82	2.62	3.35*	2.36*	2.65
27 Chemicals	.23*	1.40	3.34	-1.21	.43	-1.80	.73
28 Non metallic minerals	1.77	2.09	5.77*	2.25	1.68*	.28	2.41
29 Basic metal products	1.21*	21.18	4.75	2.09*	12.34*	.03*	3.88
31 Fabricated metals	-.35	.52	2.95*	.50	1.69*	2.81	.82
32 Transport equipment	.68	1.26*	1.23	-.16*	3.71	-1.82	.90
33 Other machinery	1.40*	1.35	5.11	1.27*	6.18	2.88	1.76
34 Misc.	2.72	2.96*	6.34	6.41	9.30	17.93	3.54
TOTAL	1.41	1.72	3.55	1.72	4.55	1.49	1.93

* indicates a sub-division with an ELQ greater than unity

period 1968-69 to 1980-81. Unlike the situation with the employment figures, few negative entries occur and in no State has total value added did not fall in any State. Ranking the States by value added growth gives the same ordering as for employment growth. The only difference between the two is that employment in South Australia grew slightly faster than for Australia while its value added grew slightly more slowly.

As with employment, value added growth has different trends in each half of the period - growth in the first and decline in the second. South Australia's results for value added follow the same trends as those for employment reflecting the harsh effects of the recession upon that State's manufacturing sector.

3.3(d) Capital Stock in the States

Although there are a few studies of the level and composition of capital stock in Australia, no estimates of capital stock in the States is available. As a result, it was necessary to construct a capital stocks series for each manufacturing sub-division in each State. The details of how this was done are given in Appendix 1.

In short, the capital stock series for the States were estimated using the PIM. The initial values of the capital stock in each State were derived from Haig's (1982) results and the annual investment by each sub-division in each State was taken from the censuses of manufacturing establishments. Further, Haig's study also gave the necessary depreciation figures.

Table 3.9 shows the annual average rate of growth of capital stock by sub-division and by State for the period 1968-69 to 1980-81. The most notable feature of this table is

TABLE 3.9
AVERAGE ANNUAL RATE OF GROWTH OF REAL
CAPITAL STOCK BY STATE AND FOR AUSTRALIA:
1968-69 to 1980-81 (per cent)

IND	NSW	VIC	QLD	SA	WA	TAS	AUST
21 Food	4.53	3.59	5.83	5.39	6.82	3.86	4.68
23 Textiles	2.36	2.33	3.06	2.26	4.53	.87	2.32
24 Clothing	1.20	1.46	.75	2.28	1.82	.84	1.36
25 Wood	4.33	3.50	3.95	5.59	4.76	8.27	4.54
26 Paper	2.99	4.19	3.28	3.71	2.66	3.04	3.47
27 Chemicals	2.31	3.94	3.82	2.63	3.76	5.93	3.10
28 Non metallic minerals	3.45	3.51	4.29	3.56	4.41	3.54	3.69
29 Basic metal products	5.23	18.08	10.89	6.33	15.89	4.51	8.20
31 Fabricated metals	3.63	4.44	4.22	-1.21	4.42	3.95	2.13
32 Transport equipment	2.02	4.44	1.04	3.74	1.57	3.90	3.35
33 Other machinery	1.98	2.07	2.52	1.34	3.40	2.89	2.03
34 Misc.	2.83	3.33	4.36	5.51	6.97	12.08	3.45
TOTAL	3.28	3.59	5.03	3.84	7.31	4.10	3.88

the lack of negative entries. This is to be expected as businesses cannot rid themselves of capital as easily as they can labour when economic conditions turn sour. Instead, the stock, or parts of it, may remain idle for the duration of a recession. As the capital stock figures presented in table 3.11 have not been adjusted to show their level of utilisation, this effect is not reflected in the data. Such adjustments however appear to change the characteristics of the data little.

Capital stock in manufacturing rose fastest in Western Australia followed by Queensland. Surprisingly, because of its poor performance in employment and value added growth, Tasmania had the third highest capital stock growth rate. The three other State's capital stocks grew less quickly than the national average.

In all, the results from all three measures of economic growth appear to tell a similar story. In most cases the ranking of the States remains the same, with the exception of the Tasmanian capital stock results. Generally Western Australia and Queensland grew faster than the national average while South Australia appears to have closely followed the national trends but has been hard hit by the recession in the second half of the 1970s. The results for the remaining three States are poor with Tasmania and New South Wales at the lower end.

3.4 Comparing Location Measures and Growth Performance

Many of the measures used to describe the pattern of industrial location and regional specialisation are merely descriptive devices used to summarize the major trends in the distribution of activity. One measure, the ELQ, has been used as a measure of industrial specialisation by a region. It is to the value of this practice that we now draw attention.

Specialists are deemed to be people or groups who do their job well as a result of devoting more of their attention to that job than others normally do. Certainly the second half of this criterion for speciality fits with the use of the ELQ as a measure of regional specialisation, but what of the first?

When presenting the results of employment growth in each State, attention was drawn to the performance of the specialised industries. In most cases these industries did perform well. As noted earlier, of the twenty-seven industries noted as being specialists in different States, only nine grew less quickly than the national average.

Another way of examining this question is to compare the productivity of each sub-division in each State to the ELQ measurement. It would be reasonable to expect that specialist industries would have high productivity levels in States which specialise in them compared to other States.

Table 3.10 presents normalised productivity (value added per employee) measures for each State by manufacturing sub-division for 1980-81. All estimates have been normalised

TABLE 3.10
NORMALISED PRODUCTIVITY BY INDUSTRY SUB-DIVISION
AND STATE: 1980-81

IND AUST	NSW	VIC	QLD	SA	WA	TAS
21 Food	.97	1.02	1.11*	.89*	.92*	.89*
23 Clothing	1.10	.98*	.71	1.00	.90	.92*
24 Textiles	.96	1.05*	.86	.90	.74	1.11
25 Wood	1.03	.98	.91*	.93*	1.00*	1.39*
26 Paper	1.02	1.03	.88	.90	.83*	1.18*
27 Chemicals	.98	.99	1.55	.75	.75	.70
28 Non metallic minerals	.99	.96	1.15*	1.01	.94*	1.00
29 Basic metal products	.85	1.06	1.42	.79*	2.08*	1.07*
31 Fabricated metals	1.01	1.03	.98*	.96	.96*	.85
32 Transport equipment	1.00	.95*	1.00	1.18*	.87	.94
33 Other machinery	.92*	1.24	.89	.84*	.99	.73
34 Misc.	.98	1.04	.98	.90	1.04	1.11
TOTAL	1.00	.98	1.07	.92	1.12	1.08

around the average Australian productivity for each sub-division in order to allow direct comparison across the States. For example, the Food sub-division in Queensland has a normalised productivity measure of 1.11 which means that its productivity is 11 per cent above the Australian average for the food sub-division. As with earlier tables, each sub-division with an ELQ greater than unity is indicated by an asterix.

Productivity varies significantly across the States both in total manufacturing and at the sub-division level. The reasons for these variations are not clear but partly may be because the industrial classification used here is not homogenous. If each was homogeneous we would not expect such large values as are recorded in the table, especially for the Basic metal products sub-divisions in Queensland and Tasmania where values of 1.42 and 2.08 are recorded. Even if each sub-division were homogeneous, this would not in itself guarantee equal productivity across States as, for example, the efficiency of management and general economic conditions may vary from State to State.

Comparing productivity between States which specialise in an industry and those which do not specialise provides a different result to the growth criterion. Of the twenty-seven cases where a State specialises in an industry, seventeen have productivity levels less than the Australian average for their industry. Given the provisos placed on the comparability of the productivity measures, it is difficult to interpret this

result. One may be tempted to suggest that the majority of the specialist industries are in a precarious position because of their low relative productivity but the growth performance of these industries suggests otherwise.

One conclusion that can be reached is that regions do not specialise only, or even mainly, in those industries where they are efficient. The reasons for this are not obvious but part of the explanation may be that if an industry is efficient, then it requires fewer people to produce a given output than if it were less efficient. The ELQ measure has been based on employment data and if efficient industries require fewer employees than the national average, they will obtain a low ELQ. Industries that are under-represented but have productivity levels equal to the national average would also have a low ELQ. The ELQ then may be unable to distinguish between efficient and inefficient industries but still remains one way of examining specialisation by a region.

3.5 Conclusions

This chapter has examined the location of manufacturing employment at the State level and described its growth in each State. Generally it was found that there were differences in the growth rates of each State with Queensland and Western Australia faring much better than the other States. This lead to a small but noticeable change in the distribution of

manufacturing employment away from Victoria and especially New South Wales.

Few industries have location patterns significantly different from the national average. Some recent changes have been noticed with the Basic metal products industry becoming more like the national distribution and the Transport equipment industry concentrating increasingly in Victoria.

It was also apparent that most of the change in the distribution of manufacturing activity occurred in the first half of the period, suggesting that the recession had lessened the rate of change in the geographic distribution of activity. Nevertheless South Australia, whose manufacturing employment grew rapidly in the first half of the seventies was particularly hard hit by the depressed conditions of the second half.

Another common feature is that each State appeared to have faced two separate growth phases with the first half of the period being one of positive growth and the second being one of decline. These two phases will be incorporated into later chapters when the reasons for State growth are examined, as the relative importance of different factors may change between the two phases.

In the following chapters, the growth experience of the States described in this chapter will be examined in a number of

ways. The next chapter examines whether the industrial structure of the States helps to explain their varying performance while later chapters examine the sensitivity of growth to the supply of inputs and to the pressure of demand.

NOTES TO CHAPTER 3

1. Australia is defined in this chapter and elsewhere as the six State sum. The ACT and Northern Territory are ignored.
2. In a study of Australia industrial development, the Bureau of Industry Economics (1981, appendix 1) identified these as the major contributors of employment change in manufacturing over the period 1968-69 to 1975-76.

TABLE A3.1

STATE DISTRIBUTION OF EMPLOYMENT IN EACH
MANUFACTURING SUB-DIVISION:
1968-69, 1974-75 and 1980-81 (per cent)

State	Year 1968-69	1974-75	1980-81
<u>21 - Food</u>			
NSW	33.84	32.57	32.27
VIC	31.12	31.04	30.41
QLD	16.80	16.85	17.99
SA	8.34	9.25	9.48
WA	6.41	7.16	6.67
TAS	3.48	3.13	3.18
<u>23 - Textiles</u>			
NSW	34.41	30.97	29.37
VIC	48.72	53.06	53.25
QLD	3.79	3.14	3.63
SA	5.19	5.56	6.99
WA	1.41	1.28	2.10
TAS	6.47	5.99	4.67
<u>24 - CLOTHING</u>			
NSW	36.40	33.70	32.09
VIC	52.34	54.36	55.36
QLD	6.02	5.37	5.05
SA	3.33	4.51	5.34
WA	1.61	1.77	1.89
TAS	.29	.29	.27
<u>25 - WOOD</u>			
NSW	33.73	33.39	34.69
VIC	23.85	24.65	24.92
QLD	15.47	15.01	15.96
SA	8.54	11.24	9.91
WA	13.01	9.85	9.76
TAS	5.39	5.87	4.77
<u>26 - Paper</u>			
NSW	40.68	38.96	38.13
VIC	33.42	33.61	33.31
QLD	8.67	9.19	9.19
SA	6.68	7.16	7.57
WA	4.87	5.57	6.33
TAS	5.69	5.51	5.48

TABLE A3.1
(Continued)
STATE DISTRIBUTION OF EMPLOYMENT IN EACH
MANUFACTURING SUB-DIVISION:
1968-69, 1974-75 and 1980-81 (per cent)

State	Year 1968-69	1974-75	1980-81
<u>27 - Chemicals</u>			
NSW	48.40	49.17	49.43
VIC	34.43	33.97	33.46
QLD	4.64	5.32	5.13
SA	5.32	4.50	4.94
WA	5.04	4.94	5.28
TAS	2.17	2.11	1.76
<u>28 - Non metallic minerals</u>			
NSW	41.88	40.48	37.47
VIC	27.46	27.63	27.34
QLD	11.22	11.35	14.70
SA	7.73	8.27	7.88
WA	9.54	10.23	10.78
TAS	2.17	2.04	1.83
<u>29 - Basic metal products</u>			
NSW	64.77	60.12	58.62
VIC	12.17	13.34	14.70
QLD	3.85	6.01	6.50
SA	10.33	10.60	9.91
WA	4.20	6.27	6.46
TAS	4.68	3.67	3.81
<u>31 - Fabricated metals</u>			
NSW	40.79	38.10	38.12
VIC	32.79	34.48	32.05
QLD	9.43	9.51	12.06
SA	8.84	9.27	7.86
WA	6.83	7.30	8.16
TAS	1.32	1.34	1.74
<u>32 - Transport equipment</u>			
NSW	31.71	27.89	27.61
VIC	37.22	41.88	44.22
QLD	9.08	7.74	9.17
SA	18.01	18.22	14.10
WA	3.12	3.47	4.39
TAS	.85	.80	.51

TABLE A3.1
(Continued)
STATE DISTRIBUTION OF EMPLOYMENT IN EACH
MANUFACTURING SUB-DIVISION:
1968-69, 1974-75 and 1980-81 (per cent)

State	Year	1968-69	1974-75	1980-81
<u>33 - Other machinery</u>				
NSW		47.05	44.38	48.10
VIC		33.83	35.49	28.08
QLD		4.53	5.62	6.63
SA		10.86	10.59	11.02
WA		3.26	3.46	5.50
TAS		.48	.46	.66
<u>34 - Miscellaneous</u>				
NSW		42.32	40.22	38.24
VIC		43.62	42.48	41.24
QLD		5.11	5.69	6.79
SA		6.43	8.41	9.17
WA		2.31	2.80	3.89
TAS		.20	.40	.67
<u>TOTAL MANUFACTURING</u>				
NSW		40.66	38.66	38.74
VIC		34.59	35.17	33.76
QLD		8.56	8.90	10.00
SA		9.04	9.85	9.31
WA		4.68	5.08	5.83
TAS		2.47	2.34	2.36

TABLE A3.2
COEFFICIENT OF LOCATION^a BY MANUFACTURING
SUB-DIVISION: 1968-69, 1974-75 and 1980-81

Sub-division	1968-69	1974-75	1980-81
21 Food	.1099	.1082	.0982
23 Textiles	.1813	.2154	.2179
24 Clothing	.1775	.1919	.2160
25 Wood	.1817	.1580	.1290
26 Paper	.0353	.0424	.0362
27 Chemicals	.0810	.1051	.1069
28 Non metallic minerals	.0874	.0941	.0965
29 Basic metal products	.2761	.2473	.2256
31 Fabricated metals	.0315	.0283	.0440
32 Transport equipment	.1213	.1508	.1525
33 Other machinery	.0821	.0678	.1107
34 Misc.	.1069	.0887	.0748

a The Coefficient of Location is measured as

$$CL_i = \frac{1}{2} \sum_S \left| \left(\frac{N_{is}}{N_i} \right) - \left(\frac{N_s}{N} \right) \right|$$

The Coefficient of Location varies between zero and unity. For an industry to have a coefficient equal to zero, the proportion of State manufacturing employment accounted for by that industry (N_{is}/N_i) must be the same as the States' shares of the Australian manufacturing workforce. As the coefficient approaches unity, the industry's location pattern becomes more unlike that of total manufacturing.

TABLE A3.3
DISTRIBUTION OF MANUFACTURING EMPLOYMENT
BY INDUSTRY SUB-DIVISION BY STATE:
1968-69 (per cent)

[illegible]

TABLE A3.3 (Continued)

DISTRIBUTION OF MANUFACTURING EMPLOYMENT
BY SUB-DIVISION BY STATE: 1974-75 (per cent)

[illegible]

TABLE A3.3 (Continued)
DISTRIBUTION OF MANUFACTURING EMPLOYMENT BY
SUBDIVISION BY STATE: 1980-81 (per cent)

[illegible]

TABLE A3.4
COEFFICIENT OF REGIONAL SPECIALIZATION^a
BY STATE: 1968-69, 1974-75 and 1980-81

State	Year 1968-69	1974-75	1980-81
NSW	.0784	.0847	.0904
VIC	.0947	.0977	.1136
QLD	.2119	.1956	.1979
SA	.1574	.1313	.0995
WA	.2267	.1997	.1377
TAS	.3807	.3610	.3334

a The Coefficient of Regional Specialisation is calculated as:

$$CRS_s = \frac{1}{2} \sum_i \left| \left(\frac{N_{is}}{N_s} \right) - \left(\frac{N_i}{N} \right) \right|$$

The CRS varies between zero and unity; zero if there is no difference between the proportion of employment in an industry in the State and the nation and unity if no employment is common.

