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Modelling the Take up of Vacant Industrial Land

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Abstract: *The study describes the moderately successful development of a practical model using readily available statistical data to directly forecast the demand of vacant, industrially zoned land within the Adelaide Statistical Division. The construction of such a model was in response to perceived constraints in Adelaide's land management which might adversely affect the state's long term economic future: namely that the long term provision of adequate and appropriate vacant land suitable for future industrial use was at risk because of over simplified notions of manufacturing decline, exaggerated claims of over supply in the states industrial land stocks and considerable levels of rezoning to residential land use. The model is constructed in light of perceived influences on business activity within the South Australia economy and takes the form of a simplified accelerator model with the use of multi variates. The limitations of the model are canvassed and the need for further refinement is discussed.*

Keywords: Industrial land; Land demand factors; Land demand forecasting.

1. Introduction to the study

Patterns of demand for urban land have changed substantially in the last decade (Blair & Yardley 1994). This applies to demand for industrial land as much as any other. The very term 'industrial' is becoming ambiguous as distinctions between commercial, industrial and retail land use practices become less clear and increased flexibility in planning controls is sought in order to generate economic and administrative advantages (Blair & Yardley 1994). Such change also reflects the developing and increasingly competitive nature of the industrial sector. For states such as South Australia (SA) land management practices which adequately provide for such change are becoming critical. This study was called for in light of perceived constraints in SA's land management which might adversely affect the state's long term economic future. Namely that the long term provision of adequate and appropriate vacant land suitable for future industrial use was at risk because of over simplified notions of manufacturing decline, exaggerated claims of over supply in the states industrial land stocks and considerable levels of rezoning to residential land use (Economic Development Authority (EDA) 1993). There was a need for information in terms of both supply and demand, particularly in terms of actual volumes of land transacted, take up rates and future demand levels. The largest planning review ever undertaken for the Adelaide Metropolitan area had reported its industrial land demand findings in 1993 (Department of Environment & Planning) but these were now considered erroneous and based on unreliable data (EDA *ibid*). This at a time when suitable land parcels had been cited as critical in influencing decisions to invest in Adelaide (EDA *ibid).*

This study focuses on demand for vacant industrial land in the Adelaide Statistical Division (ASD) and attempts to interpret and model the demand with a view to anticipating future levels. Such a study faced a number of constraints not least of which was the lack of validity attached to past attempts to produce such estimates, the almost complete lack of trend or even activity within the SA industrial land market, and the need to construct what had not been assembled before, a credible, well documented data base of industrial land transactions in SA.

2. Demand for Vacant Industrial Land

The analysis of demand for vacant industrial land within the ASD is based on the premise that such demand is strongly linked to economic activity and to opportunities for economic expansion. Such a link has been promoted by writers in Australia (Blair & Yardley 1994), in the USA (Hughes 1994, Wheaton & Torto 1990) and in the United Kingdom (Nicholson & Tebbitt 1979, Giussani & Tsolacos 1993, Tsolacos 1995). The various methodologies explored by these writers are based on the notion of demand for industrial space as a derived demand based on current or expected levels of future business activity. While the indexes selected to measure such activity vary, the proposition of such a relationship is fundamental.

This study does not consider built industrial space but has adopted a similar premise. Thus it begins with a brief consideration of the economic factors which might be considered influential in terms of business activity and hence in terms of demand for industrial space in the ASD. The following discussion on factors influencing demand for industrial space is not a definitive study. It is merely an exploration of possible links between economic activity and demand for vacant industrial land. It recognises that at times the links between such activity and demand may be tenuous in that land requirement is not a fixed factor and can vary depending on the production processes used, effectiveness of land use and level of recycling of industrial space (Adams *et al* 1992). As the level of speculation in industrial land is low and the number of user owners is relatively high, demand for vacant industrial land is likely to be "lumpy" rather than cyclical. It also means that such demand may not always respond systematically to changes in the standard macro economic stimuli (Wheaton & Torto 1990). As well the structural changes within the Australian economy have created a phenomena known as 'jobless growth' typified in part by expansion in the warehousing sector (Searle 1993). This sector is not an extensive employment generator and highlights that economic growth may no longer flow on to demand for space as previously understood. Also the transitional nature of the Australian economy means that past trends may no longer be used satisfactorily to predict future activity. Such transition forces the consideration of short term developments which may not adequately demonstrate future directions. The discussion does however focus on some of the elements that have been considered previously in the construction of demand models: GDP, manufacturing output, consumers expenditure, exports, balance of payments (Nicholoson & Tebbett 1979) employment levels (Blair & Yardley 1994) unemployment, rents, output, cost of capital, expenditure on plant and machinery (Giussani & Tsolacos 1993, Tsolacos 1995).

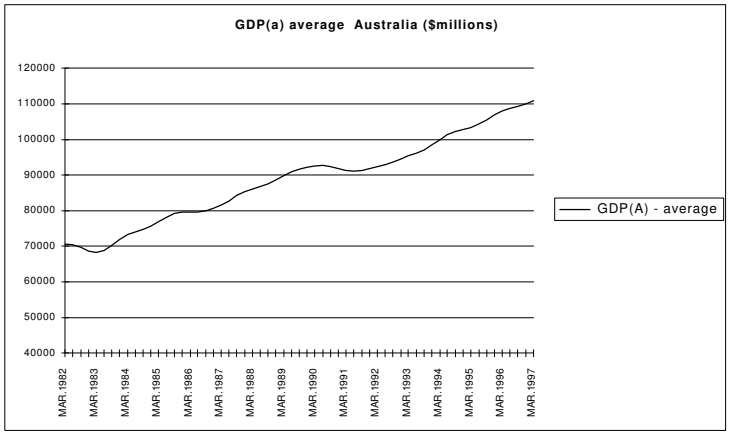
The study does not include an analysis of industrial property vacancy levels as the sales analysis excludes consideration of industrial property sales other than those for vacant industrial land. However it is recognised that demand for vacant land may be significantly influenced by vacancy levels within the total stock of industrial real estate. For instance by the availability of existing properties for lease or of improved industrial land for demolition and reuse. While it is anticipated that industrial construction levels will be included in the modelling process an analysis of vacancy levels is not proposed. The discussion also assumes that in the short to medium term there is an adequate supply of vacant industrial land in the metropolitan area of Adelaide.

3. Economic factors which influence demand for industrial land

3.1 Economic growth

Theoretically there should be a positive correlation between general levels of activity within the economy and demand for industrial land (Hughes 1994).

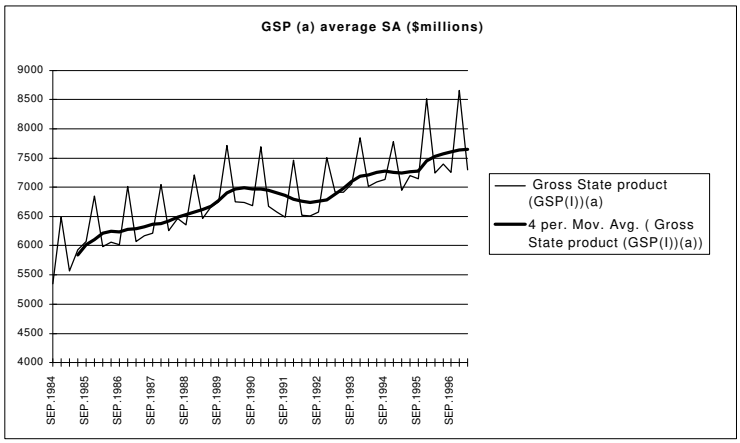
Figure 3-1 GDP (a) Australia quarterly



(*Source ABS 1997 constant figures*)

Demand for industrial land can be seen as a function of growth in the state economy as expressed in Gross State Product (GSP) which tends to follow growth in the national economy as reflected in Gross Domestic Product (GDP). Figure 3-1 and Figure 3-2 show that for SA, GSP tends to reflect national GDP levels though it is more erratic in form. The SA annual GSP growth rate of 9% was the lowest of all States (Australian Bureau of Statistics (ABS) 1997).

