Property Value Escalation Forecast

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TransGrid

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BUSINESS RESEARCH AND FORECASTING

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Contents

Tables

Charts

EXECUTIVE SUMMARY

TransGrid owns and operates the high voltage electricity transmission network in New South Wales. In line with the National Electricity Law and Rules, it is required to lodge a revenue proposal with the Australian Energy Regulator for the 2014 to 2019 regulatory period.

As part of the revenue proposal, TransGrid uses escalations to adjust the property component of capital expenditure forecasts for future changes in property values. BIS Shrapnel has been commissioned to provide these forecasts, which are to be based on a methodology that is both suitable for the task and transparent.

We reached the following conclusions:

- Methodology: Regression analysis is the most appropriate methodology for forecasting property value escalations in New South Wales. Among the three approaches tested, i.e. trend analysis, ARIMA and multivariate regression, it is the only one that possesses acceptable explanatory value/powers.
- Data: In order to reflect the variety of property classes and state's geographical diversity, four data sets were derived from the New South Wales government's Land and Property Information (LPI) division of the Department of Finance and Services. They include:
  - Residential (residential sites in the Sydney region to cover the highly urbanized metropolitan core),
  - Industrial (large industrial sites in the Sydney region to represent the metropolitan fringe),
  - Rural (rural home sites and hobby farms in lieu of regional centres and their surrounds), and
  - Agricultural (wheat and grazing land to represent the rest of the state).

  The above set was preferred to the aggregates published by the ABS—as part of its National Accounts series—due to a clearer distinction between property classes and geography.
- Property value escalations: Table I shows the results obtained using equations obtained by way of multivariate regression. The escalations reflect real, CPI-adjusted, growth rates.

Table I: NSW real land value escalations, multivariate regression, 2012 to 2019

As at June	*Residential*	*Industrial*	*Rural*	*Agricultural*
	% change per annum			
2012	-2.4	-4.5	-6.3	-3.3
forecast				
2013	3.4	-3.5	4.7	-1.5
2014	5.6	-2.6	4.6	-1.1
2015	6.2	-0.8	4.4	-1.2
2016	5.1	-0.1	3.9	-0.2
2017	1.3	1.0	1.7	-0.7
2018	-0.6	2.3	1.1	2.0
2019	1.3	2.7	2.6	1.5

Source: NSW Land and Property Information, BIS Shrapnel

– Metropolitan *residential* and *rural* residential land values are expected to witness the strongest growth over the financial year 2014 to 2019. Both will be underpinned by the long-awaited upswing in the residential building and investment cycle.

– In contrast, large industrial sites in the Sydney metropolitan area and agricultural land are likely to experience lower, partly negative, escalations over the same period. Growth in industrial land values will be held back by a very competitive development market that is restricting rental growth, while agricultural land values will be affected by falling farm incomes in response to emerging drought conditions and a competitive world environment.

– Compared with trend and ARIMA techniques, regression models suggest stronger average growth in both residential categories (metropolitan and rural), mostly over the three years to June 2016. In contrast, regression modeling resulted in weaker growth rates for metropolitan industrial land and lower/equal escalations in the case of agricultural land.

1. INTRODUCTION

TransGrid owns and operates the high voltage electricity transmission network in New South Wales. In line with the National Electricity Law and Rules, it is required to lodge a revenue proposal with the Australian Energy Regulator for the 2014 to 2019 regulatory period.

As part of the revenue proposal, TransGrid uses escalations to adjust the property component of capital expenditure forecasts for future changes in property values. BIS Shrapnel has been commissioned to provide these forecasts, which are to be based on a methodology that is both suitable for the task and transparent.

Tasks

The main tasks are:

- To procure, collate and analyse appropriate data sets for the task of modelling land value escalations.
- To undertake modelling of real (inflation adjusted) land value escalations using a range of techniques , and advise on the most robust technique for TransGrid to propose in its revenue proposal.
- To present the findings in a document, which will form part of TransGrid's 2014 to 2019 revenue proposal for the Australian Energy Regulator.

Data

- Data for the analysis was sourced from the 'Blue Book' series published by the Land and Property Information (LPI) Division of the NSW Department of Finance and Services. This was preferred to the Australian Bureau of Statistic's data series—released as part of the National Accounts suite of products—whose categories were considered too broad for meaningful interpretation. The LPI data (which is also the source of the ABS series) covers a wider range of land uses and geographies, as well as extending back to 1977 (compared with 1989–90 in the case of the ABS). However, analysis of the ABS data was included for comparative reasons.
- From the available LPI data series, we constructed 4 hybrid series in order to achieve maximum coverage in terms of property classes and geography (for more details see Appendix).