CHAPTER 4 A MODIFIED SHIFT AND SHARE ANALYSIS OF
STATE MANUFACTURING GROWTH

4.1 Introduction

A method commonly used in analysing the economic growth of regions is shift and share analysis. Basically the method attempts to divide the growth of a region into three parts. One part presumes that the region will grow at the same rate as the nation (hence the region's share of national growth), another makes the assumption that a region will grow more or less quickly than the nation due to the relative representation of fast or slow growing industries within the region and the final part attempts to identify differential growth between the nation and the region once the previous two influences have been taken into account.

In this chapter a modified shift and share analysis of employment growth in the Australian States is presented in an attempt to discern whether the industrial composition of the States has had any influence upon their relative employment growth.

These results do not actually explain growth in the States but provide a test of alternative hypotheses. The first is that industries tend to grow at much the same rate regardless of their location while the second is that regions grow rapidly or

slowly regardless of their industrial composition and more as a result of region-specific factors. If the first hypothesis is supported, then regional growth can be explained by industrial composition. If the second hypothesis is supported, attention must be focused upon factors other than industrial composition.

Section 2 describes the methodology of shift and share analysis while Section 3 outlines the major criticisms of this technique and introduces the modified shift and share equations. Section 4 presents the results of the various shift and share type studies and Section 5 concludes the chapter suggesting that more sophisticated techniques for explaining the growth of the States need to be examined.

4.2 The Methodology of shift and share analysis

Shift and share analysis is one of the most commonly used methods in examining the growth performance of regional economies. Basically the method compares the growth of a region to that of the nation and attempts to explain the differences that arise by examining the industrial structure of the region. Regions well endowed with industries that have growth rates greater than the national average can be expected to grow faster than the nation. Conversely, regions heavily dependant upon industries that are declining or growing less quickly than the national average can be expected to grow less quickly than the nation.

The first part of the analysis is to determine the region's share of national growth. If national employment grew, for example, at 10 per cent over the period being examined, then it is assumed that each region is entitled to a ten per cent growth in employment as its share of national growth. Any difference between the national and regional growth rate - the shift component - is then examined.

The difference between national and regional growth rates is explained by two components. The first depends on the industrial structure of the region and is called, variously, the industrial mix (Stilwell 1974), structural component (Vipond and Forward 1978) and proportional shift (Richardson 1978), effect. Calculation of this component requires an examination of the relative growth rates of each industry at the national level and identifies fast and slow growth industries. If, for example, an industry had employment growth at the national level of 17 per cent and the growth of total employment in the nation was 10 per cent, then this industry has a growth rate 7 per cent above the national average. Obviously, *ceteris paribus*, a region heavily dependent upon this industry can be expected to grow more quickly than the nation as a whole. Conversely some industries grow less quickly than the national average and may provide an explanation for slow growth by a region. By adding this component for each industry in the region, the industrial mix effect can be calculated. Formally, the industrial mix effect is:

$$IM_R = (E_{ir} * (G_{in} - G_n)) \quad (4.1)$$

where IM_R = the industrial mix effect in region r;
 E_{ir} = employment in the base period in industry i
in region r;
 G_{in} = the growth rate of employment in industry i
in the nation;
and G_n = the growth rate of total employment in the
nation.

The second factor accounting for differences between the national and regional growth rate is called either the competitive shift (Vipond and Forward 1978) or the differentiaial effect (Stilwell 1974 and Richardson 1978). While writers in the field have produced formula type explanations of the competitive shift effect, it is essentially a residual found by subtracting the industrial mix effect from the difference between national and regional growth. The competitive shift consists of each industry's employment in the region in the base period multiplied by the difference between the actual regional growth of employment in that industry and the national growth rate of the industry.

These components are used in an attempt to explain regional growth. Where the industrial mix effect for a region is positive, it is claimed that a region has an industrial structure conducive to growth. Where negative, the region is considered disabled by its industrial structure. The competitive shift effect is said to reflect the comparative advantage of the region. Where positive, advantages are said to

occur; where negative disadvantages. This component can be said to be due to any influence in the region that affects the relative growth of industries in a particular region compared with other regions. This includes differences in the composition of the industry (ie. differing activities of particular industries found between regions), economies or diseconomies of city size, lack of entrepreneurship, poor input-output linkages with the rest of the economy due to isolation and a native ability to do particular jobs well.

Despite the apparently neat construction of shift and share analysis, several important criticisms of it have been made. These are the subject of the following section.

4.3 Criticisms of Shift and Share

One great weakness of using shift and share methods to examine growth in the Australian States results from the dominance of New South Wales and Victoria. As has been noted in Chapter 3, over 70 per cent of total manufacturing employment and well over 50 per cent of employment in each manufacturing sub-division is accounted for by New South Wales and Victoria. As a result, the Australian growth figures are largely determined by experiences in New South Wales and Victoria so that industries which grow rapidly there will be growth industries in Australia and vice versa.

This all pervading effect of Australian manufacturing location could be expected to have important effects upon the results of a shift and share analysis of State growth as we would expect the shift effect (the difference between the national and the State results) to be smaller in New South Wales and Victoria than in the other States. Further, we would expect the industrial mix effect to be the major component of this difference in New South Wales and Victoria. Subsequently we could not expect to find large competitive shifts in these states purely because of this statistical or definitional regularity. This gives the gist of the argument presented by Vipond and Forward (1978), but as the results to be presented later show, this is not necessarily the case.

Stilwell (1974, p.72) claims to have found at least some of this effect when studying total economic growth in the Australian States, finding a small shift effect in Sydney relative to the other State capitals, but the shift effect in Tasmania is smaller (6.9 per cent in Sydney compared to 4.4 in Hobart). We will find this result repeated in this chapter. (see table 4.1).

The argument that growth industries in the large States will be growth industries in the nation would lead one to expect that the industrial mix effect would be larger than the differential effect in the large States. In Stilwell's study this is found to be the case as the absolute values of the industrial mix effect in Sydney and Melbourne follow this

pattern. This regularity, however, is broken when Stilwell's results are aggregated to the State level¹ as then the differential effect is greater in New South Wales. Again we will find the same result later in this chapter.

One qualification of particular importance to this paper is that the results obtained from shift and share analysis depend to a large degree on the level of industrial disaggregation used. This has been noted by several writers (Buck 1970, Randall 1973, Stilwell 1970 and 1974 and Vipind and Forward 1978). To demonstrate the effects on industrial classification, some figurative analysis is helpful.

Consider the case where all employment is grouped into one industry in several regions. It is possible for employment in this industry to grow at different rates in each region, so there would be a shift component to be distributed across the industrial mix and competitive effects. Clearly, however, there could not be an industrial mix effect as growth in this one industry is equal to growth in the nation. Returning to equation (4.2) above this means that $G_{in} = G_n$. All of the relative change in employment is accounted for by the competitive factor. As the level of disaggregation becomes finer, the industrial mix effect starts to appear.

No matter what level of aggregation is chosen, the total shift figure must remain the same. Changes in the level of aggregation therefore affect the relative sizes of the

industrial mix and differential components. When one rises the other must fall because they must sum to the total shift figure. Despite this inverse relationship, it is not necessarily true that there is a direct correlation between the level of industrial disaggregation and the importance of the industrial mix effect.

When moving from a coarse to a fine level of industrial aggregation, there can occur wide variations in the growth rates of sub-sectors within an industry. If a region happens to concentrate upon a sub-sector of an industry which has behaved differently from the other sub-divisions and from its parent aggregate, then there will be a redistribution between the industrial mix and differential effects. The direction of this redistribution depends both upon the industrial structure of the region and on the differential growth rates between sub-sectors of an industry.

Is there an appropriate level of disaggregation for calculating shift and share components? Berzeg (1978) has suggested a method for testing the sensitivity of shift and share techniques when different levels of industrial aggregation are available. Basically, he suggests that if the sum of the squares of error between the growth rate predicted by the industrial mix effect in shift and share and the actual growth rate is calculated for each level of industrial aggregation, then the results can be compared in a manner similar to an F test in econometrics. If the sums of square of error change

significantly between successively finer levels of industrial aggregation, then Berzeg claims that this shows the finer level of aggregation to be more suitable than the less fine.

Fothergill and Gudgin (1979) examined the effects of the level of industrial aggregation upon the results of shift and share analysis and found in their one-off example that movement from a broad to a fine level of aggregation made only a small difference to the results of their analysis.

In this study manufacturing employment has been broken into twelve industry sub-divisions. Only at this level of aggregation could a consistent industrial classification be obtained for the entire study period without resorting to an enormous data collecting exercise.

Perhaps a more pertinent question is whether this criticism is relevant. The level of disaggregation that we choose to examine any phenomenon necessarily affects our view of what has happened. This is not a new problem affecting only shift and share exercises. The size of input-output multipliers, for example, are affected by the level of industrial aggregation chosen (see ABS1).

Concern is shown by some writers (e.g. Richardson 1978) that this property of shift and share analysis helps unscrupulous researchers to 'cook' their results, but it is

probably true that this is a weakness of many other methods of analysis. This criticism would seem to hold water only if the system is used to draw precise conclusions rather than using the results to test the hypothesis that industrial composition largely explains regional growth and to guide further analysis. Where this is the case, data constraints and the requirements of the further techniques may dictate the level of industrial aggregation.

A further criticism of the system is the sensitivity of results to the time period of the analysis. Vipond and Forward (1978), in their study of shift and share analysis in Australia, have shown that separate studies, performed over different time periods, for the same areas have given different results. This suggests that the results obtained through shift and share analysis are unstable. Again, it is useful to examine this criticism more fully.

The previous chapter examined the growth of the Australian States between 1968-69 and 1980-81 and the sub-periods 1968-69 to 1974-75 and 1974-75 to 1980-81. Major differences in the growth of each industry and for total employment across States were noted. Obviously a shift and share analysis of each separate period would provide different results. It is possible that the results in each separate period may faithfully reflect something of what was happening in each period.

This may be reasonable in times when there are large fluctuations in economic activity. Vipond and Forward's example

is drawn from two studies of the six State capitals between 1954 and 1966 (from Stilwell 1974) and the sub-periods 1954 to 1961 and 1961 to 1966 (from Kerr 1974). This was a time of fairly constant growth. The two studies show reversal of sign on the competitive shift effect over the sub-periods in five of the six State capitals.

If the results of shift and share analysis are to be used to test the alternate hypotheses, then sign reversal on either of the shift components is of little consequence. What is more important is the relative magnitudes of the composition and competitive effects. It is only when shift and share analysis is used to explain growth that sign reversal becomes a problem.

Another criticism of shift and share analysis is given by Dixon and Thirlwall (1975). They point out that shift and share analysis uses a mixture of regional and national weights in its calculations. In order to show this it will be necessary to trace the explanations behind shift and share in another way.

The growth of the nation, or any region, is composed of the growth of each individual industry in the nation, or region, weighted by the relative importance of these industries. For the nation, growth can be represented as:

$$G_n = \sum R_{in} P_{in} \quad (4.2)$$

where G_n = growth of the nation;
 R_{in} = growth rate of industry i in the nation;
 and P_{in} = the proportional representation of industry i
 in the nation.

Similarly, State growth can be represented as:

$$G_s = R_{is} P_{is} \quad (4.3)$$

where G_s = growth of the State;
 R_{is} = growth rate of industry i in State S;
 and P_{is} = the proportional representation of industry i
 in the State S.

Clearly the growth rate of a State will vary from that of the nation (i.e. $G_s = G_n$) because either the growth rate of industries in the State differ from that of the nation ($R_{is} = R_{in}$) or because the relative importance of industries differ ($P_{is} = P_{in}$). Variations in growth between the region and the nation can be analysed through the difference between national and State growth (i.e. $G_n - G_r$).

Noting these possible sources of difference between State and national growth, it is possible to compare the growth rate of the nation and the State by assuming hypothetical situations for the State. By assuming that all industries in the State grow at the same rate as those in the nation, the 'rate-constant' growth rate can be calculated. This is:

$$RC_s = R_{in} P_{is} \quad (4.4)$$

Similarly, the State can be assumed to have the same industrial composition as that of the nation. This yields the 'composition-constant' growth rate of the State and is calculated as:

$$CC_s = R_{is} P_{in} \quad (4.5)$$

The estimated contribution of these two factors to the total difference between State and national growth will depend upon the weights one attributes to each factor. Five possible weighting systems are available. These are:

$$G_s - G_n = \sum_i R_{is} (P_{is} - P_{in}) + \sum_i P_{in} (R_{is} - R_{in}) \quad (4.6)$$

$$G_s - G_n = \sum_i R_{in} (P_{is} - P_{in}) + \sum_i P_{is} (R_{is} - R_{in}) \quad (4.7)$$

$$G_s - G_n = \sum_i R_{is} (P_{is} - P_{in}) + \sum_i P_{is} (R_{is} - R_{in}) + \sum_i (P_{is} - P_{in})(R_{in} - R_{is}) \quad (4.8)$$

$$G_s - G_n = \sum_i R_{in} (P_{is} - P_{in}) + \sum_i P_{in} (R_{is} - R_{in}) + \sum_i (P_{in} - P_{is})(R_{in} - R_{is}) \quad (4.9)$$

$$G_s - G_n = \sum_i \frac{1}{2} (R_{is} + R_{in}) (P_{is} - P_{in}) + \sum_i \frac{1}{2} (P_{is} + P_{in}) (R_{is} - R_{in}) \quad (4.10)$$

Note that in each equation the first term shows the effect of differences between the industrial composition of the State and the nation (the composition effect) and the second gives the

effect of differential industrial growth rates between the State and the nation (the growth effect).

Equations (4.6) and (4.9) equate difference between regional and national growth to differences in the industrial composition and growth rates using a mixture of State and national weights. This completely exhausts the difference. Equation (4.7) is the normal method of calculating shift and share components.

Equations (4.8) and (4.9) differ from the earlier equations by using either exclusively regional weights in (4.8) or national weights in (4.9). This method brings to light the presence of a third factor ignored by shift and share calculations - an interaction term representing the joint impacts of the growth and composition effects.

Shift and share analysis implies that there is no inter relationship between the growth and composition effects, so each industry within a region is assumed to be independent. Input-output linkages between firms in a region are not seen as important in explaining or classifying the growth experience of regions. For example, a low growth rate in a region could be partly due to the structure of that region whereby industries that at the national level are seen to be doing well, perform badly because they are supplying goods to depressed industries which may be highly represented in the region. The only form of interdependence between structure and growth that the standardisation procedures can take account of, is that arising

as a result of specialisation in an activity by a region. This specialisation may arise from acquired advantages, lower costs or many other factors. In Chapter 4, it was noted that sub-divisions with an Employment Location Quotient greater than unity generally grew faster than the national average for that sub-division, adding weight to the arguments for including this element in shift and share analyses.

A negative sign for the interaction term in equation (5.8) indicates a positive relationship between State specialisation and the difference between State and national growth. A positive sign for the interaction term in equation (5.9) indicates a positive relation between structure and growth.

Although equations (5.8) and (5.9) include an interaction effect, each equation uses a different set of weights. There is no reason to prefer either weighting system and so if the interaction effects are not seen as important, equation (5.10) may be the most useful way of examining regional growth. Equation (5.10) simply applies the mean of national and regional weights to the growth and composition effects.

This issue of weighting displays one of the greater weaknesses of shift and share analysis. By mixing regional and national weights, interaction effects are ignored. Further the popular method of calculating shift and share components is one of five possible methods. This weakens the view of the method as a neat accounting identity.

Most of the criticisms of shift and share analysis are directed at it when used as a method of explaining regional growth. With the exception of the weighting problem, it has been argued that none of these detract from the value of shift and share as a hypothesis testing device. It is in this way that the following modified shift and share results are to be used.

4.4 Various Shift and Share Results of State Manufacturing Growth

Table 4.1 presents estimates of the growth and composition effects of State employment growth in manufacturing for the period 1968-69 to 1980-81 using equation (4.7). This is equivalent to the often used shift and share analysis, with the composition effect being equivalent to the industrial mix effect and the growth effect being equivalent to the competitive effect.

As with most studies of this kind, the growth effect dominates. In five of the six States the growth effect was greater than the composition effect. It was mentioned earlier that due to the large shares of New South Wales and Victoria in the national results, the difference between national and those State results should be comparatively small and the composition effect should dominate results in these States. Whilst this is true for Victoria, the results for New South Wales show the

growth effect dominating. Furthermore, the total difference between the State and national results for New South Wales is greater than those for South Australia and Tasmania.