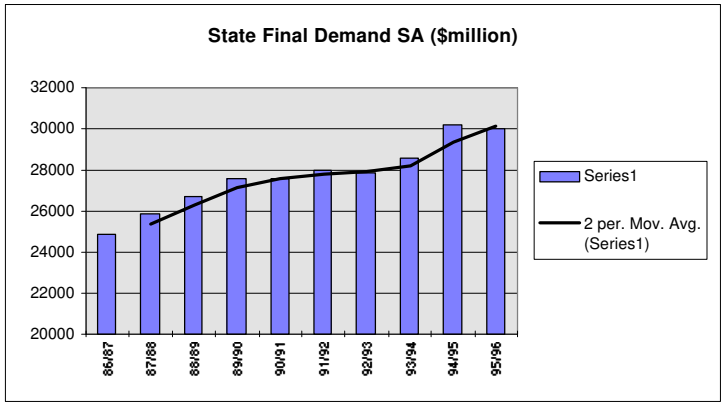
Figure 3-2 GSP (a) South Australia quarterly



(*Source ABS 1997 constant figures*)

GSP grew by .5% in the December quarter compared with a .6% increase in the national average. This represented a significant improvement on the fall of .2% and the increase of .1% recorded in the June and September quarters respectively (ABS *ibid*). State Final Demand (SFD) increased by 1.3% in the December quarter and has for the past three quarters grown at a faster rate than GSP (Figure 3-3). December growth in SFD was the highest of all States and more than double the National Average (ABS *ibid*). Such demand is normally associated with higher levels of retail turnover and in increased need for warehousing and distribution space within the industrial sector.

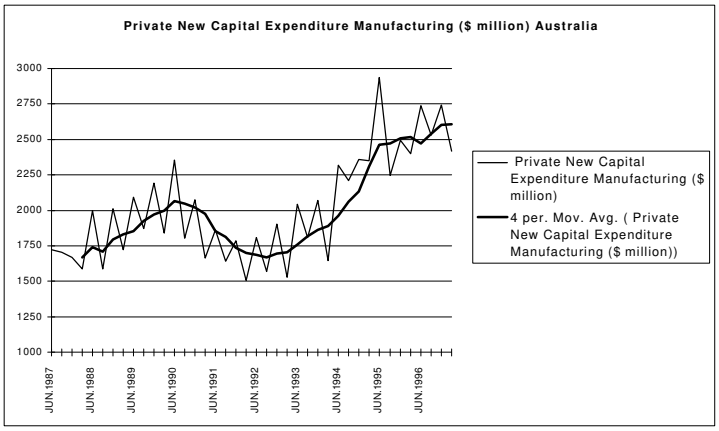
Figure 3-3 SFD SA Annual (Source ABS 1997 constant figures)



Other economic indicators which reflect overall demand for goods and services and hence demand for industrial land include items such as investment in plant and equipment, final demand indicators and private new capital expenditure. Such expenditure is influenced in turn by ongoing interest rate levels.

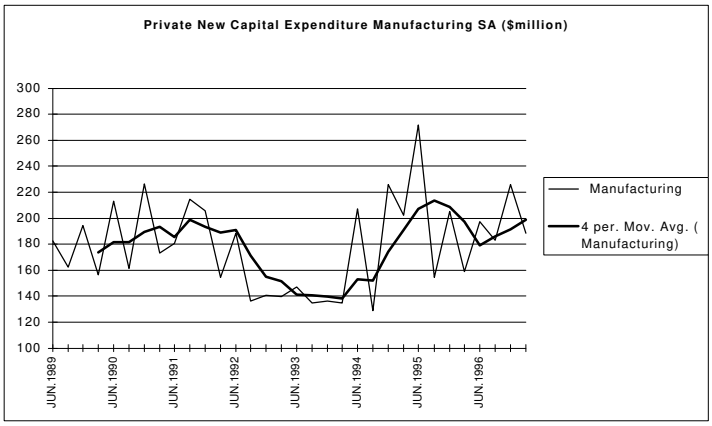
A significant factor in the SA State accounts for June 1997 was the 8% increase in private gross fixed capital expenditure, in particular expenditure on equipment (ABS *ibid*). Such expenditure may be correlated with increasing building and industrial activity, particularly in manufacturing. Figure 3-3 & Figure 3-4 illustrate the long term trends in private new capital expenditure in the manufacturing sector for Australia and for South Australia. Expenditure at the national level has shown a trend increase over the last decade while SA's trend showed a significant downturn in the early nineties. It is anticipated that this trend may correlate with demand for industrial land within the ASD.

Figure 3-4 private new capital expenditure manufacturing Australia quarterly



(*Source ABS 1997 constant figures*)

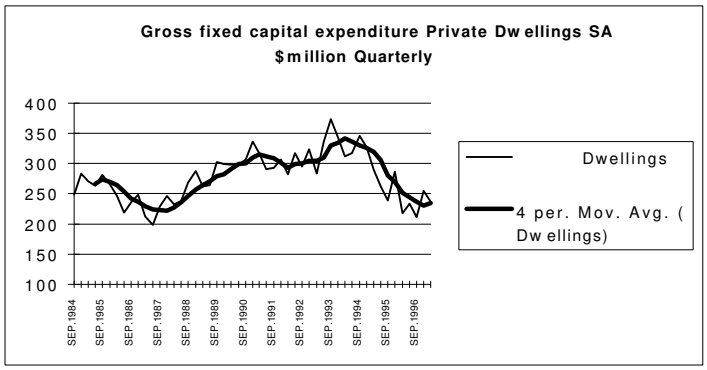
Figure 3-5 Private new capital expenditure manufacturing SA quarterly



(*Source ABS 1997 constant figures*)

With economic recession there follow major downturns in industrial property market activity and increased vacancies in industrial space. Such economic recession is soon reflected in building activity generally.

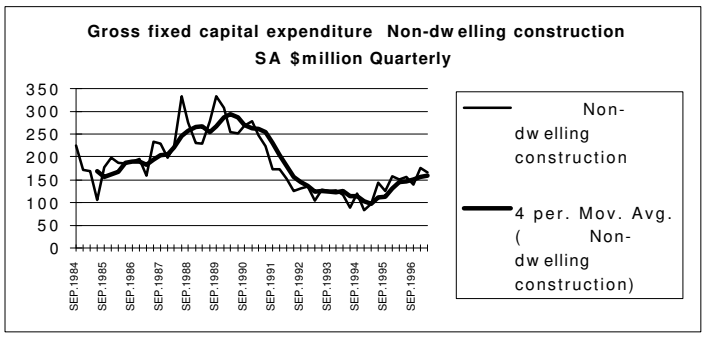
Figure 3-6 Gross fixed capital expenditure Private dwelling construction SA quarterly



(*Source ABS 1997 constant figures*)

Figure 3-6 & Figure 3-7 illustrate the cyclical nature of the property market and for SA adequately represent the ASD. As of June 1997 expenditure on dwellings rose for the first time since the September quarter 1994 (ABS *ibid*). Expenditure on non dwelling construction may correlate positively with demand for industrial space.

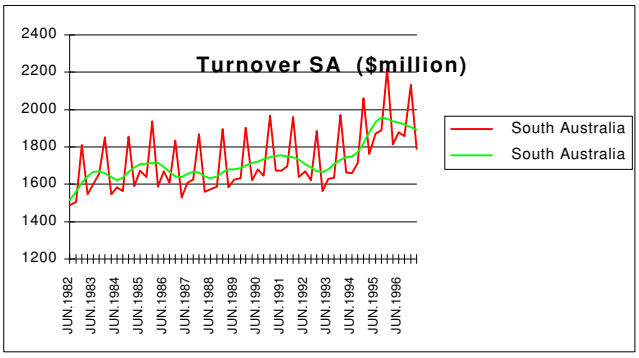
Figure 3-7 Gross fixed capital expenditure non dwelling construction SA quarterly



(*Source ABS 1997 constant figures*)

Retail activity may be an important indicator of overall demand and in particular should be a good indicator of demand by the warehousing and distribution sectors for new industrial space. South Australia's retail activity has been fairly flat in the short term (Figure 3-8).