  Sydney metropolitan region (63% of NSW population at Census 2011)[1]

  – Residential (home sites) and
  – Industrial (large sites)

  NSW remainder (37% of population)

  – Rural (rural home sites and hobby farms) and
  – Agricultural (wheat and grazing).

- All nominal data was deflated by the Consumer Price Index (CPI), including land values and variables used in statistical analyses. Historical CPI data was sourced from the ABS, while forecasts are BIS Shrapnel's own (see Table A11 in the Appendix).

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[1] http://www.abs.gov.au/ausstats/abs@.nsf/Products/3218.0~2010-11~Main+Features~New+South+Wales, accessed 18 Sept 2013

Structure of the report

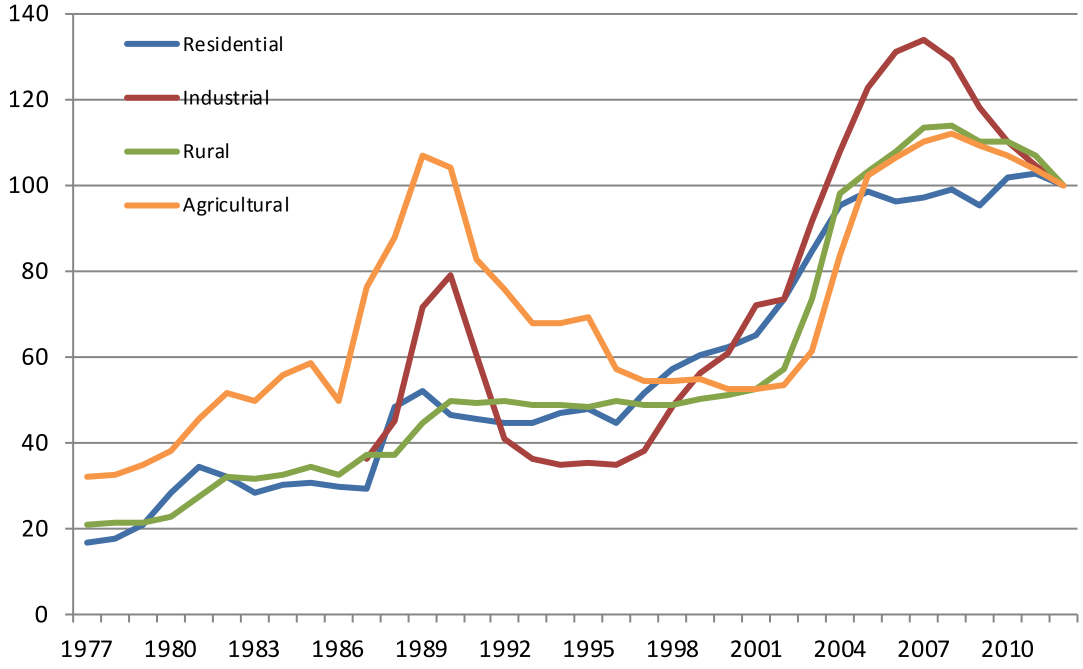
The document is divided into two main sections:

- In Part 1 we use the techniques of *trend analysis* and the *autoregressive integrated moving average* (ARIMA) *model* for estimating future land value escalations, while
- Part 2 employs *regression analysis* for the same purpose.

2. DATA

All 4 hybrid property value series display a high degree of cyclicality over their available history (the length of the time series; see Chart 2.1).

Chart 2.1: Real property value indices, 1997 to 2012 (2012=100)