TABLE 4.1

ESTIMATES OF GROWTH AND COMPOSITION EFFECTS

USING EQUATION 5.7: 1968-69 to 1980-81

(per cent per annum)

State	Composition Effect	Growth Effect	Difference between State and National employment growth
NSW	.72	-5.27	-4.55
VIC	-2.88	.75	-2.14
QLD	3.03	13.06	16.09
SA	1.26	1.47	2.73
WA	4.55	17.01	21.56
TAS	3.98	-8.38	-4.40

By using only regional weights, an interaction term is introduced. Table 4.2 presents the results obtained by using equation (4.8). It can be seen that the original composition effect is the same as in Table 4.1 but with the inclusion of the

interaction effect, some of the growth effect is redistributed towards the 'adjusted' composition effect thus changing the growth effect.

TABLE 4.2

ESTIMATES OF GROWTH, COMPOSITION, INTERACTION AND
ADJUSTED COMPOSITION EFFECTS
USING EQUATION 5.8: 1968-69 to 1980-81
(per cent per annum)

State	Composition Effect	Interaction Effect	Adjusted Composition Effect	Growth Effect	Difference between State and national employment growth
NSW	.72	.12	.84	-5.39	-4.55
VIC	-2.88	-.65	-3.53	1.40	-2.14
QLD	3.03	-4.52	-1.49	17.58	16.09
SA	1.26	-6.05	-4.79	7.52	2.73
WA	4.55	-9.86	-5.31	26.87	21.56
TAS	3.98	-17.51	-13.53	9.14	-4.40

The interaction effect attempts to identify factors in the growth of a region that are due indirectly to its industrial structure. As a result, it is appropriate to add it to the composition effect. A positive interaction component suggests that such things as input-output linkages between industries in a region served to help that region's performance. A negative interaction effect suggests poor linkages between industries in a region. If the interaction effect were added to the growth effect, the results become identical to Table 4.1.

The table suggests that interaction effects were of little importance in the two major States of New South Wales and Victoria and of more importance in the smaller States, but this would be a misleading conclusion to draw if we keep in mind the comments about the effect of regional size upon the results of shift and share type studies. What does seem apparent is that only in New South Wales has the interaction effect been beneficial to economic growth.

Despite these adjustments, only in Tasmania does the relative importance of the two effects change, with the composition effect now outweighing the growth effect. In both those States where the composition effect dominates, Victoria and Tasmania, the results suggest that their industrial structure may explain their comparatively slow manufacturing growth.

Table 4.3 sidesteps the problem of weighting and the distribution of the interaction effect by using equation (4.10) which averages the interaction effect between the growth and composition effects. Again four of the six States have dominant growth effects with Victoria and Tasmania remaining the exceptions.

Dixon and Thirlwall expressed a preference for equation (4.10) in using shift and share approaches precisely because it sidesteps the weighting and distribution issues, so it is to this equation that we turn to examine the two half periods.

TABLE 4.3

ESTIMATES OF THE COMPOSITION AND GROWTH EFFECTS
 USING EQUATION 4.10: 1968-69 to 1980-81
 (per cent per annum)

State	Composition Effect	Growth Effect	Difference between State and national employment growth
NSW	.78	-5.33	-4.55
VIC	-3.21	1.07	-2.14
QLD	.77	15.32	16.09
SA	-1.76	4.49	2.73
WA	-.38	21.94	21.56
TAS	-4.78	.38	-4.40

Tables 4.4 and 4.5 show the results of applying equation (4.10) to the manufacturing growth of the States over the two half periods. In each period the growth effect dominates. In the full period four of the six States have a growth effect larger than a composition effect. In the first half this becomes five and in the second half, all six.

There are some differences between the tables as sign reversal on both the composition and growth effects is common. It has been argued above, however, that it is the relative magnitudes of these effects, and not their signs, which is important.

TABLE 4.4

ESTIMATES OF THE COMPOSITION AND GROWTH EFFECTS
 USING EQUATION 4.10: 1968-69 to 1974-75
 (per cent per annum)

State	Composition Effect	Growth Effect	Difference between State and National employment growth
NSW	.81	-5.65	-4.83
VIC	-2.35	3.97	1.62
QLD	-.74	4.67	3.94
SA	1.30	7.53	8.83
WA	.25	8.22	8.48
TAS	-2.91	-2.55	-5.46

TABLE 4.5

ESTIMATES OF THE COMPOSITION AND GROWTH EFFECTS
 USING EQUATION 4.10: 1974-75 to 1980-81
 (per cent per annum)

State	Composition Effect	Growth Effect	Difference between State and national employment growth
NSW	.13	-.24	-.11
VIC	-1.13	-2.44	-3.57
QLD	1.50	10.52	12.02
SA	-2.26	-2.68	-4.94
WA	-.62	13.33	12.72
TAS	-.20	.86	.65

The results presented here display several of the regularities which were noted earlier in the chapter. Most important is the dominance of the growth effect in each period. this finding suggests that in order to examine the factors affecting manufacturing growth in the Australian States, attention must be focused upon factors other than their industrial structure.

4.5 Conclusions

This chapter has examined the growth differentials in manufacturing between Australia and its States using a modified shift and share technique. Many of the criticisms of this technique have been addressed before the results were presented so that they could be interpreted in the light of their limitations. Several of these criticisms were found to be relevant only if the results of shift and share type analyses are used to explain regional growth. When shift and share is used as a means of testing some alternative hypotheses, only those criticisms concerning the level of industrial aggregation and the weighting system appear to be important. Given these qualifications, the results suggest that manufacturing growth in the Australian States cannot be explained by their industrial structure. Other factors must be examined.

The results presented in this chapter and the discussion that preceeds them should not be dismissed as unimportant.

Chapter 2 noted that at least one model of the Australian economy has been disaggregated to the State and Statistical Division levels using the industrial structure of these areas as the major explanator. The arguments presented here and the dominance of the growth effect suggest that this may be inappropriate. Further, one solution to State and regional unemployment and growth problems commonly touted is the establishment of high growth industries in particular areas. The proposals for high technology parks and of attracting sunrise industries to depressed areas become, in the light of the arguments raised earlier, less of a panacea. To find solutions to these problems we must turn to explanations of regional growth other than the industrial structure argument.

NOTES TO CHAPTER 4

1. Stilwell's study identifies three areas in each State - metropolitan, other urban and rural. The relevant State results are obtained simply by adding the results in persons (not percentages) for each State across these three areas.

CHAPTER 5 A SUPPLY ORIENTED EXPLANATION OF MANUFACTURING GROWTH
IN THE AUSTRALIAN STATES

5.1 Introduction

Earlier chapters have described the location of manufacturing industry and the growth of manufacturing in the Australian States. It was found that most manufacturing activity is located in New South Wales and Victoria and that Tasmania is the most specialised State. Despite the generally low levels of specialisation by the mainland States, very different growth experiences occurred in each. Queensland and Western Australia were seen to fare better than the Australian average, which may be due to the effects of the resources boom upon these States. The other States generally performed below the Australian average, with New South Wales and Tasmania having the lowest growth figures and South Australia being particularly hard hit by the onset of the recession in the second half of the 1970s.

The previous chapter presented the results of a modified shift and share analysis of total manufacturing growth in each of the States. It was found that the industry structure of the States did not provide an adequate explanation of their growth experiences. States with above average manufacturing growth were not found to have above average representation of high growth industries and vice versa.

This chapter turns to a supply oriented explanation of manufacturing growth in the Australian States based largely upon the simple neoclassical explanation outlined in Chapter 2. At the heart of this explanation lies the production function, which attempts to relate the output of an economic unit to the amount of capital and labour that it employs. This chapter estimates the Cobb-Douglas production function for total manufacturing and for each manufacturing sub-division in the States and relates this to their growth experiences. In the course of this investigation, the production functions for each State will be compared to see if they differ significantly. This chapter will not attempt to model factor movements, which some consider to be very important in explaining regional economic growth, because the concern here is only with manufacturing and not total State economic growth and because it is not absolutely necessary to do so for a supply oriented explanation of economic growth.

This chapter is structured as follows. Following this introduction, section 2 surveys the previous use of production functions and the criticisms of them. Section 3 explains why the Cobb-Douglas production function will be used in this chapter and section 4 reviews the estimation of production functions at the regional level. Section 5 concludes the chapter, reiterating the main points and foreshadowing the next.

5.2 The Use and Limitations of Production Functions

Several types of production function are available, each of which places a different restriction upon the parameters of the function. Intrilligator (1978) and Woodland (1976) provide descriptions of various production functions and their previous use. Bosworth (1976) also provides an extensive analysis of the theory behind and the use of production functions, paying particular attention to vintage formulations.

Production functions usually vary based upon the restriction placed on the elasticity of substitution between the factors of production. Three functions of particular interest are the Cobb-Douglas, Constant Elasticity of Substitution (CES) and Variable Elasticity of Substitution (VES) production functions. In the Cob-Douglas production function the elasticity of substitution is restricted to equal unity, while in the CES function this elasticity is assumed to be constant over time and between economic units but can differ from unity. The VES function allows the elasticity of substitution to change over time and economic units according to the relative levels of factor inputs.

Production functions are usually estimated for nations or industries at the national level either to examine the characteristics of production in an industry or an economy, or as will be the case in this chapter, to examine the growth experience of an economic unit. Caddy (1978) provides a review

of studies that estimate production functions for industries at the national level using either time series or cross-sectional data.

Denison (1967) produced a lengthy study of growth in the United States and in Western European countries based upon a production function framework. Instead of actually estimating production functions for the United States and the European countries, Denison called upon marginal productivity theory to provide the parameters of a Cobb-Douglas function. Basically, if we accept the tenant of marginality that factors are paid according to their marginal productivities, then the share of total output accounted for by payment to each factor can be seen to give their relative importance of contribution to production. Denison extends his analysis to include increases in output due to increments in the quality or productivity of each factor. These improvements include, for example, educational advancement in the labour force, changes in the number of hours worked, industry shifts from agriculture to manufacturing and economies of scale effects.

Denison in effect assumes that activity can be adequately represented through a Cobb-Douglas production function, which can be written in rate of change terms as:

$$y = ak + bl + t$$

(6.1)

where y is the rate of growth of output;
 k is the rate of growth of capital;
 l is the rate of growth of labour;
 a is the partial elasticity of output with respect to capital;
 b is the partial elasticity of output with respect to labour;
and t is the rate of technical change.¹

Direct estimation of the production function would provide another method of calculating the relative importance to output of each factor. This is to be favoured when time series information is available as economies of scale could be estimated more satisfactorily than the near arbitrary method adopted by Denison and statistical tests of the significance of parameters could be made.

The production function approach relies upon the neoclassical explanation of economic growth. Several criticisms of this approach were raised in Chapter 2. When the production function approach is used to examine economic growth, several specific problems arise. One of the great weaknesses of the production function approach to explaining economic growth is its lack of accuracy. In reviewing Denison's study of the causes of United States economic growth, Abramovitz (1962) noted that 50 per cent of the explanation relied upon technical change. Solow's (1957) study of growth in the American economy between 1909 and 1949, a similar period to that studied by

Denison, attributed 87.5 per cent of the increase in output per worker to technical change.

The representations of technical change used in these studies, however, are very simple. In both cases technical change is seen to be a costless bonus allowing an unaccounted increase in output over time even if there is no increase in factor inputs. Such a pattern of technical change can be either Hicks neutral or Harrod neutral. Hicks neutral technical change, which is used explicitly by Solow and in many studies of production functions over time, assumes that for a given capital to labour ratio, the ratio of the marginal product of capital to that of labour remains constant as technical progress occurs. Consequently the shares of total income received by each factor remain constant. Harrod neutral technical change assumes that at a constant capital to output ratio, the marginal product of capital remains unchanged. As Jones (1976) points out, it is necessary to have Harrod neutral technical change in order to replicate steady state growth.

These simple forms of technical progress have been considered inadequate by several writers who have designed more complicated methods of incorporating technical change into production functions. These include the vintage formulation and other forms of technical change that are embodied in the separate factor inputs rather than left in the disembodied form of the Hick's and Harrod neutral formulations which represent shifts in the whole production function over time.

These simple representations of technological change may not be entirely in disrepute however. Noting the poor results obtained in other studies using production functions to explain economic growth, Jorgensen and Grilliches (1967) estimated a production function for the total private United States economy over the period 1945 to 1965 after taking account of what they considered to be measurement and aggregation errors in the previous studies. They claim that, after all corrections, the rate of growth of factor inputs explained 96.7 per cent of the growth of output with changes in technology explaining only 3.3 per cent. These results have been questioned by Kennedy and Thirlwall (1972) who claim that many of the corrections that are made are really productivity adjustments and should be included in that variable.

Of interest to this study is the work by Sampson (1969) which applied Solow's method to Australian data for the post-war period and found that technical progress was of far lesser importance than the growth of factor inputs. This suggests that it would be worthwhile continuing to use the Hick's neutral specification of technical change in examining manufacturing growth in the Australian States.

The problems with the incorporation of technical change into a production function extend further. When a production function allows both returns to scale and technical progress, an identification problem arises meaning that it is not possible to define their individual effects. It is partly for this reason

that many studies of economic growth or technical change use production functions restricted to constant returns to scale. This problem is not restricted to the Cobb-Douglas function as Tsurumi (1970) has shown how the same problem arises with the CES production function.

The reason for this can be explained intuitively. If we assume that the production function is affected both by increasing returns to scale and by technical change then output can be changed autonomously due to either factor. If all inputs to production were increased equally over time, then output would increase firstly due to the increased inputs, secondly due to increasing returns and thirdly due to technical change. The second and third elements are bonuses received without cost, with increasing returns suggesting a movement along the production function and technical change suggesting a shift in the whole function. The two effects cannot be identified separately.

A further reason for using a production function restricted to constant returns is given by Zarembka (1970) who claims that production functions often show this to be the case anyway. Consequently there may be little misspecification involved in restricting the function.

A further criticism concerns the common use of the Cobb-Douglas production function to explain economic growth. It was mentioned above that Cobb-Douglas is one of the most restrictive production functions as the elasticity of

substitution between factors of production is assumed to be unity. If this elasticity varied greatly from unity then one could claim that Cobb-Douglas would be an inappropriate and inaccurate function to use, leading to specification errors. Salter (1966) considered this to be the case as he saw that between 26 and 40 per cent of growth could be explained by factor movements. This criticism has been soundly met by Nelson (1965) who shows that for the United States economy, only a very small part of growth is explained by factor substitution that is included in the more loosely specified CES production function. Zarembka (1970) has further supported this view as time series studies of the CES production function have regularly shown the elasticity of substitution to be close to unity anyway. These arguments suggest that there is little gain to be made in extending the analysis to more complicated but less restrictive production functions when one is attempting to explain growth.

Estimation of production functions is further complicated by the presence of multicollinearity between the factors of production. If estimating a function over time, it would be reasonable to expect that as output grew, the quantity of inputs would also grow and so give rise to multicollinearity. Many early papers estimating production functions fail to examine this, leading to questionable results.

These criticisms of production functions appear to be quite damaging. Nonetheless, production functions remain in vogue

both in theoretical and in applied economic studies because of their consistency with microeconomic theory and their convenience.

5.3 The Use of Production Functions at the Regional Level

The review of regional economic growth theories given in Chapter 2 showed that several authors have proposed neoclassical models. Surprisingly, few have examined the growth of regions following a production function method. The work of Borts and Stein (1964) has been mentioned in this respect. Lande and Gordon's (1977) re-estimation of Borts and Stein's work uses the VES production function instead of Cobb-Douglas and ends up accepting the neoclassical model where Borts and Stein rejected it.

Several authors have estimated production functions at the regional level for reasons other than studying economic growth. Lande (1978) compared the Cobb-Douglas, VES and translog production functions at the regional level and found that a theory of regional growth based upon interregional differences in technology would be appropriate. Vinod (1973) estimated a VES production function for one industry across the States of America to compare the characteristics of production in each. Tooze (1976) calculated the elasticity of substitution in regions of the United Kingdom to examine the effects of some government policies upon employment in depressed regions.

These studies, however, are not in the same vein as this chapter as they study either a whole economy rather than just one sector of it or are concerned with topics other than growth. Studies similar to this are given by Dixon and Thirlwall (1975) for manufacturing in regions of the United Kingdom and the updated estimates of their work by Armstrong and Taylor (1978). Theirs are cross-sectional studies using regions as economic units and because of the absence of regional capital stocks data, they estimate a restricted Cobb-Douglas production function that has been rearranged so that changes in output per person employed is related to changes in the proportional amount of factor payments.