Figure 3-8 Retail Turnover SA quarterly



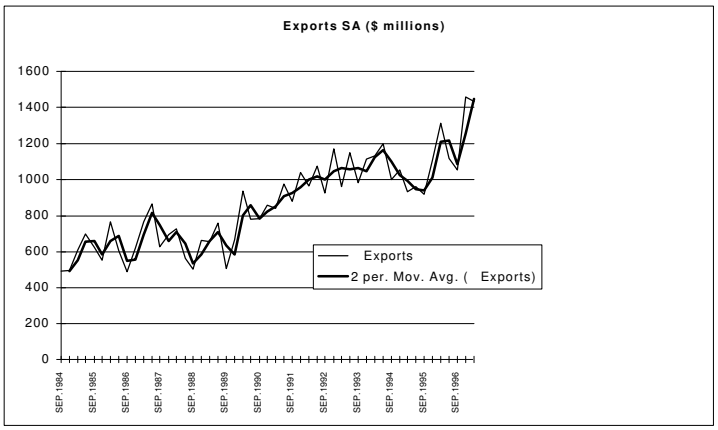
(*Source ABS 1997 constant figures*)

3.2 Trade

Trade levels are an important indicator of economic growth. On average SA is a net overseas exporter of goods and a net importer from other states. In the past there has been a strong export culture in SA including manufactured products. Exports interstate are twice the overseas level with interstate exports dominated by manufacturing goods, especially motor vehicles and parts and overseas exports dominated by primary production (ABS *ibid*). SA exports as a proportion of GSP have increased steadily over the past years to a high of 13% in 1995-96 which is comparable to the national ratio

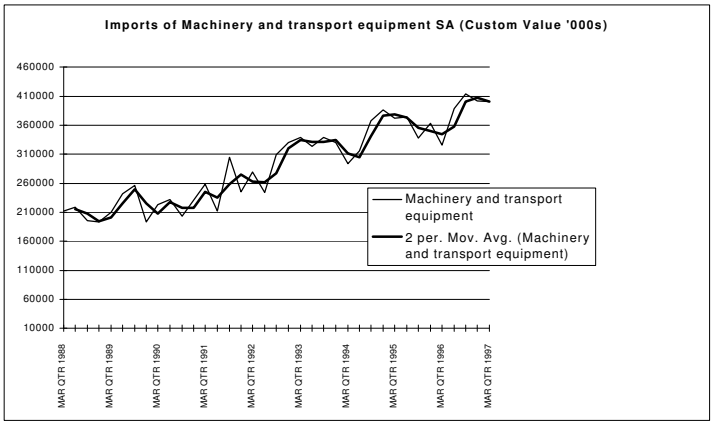
(Figure 3-9). Although a significant proportion of SA exports are commodity based (ABS *ibid)* such overall increases should lead to higher demand for industrial property. Also significant to industrial activity are rising levels of imports in machinery and transport equipment (Figure 3-10).

Figure 3-9 Exports SA quarterly



(*Source ABS 1997 constant figures*)

Figure 3-10 Imports of Machinery & Transport Equipment SA quarterly

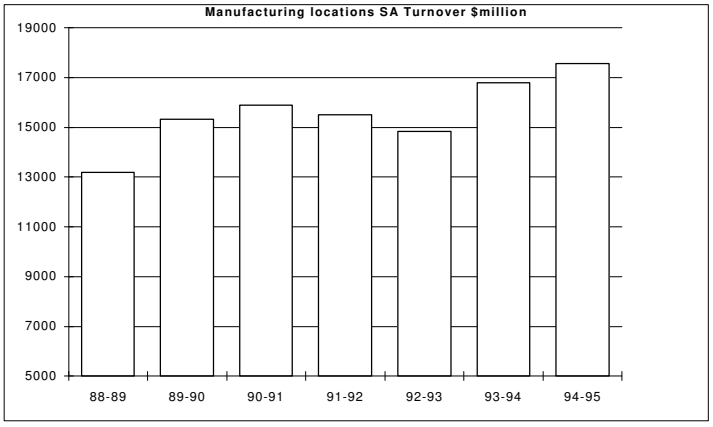


(*Source ABS 1997 constant figures*)

3.3 Labour productivity

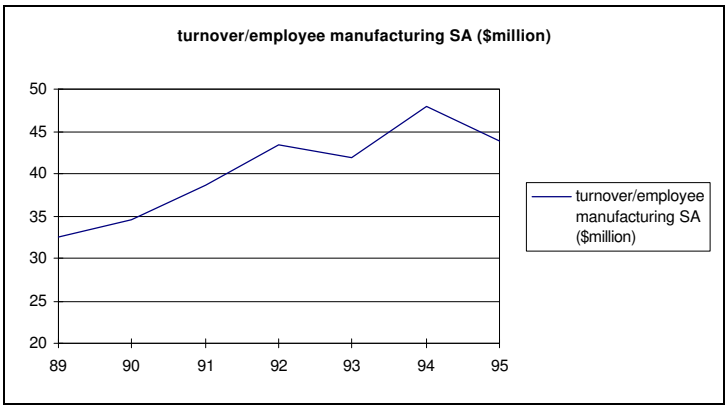
High levels of labour productivity improves cost competitiveness. SA productivity levels are normally considered about the national average production (ABS *ibid*). Annual turnover for manufacturing locations in SA has increased in the last decade (Figure 3-11) while productivity levels after increasing strongly as of 1995, appear to have slowed up (Figure 3-12) It is expected that such a trend may have a negative impact on demand for industrial space.

Figure 3-11 Manufacturing locations Turnover SA annual



(Source ABS 1997 constant figures)

Figure 3-12 Turnover per employee Manufacturing SA annual

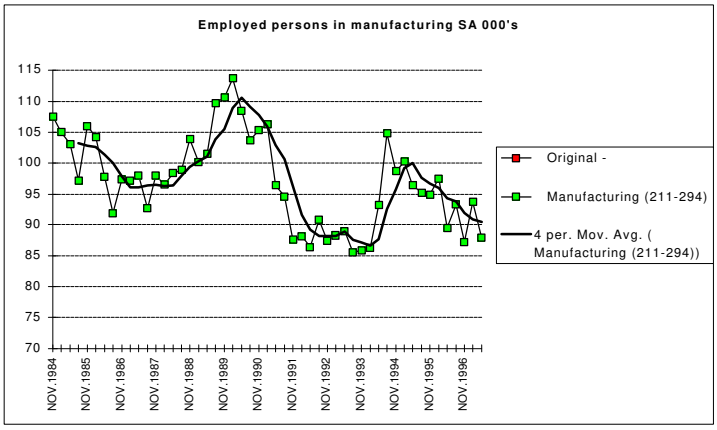


(*Source ABS 1997*)

3.4 Levels of employment

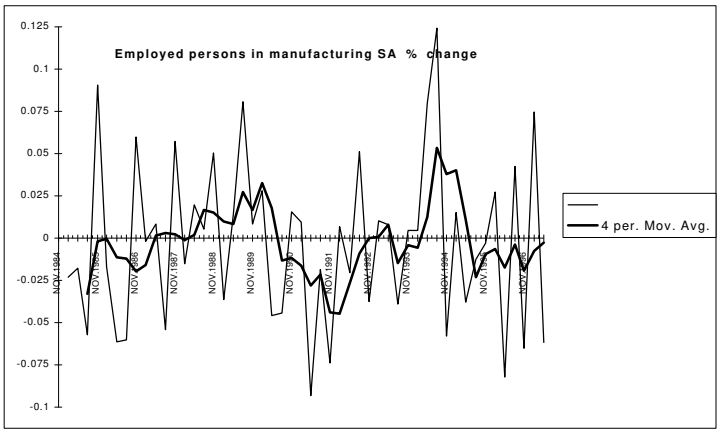
Levels of employment determines absolute demand. Both nationally and at state level there has been structural unemployment with loss of blue collar jobs (Stilwell 1992). Most apparent is the decline in manufacturing employment which in SA has been particularly significant in the last decade (Figure 3-13 & Figure 3-14). At national levels the trend has been similar though of late it may be showing some reversal. Such changes would be anticipated to have a negative impact on demand for vacant industrial space.