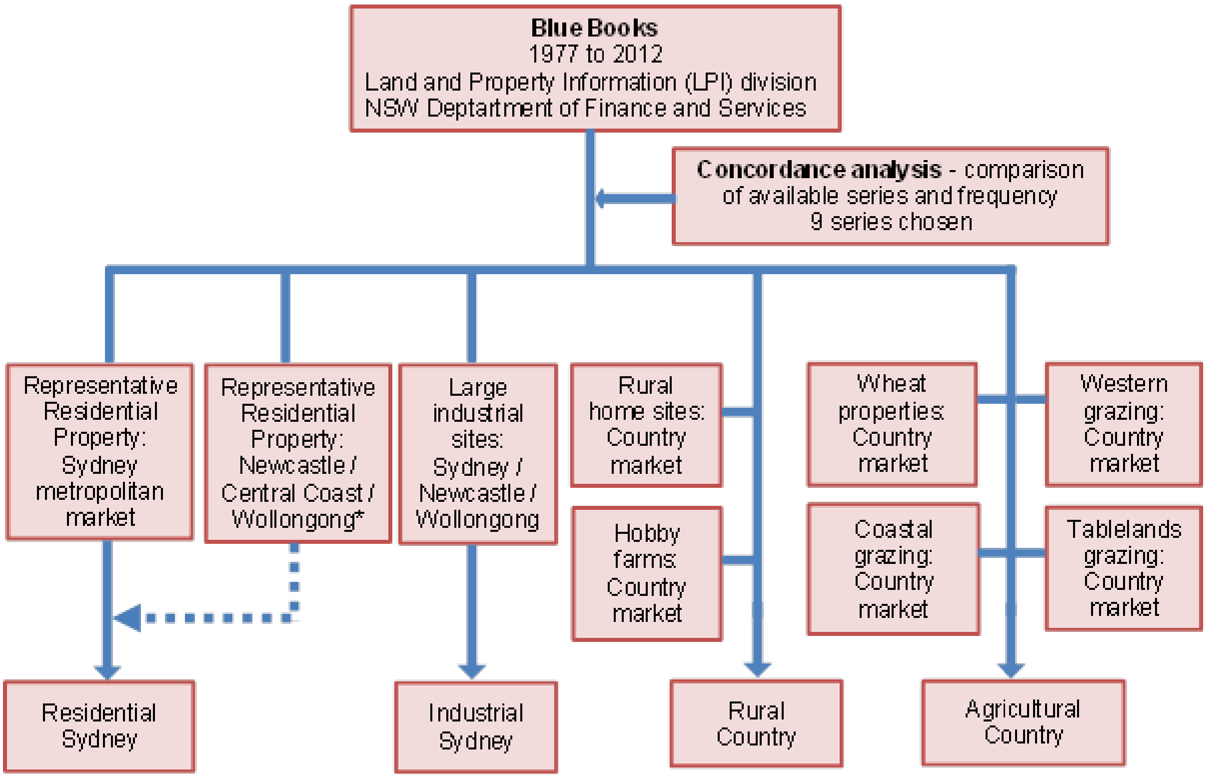
Year ended June

Source: NSW Land and Property Information

There have been two distinct cycles over this period, with two distinct upswings:

- The first occurred in the second half of the 1980s and was the result of a boom/bubble in asset prices in the aftermath of the 1987 stock market crash that led to wide spread overbuilding. At the same time, surging prices for rural commodities (especially wool) and resultant rises in farm incomes encouraged trade in and prices of agricultural land.
- The second started in the late 1990s with a boom in residential construction and investment, later joined by industrial property, rural and agricultural land during the time of structural change (in industrial) and the boom in financial engineering post 2003 (industrial, rural and agricultural). Agricultural land benefited from the listing of rural enterprises, as well as overseas investment in the wake of financial engineering.
- Each boom was followed by a bust: the first resulted in the early 1990s recession, which was characterised by severe falls in asset prices, particularly amongst commercial property in metropolitan areas around Australia.
- The second bust was caused by the GFC, when a crisis in financial markets led to a large correction in property prices across all sectors bar residential. The main difference to the first downturn was that most property markets were not oversupplied when the GFC hit.

Chart 2.2: Derivation of data, flow diagram



*Newcastle/Central Coast/Wollongong residential property takes its lead from metropolitan Sydney, acting as partial overflow markets. Excluded from the analysis due to lack of both consistent, long-term house price data and available forecasts

3. PART 1: TREND ANALYSIS AND ARIMA

3.1 Summary

The outcomes for future land value escalations using trend analysis and ARIMA are summarised in Table 3.1.