In Australia, despite the early estimation of production functions for New South Wales and Victoria (see Douglas 1948), there appears to be only one production function estimate of economic growth in the States and this is provided by Donovan (1978) who estimates contributions to total economic growth based upon the State social accounts be derived. This is done in a manner similar to that used by Denison. In the following section, production function based estimates of manufacturing growth in the Australian States over the 1970s are presented.

5.4 Production Functions for Manufacturing in the Australian States

Although intrinsically non-linear, the Cobb-Douglas production function can be estimated by least squares techniques when it is converted into natural logarithm form. In this form the equation is as follows:

$$\ln Q_{st} = a + b \ln K_{st} + c \ln L_{st} + d \text{tech}_{st} + \text{error} \quad (5.1)$$

where Q_{st} is the output of a manufacturing subdivision in State s in time t ;

K_{st} is the stock of capital in a manufacturing subdivision in State S in time t ;

L_{st} is the average number of persons employed in a manufacturing subdivision in State s in time t ;

tech_{st} is the rate of Hick's neutral technological change in State s in time t ;

a , b , c and d are parameters;

and error is the classical error term.

Equation (5.1) was estimated for each State separately over the period 1968-69 to 1980-81. Unfortunately, the low numbers of observations and the instability of the State and national economies over the 1970s lead to unacceptable results. The capital and labour parameters were unrealistic, at times being negative, and the implied returns to scale (given by the

summation of the capital and labour parameters) was in many instances too high. Several sub-divisions gave returns to scale estimates of around 2.0 suggesting enormous returns to scale and partial output elasticities on either labour or capital.

Given the not unexpected failure of this first procedure, all data for each industry sub-division for all States was pooled into one series of 78 observations (i.e. 6 states with 13 observations) and various modifications of equation (5.1) were tested to see if production functions for the individual states could be discerned. This procedure opens the door to a varying parameters approach.

Varying parameter models have been used in applied economic studies for a long time. Early studies using varying parameter models were made by Fisher (1964) and Balestra (1967) but recently several surveys of the subject have been made, notably by Raj and Ullah (1981) and Judge, Griffiths, Hill and Lee (1980). Varying parameter estimation attempts to model movements in variables using parameters that are non-constant over time or cross-sectional units. Depending on the subject, there are several possible ways of describing the movements of the parameters. One form of varying parameter model allows the parameters of the equation to be largely estimated separately for each cross sectional unit and then be "corrected" for any possible dependency between the cross sections. This is provided through a Seemingly Unrelated Regressions (SUR) approach. This procedure, which was first suggested by Zellner

(1962) is amongst the least restrictive forms of representing parameter variation across cross sectional units, but as it divides the data into its cross sectional units, an appropriate number of observations on each cross section is needed to lift estimation from the problems of low degrees of freedom. As discussed above, this is a problem with the data set being used here.

SUR estimates of the Cobb-Douglas production function for each State provided unsatisfactory results. Negative coefficients on capital and labour, unrealistic returns to scale and poor t statistics occurred again. Consequently this method was explored no further.

A further possible explanation of parameter variation is given by an error components model. This method of modelling parameter movements makes various statements about the structure of the error term which is then modelled to represent movements in the whole of the equation. Error components models do not assume that each parameter varies but represents movements in the whole equation, allowing the intercept term to change over time. This variation, however, is assumed to be random and the interpretation of a randomly varying parameter would be difficult when a production function is going to be used to help explain economic growth. The movements here would have to be explained as some form of technological change and it would be better if this were included explicitly within that parameter.

Having found that SUR estimation gave unacceptable results and that a randomly varying estimation procedure is inappropriate for this study, the simpler but more restrictive dummy intercept model was estimated for each State from the pooled data. That is, equation (5.1) was altered to read:

$$\ln Q_{st} = b \ln K_{st} + c \ln L_{st} + d \text{tech}_{st} + a_s + a_1 \text{Vic} + a_2 \text{Qld} + a_3 \text{SA} + a_4 \text{WA} + a_5 \text{Tas} + \text{error} \quad (5.2)$$

where a_0 is the intercept;
 VIC is a binary dummy variable for Victoria;
 QLD is a binary dummy variable for Queensland;
 SA is a binary dummy variable for South Australia;
 WA is a binary dummy variable for West Australia;
 TAS is a binary dummy variable for Tasmania;
 and a_1, a_2, a_3, a_4, a_5 are the parameters for
 intercept variation for each state.

This approach normalises the intercepts around that for New South Wales and allows the intercept for each State to vary according to the size of the parameter on its individual dummy coefficient. The intercept term in the Cobb-Douglas production function is also known as the scale factor and simply makes allowance for the size of the economy being examined. Chapter 3 showed that Victoria and New South Wales each contain about 40 percent of activity in the manufacturing industries being examined with each of the four smaller States having much smaller shares. Given this location pattern, it would be

reasonable then to expect that this approach would be appropriate. In effect, equation (5.2), if shown to be a reasonable representation of the State manufacturing industries, would suggest that each State operates under the same production function with the only difference being a scale effect. This follows because the parameters on capital, labour and technology would be the same for each State.

Again the results from this procedure were unconvincing. Only in two sub-divisions were the results plausible. These were the Textiles and Basic Metal Products sub-divisions. While the results for food processing and total manufacturing seemed reasonable, the implied returns to scale of 1.47 and 1.33 respectively seemed respectively high.

Despite the apparently satisfactory results for textiles and basic metal processing, it was decided not to continue estimation by equation 5.2 because the dummy intercepts in each equation were not significant at the 5 per cent level. This is despite the significantly improved performance of the equations as a whole as indicated by a Chow test.²

The remaining nine sub-divisions performed poorly under this specification with dummy variables being largely insignificant and some of the parameters or individual factor inputs being either negative or greater than or close to unity. The results of this estimation for the full time period are given in appendix table A5.1

A similar exercise whereby a single dummy intercept for the small States (Qld, SA, WA and TAS) was used returned poor results. Only in five cases were the dummy intercepts significantly different from zero at the 5 per cent level and in two of these cases the labour coefficient was negative at the same time.

The failure of these regression results suggests that while there may be differences in the production structures between the States, as evidenced by the Chow test, plausible results could only be obtained if the States are pooled into one homogeneous set. In a study of nine census regions in the United States, Alperovich (1980) found that he could not discern any significant parameter variation, suggesting that the approach to be followed here is not new.

With the failure of these specifications it was decided to move to the most restrictive form of estimation, which involves no variation in the parameters over the States. This means reverting to equation (5.1) and using all 78 observations in the one equation. The results obtained are given in table 5.1 and the corresponding results for the two half periods (each of which has 36 observations as the mid year 1974-75 was excluded) are presented in tables 5.2 and 5.3.

TABLE 5.1
 POOLED ESTIMATES OF COBB-DOUGLAS PRODUCTION
 FUNCTION: 1968-69 to 1980-81

IND	K	L	Tech	Int	$\bar{R}^2$	SSE
21 Food	.52** (3.17)	.52** (3.12)	.01 (1.07)	.38 (.81)	.99	.8524
23 Textiles	.55** (7.19)	.45** (5.57)	.01* (2.09)	.48* (2.48)	.99	.8218
24 Clothing	-.06 (-.54)	1.12** (9.87)	.06** (8.99)	.98** (9.91)	.99	.8806
25 Wood	.55** (11.77)	.49** (11.99)	-.02** (-5.63)	.66** (3.04)	.99	.3271
26 Paper	.34** (9.22)	.68** (17.56)	.01** (5.78)	1.21** (9.00)	.99	.3032
27 Chemicals	.86** (5.39)	.21 (1.37)	-.02* (-2.41)	-1.19 (-1.67)	.98	1.8991
28 Non metallic minerals	-.14 (-1.33)	1.10** (11.06)	.03** (6.16)	-3.35** (7.92)	.99	.4838
29 Basic metal products	.42** (6.55)	.52** (9.12)	.00 (.45)	1.58** (3.00)	.88	6.3332
31 Fabricated metals	.30** (4.91)	.71** (10.57)	.00 (-1.08)	1.47** (10.17)	.99	.2138
32 Transport equipment	.01 (1.20)	.90** (10.04)	.03** (4.55)	1.87** (8.95)	.99	1.4904
33 Other machinery	-.00** (-3.17)	1.05** (13.21)	.03** (9.38)	1.62** (9.04)	.99	.5464
34 Misc.	.01 (.05)	1.00** (7.06)	.05** (8.87)	1.89** (6.76)	.99	1.0696
TOTAL	.41** (5.64)	.60** (9.05)	.01* (2.51)	1.03** (3.45)	.99	.3174

* denotes significance at the 5% level

** denotes significance at the 1% level

TABLE 5.2
 POOLED ESTIMATES OF COBB-DOUGLAS PRODUCTION
 FUNCTION: 1968-69 to 1973-74

IND	K	L	Tech	Int	$\bar{R}^2$	SSE
21 Food	.59** (3.70)	.43* (2.67)	.01 (.87)	.27 (.61)	.99	.1310
23 Textiles	.78** (8.15)	.22* (2.27)	.01 (1.01)	-.16 (-.66)	.99	.2264
24 Clothing	-.13 (-.79)	1.23** (6.67)	.07** (7.36)	.85** (6.09)	.99	.1558
25 Wood	.50** (6.90)	.53** (7.70)	.01 (1.63)	.80** (3.03)	.99	.0923
26 Paper	.23** (3.58)	.79** (12.30)	.02* (2.67)	1.46** (6.14)	.99	.1594
27 Chemicals	.82** (8.78)	.24* (2.62)	.04** (4.85)	-1.09* (-2.71)	.99	.1631
28 Non metallic Minerals	.11 (1.32)	.83** (10.97)	.05** (9.13)	2.59** (7.81)	.99	.0594
29 Basic metal products	.41** (3.43)	.54** (5.16)	.02 (.38)	1.66 (1.68)	.81	4.9902
31 Fabricated metals	.24* (2.58)	.77** (7.89)	.02** (3.99)	1.46** (6.12)	.99	.0770
32 Transport equipment	-.29 (-1.45)	1.34** (6.29)	.04** (3.43)	2.31** (5.60)	.99	.4150
33 Other Machinery	.31** (3.14)	.72** (6.97)	.03** (6.24)	.87** (3.59)	.99	.0799
34 Misc.	.17 (1.43)	.86** (6.77)	.07** (11.04)	1.17** (4.34)	.99	.1420
TOTAL	.24** (2.76)	.76** (9.36)	.03** (3.60)	1.55** (4.36)	.99	.0901

* denotes significance at the 5% level

** denotes significance at the 1% level

TABLE 5.3
 POOLED ESTIMATES OF COBB-DOUGLAS PRODUCTION
 FUNCTION: 1975-76 to 1980-81

IND	K	L	Tech	Int	$\bar{R}^2$	SSE
21 Food	.47** (2.82)	.58* (3.38)	-.04** (-3.73)	1.05* (2.16)	.99	.2134
23 Textiles	.13 (.96)	.89** (5.98)	.00 (.09)	1.78** (4.83)	.99	.3227
24 Clothing	-.13 (-.96)	1.18** (7.72)	.04** (3.30)	1.51** (7.01)	.99	.4316
25 Wood	.54** (8.96)	.51** (10.97)	-.02** (-3.73)	.65 (1.91)	.99	.1178
26 Paper	.46** (10.76)	.54** (11.76)	.02** (3.18)	.98** (6.06)	.99	.0871
27 Chemicals	.96** (3.21)	.12 (.45)	-.07** (-3.03)	-1.23 (-.90)	.98	1.0263
28 Non metallic minerals	-.37* (-2.50)	1.36** (9.59)	.02* (2.36)	4.16** (6.93)	.99	.1893
29 Basic metal products	.50** (8.27)	.47** (8.98)	.01 (.51)	1.08 (2.15)	.96	.8128
31 Fabricated metals	.18* (2.11)	.84** (9.06)	-.01** (-2.99)	1.77** (9.15)	.99	.0367
32 Transport equipment	.14 (1.46)	.82** (7.91)	-.00 (-.07)	2.28** (7.14)	.99	.7474
33 Other machinery	-.08 (-.73)	1.14** (9.27)	.02 (1.56)	1.95** (6.89)	.99	.3506
34 Misc.	.23 (1.27)	.72** (3.68)	-.00 (-.20)	2.31** (6.15)	.99	.3139
TOTAL	.47** (5.42)	.53** (6.68)	-.02** (-2.75)	1.08** (2.86)	.99	.0864

* denotes significance at the 5% level

** denotes significance at the 1% level

The results obtained in these simple regressions are much better than the earlier specifications but still suffer from some problems. In seven of the twelve sub-divisions the results are acceptable for the full period with realistic parameter values and high explanatory values of the equations in terms of $\bar{R}^2$ and F statistics and significant values for the greater majority of t statistics.

In five sub-divisions the results are not pleasing. In the Clothing, Non-metallic minerals, Transport equipment, Other machinery and Miscellaneous sub-divisions, negative, near-zero and unrealistically high parameter values occur. These results are largely repeated in the two half periods. Consequently, while these results are a great improvement on earlier estimates, this occurs for only about half the sub-divisions.

There could be several reasons for this poor performance. First, multicollinearity between the explanatory variables may be disturbing the estimates. While regression estimates remain unbiased and consistent, multicollinearity makes them inefficient so that the confidence intervals on the parameters would be wider than normal, decreasing the accuracy of t statistics and making it difficult to deduce the values of individual parameters.

Several writers have suggested various estimating procedures, such as Variance Inflation Factors (VIF) and Ridge

Regression techniques, to move around this problem. Many of these procedures are reviewed by Judge, Griffiths, Hill and Lee (1980) who reject them all as unacceptable because they produce no greater efficiency.

Multicollinearity, whilst a common problem in the study of production functions, does not appear to be a problem here as the parameters in the majority of equations are strongly significant. Multicollinearity would be a problem when the parameter estimates are found to be just significant or insignificant whilst the equation itself has high explanatory power (given by high $\bar{R}^2$ and F statistics).

As a further check on this problem a version of the Cobb-Douglas production function where the returns to scale have been constrained to sum to unity was estimated. This method of restricting parameters to deal with multicollinearity is one suggested by authors such as Goldberger (1964) and Valentine (1969). When estimated in this form, the Cobb-Douglas production function is said to be in the intensive form given in equation (5.3) below:

$$\ln \frac{VA}{L}_{st} = a + b \ln \frac{K}{L}_{st} + c \text{tech}_{st} + \text{error} \quad (5.3)$$

In this form multicollinearity will obviously not be a problem as the two variables of main concern (capital and labour) do not appear individually. The coefficient on the

capital to labour ratio (b) gives the partial elasticity of output with respect to capital and, as the equation is restricted to constant returns, the labour elasticity is given as $(1-b)$.

One of the disadvantages of this approach, apart from the restriction it enforces, is that tests of significance for the labour parameter are not possible, requiring our degree of faith in the functional form (i.e. Cobb-Douglas) to be widened.

The estimates obtained from equation 5.3 for the full period are presented in appendix table A5.2. For the full time period, there were only two cases (Food and Clothing) where the parameters differ from the estimates in table 5.1 by more than 0.1, while for the half periods these occurrences were more common (eleven in both periods). The stability of these results in the full period at least suggest that multicollinearity is not a problem here.

Of more interest are the problems of heteroskedasticity and autocorrelation. Whilst producing unbiased estimates, both of these problems cause inefficiency in the parameters. The question however is how to detect these problems, if they do exist, in pooled estimates.

Autocorrelation in its first order form is usually detected through the Durbin-Watson statistic, however in any cross-section study the Durbin-Watson statistic becomes

meaningless as its value is dependent upon the ordering of the data deck. Its value could in effect be changed simply by 'shuffling' the data, changing the order in which the States appear. To compensate for this, an adjusted Durbin-Watson statistic whereby data movements between the States (e.g., the two data points representing NSW at 1980-81 and Victoria at 1968-69) was ignored. The adjusted Durbin-Watson statistic was calculated as:

$$DW_{adj} = \frac{\sum_{S=1}^6 \sum_{t=2}^{13} (e_{St} - e_{St-1})^2}{\sum_{S=1}^6 \sum_{t=2}^{13} (e_{St})^2}$$

where S is the indicator of the State involved where $S = 1 \dots 6$;
 t is the observation number where $t = 2 \dots 13$;
 and e is the error from the simple pooled equation.

The adjusted Durbin-Watson statistic for each industry showed there to be appreciable autocorrelation in each of the equations and so the equations should be adjusted to meet this.