Figure 3-13 Employed persons in Manufacturing SA



(*Source ABS 1997*)

Figure 3-14 Employed persons in Manufacturing SA % change quarterly



(*Source ABS 1997*)

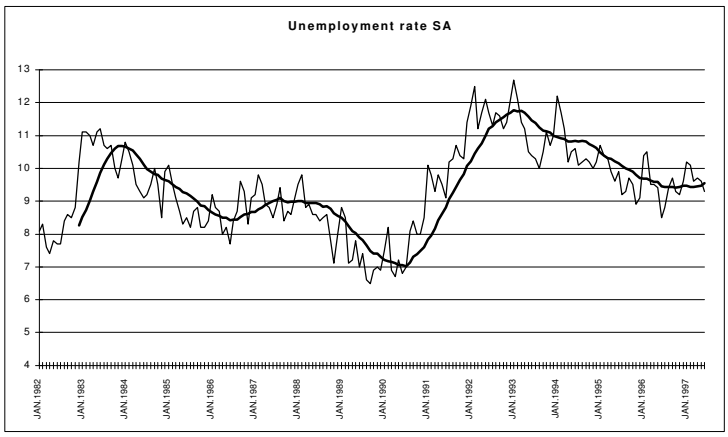
Figure 3-15 illustrates the fall in employment levels within the manufacturing sector down to about 13% of employed persons in South Australia. However this level seems to be one that may be maintained in the medium term.

Figure 3-15 Percentage of total employed persons in Manufacturing SA quarterly

(*Source ABS 1997*)

As of June '97 the SA trend unemployment rate was 9.5% (Figure 3-16) which was above the national average of 8.7%. Such a rate is expected to have a negative impact on industrial activity.

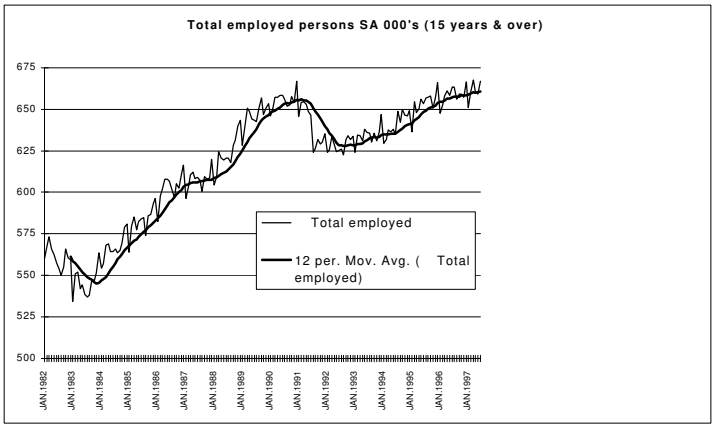
Figure 3-16 Unemployment rate SA quarterly



(*Source ABS 1997*)

Trend estimates of employed persons in South Australia has increased for six consecutive months up to April 1997 (Figure 3-17). This represents a .7% increase over the level of twelve months ago (ABS *ibid*). Such trends are anticipated to correlate with demand for industrial space and are in line with national trends.

*Figure 3-17 Total employment SA quarterly (*Source ABS 1997 *)*



3.5 Changes in technology.

New technology has changed performance standards which the existing industrial built form may not meet. Over many years multiple storey factories have been replaced by single storey premises to better accommodate production line assembly. Now the growing use of computers may demand more

reliable and sophisticated space for instance with respect to air conditioning and power supplies. The use of computer based equipment is also increasing the space required to conduct many forms of business (Rae 1995).

Building requirements are changing as users of industrial space may need less space through mechanisation and therefore there may be some fall in factory floor space although machines used are bigger. At the same time fewer components are required therefore there is less need for production and storage space. Computerised inventory systems have allowed large firms to switch some internal production to cheaper or more flexible outside suppliers with inventories supplied just in time (Rae *ibid*) Therefore there is a need for improved coordination with suppliers. Such systems are predicted to lead to a concentration of warehouse activity in larger more sophisticated buildings close to major roads. There is also anticipated demand for buildings with substantial office content to accommodate a higher proportion of white collar workers in manufacturing with blurring between production and office work (Rae *ibid*). Average worker densities are predicted to fall with automated and technological changes and also as a result of planning controls including site cover, landscaping, set back and parking requirements. As a result increases in demand for industrial land may be the result of increasing space requirements per establishment rather than expansion of manufacturing sector (Searle 1992).

3.6 Change in industry structure

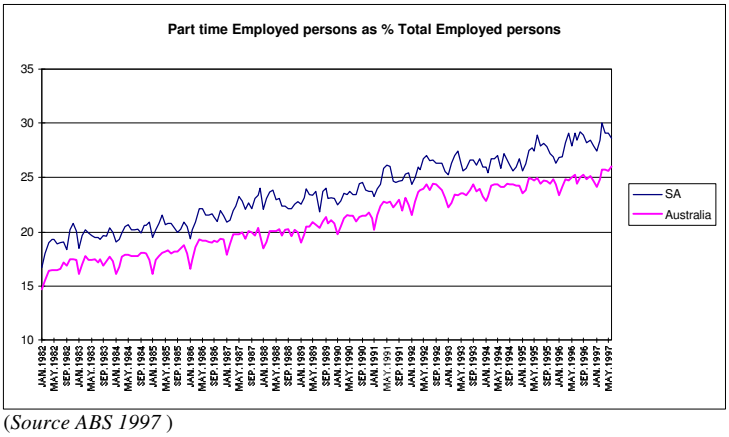
Historically within the SA economy, a greater level of GSP has been attributed to agriculture, manufacturing and public administration than for other states. As discussed previously manufacturing employment has been in decline showing change in the structure of the state and national economy with employment growth in the tertiary and quaternary sectors. There has been growth in warehousing activity but this is not an extensive employment generator, Table 3-1 Employment numbers by sector SA (Source JLW 1996)

Table 3-1 Employment numbers by sector SA (Source JLW 1996)

	As of May 1995	**As of May 1996**	**% change**
Employment SA			
Manufacturing	101600	96400	-5.11
Wholesale	37100	33300	-10.24
Transport & Storage	30000	28600	-4.6
Total	168700	158300	-6.16

As well part-time employment has been increasing. There has been a 3.8% rise in part-time employment in SA over the last six months (ABS *ibid*). Currently 28.9% of all employed persons in SA work in a part-time capacity. This is considerably high than the national average (Figure 3-18). Such rises may have a negative impact on demand for industrial space.

Figure 3-18 Part time employed personsas a % Total employed persons



(*Source ABS 1997*)

There has also been a vertical disintegration of industrial organisation with enterprise specialisation in different phases of production of an industry. It is predicted that this may result in geographic clustering of small or medium sized industries with sub contracting of facilities such as technical

information, machinery, marketing and trade (Florida 1995). This should promote smaller flexible production systems which lower risk and allow a more rapid response to changing conditions (Searle 1992). This in turn requires an efficient system of transport and logistics to ensure production schedules are maintained and customers receive their goods as and when agreed. There is also anticipated to be a continuing increase in the use of industrial land by warehousing, transport industry and construction industry land users.