A problem common to cross sectional studies and a bug-bear of pooled estimation is heteroskedasticity. In this case, however, the mixture of time-series and cross sections rules out the use of some of the more common heteroskedasticity tests such

TABLE 5.4
CORRECTED POOLED ESTIMATES OF COBB-DOUGLAS PRODUCTION
FUNCTION: 1968-69 to 1980-81

IND	K	L	Tech	Int	$\bar{R}^2$	SSE
21 Food	.47 (1.84)	.56* (2.12)	.01 (.77)	.57 (.76)	.99	.5063
23 Textiles	.51** (6.73)	.49** (6.31)	.01 (1.87)	.66** (2.74)	.99	.4906
24 Clothing	.11 (1.11)	.97** (9.42)	.05** (6.82)	.73** (2.88)	.99	.3425
25 Wood	.52** (6.89)	.52** (7.42)	-.01** (-3.17)	.71* (2.49)	.99	.2633
26 Paper	.34** (4.90)	.70** (9.15)	.01** (4.60)	1.04** (6.58)	.99	.1990
27 Chemicals	.54* (2.61)	.51* (2.49)	-.01 (-1.04)	.18 (.21)	.99	.8244
28 Non metallic minerals	-.03 (-.22)	.98** (8.17)	.03** (4.45)	3.00** (6.03)	.99	.2621
29 Basic metal products	.58** (5.15)	.39** (3.41)	-.02 (-1.62)	.97 (1.85)	.94	.3480
31 Fabricated metals	.19* (2.24)	.83** (9.41)	.00 (.31)	1.68** (8.99)	.99	.1623
32 Transport equipment	.19 (1.47)	.82** (5.95)	.02* (2.70)	1.56** (4.85)	.99	.8238
33 Other machinery	-.13 (1.59)	1.18** (13.72)	.03** (7.72)	1.96** (7.92)	.99	.2314
34 Misc.	.19 (1.22)	8.3** (5.27)	.04** (6.15)	1.37** (2.92)	.99	.5136
TOTAL	.29 (1.91)	.71** (5.11)	.01 (1.75)	1.50* (2.34)	.99	.1058

* denotes significance at the 5% level

** denotes significance at the 1% level

TABLE 5.5
CORRECTED POOLED ESTIMATES OF COBB-DOUGLAS PRODUCTION
FUNCTION: 1968-69 to 1973-74

IND	K	L	Tech	Int	$\bar{R}^2$	SSE
21 Food	.63** (3.12)	.39 (1.85)	.01 (1.11)	.25 (.47)	.99	.0474
23 Textiles	.80** (6.18)	.22 (1.68)	.01 (.40)	-.42 (-.98)	.99	.1259
24 Clothing	-.26 (.15)	1.11** (5.66)	.07** (5.87)	.75** (4.67)	.99	.0725
25 Wood	.50** (3.39)	.53** (3.61)	.01 (1.23)	.76 (1.84)	.99	.0874
26 Paper	.27 (1.89)	.77** (5.39)	.02* (2.53)	1.21* (2.54)	.99	.0748
27 Chemicals	.67** (4.03)	.38* (2.20)	.05** (5.30)	-.48 (-.75)	.99	.1125
28 Non metallic minerals	.13 (.77)	.82** (5.29)	.05** (7.40)	2.50** (3.84)	.99	.0337
29 Basic metal products	.50 (1.84)	.47 (1.52)	.02 (.48)	1.15 (1.10)	.90	2.5875
31 Fabricated metals	.24 (1.75)	.78** (5.41)	.02** (3.58)	1.44** (4.77)	.99	.0675
32 Transport equipment	-.55 (-.15)	1.09** (2.87)	.05** (3.17)	1.86** (2.26)	.99	.2042
33 Other machinery	.25 (1.53)	.79** (4.81)	.03** (4.35)	1.02* (2.56)	.99	.0571
34 Misc.	.23 (1.23)	.80** (4.04)	.07** (8.51)	1.08* (2.28)	.99	.1072
TOTAL	.01 (.06)	.98** (6.87)	.03** (3.91)	2.38** (4.34)	.99	.0243

* denotes significance at the 5% level

** denotes significance at the 1% level

TABLE 5.6
CORRECTED POOLED ESTIMATES OF COBB-DOUGLAS PRODUCTION
FUNCTION: 1975-76 to 1980-81

IND	K	L	Tech	Int	$\bar{R}^2$	SSE
21 Food	.55* (2.45)	.51* (2.09)	-.05** (-2.92)	.78 (1.45)	.99	.1867
23 Textiles	.21 (1.07)	.80** (3.93)	-.00 (.16)	1.79** (3.20)	.99	.1944
24 Clothing	-.13 -.55	1.21** (4.67)	.03** (3.48)	1.31** (4.19)	.99	.1470
25 Wood	.51** (3.96)	.54** (4.96)	-.01 (-1.70)	.67 (1.04)	.99	.0939
26 Paper	.46** (6.14)	.54** (6.35)	.01* (2.32)	1.00** (3.83)	.99	.0694
27 Chemicals	.74* (2.65)	.33 (1.22)	-.05** (-3.05)	-.38 (-.32)	.99	.3674
28 Non metallic minerals	-.35 (-1.47)	1.34** (5.79)	.02 (1.61)	4.08** (4.28)	.99	.1505
29 Basic metal products	.48** (3.86)	.48** (4.37)	-.00 (-.16)	1.37 (1.86)	.96	.7237
31 Fabricated metals	.14 (1.13)	.89** (6.61)	-.01 (1.71)	1.86** (6.59)	.99	.0324
32 Transport equipment	.25 (1.14)	.72** (3.02)	-.01 (-.51)	1.93** (2.97)	.99	.5146
33 Other machinery	-.25* (2.34)	1.30** (10.82)	.01 (1.67)	2.52** (9.00)	.99	.1242
34 Misc.	.58 (1.94)	.35 (1.05)	-.01 (-.85)	1.55* (2.54)	.99	.2581
TOTAL	.28 (1.43)	.71** (3.96)	-.01 (-1.16)	1.88* (2.22)	.99	.0367

* denotes significance at the 5% level

** denotes significance at the 1% level

as the Goldfeld-Quandt test. Consequently the Bruesch-Pagan test (Bruesch and Pagan (1979)) was used to test for unequal variances across the States. Each equation displayed appreciable heteroskedasticity across the States. Consequently, the equations needed to be adjusted further to compensate for this.

Given these problems, it was necessary to correct the estimates in tables 6.1 to 6.3. Kmenta (1971, pp 508-11) provides the necessary theory for this. Basically the procedure involves first transforming the data to correct for autocorrelation and then using weighted least squares techniques to correct for heteroskedasticity. This procedure has been implemented in version 4.4 of the SHAZAM econometrics computer program (see White (1978)). The results of these regressions are presented in tables 5.4, 5.5 and 5.6. Whereas previously five sub-divisions returned questionable results in the full period, this has been reduced to two in the corrected series (non-metallic minerals and other machinery).

In the first half period the Clothing, Transport equipment and Total sub-divisions displayed poor results and in the second half period questionable results were obtained in the Clothing, Non-metallic mineral and Other machinery sub-divisions.

The results obtained suggest that few industries display evidence of increasing returns³ and that the technical change representation used here is of minor importance. These comments

however must be interpreted in the light of the observation made in the previous section that there exists an identification problem when both returns to scale and technical change are examined. As the results are displaying near constant returns this would not appear to be a great problem here. There would be little gain in re-estimating the equations with the restricted Cobb-Douglas function.

Despite the uniformity of the results in displaying near constant returns, the individual parameter estimates are noticeably different as we move between industries. For example, the Clothing sub-division in the full period has a very high labour coefficient whereas in the Basic metal products subdivision, capital appears to take a leading role.

The results for total manufacturing are disappointing. Whereas in the uncorrected estimates the results are robust with high levels of significance on all coefficients and plausible results, the corrected estimates fail to return a significant labour coefficient in any of the time periods and the results for the first half period are not explainable.

The results in tables 5.4 to 5.6, including those considered unacceptable, were used to estimate the predicted growth rate in each sub-division in each of the States and in Australia, over the full and half periods.

To obtain estimates of the contribution of each factor to growth in each State, the growth rate of each factor of production (i.e. capital and labour) is related to the parameters of the estimated production function. Remembering that each parameter represents the partial elasticity of output with respect to each factor, the summation of these parameters when multiplied by their factor input growth rates gives an estimate of the expected rate of output growth. For example, if the capital and labour parameters were 0.3 and 0.7 respectively and capital and labour grew at an annual rate of 2 and 1 per cent respectively, then the expected annual rate of output growth would be (ignoring the rate of technical change):

$$[0.3 \times 2] + [0.7 \times 1] = 1.3\%$$

The annual average growth rate of each factor and output has been described in Chapter 3. Multiplying these by the relevant parameter values gives the expected annual growth rate. These results are presented in table 5.7 for total manufacturing. The penultimate column in this table shows the difference between the actual and predicted growth rates. Similar calculations were made for each sub-division.

TABLE 5.7

SUPPLY ORIENTED EXPLANATIONS OF
TOTAL MANUFACTURING GROWTH BY STATE
(per cent per Annum)

STATE	CAPITAL	LABOUR	TECH	PREDICT	ACTUAL	DIFF	% EXPL
<u>1968-69 to 1980-81</u>							
NSW	.95	-.81	.06	.20	1.41	1.21	14.31
VIC	1.04	-.48	.06	.63	1.72	1.09	36.36
QLD	1.46	.45	.06	1.97	3.55	1.58	55.58
SA	1.11	-.33	.06	.84	1.72	.88	48.83
WA	2.12	.75	.06	2.93	4.55	1.62	64.45
TAS	1.19	-.80	.06	.45	1.49	1.04	30.46
AUST	1.13	-.45	.06	.74	1.93	1.19	38.23
<u>1968-69 to 1974-75</u>							
NSW	.14	-.82	.18	-.51	3.60	4.11	*
VIC	.14	.24	.18	.57	4.22	3.65	13.50
QLD	.19	.63	.18	.99	7.17	6.18	13.87
SA	.14	1.39	.18	1.72	4.71	2.99	36.42
WA	.30	1.20	.18	1.67	5.42	3.75	30.88
TAS	.17	-.93	.18	-.58	4.58	5.16	*
AUST	.16	-.02	.18	.32	4.36	4.04	7.24

1974-75 to 1980-81

NSW	.56	-1.02	-.06	-.53	-.78	-.25	67.33
VIC	.66	-1.13	-.06	-.53	-.77	-.24	68.22
QLD	1.07	.45	-.06	1.45	-.07	-1.52	*
SA	.81	-1.67	-.06	-.92	-1.27	-.35	75.17
WA	1.31	.64	-.06	1.89	3.68	1.79	51.34
TAS	.69	-.93	-.06	-.30	-1.41	-1.11	21.17
AUST	.73	-.89	-.06	-.22	-.50	-.28	44.46

* denotes different signs on the predicted and actual growth figures

The results are not pleasing despite their statistical properties. The accuracy of the estimates as measured by the percentage explained is, in the majority of cases, poor. According to table 5.7, only in Queensland and Western Australia did the estimated growth rates explain more than half of the actual growth for the full period. The results for New South Wales are especially disappointing. Of the half period results, the second displays much greater accuracy.

The results between the full and half periods vary greatly in some respects. Whereas for the full period capital growth is more important than labour supply changes in all States, generally the reverse is true in the two half periods. The similarity between all the results is the predominant role of the unexplained element. In the majority of cases this is the largest contributor, suggesting that the explanation given so far is deficient in some way.

The discussion at the beginning of this chapter had alerted us to the poor performance of these forms of studies in the past, but the model presented here so far is the simplest possible. It would be appropriate in the light of the dominant unexplained element to try to take more of this into account. One possible way to move around this is to adjust the measurement of capital and labour to take account of changes in utilisation over the period.

To modify the labour series into a utilised series an index of average weekly hours worked was obtained from published data (see ABS(k)). This series covers total employment and not just that in manufacturing and was for Australia only and not for each of the States. To obtain the utilised labour series, average employment in each sub-division was multiplied by the index of average hours worked. This did not change the labour series greatly as the index, which was set at unity for 1974-75, ran from a maximum of 1.03 at 1968-69 to a minimum of 0.97 in 1980-81.

To adjust the capital stock data, unemployment rates for the total economy in each State was obtained from ABS(k) and the capital stock figures were reduced by this amount.

These new data series were used to re-estimate equation (5.1). The results are given in tables 5.8, 5.9 and 5.10. These results display much the same traits as those in tables 5.4 to 5.6. Again there is little evidence of increasing

TABLE 5.8
CORRECTED POOLED ESTIMATES OF UTILISED COBB-DOUGLAS PRODUCTION
FUNCTION: 1968-69 to 1980-81

IND	K	L	Tech	Int	$\bar{R}^2$	SSE
21 Food	.61* (2.42)	.41 (1.56)	.01 (.63)	.25 (.35)	.99	.5167
23 Textiles	.51** (6.90)	.49** (6.36)	.02** (2.71)	.66** (2.79)	.99	.4928
24 Clothing	.17 (1.83)	.88** (8.56)	.05** (6.90)	.69** (2.70)	.99	.3529
25 Wood	.53** (7.60)	.51** (7.81)	-.01* (-2.24)	.67* (2.63)	.99	.2497
26 Paper	.34** (4.91)	.69** (8.93)	.02** (6.17)	1.02** (6.41)	.99	.2020
27 Chemicals	.54** (2.68)	.51* (2.52)	-.01 (-.54)	.18 (.22)	.99	.8096
28 Non metallic minerals	.02 (.15)	.94** (7.64)	.03** (4.84)	2.77** (5.55)	.99	.2535
29 Basic metal products	.60** (5.39)	.37** (3.27)	-.01 (-1.29)	.92 (1.86)	.94	3.4221
31 Fabricated metals	.25** (3.29)	.77** (9.57)	.01 (1.90)	1.53** (9.28)	.99	.1526
32 Transport equipment	.24 (1.86)	.77** (5.54)	.02** (3.18)	1.43** (4.56)	.99	.8390
33 Other machinery	-.02 (-.20)	1.08** (11.57)	.04** (7.87)	1.54** (6.21)	.99	.2600
34 Misc.	.28 (1.90)	.73** (4.78)	.04** (6.55)	1.09* (2.42)	.99	.5198
TOTAL	.55** (3.44)	.46** (3.09)	.01 (.70)	.55 (.83)	.99	.1149

* denotes significance at the 5% level

** denotes significance at the 1% level

TABLE 5.9
CORRECTED POOLED ESTIMATES OF UTILISED COBB-DOUGLAS PRODUCTION
FUNCTION: 1968-69 to 1973-74

IND	K	L	Tech	Int	$\bar{R}^2$	SSE
21 Food	.54** (3.12)	.48* (2.53)	.01 (1.63)	.45 (1.01)	.99	.0516
23 Textiles	.83** (5.98)	.19 (1.36)	.00 (.29)	-.39 (-.95)	.99	.1266
24 Clothing	.02 (.08)	1.07** (4.80)	.06** (4.97)	.68** (4.12)	.99	.0787
25 Wood	.51** (3.39)	.52** (3.44)	.01 (1.28)	.75 (1.79)	.99	.0933
26 Paper	.28 (1.96)	.74** (5.00)	.03* (2.43)	1.13* (2.34)	.99	.0811
27 Chemicals	.71** (4.34)	.34 (2.03)	.05** (4.79)	-.57 (-.90)	.99	.1163
28 Non metallic minerals	.09 (.59)	.85** (5.71)	.05** (8.20)	2.62** (4.32)	.99	.0330
29 Basic metal products	.54 (1.97)	.42 (1.37)	.01 (.42)	1.11 (1.05)	.90	2.5423
31 Fabricated metals	.27* (2.13)	.75** (5.52)	.02** (3.86)	1.36** (5.24)	.99	.0714
32 Transport equipment	.06 (1.59)	.97* (2.58)	.04** (3.14)	1.62 (1.96)	.99	.2176
33 Other machinery	.30 (1.77)	.74** (4.23)	.03** (4.07)	.87* (2.14)	.99	.0619
34 Misc.	.27 (1.39)	.76** (3.76)	.07** (8.48)	.97* (2.04)	.99	.1102
TOTAL	.01 (.05)	.97** (4.29)	.04** (2.77)	2.32** (2.75)	.99	.0324

* denotes significance at the 5% level

** denotes significance at the 1% level

TABLE 5.10
CORRECTED POOLED ESTIMATES OF UTILISED COBB-DOUGLAS PRODUCTION
FUNCTION: 1975-76 to 1980-81

IND	K	L	Tech	Int	$\bar{R}^2$	SSE
21 Food	.60* (2.71)	.44 (1.79)	-.04** (-2.98)	.71 (1.38)	.99	.1819
23 Textiles	.20 (1.10)	.80** (4.15)	.00 (.16)	1.79** (3.38)	.99	.2006
24 Clothing	-.06 (-.25)	1.13** (4.32)	.04** (3.46)	1.24** (3.74)	.99	.1499
25 Wood	.52** (4.30)	.53** (5.05)	-.01 (1.32)	.62 (1.06)	.99	.0917
26 Paper	.46** (6.06)	.54** (6.33)	.02** (2.92)	1.01** (3.79)	.99	.0715
27 Chemicals	.73* (2.66)	.34 (1.28)	-.05* (-2.70)	-.29 (-.25)	.99	.3772
28 Non metallic minerals	-.33 (-1.34)	1.32** (5.43)	.03 (1.74)	3.98** (4.06)	.99	.1505
29 Basic metal products	.48** (3.89)	.47** (4.34)	.00 (.09)	1.37 (1.91)	.96	.7257
31 Fabricated metals	.16 (1.27)	.86** (5.99)	-.01 (-.92)	1.78** (6.16)	.99	.0321
32 Transport equipment	.27 (1.18)	.70** (2.92)	.00 (-.32)	1.91** (2.91)	.99	.5159
33 Other machinery	-.25* (-2.12)	1.30** (9.96)	-.02 (1.89)	2.47** (8.12)	.99	.1380
34 Misc.	.60* (2.11)	.32 (1.02)	-.01 (-.68)	1.52* (2.67)	.99	.2622
TOTAL	.33 (1.65)	.66** (3.60)	-.01 (-.89)	1.66 (1.92)	.99	.0393

* denotes significance at the 5% level

** denotes significance at the 1% level

returns to scale, the Hick's neutral technical change effect is small and the labour is regularly seen to be the more significant variable. These similarities are to be expected however as the adjustments made to the data are small. Where this adjusted data set does appear to make a difference is in its effect upon the negative valued coefficients. These are anomalous as they have no rational meaning. Whilst not removing them all, the utilisation adjusted data series appears to have lessened each of them.