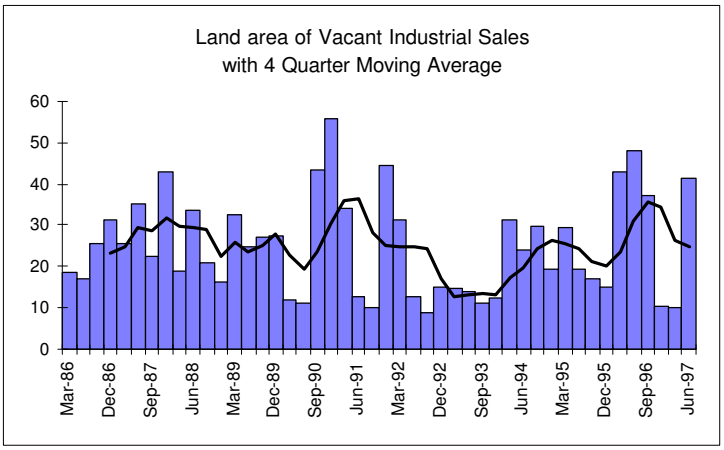
4. Demand Model for Vacant Industrial Land

4.1 Introduction

As discussed above the main influences on demand for industrial land are anticipated to be factors linked to growth in the state and national economies. A review of such factors would normally require significant lead times because of the delay in the uptake of industrial land. However given the transitional nature of the SA economy impacts may be more immediate.

Economic indicators which have been derived from the ABS have been used to track the quarterly movement of the national and state economies over a ten year period (see appendix). These changes have been monitored against changes in the volume of sales in vacant industrial land within the ASD (Figure 4-1).

Figure 4-1 Volume of Sales per quarter ASD



A selection of these indicators have been regressed against the volume of sales to indicate the strength and direction of any causal relationships which exist. Such indicators are readily available in Adelaide and given a certain level of significance should allow for future manipulation of the model. ARIMA projections of these economic indicators allowed for further extrapolation of demand levels for the ASD on a quarterly basis. Over a five year period these levels have been aggregated to provide an indication of the impact on total demand levels. A five year ARIMA forecast based on sales only was also attempted and the results compared to the Demand Model forecast.

4.2 Constraints on modelling

In both cases five year forecasts of demand have been attempted though it must be recognised that these are constrained by the volatility and lack of trend within the original data set, by the small number of original data points (40), by the need for economic data which was readily available on a quarterly basis and consistent in its definition, and by the desire to produce a demand model which could be interpreted easily and manipulated as required. Sophisticated input output models which had been provided in the past had not proved 'user friendly'. The ARIMA model as with most forecasting models cannot be extended indefinitely and is primarily a short term forecasting tool.

4.3 Methodology

The methodology adopted was an intuitive and pragmatic attempt to identify a causal relationship between demand and a series of indexes representing economic activity. In hindsight it represents a somewhat *ad hoc* and simplistic attempt to mimic the traditional so called flexible accelerator models (Nicholoson & Tebbutt 1979, Guissani & Tsolacos 1993) which consider such demand to reflect

investment decisions on the part of current or future owner users. Demand is based on expected levels of future output in the manufacturing and wholesale sectors as well as the cost of capital. The assumption is made that the information set used to predict these levels consists of current and past values of output, employment, cost of capital etc. In other words expectations about future levels of output and hence demand can be approximated by considering the performance of past output levels (Guissani & Tsolacos 1994). Firms will not respond immediately for a variety of reasons and so there will be a lagged effect in terms of changes to output and hence to demand. In line with the methodology adopted in this paper most models have used a simple linear approach though they have been mainly univariate. Thus the approach taken is in line with previous studies but there is no attempt (as yet!) to offer any meaningful discourse on the pros and cons of the methodology, or the results, in light of other work.

The following steps were taken:

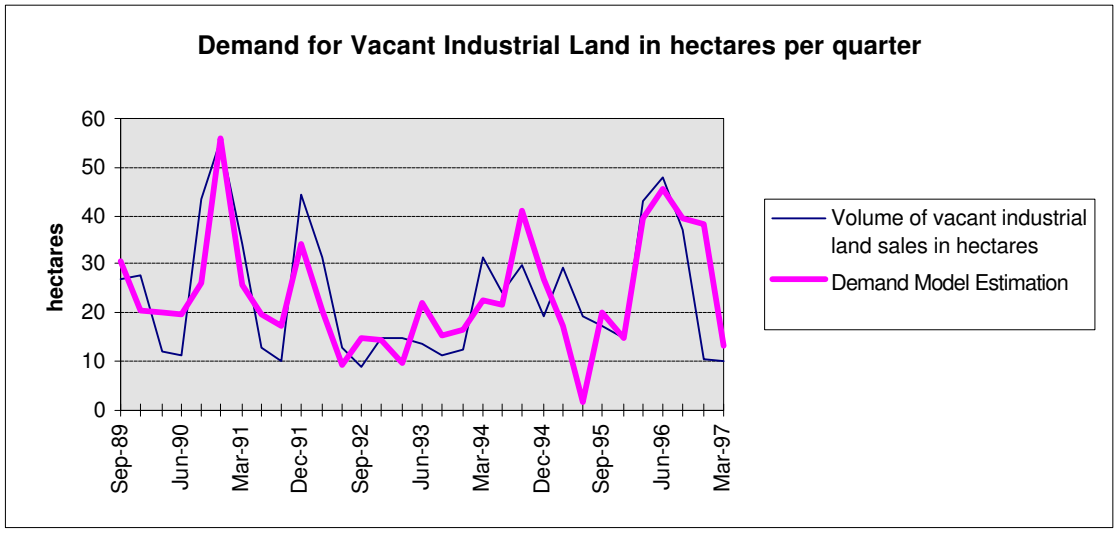
- Measurement of volume of vacant industrial land sold in hectares on a quarterly basis for the ASD and Mount Barker over a ten year period from March 1987 to March 1997.
- Selection of a number of economic, demographic and business survey variables including which are hypothesised to forecast demand for land based on previous empirical studies and on theoretical explanations of demand for land (see appendix). These variables have been measured where possible on a quarterly basis and over a ten year time period from March 1987 to March 1997.
- Auto correlations of the time series data was undertaken to identify trends.
- Where necessary data was differenced to make the time series stationary.
- Auto correlations of the de-trended data was undertaken to identify seasonal data.
- Seasonal data was smoothed.
- Factor analysis was undertaken to identify any broad dependencies within the data.
- Cross correlations lagged forward and back by up to eight time periods was undertaken between the sales volume variable and selected time series data. These cross correlations indicated any significant leading or lagging influences on the dependent variable, sales volume.
- Cross correlations of significant lagged times series data with the dependent variable was undertaken to indicate strength and direction of relationships.
- Multiple regression analysis (MRA) was undertaken based on the assumption of a causal relationship between the dependent variable, sales volume, and a selection of the de trended time series data as independents. A series of nine models were tested to determine a best fit. Analysis of residuals, regression coefficients, beta values, t tests, adjusted R values and bi variate correlations was applied to test for the validity of the models and multi collinearity in the model variables.
- Based on projected values for the independents using ARIMA analysis, a five year quarterly forecast was attempted using the MRA Demand Model to determine take up rates for vacant industrial land in the ASD.
- An ARIMA forecast based on total sales volume was also undertaken and compared with the MRA Demand Model forecast with the standard deviations of each model identified.

4.4 Results

The results below show the independent variables which from a review of cross correlations were considered to have an influence on the total volume of land sold in hectares per quarter for the ASD and Mount Barker. From this analysis the model below was selected based on test statistics R square, Adjusted R Square, t tests of the coefficients and F test for the model. Based on the regression results the following indexes may be considered indicators of demand for vacant industrial land within the ASD and Mount Barker.

- V49_1_1 Quarterly Retail Turnover ($m) SA Smoothed, Differenced by 1 quarter *(ABS Cat No 8623.4)*
- V46_1 Actual Private new capital expenditure by Manufacturing SA ($m), Lagged by 1 quarter (*ABS Cat No 5646.0)*
- V86_1 Other Business Premises Completions Floor Area square metres ASD, Lagged by 2 quarters *(ABS Cat No 8753.0)*
- V54_1_1 Private Gross Fixed Capital Expenditure - Plant & Equipment ($m) SA, Moving Average over 2 quarters, Lagged by 6 quarters, *(ABS Cat No 5625.0)*
- V61_1_1 10 Year Bond Rate, Lagged by 4 quarters, Differenced by 1 quarter, *(Commonwealth Treasury)*

Figure 4-2 Demand Model



Primary statistical output is provided below (Table 4-2) along with a figure showing the relationship of the demand model predictions to the original sales volume over time (Figure 4-2). Auto correlation of the residuals is also shown (Figure 4-3). The model is considered to be at least moderately successful in explaining the volatility of the vacant land market in the ASD. The test statistics for the model are considered acceptable with an R square of .67 and an Adjusted R of .60. The individual variables within the model are also valid in terms of their level of significance.