Comparing the error sums of squares between tables 5.4 to 5.6 with those of tables 5.8 to 5.10 reveals that there has been only a small improvement in fit in five of the thirteen sub-divisions in the full period. In all other cases the error sum of squares increased. The corresponding figures for the two halves are two in the first and three in the second. As a result, it would appear that this adjustment has not improved the properties of the estimates.

Table 5.11 presents the utilisation adjusted estimates of the contributions to economic growth for total manufacturing in each State and for Australia in the full and the half periods. Here there appears to be an increase in accuracy. The results for the full period are much better than those reported in table 5.7. All States have greater than sixty per cent of their growth accounted for in the full period. The results for the second half period also show some improvement but those for the first half remain inaccurate.

TABLE 5.11

UTILISATION ADJUSTED SUPPLY ORIENTED EXPLANATION
OF TOTAL MANUFACTURING GROWTH BY STATE
(per cent per Annum)

STATE	CAPITAL	LABOUR	TECH	PREDICT	ACTUAL	DIFF	% EXPL
<u>1968-69 to 1980-81</u>							
NSW	1.59	-.75	.06	.90	1.41	.51	63.48
VIC	1.80	-.54	.06	1.33	1.72	.39	77.08
QLD	2.54	.06	.06	2.66	3.55	.89	74.93
SA	1.83	-.45	.06	1.45	1.72	.27	84.03
WA	3.76	.26	.06	4.07	4.55	.48	89.54
TAS	2.05	-.75	.06	1.36	1.49	.13	91.02
AUST	1.92	-.52	.06	1.47	1.93	.46	75.92
<u>1968-69 to 1974-75</u>							
NSW	.04	-1.29	.24	-1.01	3.60	4.61	*
VIC	.05	-.23	.24	.05	4.22	4.17	1.29
QLD	.06	.15	.24	.45	7.17	6.72	6.23
SA	.05	.89	.24	1.18	4.71	3.53	25.03
WA	.10	.71	.24	1.04	5.42	4.38	19.27
TAS	.06	-1.40	.24	-1.10	4.58	5.68	*
AUST	.05	-.49	.24	-.20	4.36	4.56	*

1975-76 to 1980-81

NSW	.45	-1.29	-.06	-.89	-.78	.11	114.73
VIC	.60	-1.39	-.06	-.85	-.77	.08	109.79
QLD	1.02	.08	-.06	1.04	-.07	-1.11	*
SA	.66	-1.89	-.06	-1.29	-1.27	.02	101.65
WA	1.32	.26	-.06	1.52	3.68	2.16	41.23
TAS	.57	-1.19	-.06	-.68	-1.41	-.73	48.26
AUST	.64	-1.15	-.06	-.57	-.50	.07	114.96

* denotes different signs on the predicted and actual growth figures

These results however are more the result of a happy accident than the result of increased knowledge of economic growth in the States. The explanatory model is the same as that used earlier. The only change is in the data used.

The increased accuracy of the model is belied on two grounds. First is the argument mentioned above. Comparison of error sums of square does not support the increased accuracy hypothesis. For example, the estimated equations for total manufacturing in all three periods examined have greater error sums of square using the utilised data series. This has not adversely affected the growth estimates. Second this increased accuracy does not occur in all cases. Appendix table A5.3 presents an abbreviated, utilisation adjusted, supply oriented growth explanation for each manufacturing sub-division for the full period only. The results here are not as good as those in table 5.11. Only in the Food processing industry is there a high degree of accuracy. In most cases unexplained factors remain dominant.

If we are to believe the results in tables 5.11 and A5.3, Hick's neutral technical change plays a small part in explaining manufacturing growth in all of the States and the dominant factor in the growth of each sub-division in each period varies. In many cases the residual is the most important element but where the model shows some degree of accuracy, capital input appears to be most important. This is most noticeable in the Food processing industry.

Generally the results for the full period appear to be more accurate than those for the two halves but this accuracy is not especially great. It would appear that the recession in the second half of the seventies cannot be adequately explained by capital and labour input growth, with the residual factor dominating very strongly in most industries over this period. No clear pattern is discernable for the first half.

5.5 Conclusions

At the beginning of this chapter previous production function studies of economic growth were reviewed. The general conclusion was that this type of approach has been found wanting, so it should be no surprise that the results obtained here are found to be less than satisfactory. If we are to believe these results and ignore unexplained factors, capital input growth must be seen as the dominant factor in the growth of each manufacturing sub-division for each State and for Australia.

There are several avenues that this chapter has not explored. It would be interesting to see whether a different production would explain State manufacturing growth differences more fully. There are two reasons for not doing this. First, the discussion in section 2 showed that the Cobb-Douglas production function is adequate for this task and second, the results obtained from applying a VES production function to the problem did not return any better results. Whilst not used in the body of this thesis, the VES results are presented in appendix 2 in an attempt to discern whether there are any differences in the production structures of the States and in an attempt to find the elasticity of substitution for each subdivision in each State.

This chapter has also ignored aggregation problems in its approach. Klein (1962) and Caddy (1978)⁴ have shown that it may be more appropriate to estimate the function for total manufacturing from the geometric mean of the data than from the summed total. Klein responds however that it is doubtful whether anybody is interested in having a figure on the geometric mean of factor inputs and output. Furthermore, Klein points out that there is a simple ratio between the geometric and the arithmetic mean so that this problem can be circumvented if necessary. This chapter has not followed this path as it is not the procedure normally followed in production function studies and because the chapter is not trying to estimate the parameters for average manufacturing in each State. When the growth of total manufacturing in each State is examined our

concern is to discover the factors behind the growth of the total sector. If the main concern were to find the average elasticity of substitution in each State for manufacturing, then it would appear to be more appropriate to use geometric means of the data rather than arithmetic means.

The chapter also found that it is not possible to rule out the probability that production techniques vary between the States. Although some exploration of possible differences in the production function was made, no acceptable results were obtained, forcing the assumption that the production functions were identical between States. This may be an avenue for further study. It is partly for this reason that the estimates of the VES production function presented in Appendix 2 were made.

It was commented earlier in the chapter that despite the common use of neoclassical formulations to explain growth in regions, few have gone to the trouble of examining the production function at the regional level. This chapter hopefully redresses a little of this imbalance but, as with many other studies, it appears to have raised as many questions as it has answered.

NOTES TO CHAPTER 5

1. Denison does not make it clear whether he is considering Hicks or Harrod neutral technical change. As the income shares of the factors of production remain constant over time in this formulation, it could be either.
2. Judge, Griffiths, Hill, Lutkepohl and Lee (1982, p. 484) suggest that it is not adequate to test the relevance of intercept variation using only t-statistics. They suggest that it is more important to test whether the explanatory power of the whole equation is improved by the use of dummy intercepts. This is done by a Chow-type test as follows:

The hypotheses to be tested are:

$$H_0 : a_1 = a_2 = \dots = a_5$$

$$H_1 : a_1 = a_2 = \dots = a_5$$

The relevant F statistic is given by:

$$F = \frac{(\bar{e}'\bar{e} - \hat{e}'\hat{e})/N-1}{\hat{e}'\hat{e} / (NT - N - K')}$$

where

$\bar{e}'\bar{e}$ is the residual sum of squares from equation (6.1)

$\hat{e}'\hat{e}$ is the residual sum of squares from equation (6.2)

$(N-1)$ is the number of linear restrictions

$(NT-N-K')$ is the number of degrees of freedom in equation (6.2)

The F statistic has $[(N-10), (Nt-N-K')]$ degrees of freedom.

3. The highest implied returns to scale is in the Clothing sub-division for the full period, where the sum of the capital and labour coefficients is 1.08.
4. Klein addresses this in the case of Cobb-Douglas and Caddy for the CES production function.

TABLE A5.1
DUMMY VARIABLE INTERCEPT COBB-DOUGLAS MODEL:
1968-69 to 1980-81

IND	K	L	Tech	Int	DV	DQ	DS	DW	DT	R ²	SSE
21 Food	.85 (3.21)	.62 (2.08)	-.01 (-.51)	-5.35 (1.88)	.10 (2.27)	.33 (2.22)	.63 (2.05)	.61 (1.71)	1.10 (2.02)	.99	.6464
23 Textiles	.51 (2.41)	.49 (5.84)	.02 (2.01)	.55 (.22)	-.03 (-.28)	-.13 (-.29)	-.01 (-.02)	.06 (.11)	.02 (.04)	.99	.5537
24 Clothing	1.49 (4.79)	.58 (5.06)	.02 (2.13)	-12.47 (-3.68)	-.49 (-3.67)	2.11 (3.75)	2.87 (4.14)	3.45 (3.80)	5.56 (3.90)	.99	.4031
25 Wood	.56 (6.30)	.77 (6.48)	-.02 (-3.54)	-2.22 (-1.38)	.13 (2.25)	.22 (1.74)	.35 (1.97)	.33 (1.83)	.55 (2.18)	.99	.2742
26 Paper	-.12 (-.82)	.56 (3.85)	.03 (5.66)	8.66 (4.04)	-.09 (-2.81)	-.97 (-3.53)	-.97 (-3.19)	-1.25 (-3.47)	-.98 (-3.14)	.99	.2064
27 Chemicals	.47 (1.57)	1.04 (4.23)	.00 (1.00)	-4.33 (-.89)	.06 (.40)	1.22 (1.50)	1.01 (1.13)	1.13 (1.38)	1.34 (1.15)	.99	1.1019
28 Non metallic minerals	.61 (2.19)	1.13 (9.06)	.01 (.46)	-6.99 (-2.14)	.34 (3.51)	1.04 (3.60)	1.28 (3.29)	1.03 (3.50)	2.24 (3.27)	.99	.3304
29 Basic metals products	.69 (4.73)	.46 (1.49)	-.02 (-1.37)	-1.47 (-.53)	.28 (.72)	.44 (.67)	.37 (.81)	-.14 (-.22)	.56 (.78)	.92	4.1192
31 Fabricated metals	.90 (4.01)	.77 (11.04)	-.01 (-3.03)	-7.39 (-2.54)	.09 (2.86)	1.00 (3.14)	1.07 (3.07)	1.19 (3.23)	2.38 (3.09)	.99	.1660
32 Transport equipment	-.26 (-1.03)	.71 (5.48)	.03 (4.10)	8.64 (2.39)	.33 (2.35)	-.63 (-1.74)	-.30 (-2.90)	-1.31 (-2.00)	-1.96 (-1.88)	.99	1.0238
33 Other machinery	.45 (1.63)	1.04 (12.72)	.02 (2.99)	-4.61 (-1.36)	.16 (2.84)	1.13 (1.94)	.63 (1.67)	1.26 (2.06)	2.02 (1.86)	.99	.2461
34 Misc.	.63 (3.71)	.98 (6.84)	.01 (1.42)	-5.80 (-45.43)	-.05 (-1.20)	1.25 (7.75)	1.02 (7.14)	1.60 (7.85)	3.01 (8.08)	.99	.4694
TOTAL	.56 (3.98)	.77 (4.66)	.01 (.69)	-3.55 (-2.14)	.04 (1.70)	.50 (2.94)	.41 (2.40)	.53 (2.29)	.89 (2.75)	.99	.1619

TABLE A5.2
CORRECTED POOLED ESTIMATES OF
INTENSIVE COBB-DOUGLAS PRODUCTION FUNCTION:
1968-69 to 1980-81

IND	K	L	Tech	Int	$\bar{R}^2$
21 Food	.75 (8.75)	.25 *	.00 (.29)	.09 (.38)	.79
23 Textiles	.58 (12.89)	.42 *	.01 (1.76)	.48 (4.12)	.87
24 Clothing	.32 (4.17)	.68 *	.04 (8.67)	.96 (7.61)	.93
25 Wood	.52 (9.44)	.48 *	-.02 (-3.28)	1.10 (8.33)	.77
26 Paper	.38 (10.71)	.62 *	.01 (4.44)	1.25 (12.11)	.83
27 Chemicals	.55 (4.91)	.45 *	-.00 (-.28)	.56 (1.33)	.71
28 Non metallic minerals	.06 (.83)	.94 *	.02 (4.59)	2.32 (9.39)	.81
29 Basic metal products	.57 (8.09)	.43 *	-.01 (-.86)	.62 (2.76)	.74
31 Fabricated metals	.30 (5.65)	.70 *	-.00 (-8.85)	1.52 (9.85)	.51
32 Transport equipment	.14 (2.32)	.86 *	.02 (3.74)	1.70 (10.49)	.66
33 Other machinery	-.13 (-1.90)	1.13 *	.37 (7.09)	2.38 (13.03)	.88
34 Misc.	.17 (1.67)	.83 *	.04 (8.74)	1.51 (5.50)	.85
TOTAL	.30 (3.28)	.70 *	.01 (2.16)	1.42 (5.04)	.93

* t statistics could not be obtained in these cases as the function was estimated in its constrained form.

TABLE A5.3
 UTILISATION ADJUSTED SUPPLY ORIENTED EXPLANATION
 OF MANUFACTURING GROWTH BY STATE AND
 BY SUB-DIVISION:
 1968-69 to 1980-81
 (per cent per annum)

STATE	PREDICTED	ACTUAL	% EXPLAINED
<u>21 - Food</u>			
NSW	2.25	3.01	74.65
VIC	1.74	2.48	70.30
QLD	3.42	4.17	82.00
SA	3.29	4.07	80.86
WA	3.89	3.80	102.48
TAS	1.70	2.39	71.00
AUST	2.48	3.17	78.37
<u>23 - Textiles</u>			
NSW	-1.60	-.23	695.26
VIC	-.62	.14	*
QLD	-.79	-.35	224.86
SA	.15	3.77	3.86
WA	1.73	2.84	60.76
TAS	-3.04	-2.02	150.48
AUST	-.98	.14	*
<u>24 - Clothing</u>			
NSW	-4.06	-.21	1934.67
VIC	-2.68	1.42	*
QLD	-4.50	.36	*
SA	.47	5.99	7.77
WA	-1.88	2.12	*
TAS	-3.68	4.09	*
AUST	-3.12	1.01	*

TABLE A5.3 (Continued)

STATE	PREDICTED	ACTUAL	% EXPLAINED
<u>25 - Wood</u>			
NSW	1.95	1.32	147.90
VIC	1.57	.91	172.30
QLD	1.76	1.82	96.46
SA	3.07	1.68	182.82
WA	.80	.87	92.14
TAS	3.40	2.53	134.51
AUST	1.93	1.35	142.99
<u>26 - Paper</u>			
NSW	.46	2.45	18.58
VIC	1.22	2.80	43.40
QLD	1.26	2.82	44.60
SA	1.75	2.62	66.77
WA	2.20	3.35	65.66
TAS	.63	2.36	26.88
AUS	.98	2.65	37.14
<u>27 - Chemicals</u>			
NSW	.59	.23	256.43
VIC	1.25	1.40	89.31
QLD	1.74	3.34	51.98
SA	.30	-1.21	*
WA	1.44	.43	334.19
TAS	1.56	-1.80	*
AUST	.92	.73	125.92

TABLE A5.3 (Continued)

STATE	PREDICTED	ACTUAL	% EXPLAINED
<u>28 - Non metallic minerals</u>			
NSW	-1.85	1.77	*
VIC	-1.02	2.09	*
QLD	1.15	5.77	19.95
SA	-.83	2.25	*
WA	.00	1.68	*
TAS	-2.30	.28	*
AUST	-.98	2.41	*
<u>29 - Basic metal products</u>			
NSW	2.62	1.21	216.46
VIC	11.21	21.18	52.93
QLD	7.93	4.75	166.89
SA	3.39	2.09	162.24
WA	10.61	12.34	86.00
TAS	1.88	.03	6257.67
AUST	4.70	3.88	121.19
<u>31 - Fabricated metals</u>			
NSW	-.19	.35	*
VIC	.25	.52	47.87
QLD	1.93	2.95	65.46
SA	-.57	.50	*
WA	1.51	1.69	89.64
TAS	2.09	2.81	74.34
AUST	.31	.82	38.13

TABLE A5.3 (Continued)

STATE	PREDICTED	ACTUAL	% EXPLAINED
<u>32 - Transport equipment</u>			
NSW	-1.42	.68	*
VIC	1.15	1.26	91.13
QLD	-.71	1.23	*
SA	-1.72	-.16	1073.75
WA	1.52	3.71	41.05
TAS	-3.42	-1.82	187.75
AUST	-.23	.90	*
<u>33 - Other machinery</u>			
NSW	-2.02	1.40	*
VIC	-3.89	1.35	*
QLD	1.20	5.11	23.51
SA	-2.07	1.27	*
WA	2.48	6.18	40.15
TAS	.77	2.88	26.82
AUST	-2.21	1.76	*
<u>34 - Miscellaneous</u>			
NSW	.12	2.72	4.46
VIC	.53	2.96	17.76
QLD	2.88	6.34	45.43
SA	3.61	6.41	56.31
WA	5.05	9.30	54.27
TAS	10.58	17.93	58.99
AUST	.90	3.54	25.42

CHAPTER 6 A DEMAND ORIENTED EXPLANATION OF MANUFACTURING GROWTH
IN THE AUSTRALIAN STATES

6.1 Introduction

The previous chapters presented a modified shift and share and production functions approach to explaining manufacturing growth in the Australian States. Both of these approaches, however, are supply oriented and so it is appropriate to now turn to a demand oriented model.

The demand oriented models reviewed in chapter 2 were the export base and export led models, but they will not be used in this chapter for two principal reasons. First, both are related to the aggregate regional economy. Unlike the shift and share and production function approaches which can be related to sectors within or to the whole economy, these models can represent only the total economy as the activities of the services sector are included.

Second, in order to operationalise the export led model, which is the more realistic of the two, several elasticities would have to be computed. This is in itself a major task that falls outside the scope of this thesis.

Instead of using these models, the labour requirements approach will be used to offer another possible explanation of State manufacturing growth.

Following this introduction, section two presents the results obtained from applying the labour requirements approach and section three concludes the chapter.

6.2 The Labour Requirements Approach

Demand oriented approaches to growth suggest that a causal link exists between the rate of growth of demand and the rate of growth of employment. Growth in demand is translated into increased output at the firm or industry level. It is this increased output which requires entrepreneurs to hire labourers, resulting in employment growth. Decreases in demand have the opposite effect. This then is a simple Keynesian model of growth and differs from the neoclassical supply oriented model in that its causal link is reversed.

Employment growth is not entirely predicated upon output growth as changes in labour productivity are also allowed in the labour requirements approach. For any given increase in output, changes in labour productivity inversely affect employment growth (i.e. increased labour productivity will decrease the amount of labour required at any level of output and vice versa).

These two influences on employment growth can be shown to arise from a definitional identity. The level of employment at any time can be expressed in the following way:

$$N_{is} = \left(\frac{N}{\bar{VA}} \right)_{is} VA_{is} = \left(\frac{1}{\bar{VA}/\bar{N}} \right)_{is} VA_{is} \quad (6.1)$$

where N_{is} is the level of employment in industry i in State s ;

VA_{is} is the level of Value added in industry i in State s ;

and $\left(\frac{VA}{\bar{N}} \right)_{is}$ is the level of labour productivity in industry i in State s .

Totally differentiating (6.1) and dividing through by employment gives the rate of growth of employment

$$\left(\frac{dN}{N} \right)_{is} = \left(\frac{dVA}{VA} \right)_{is} - \left(\frac{d(VA/\bar{N})}{(VA/\bar{N})} \right)_{is}$$

$$\text{or } n_{is} = g_{is} - r_{is} \quad (6.2)$$

where n_{is} is the rate of employment growth in industry i in State s ;

g_{is} is the rate of growth in value added in industry i in State s ;

and r_{is} is the rate of growth of labour productivity in industry i in State s .

The effects of output and productivity growth (g_{is} and r_{is}) must always add back to employment growth (n_{is}). In this sense at least, the labour requirements approach is based upon a truism. This, in itself, is not a weakness in the technique as it allows one to disentangle some of the factors at work in employment growth.

One weakness of this approach is the treatment of labour productivity. Increases in productivity, according to equation (6.2) lead to lower employment growth than would be possible without any productivity change. Indeed negative productivity growth would be beneficial to employment growth. In a competitive market, it could be argued that differences in productivity between producers, a condition that exists in the case of the Australian States, lead to differential experiences in employment growth. Those with faster than average productivity growth could be expected to become more competitive in the production and supply of a commodity and this may be at the expense of lower productivity growth areas. Without the competitive gain which increased productivity allows, employment losses in a State may have been greater than actually did occur.

This 'fault' in the labour requirements approach arises as it is a limited model that considers only the first round or direct effects of changes in variables. By definition, increased productivity means that less labour is required. It does not therefore follow that less employment growth occurs. In interpreting the results from the labour requirements approach, this must be kept firmly in mind.¹

Table 6.1 reports the results of applying equation (6.2) to total manufacturing employment growth in each State over the full and half periods. In the full period and the first half, States with negative employment growth had a rate of productivity growth faster than output growth while those with positive

employment growth had a faster output growth rate. This is to be expected as all of the output and productivity growth rates over the period were positive. The simple form of equation (6.2) ensures that when this is so, productivity growth must exceed output growth when employment declines and vice versa. It is only in the second half that interesting results arise as some negative output and productivity growth occurs.

In the second half all States with negative employment growth, and Australia, had negative output growth. Productivity growth further reduced labour requirements in each of these States except Tasmania. Unlike the full period, output growth dominated results in the majority of States, the exception being New South Wales. The results for Queensland are interesting. Although it had negative output and productivity growth, positive employment growth occurred as the loss of productivity offset the decline in output.

The results for each industry sub-division show much the same trend as for total manufacturing. The full period and first half have few negative entries for output and productivity growth, leading to predictable results. In the second half, only occasionally does negative productivity growth reverse the expected results.

TABLE 6.1
 LABOUR REQUIREMENTS APPROACH TO TOTAL MANUFACTURING
 EMPLOYMENT GROWTH FOR THE STATES AND AUSTRALIA:
 1968-69 to 1980-81; 1968-69 to 1974-75;
 and 1974-75 to 1980-81

STATE	n	g	r
<u>1968-69 to 1980-81</u>			
NSW	-1.14	1.41	2.55
VIC	-.67	1.72	2.39
QLD	.64	3.55	2.91
SA	-.47	1.72	2.19
WA	1.06	4.55	3.49
TAS	-1.12	1.49	2.61
AUST	-.63	1.93	2.56
<u>1968-69 to 1974-75</u>			
NSW	-.84	3.60	4.44
VIC	.25	4.22	3.97
QLD	.64	7.17	6.53
SA	1.42	4.71	3.29
WA	1.22	5.42	4.20
TAS	-.95	4.58	5.53
AUST	-.02	4.36	4.38
<u>1974-75 to 1980-81</u>			
NSW	-1.44	-.78	.66
VIC	-1.59	-.77	.82
QLD	.63	-.07	-.70
SA	-2.35	-1.27	1.08
WA	.90	3.68	2.78
TAS	-1.31	-1.41	-.10
AUST	-1.25	-.50	.75

These results can be used to suggest where the major factors leading to differences in employment growth between the States lie. Dixon and Thirlwall (1975) suggest a method of standardising regional results around some benchmark, in this case the Australian results, in order to see the major factors leading to different results.

Take a figure that is formed by the difference of two variables. The result and each variable can be expressed as deviations from the national results. To evaluate the contribution of each component to State or regional variation, square both sides of the relevant equation (in this case equation (6.2)) and sum over all States, to yield for industry i:

$$\begin{aligned}\sum_S (n_{is} - n_{aus})^2 &= \sum_S [(g_{is} - g_{aus}) - (r_{is} - r_{aus})]^2 \\ &= \sum_S (g_{is} - g_{aus})^2 + \sum_S (r_{is} - r_{aus})^2 \\ &\quad - 2 \sum_S [(g_{is} - g_{aus})(r_{is} - r_{aus})]\end{aligned}$$

or

$$\sum_S \Delta n_i^2 = \sum_S \Delta g_i^2 + \sum_S \Delta r_i^2 - 2 \sum_S \Delta g_i \Delta r_i \quad (6.3)$$

where Δn_i is the difference between the State and the national employment growth rates in industry i;
 Δg_i is the difference between the State and national growth in value added in industry i;
 and $2 \sum_S \Delta g_i \Delta r_i$ is an interaction term.

The various components of equation (6.3) can be measured against the squared employment figure to gauge their relative importance in explaining the differences between the State and national results. The inclusion of the interaction term as a result of the techniques used in producing equation (6.3) is noticeable. The idea of some sort of interaction between productivity and output growth is appealing as it goes some way to meeting the arguments above about the treatment of productivity in the labour requirements approach.

Table 6.2 presents the results of applying equation (6.3) to the total manufacturing sector in each State over the full and half periods. In the full period and the second half, differences in the rate of output growth contributed most to interregional differences in employment growth. In the first half, the interaction term dominated. These results are largely replicated at the sub-division level. Of a total of 13 sub-divisions, the growth component was the major contributor in nine cases for the full period and 10 in the second half. In the first half, the interaction component dominated in 10 cases.

These results suggest that, as a general rule, differences in output growth were the major explanation of differences in employment growth between the States. To the extent that demand determines the level of output and its growth, different pressures of demand upon the States appears to have lead to their different employment growth rates.

TABLE 6.2
SOURCES OF INTERSTATE DIFFERENCES
IN EMPLOYMENT GROWTH

Source of Variation	Sum of Squares	Percent explained
<u>1968-69 to 1980-81</u>		
Δg^2	10.04	200.96
Δr^2	1.56	23.13
$-2 \sum \Delta g^2 \Delta r^2$	-6.20	-124.10
	5.00	100.00
<u>1968-69 to 1974-75</u>		
Δg^2	9.79	173.02
Δr^2	7.34	129.70
$-2 \sum \Delta g^2 \Delta r^2$	-11.47	-202.72
	5.66	100.00
<u>1974-75 to 1980-81</u>		
Δg^2	19.23	201.94
Δr^2	7.07	74.22
$-2 \sum \Delta g^2 \Delta r^2$	-16.78	-176.17
	9.52	100.00

6.3 Conclusions

This chapter has presented a simple demand oriented model of employment growth in the Australian States. The results obtained in the full period and the first half were largely expected as there were few negative output and productivity growth rates over those periods. In the second half, negative productivity growth occurred occasionally, reversing the expected results. The results presented in the first section of this chapter should be interpreted with some caution because of the treatment of productivity in the analysis.

The analysis of State variation in the results suggested that different levels of demand and its growth was the major contributor to State variation in employment growth.

NOTES TO CHAPTER 6

1. This line of reasoning has not been restricted to the labour requirements approach. In the Bureau of Industry Economics' (1981) study of developments in Australian industry, appendix 1 uses a method of analysis which shows increasing productivity as a factor in employment losses.

CHAPTER 7 SUMMARY AND CONCLUSIONS

This thesis has used three different methods of analysis to describe the growth of manufacturing in the Australian States over the period 1968-69 to 1980-81. This period was found to be of interest because the Australian economy had undergone noticeable change, with a period of prosperity in the first half of the 1970s being followed by a recession in the second half.

In chapter 1 it was argued that it was appropriate to confine the study to the manufacturing sector even though it employed only 17.7 per cent of the Australian workforce in 1981. This was because although total employment in the Australian economy and each of the States increased over the period, manufacturing employment over the same period decreased in four of the six States. Secondly, some theorists argue that the manufacturing sector plays an important role in determining economic growth. Third, the availability of data on manufacturing at the national and State levels made the task of examining manufacturing growth at the State level tenable.

Chapter 1 also argued that it is appropriate to study manufacturing at the State level as there are few analyses of the State economies and those that do exist are either dated or purely descriptive. This neglect of the States meant that, although data describing the manufacturing sector at the State level was available, it had to be adjusted to account for variations in coverage and definition over time. As a result, a

large amount of time had to be devoted to making the database consistent and to constructing a capital stocks series for manufacturing at the industry sub-division level for each of the States. The construction of this database meant that an analysis of State manufacturing growth could be made rather than a purely descriptive study.

Chapter 2 surveyed the literature on regional economic growth under the main headings of supply and demand oriented approaches.

Chapter 3 studied the data lacking especially at the manufacturing location patterns, industrial specialisation by the States and describing manufacturing growth in the Australian States. It was found that New South Wales and Victoria were the major industrial States as usually more than seventy per cent of employment in any sub-division was located in these two States. Their comparatively large manufacturing sectors also made them the least specialised States. Tasmania, with the smallest manufacturing sector, was found to be the most specialised.

Changes in the industrial location at the State level were also studied and it was found that Queensland and Western Australia had increased their shares of manufacturing employment over the period at the expense of the other States - a pattern similar to that found in population movements over the same period. It was also interesting to note that most of the relocation of manufacturing activity over the period occurred in

the first half suggesting that the recession in the second half of the 1970s had slowed geographic reorganisation of Australian manufacturing.

Growth in the States varied significantly. The resource rich States of Queensland and Western Australia fared much better than the other States while New South Wales and Tasmania had the lowest growth rates. No matter what measure of growth was used (e.g., employment, value added or capital), the results differed little except for Tasmania. Despite its poor employment and value added results, Tasmania had the highest growth rate of real capital stock over the period. The results for South Australia showed that although it did comparatively well in the first half of the seventies, the recession of the second half appeared to be severely affecting its manufacturing sector. A sideline to this chapter was the comparison of the employment location quotient to various other measures. It was found that the location quotient could not predict which industries are highly productive in a State but gave reasonable predictions of those industries in which a State could be expected to grow comparatively quickly.

Chapter 4 examined the arguments for and against shift and share examinations of regional growth and suggested that several of these arguments were overstated. Shift and share type analysis, if properly interpreted can aid in examining alternative hypotheses of regional growth. It was found that no matter what weighting system was used, little of the differences in manufacturing growth between the States could be explained by

their industrial structure. This finding suggests that the oft touted policy of locating high growth or 'sunrise' industries in depressed regions in an attempt to revive their ailing economies may not be a suitable policy.

Chapter 5 estimated production functions for manufacturing sub-divisions in the States and for total manufacturing. No variation in the parameters of the Cobb-Douglas production function was discernable at the State level and the results of this estimation, when applied to State manufacturing growth, did not provide an accurate explanation. The results of further estimation appear in appendix 2, where estimates of the elasticity of substitution between capital and labour at the manufacturing sub-division level in the States is presented.

Chapter 6 presented a demand oriented explanation of manufacturing growth in the Australian States. Some reservations were expressed as to the treatment of productivity change in this approach but the analysis suggested that variation in the growth of manufacturing in the States was largely accounted for by differences in the pressure of demand, rather than productivity of other factors, between the States.

A major achievement of this thesis has been the construction of the database. This enabled the thesis to move past simple shift and share type analyses of State manufacturing growth. These further analyses suggest that the factors behind regional

growth are still largely unexplained. The development of the database also allowed a description of industrial location and specialisation at the State level and for manufacturing growth in the States over the 1970s to be documented. Surprisingly, such purely descriptive work is not readily available.

To examine State manufacturing growth properly, researchers must move past shift and share type analyses, but this can be done only by constructing specific data sets. The results of this thesis suggest that such data sets can and should be constructed.