The collinearities within the model are not excessive and auto correlations of the residuals display no significant pattern or significant levels of correlation over successive time lags. The betas (Table 4-1) show the relative influence of the independent variables on the dependent variable and indicate that Variable 54 (Private gross fixed capital expenditure on plant & equipment) has the strongest positive influence, followed in order of decreasing influence by Variable 86 (Other business premises completions floor area), Variable 49 (Quarterly Retail Turnover) and Variable 46 (Actual Private new capital expenditure by Manufacturing). Variable 61 (Bond Rate) has a negative influence on demand for industrial land. While the betas indicate that the variables are fairly similar in their level of influence on demand levels they do suggest that expenditure on plant and equipment could be the more significant indicator of future demand for vacant industrial land while rising interest rates may indicate a future drop in demand. This is consistent with the variates adopted by previous studies using flexible accelerator models (Tsolacos 1995, Nicholoson & Tebbutt 1979).

Table 4-1 Demand Model Primary Output

```
Equation Number 1    Dependent Variable..   TOTALVOL   volume of sales in hectares

Block Number  1.  Method:  Enter
   V46_1    V54_1_1  V86_1    V61_1_1  V49_1_1

Variable(s) Entered on Step Number
1.   V49_1_1  [DIFF(V49_1,1] Quarterly Retail Turnover ($m) SA Smoothed, Differenced
by 1 quarter,
2.   V46_1     Actual Private new capital expenditure by Manufacturing SA($m, Lagged
by 1 quarter
 3.    V86_1     Other business premises completions floor area square metres ASD,
Lagged by 2 quarters
4.    V54_1_1   [MA(V54_1,2,2)]Private Gross Fixed Capital Expenditure - Plant &
Equipment ($m) SA, Lagged by 6 quarters, Moving Average over 2 quarters
5. V61_1_1   [DIFF(V61_1,1)]10 Year Bond Rate, Lagged by 4 quarters, Differenced by 1
   quarter


Multiple R          .82155
R Square            .67494
Adjusted R Square   .60992
Standard Error     8.30078

Analysis of Variance
                    DF      Sum of Squares      Mean Square
Regression           5          3576.62384        715.32477
Residual            25          1722.57363         68.90295

F =      10.38163       Signif F =  .0000

------------------ Variables in the Equation ------------------

Variable              B        SE B       Beta          T  Sig T

V46_1           .136820     .046283    .366180     2.956  .0067
V54_1_1         .091256     .021267    .522788     4.291  .0002
V86_1       4.33174E-05  1.2265E-05    .410747     3.532  .0016
V61_1_1       -7.273685    2.526806   -.403684    -2.879  .0081
V49_1_1         .279832     .096109    .390983     2.912  .0075
(Constant)   -47.164579   12.537261               -3.762  .0009
```

4.5 Demand Model

The model takes the form

$$Y = -b_o + b_1 X_1^{t-1} + b_2 X_2^{t-6} + b_3 X_3^{t-2} + b_4 \Delta X_4^{t-4} + b_5 \Delta X_5 + e$$

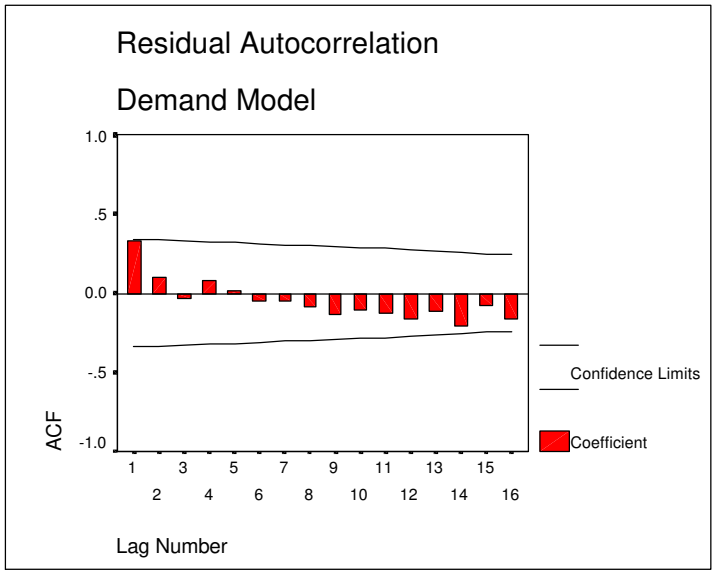
where Δ signals differencing by 1 time period

Volume of sales in hectares = - 47.16457 + .13682* Actual Private new capital expenditure by Manufacturing SA ($m), Lagged by 1 quarter + .09125* Private Gross Fixed Capital Expenditure - Plant & Equipment ($m) SA Moving Average, Lagged by 6 quarters + .00004* Other Business Premises Completions Floor Area square metres ASD, Lagged by 2 quarters - 7.27368* 10 Year Bond Rate, Differenced by 1 quarter, Lagged by 4 quarters + .27983* Quarterly Retail Turnover ($m) SA , Smoothed, Differenced by 1 quarter, + Error term

Table 4-2 Correlation matrix independent variables

	V46_1	V54_1_1	V49_1_1	V61_1_1	V86_1
V46_1	1.0000	.0257	.0437	.3607*	-.0741
V54_1_1	.0257	1.0000	-.2727	-.1749	.1801
V49_1_1	.0437	-.2727	1.0000	.3354*	-.1059
V61_1	.3607*	-.1749	.3354*	1.0000	-.0084
V86_1	-.0741	.1801	-.1059	-.0084	1.0000

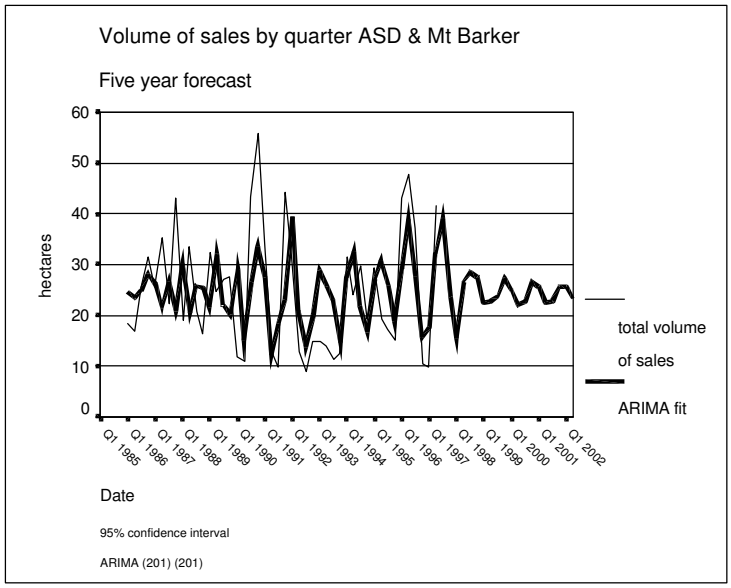
Figure 4-3 Demand Model Residuals



4.6 ARIMA Forecast Total Volume of Sales

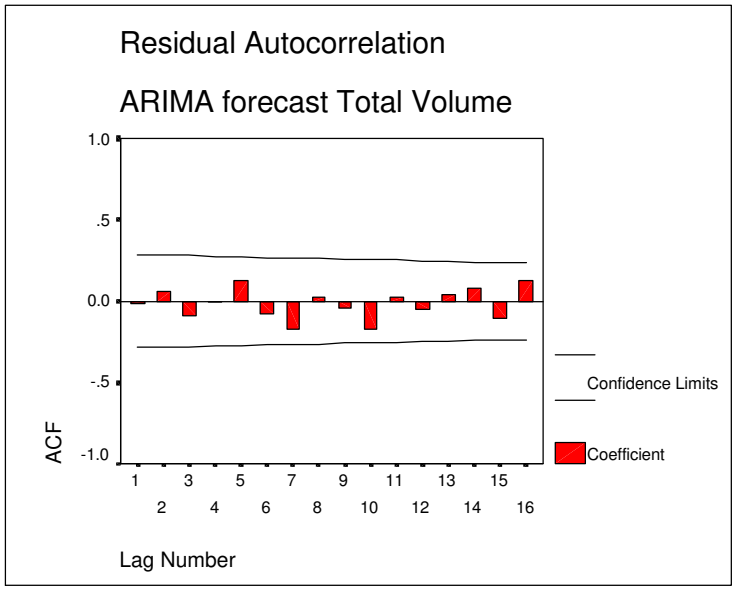
A standard ARIMA forecast was applied to the quarterly sales data assembled for a ten year period. The ARIMA projection was for a five year period up to and including the second quarter 2002 based on auto regressions and moving average extrapolations of 2 periods. The sales volume time series have not been differenced as analysis of the auto and partial correlations displayed no significant trends or seasonal movement in any of the data series for any market group. The results are based on 95% confidence intervals. Over the forecast period the range of volume for all sales is projected to be 23 hectares with a minimum volume of 15.41 and a maximum volume of 39.08 hectares sold per quarter (Figure 4-4). The total volume of sales over the five year period is projected to be 498.99 hectares with an average volume of 24.95 hectares sold per quarter.

Figure 4-4 ARIMA forecast Total Sales



The auto correlations of the error estimates show no particular pattern (Figure 4-5) and none of the correlation levels are significant.

Figure 4-5 Residuals Total Sales



4.7 Demand Model Forecast Total Volume of Sales

Next ARIMA projections of the independent variables used in the demand model were undertaken with various levels of success. For certain variables the forecasts proved successful. However the variable for Other Business Premises Completions was not well forecast despite the auto correlations being free of pattern. The variables for Actual Private Capital Expenditure by Manufacturing and Gross Capital Expenditure on Plant & Equipment had acceptable forecast trends but their auto correlations while revealing little pattern, were on the boundary of significance for certain time lags.

4.8 Comparison of the Models

The Demand model forecast is shown with the ARIMA forecast for total volume (Figure 4-7) with forecast volumes tabled below (Table 4-3). A table showing the range, sum and mean quarterly values produced by each forecast is also provided (Table 4-4). Over the five year forecast period the total volumes and the average quarterly take up rates forecast by each model are consistent. The auto correlations for the ARIMA forecast indicate no significant pattern or lagged correlations (Figure 4-8). The greatest discrepancy between the forecasts occurs at the first quarter of 1998 (Figure 4-9).

Figure 4-6 Demand v ARIMA forecast

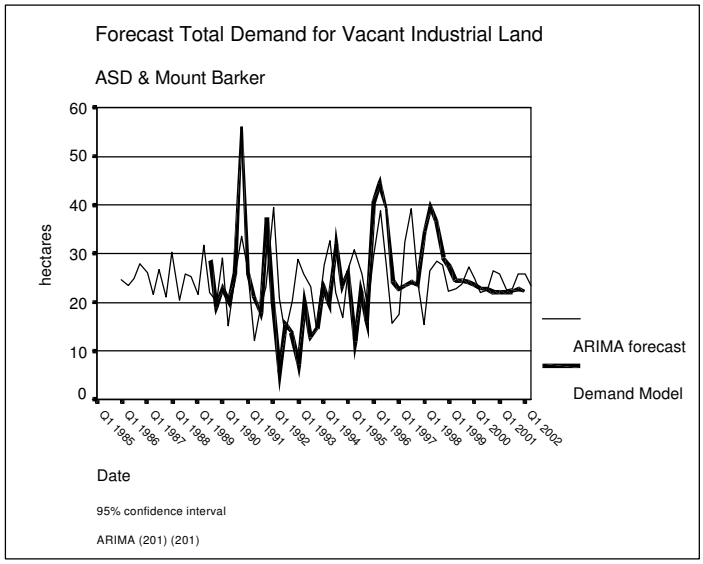


Table 4-3 Five Year Forecast Volumes

	ARIMA	*MRA*
Q3 1997	39.08	24.26
Q4 1997	23.58	23.50
Q1 1998	15.41	34.42
Q2 1998	26.55	39.64
Q3 1998	28.41	36.76
Q4 1998	27.52	29.20
Q1 1999	22.41	27.36
Q2 1999	22.74	24.65
Q3 1999	23.74	24.59
Q4 1999	27.29	24.27
Q1 2000	24.99	23.61
Q2 2000	22.09	22.87
Q3 2000	22.65	22.74
Q4 2000	26.56	22.09
Q1 2001	25.74	22.12
Q2 2001	22.55	22.07
Q3 2001	22.85	22.27
Q4 2001	25.79	22.72
Q1 2002	25.70	22.30
Q2 2002	23.32	*

* one quarter lost through differencing

Table 4-4 Forecast Volume of Sales summary statistics

	Total demand forecast over 4 ¾ * years	Minimum demand forecast per quarter	Maximum demand forecast per quarter	Average demand forecast per quarter	Standard Deviation of demand forecast per quarter
Demand Model	491	22.07	39.64	25.86	5.3
ARIMA Forecast	476	15.41	39.08	25.03	4.47