APPENDIX 1: THE DATAA1.1 Introduction

This appendix details the methods used to establish the database used throughout the study. Due to the need to overcome definitional changes in the data, compilation of the database was a long and tedious task. In order to display the problems encountered and the methods used to overcome them, this appendix is presented in six sections.

Following this introduction section two describes the main body of data, defines the variables, explains the level of aggregation chosen for the study and points out the definitional changes encountered. Section 3 details the methods used to overcome these definitional changes and demonstrates the importance of these corrections. Section 4 describes the deflators used in converting the data to constant prices. Section 5 explains the capital stock series and section 6 shows how the various elements mentioned above were combined to form the final version of the database.

A1.2 The Main Body of Data

The data used in this paper has been gathered from the Australian Bureau of Statistics annual census of manufacturing

establishments for each State given in references ABS(a) to ABS(f). Annual data was collected on the average number of persons employed,¹ wages and salaries paid, value added and the fixed capital expenditure less disposals for each manufacturing industry sub-division (i.e., 2 digit ASIC classification). Most of the concepts in these data are easily recognised but it is necessary to describe them more fully in order to foreshadow the adjustments that will be discussed in the next section.

Employment is defined as the number of employees plus working proprietors on the pay roll of an establishment. Average annual employment was used as this was considered to be a more representative measure of an industry's annual labour requirements than employment at the end of the financial year.

Wages and salaries enumerates all monies paid to all employees of an establishment but does not include the drawings of working proprietors. Obviously there is a discrepancy between the employment and wages and salaries variables because of the differing treatment of working proprietors.

Value added is generally accepted as the measure of an industry's contribution to total production. Broadly, it measures the total revenue of an establishment² plus (or minus) the change in stocks less all of its purchases.

Fixed capital expenditure less disposals measures the outlay on new and second hand fixed tangible assets less disposals on

both currently operating establishments and those not yet in operation.

A problem encountered early in the series is the lack of census data for 1970-71. ABS did not conduct a manufacturing establishments concensus in that year due to a heavy backlog of work in this area, nor have any proxy figures been published. As a result, the data used for 1970-71 are simply the arithmetic means of the 1969-70 and 1971-72 values.

In 1974-75, ABS changed the census in two ways. First, it changed its industrial classification within the ASIC. These changes involved reclassifying some activities previously classified as mining to manufacturing (e.g., pelletising of iron ore) and forming a new set of aggregations within each industry sub-division (i.e. 2 digit ASIC). Subsequently, gathering a consistent data set by industry class (4 digit ASIC) or industry group (3 digit ASIC) over the period to be examined, whilst possible, was out of the question. Changes at the industry sub-division level were negligible as can be seen from the mapping between the two ASIC given in ABS(g). The industry sub-division level offers a sufficiently detailed picture of the manufacturing sector to enable analysis to be undertaken. At this level of aggregation the following industries were identified:

- 21 Food, beverages and tobacco;
 - 23 Textiles;
 - 24 Clothing and footwear;
 - 25 Wood, wood products and furniture;
 - 26 Paper, paper products, printing and publishing;
 - 27 Chemicals, petroleum and coal products;
 - 28 Non metallic mineral products
 - 29 Basic metal products;
 - 31 Fabricated metal products;
 - 32 Transport equipment;
 - 33 Other machinery and equipment;
 - 34 Miscellaneous manufacturing
- and Total manufacturing.

Even at this level of aggregation confidentiality criteria required that observations for industry sub-divisions 27 and 32 in 1977-78 and sub-divisions 27,29 and 32 in 1978-79 in Tasmania not be published. In these cases surrogate figures were calculated as follows. By subtracting the known figures from those for total manufacturing in the State, the amount to be distributed across these sub-divisions is given. Each variable was then pro-rated on the basis of the previous year's figures of these excluded industries. For example, wages and salaries for Tasmania industry sub-divisions 27 and 32 in 1977-78 were based upon the proportions of wages and salaries paid in these sub-divisions in 1976-77.

The second definitional change was the exclusion from the census from 1975-76 of establishments employing fewer than four persons. In order to make the series comparable, ABS foreshadowed this change in 1974-75 and published separate results for small and large establishments in that year. From 1975-76 on, the only data collected from the small establishments was the number of establishments and employees at 30 June each year and wages and salaries paid during the year. This change was made in an attempt to relieve some of the clerical workload forced on small establishments by ABS demands and in the light of the small proportion of total production accounted for by these establishments. In terms of total manufacturing production, this is usually less than one per cent of each variable.

Due to the differential treatment of working proprietors and the decision to drop small establishments from the census, it was necessary to adjust the data. The nature and importance of these adjustments is discussed in the following section.

Al.3 Adjustments to the main body of data

The first adjustment made to the data involved correcting the employment series to make it compatible with wages and salaries. This was done by subtracting working proprietors from the employment series. This may be partially incorrect as working proprietors may decide to pay themselves a wage as well as making drawings, but the adjustment was small in most cases and easily implemented.

All other adjustments involved correcting the main data series for the definitional changes involved in omitting small establishments after 1974-75. The employment and wages and salaries series were easily corrected by adding the figures for small establishments published in the ABS censuses from 1974-75 onwards. The fixed capital expenditure and value added series from 1974-75 onwards were multiplied by a constant factor to account for this change. This factor was calculated as the proportion of value added accounted for by small establishments in 1974-75 in each sub-division in each State. If, for example, value added for a sub-division by large establishments in 1974-75 was \$100 and small establishments value added was \$1, then all value added figures would be scaled upwards by a factor of 1.01.

A further series that had to be adjusted was that of working proprietors. From 1974-75 onwards this series does not take account of small establishments. Only Victoria published linking figures in 1974-75 between small and large establishments for working proprietors, so figures for all States were adjusted by a constant factor calculated from the Victorian data.

One may ask if these adjustments are necessary if the share of total manufacturing accounted for by small establishments is small. Whilst this is true in terms of total employment, the importance of small establishments across industry sub-divisions across States may vary as the figures in table APP2.1 suggest.

Table APP2.1 shows the adjustment factors used for industry sub-division 32 for fixed capital expenditure, value added, working proprietors and the equivalent adjustment factor for employment at 1974-75 by State. The small shares of employment and value added accounted for by small establishments in each State are confirmed. However, the capital expenditure figures suggest that 16 per cent of total fixed capital expenditure in this industry in Tasmania was accounted for by small establishments, suggesting that there are cases where the small establishment is of great import to an industry at the State level. The high value of the adjustment for working proprietors is to be expected as small establishments can be expected to account for a large number of working proprietors.

TABLE APP1.1
ADJUSTMENT FACTORS FOR FIXED CAPITAL EXPENDITURE,
VALUE ADDED, WORKING PROPRIETORS AND EMPLOYMENT
BY STATE FOR INDUSTRY SUB-DIVISION 32

Variable State	Fixed Capital Expenditure	Value Added	Working Proprietors	Employment
NSW	1.0224	1.0048	2.0894	1.0062
VIC	1.0010	1.0029	2.0894	1.0039
QLD	1.0142	1.0068	2.0894	1.0126
SA	1.0007	1.0028	2.0894	1.0036
WA	1.0161	1.0129	2.0894	1.0190
TAS	1.1551	1.0086	2.0894	1.0279

A1.4 Deflators

Data in the censuses are in current dollar terms. To place this data in constant price terms, several deflators were used to centre the data at 1974-75 prices.

The wages and salaries series for each industry was deflated by the consumer price index for each State capital obtained from ABS(h). All fixed capital expenditure data were deflated by the implicit price deflator for total private gross fixed capital expenditure given in the Australian National Accounts (See ABS(i)).

Value added for each sub-division was deflated by the price deflator of manufacturing articles produced given in ABS(j).

A1.5 The Capital Stock Series

Capital stock figures for Australian manufacturing industries are provided by Hourigan (1980) for input-output industries at 1971-72, by Bailey (1981) for total manufacturing during the late sixties and the first half of the 1970s and by Haig (1978) for the period 1919-20 to 1976-77. None of these studies have produced capital stocks series for industries at the State level. As Haig's data is for several industry groupings and these groups are reconcilable with those used in this study, it was decided to use his figures as a starting point for a

capital stocks series for each industry sub-division within each State.

Haig presents several net capital stock series based upon differing length of life and depreciation assumptions and a gross capital stocks series for several broad manufacturing industries. It was decided to use Haig's estimates using 100 per cent depreciation of capital at the end of its service life as this appears to be his preferred series. Although valued at 1938-39 prices, this series was easily rescaled to 1974-75 prices by use of the price indexes given by Haig in his Table 16. These indices were for plant and machinery and buildings and structures. To form an appropriate index for total capital stock at 1974-75, a weighted average of the two series was formed based upon the relative importance of plant and machinery and buildings to total capital stock at 1974-75.

The next step was to form initial capital stock estimates for each industry in each State at 1967-68 so that the fixed capital expenditure figures for each industry could be used to form a capital stocks series based upon these starting values. To do this, Haig's 1967-68 estimate of total gross capital stock for Australia was mapped into ASIC sub-divisions at the national level and then pro-rated to the States on the basis of value added shares at 1968-69.

Once these figures had been obtained, the fixed capital expenditure figures (at 1974-75 prices) were added sequentially

to this to form a capital stock series ignoring depreciation. To take account of capital deterioration, this capital stocks series was decreased by the value of investment in plant and machinery 15 years earlier. This assumption of a 15 year life for plant and machinery is in line with Haig's work. It was decided not to decrease capital stock by building investment in earlier years because of the very long life of this form of investment in relation to the time period under study (40 years compared to 13 years) and, more importantly, due to the small amounts involved. These manipulations produced a capital stocks series for each State over the study period similar to that given by Haig for Australia.

This method of calculating a capital stock series has several drawbacks. No account is taken of capital rented by industries. Haig corrects for this by multiplying his series by a constant factor. This would make little difference to the estimates used in this study as it would simply affect all industries equally across all States, affecting only the intercept terms in the regressions. Secondly, it uses a very simple depreciation structure which leads to an overestimate of capital stocks and finally it begins with national figures pro-rated to a State level.

The advantages of the method are that it uses the data on fixed capital expenditure available at the State level and therefore allows for more sudden changes in the level of capital stock across States than simply pro-rating national figures by value added in each year.

6. Final Compilation of the Database

Once all of the relevant parts of the database were compiled a computer programme was used to make the necessary additions and multiplications to form the final version of the database. This database was then stored on computer file for later use.

APPENDIX 2 THE VES PRODUCTION FUNCTION APPLIED TO THE AUSTRALIAN STATES

This appendix presents estimates of the parameters of the Variable Elasticity of Substitution (VES) production function in an attempt to allow some variation in production structures of the Australian States. Furthermore, the results obtained allow us to gain an estimate of the elasticity of substitution in each sub-division in each State. This approach has been suggested by Vinod (1973).

The VES production function differs from both the Cobb-Douglas and Constant Elasticity of Substitution (CES) functions as it is non-homogeneous. It takes the form

$$y = e^{a_0} K^{a_1 + a_3 \ln L} L^{a_2} e^{a_4 t} \quad (A2.1)$$

which can be expressed in log-linear form as

$$\ln y = a_0 + a_1 \ln K + a_2 \ln L + a_3 \ln K \ln L + a_4 t \quad (A2.2)$$

The output elasticity of capital and labour are given by:

$$E_K = a_1 + a_3 \ln L \quad (A2.3)$$

$$\text{and } E_L = a_2 + a_3 \ln K \quad (A2.4)$$

The returns to scale is given as the summation of E_K and E_L . The elasticity of substitution between capital and labour is given by:

$$= \frac{E_K + E_L}{E_K + E_L + 2a_3} \quad (A2.5)$$

When the parameter a_3 is equal to zero, the VES function collapses to the Cobb-Douglas as can be seen from equation A2.2 and so the elasticity of substitution becomes unity, as can be seen from equation A2.5.

Equation 7.2 was applied to the pooled utilisation adjusted data set which has been described in Appendix 1 and Chapter 5. As with the pooled estimates of the Cobb-Douglas production function the equation had to be corrected for heteroskedasticity and autocorrelation. The results for the full period is presented in Table APP2.1. The results are not pleasing as the majority of the parameters are insignificant while high $\bar{R}^2$ occur suggesting a severe multicollinearity problem. This should not be surprising as the adjustment factor is the product of the two other explanatory variables. Like in the Cobb-Douglas function, Hick's neutral technical change appears to play little role. Despite the weakness of these equations these results were used to estimate the partial elasticities of output with respect to capital and labour and the elasticity of substitution for each sub-division in each State. The results were generally similar to those given by the Cobb-Douglas production function as the value of the coefficient on the adjustment factor was always low and in some cases zero. The results for total manufacturing only are presented in table APP2.2.

TABLE APP2.1
CORRECTED POOLED ESTIMATES OF VES UTILISATION ADJUSTED
PRODUCTION FUNCTION:
1968-69 to 1980-81

IND	K	L	Tech	Adj	Int	$\bar{R}^2$
21 Food	.41 (.69)	.23 (.33)	.01 (.66)	.02 (.33)	2.45 (.36)	.99
23 Textiles	.52** (3.43)	.60** (3.03)	.02** (2.73)	-.01 (-.40)	.18 (.12)	.99
24 Clothing	.06 (.30)	.75** (3.04)	.05** (6.44)	.01 (.59)	1.92 (.96)	.99
25 Wood	-.10 (-.22)	-.20 (-.39)	-.01 (-1.56)	.06 (1.38)	7.91 (1.51)	.99
26 Paper	.01 (.04)	.28 (.76)	.02** (6.05)	.03 (1.11)	5.06 (1.37)	.99
27 Chemicals	.57 (1.21)	.79 (1.33)	-.00 (-.24)	-.01 (-.32)	-1.13 (-.21)	.99
28 Non metallic minerals	.23 (1.10)	1.21** (4.53)	.03** (4.54)	-.02 (-1.23)	.29 (.14)	.99
29 Basic metal products	.21 (.34)	-.10 (-.13)	-.01 (-.85)	.04 (.60)	5.80 (.72)	.93
31 Fabricated metals	.30** (2.86)	.79** (7.00)	.00 (1.59)	-.00 (-.55)	1.09 (1.38)	.99
32 Transport equipment	.09 (.31)	.68** (2.59)	.02** (3.38)	.01 (.47)	2.71 (1.01)	.99
33 Other machinery	.38 (.25)	1.13** (8.84)	.04** (7.48)	-.01 (-.57)	.98 (.90)	.99
34 Misc.	.29 (1.52)	.71** (2.94)	.04** (6.63)	.00 (.08)	1.15 (.85)	.99
TOTAL	.12 (.32)	-.10 (-.21)	.01 (.66)	.04 (1.25)	7.04 (1.37)	.99

* denotes significance at the 5% level

** denotes significance at the 1% level

TABLE APP2.2
ESTIMATED COEFFICIENTS FROM VES PRODUCTION FUNCTION

State	Partial Elasticity of		Elasticity of Substitution
	Capital	Labour	
NSW	.77	.42	.94
VIC	.76	.42	.94
QLD	.71	.36	.93
SA	.71	.37	.93
WA	.70	.34	.93
TAS	.67	.31	.92

Table APP2.3 presents the elasticity of substitution calculated for each sub-division in each State from Table APP2.1. It is noticeable that there is little variation in the elasticity between the States and most approach the unity value assumed in the Cobb-Douglas formulation.

It would be incorrect to read much into these estimates as their statistical properties are quite poor. Attempts to check the estimates of the elasticity of substitution by calculating a CES production function and its labour first order condition proved unfruitful, but the failure of these estimates to provide worthwhile results should not deter from further work in this area.

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TABLE APP2.3
ELASTICITY OF SUBSTITUTION BY INDUSTRY
SUB-DIVISION AND STATE

IND	NSW	VIC	QLD	SA	WA	TAS
21 Food	.97	.97	.97	.96	.96	.96
23 Textiles	1.02	1.02	1.02	1.02	1.02	1.02
24 Clothing	.98	.98	.98	.98	.98	.98
25 Wood	.90	.90	.90	.89	.89	.88
26 Paper	.94	.94	.94	.94	.94	.94
27 Chemicals	1.02	1.02	1.02	1.02	1.02	1.02
28 Non metallic minerals	1.04	1.04	1.04	1.04	1.04	1.04
29 Basic metal products	.93	.93	.92	.92	.93	.92
31 Fabricated metals	1.00	1.00	1.00	1.00	1.00	1.00
32 Transport equipment	.98	.98	.98	.98	.98	.98
33 Other machinery	1.02	1.02	1.02	1.02	1.02	1.02
34 Misc.	1.00	1.00	1.00	1.00	1.00	1.00
TOTAL	.94	.94	.93	.93	.93	.92

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