* one quarter lost through differencing

Figure 4-7 Forecast Models

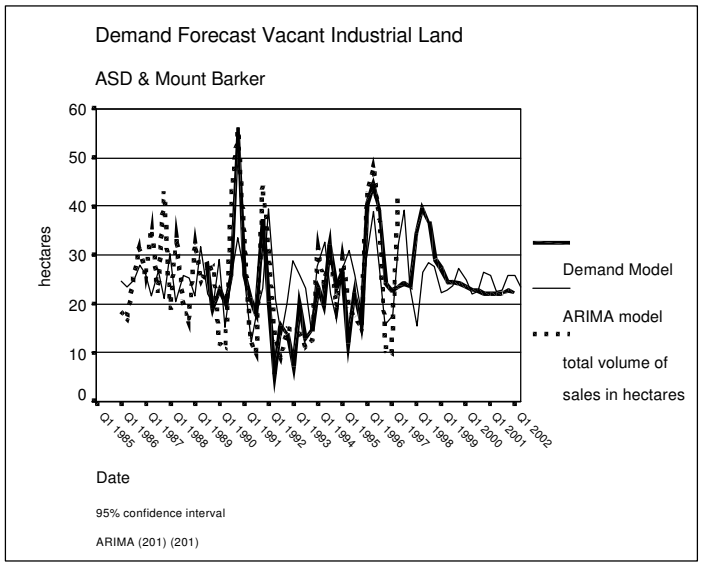


Figure 4-8 Residuals ARIMA forecast

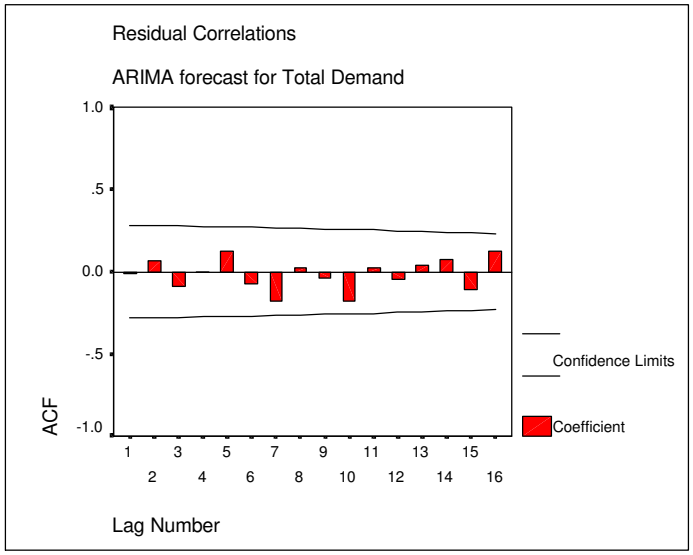
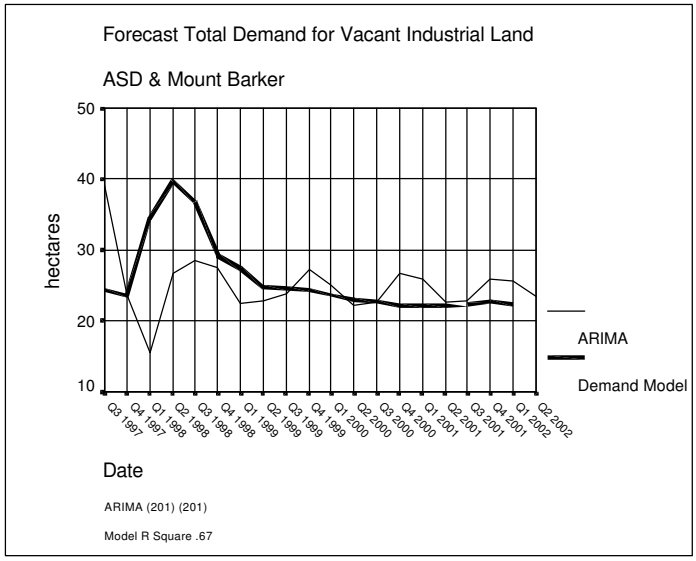


Figure 4-9 Five year Forecast



5. Conclusion and Implications

The annual take up rate predicted by the Demand Model was considered to be realistic and in line with government and EDA land planning expectations. In terms of land management the study does focus on indicators which may shed some light on future demand levels in the ASD. However as with previous studies (Adams et al 1992) it also articulates the incertitude of using past levels of demand for industrial space to anticipate future demand in a changing and uncertain sub market. The implications for policy makers are that such forecasts are not easily determined and that equal consideration should be given to expert advice provided by agents and professionals working in the industrial land market.

Statistically the model needs refinement and should use fewer determinants given the small sample size of less than 40 cases. It would be worthwhile to review the methodology, the variates and the alternative models in light of the work done most recently by Giussani & Tsolacos (1994), Tsolacos (1995) and Blair & Yardley (1994). However the selected model does fulfil the initial requirements of simplicity, practicality and ease of manipulation. The dependents exhibit appropriate signs and are commonly referred to by local economists and financiers as general indicators of activity in the SA business community. There would be a need to monitor the model and to introduce adaptive control measures as required. The take up of industrial land is at the end of a long line of effects and thus while the modelling may prove statistically significant, further investigation would be required to

check out the data. Ideally the model needs to be tested over an 18 month to two year period. As well the time series data is not considered long enough in terms of market cycles but a twenty year analysis was beyond the scope of this study.

So far no significant scenario analysis has been attempted and yet a small change in the input variables to the demand model could change significantly the long term prediction as there may be exponential or compounding effects where future governments continue to pursue an aggressive policy. This may create events or economic 'shocks' leading to substantial changes in market demand. Longer term predictions have very large error terms because of the impact of major policy decisions such as the Adelaide to Darwin railway, future tariff cuts or defence budget cuts. In terms of more general industrial market research, decision making with respect to industrial space and critical site selection characteristics within the ASD, also remain to be explored.

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7. Appendix

	MRA variables used in Demand Modelling
	Quarter
	Pricesqm
	Prqrtchg
	Totalvol - total volume of sales in hectares
	Salevol1 - up to 1000 sqm
	Salevol2 - >1000to2000sqm
	Salevol3 - >2000to5000sqm
	Salevol4 - >5000sqm
	sales1 - number of sales up to 1000sqm
	sales2 - number of sales >1000 to 2000sqm
	sales3 - number of sales >2000 to 5000sqm
	sales4 - number of sales >5000sqm
v2	Business Conditions (Westpac/Yellow Pgs Survey Business Expectations thru to V39)
v3	Capacity Utilisation
v4	Orders (Factors limiting Production)
v5	Materials (Factors limiting Production)
v6	Finance (Factors limiting Production)
v7	Labour (Factors limiting Production)
v9	Capacity (Factors limiting Production)
v9	Availability of Labour
v10	Availability of Finance
v11	Capital Expenditure Buildings
v12	Capital Expenditure Plant & Equipment
v13	Employment Past
v14	Employment Expected
v15	Overtime Past
v16	Overtime Expected
v17	New Orders Received
v18	New Orders Expected
v19	Backlog of Outstanding Orders
v20	Expected Backlog of Outstanding Orders
v21	Output Past
v22	Output Expected
v23	Profit Expectations for next 12 Months
v24	Stocks of Raw Materials Past
v25	Stocks of Raw Materials Expected
v26	Stocks of Finished Goods Past
v27	Stocks of Finished Goods Expected
v28	Confidence SA
v29	Confidence National
v30	Confidence in own business prospects 12 months SA
v31	SA Sales Value Actual
v32	SA Sales Value Expected
v33	SA Workforce Actual
v34	SA Workforce Expected
v35	SA Profitability Actual
v36	SA Profitability Expected
v37	SA Capital Expenditure Actual
v38	SA Capital Expenditure Expected
v39	Business Conditions Composite Index
v40	GSPI(a) SA ($m)
v41	% change GSPI(a) SA
v42	GDP(a) ($m)
v43	% change GDP(a)
v44	State Final Demand SA ($m)
v45	Exports SA ($m)

v46	Actual private new cap expend by Manufacturing SA ($m)
v47	Actual private new cap expend by Manufacturing Australia ($m)
v48	Actual priv new cap expend Plant Equipment Machinery SA ($m)
v49	Quart Retail Turnover SA ($m)
v50	Imports Machinery & Transport Equip SA ($m)
v51	Total Private New Capital Expenditure SA ($m)
v52	Prv gross fixed cap exp - Dwellings SA ($m)
v53	Prv gross fixed cap exp - Non dwell SA ($m)
v54	Prv gross fixed cap exp - Equip SA ($m)
v55	Prv gross fixed cap exp - RE Transfer fees SA ($m)
v56	Public Gross Fixed Capital Expenditure SA
v57	Persons wage & salary earners in Manufacturing SA ('000s)
v58	% change Persons wage & salary earners in Manufacturing SA
v59	Persons wage & salary earners in Manufacturing Australia ('000s)
v60	% change Persons wage & salary earners in Manufacturing Australia
v61	10 year Bond Rate
v62	90 day Bank Bill Rate
v63	Rate Differential
v64	Unemployment rate SA
v65	Public Gross fixed Cap Expend SA as % GSP
v66	Private Gross fixed Cap Expend SA as % GSP
v67	Persons Employed in Manufacturing as % of Total Employed SA
v68	Part time Employ as % Total Employ SA
v69	Part time Employ as % Total Employ Australia
v70	% change Retail Turnover
v71	Estimated Resident Population SA ('000s)
v72	% change population quarterly
v73	South Australia GSP per capita Constant Prices Index
v74	Victoria GSP per capita Constant Prices Index
v75	Difference in GSP per capita Index SA & Victoria
v76	Gross State Product At Factor Cost, By Industry Manufacturing as % of Total Industries SA
v77	Gross State Product At Factor Cost, By Industry Wholesale Trade as % Total Industries SA
v78	Gross State Product At Factor Cost, By Industry Transport & Storage as % Total Industries SA
v79	Bank rates Small Business Loans
v80	Manufacturing Number of employed persons (000's) SA
v81	Transport and Storage Number of employed persons (000's) SA
v82	Wholesale Trade Number of employed persons (000's) SA
v83	CPI SA
v84	Job vacancies SA as % of number of employees plus vacancies
v85	Factories Completions Floor Area sqm ASD
v86	Other Business Premises Completions Floor Area sqm ASD