Table 3.1: Real property value escalations, trend analysis vs ARIMA

As at June	*Residential*	*Industrial*	*Rural*	*Agricultural*
		Trend, full sample (% ch)		
2012	-2.4	-4.5	-6.3	-3.3
forecast				
2013	2.5	3.0	2.6	1.7
2014	2.5	2.9	2.5	1.6
2015	2.4	2.8	2.4	1.6
2016	2.3	2.7	2.4	1.6
2017	2.3	2.7	2.3	1.6
2018	2.2	2.6	2.3	1.5
2019	2.2	2.5	2.2	1.5
		ARIMA (% ch)		
2012	-2.4	-4.5	-6.3	-3.3
forecast				
2013	2.4	2.5	2.2	0.0
2014	2.3	2.4	2.2	0.0
2015	2.3	2.4	2.2	0.0
2016	2.2	2.3	2.1	0.0
2017	2.2	2.2	2.1	0.0
2018	2.1	2.2	2.0	0.0
2019	2.1	2.1	2.0	0.0

Source: NSW Land and Property Information, BIS Shrapnel

Both techniques produce comparable results for residential, industrial and rural property. However, there was a marked difference in escalations for agricultural land.

With no independent variables present, neither technique takes into account the underlying drivers of land value escalations. They cannot explain what caused past variation, nor are they projections sensitive to future changes in those underlying variables.

We regard both techniques as unsuitable for the purpose of determining medium term land value escalations.

3.2 Trend analysis

3.2.1 Future escalations

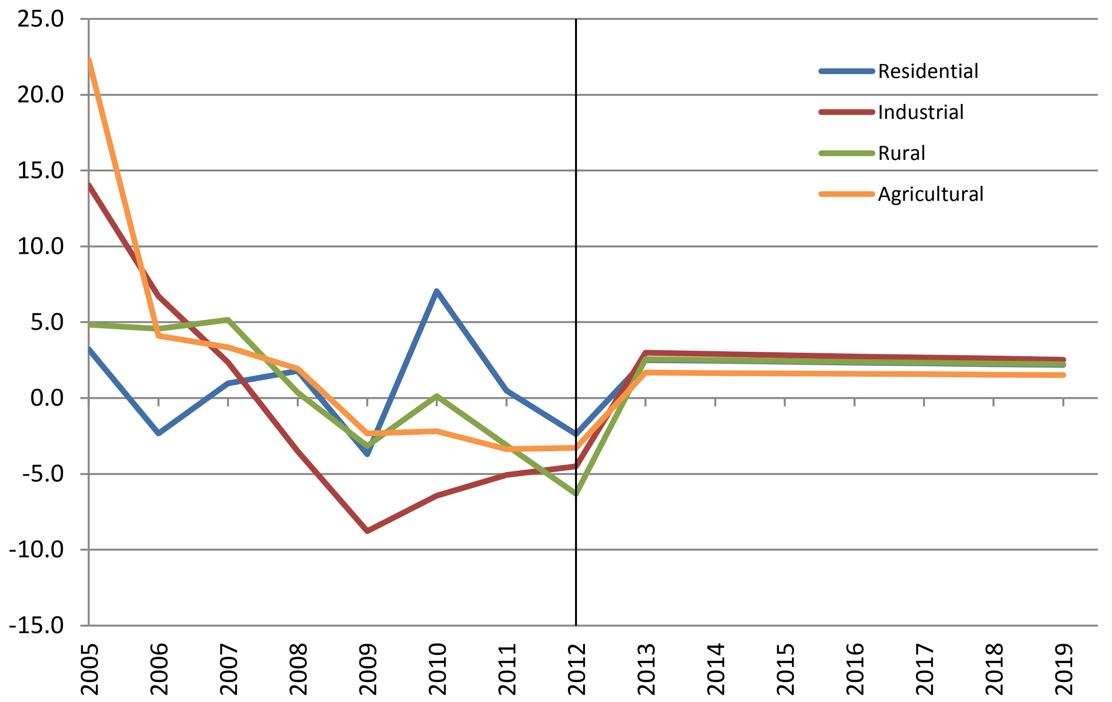
Table 3.2 and Chart 3.1 show the results of linear trend forecasts using the average (trend) growth rate of the entire available sample history. In the case of residential, rural and agricultural property, the series start in 1977, whereas data for large industrial sites in the Sydney metropolitan area was not available prior to 1987.

Table 3.2: Future real property value escalations, trend analysis (full sample)

As at June	*Residential*	*Industrial*	*Rural*	*Agricultural*
		% ch		
2012	-2.4	-4.5	-6.3	-3.3
forecast				
2013	2.5	3.0	2.6	1.7
2014	2.5	2.9	2.5	1.6
2015	2.4	2.8	2.4	1.6
2016	2.3	2.7	2.4	1.6
2017	2.3	2.7	2.3	1.6
2018	2.2	2.6	2.3	1.5
2019	2.2	2.5	2.2	1.5

Source: NSW Land and Property Information, BIS Shrapnel

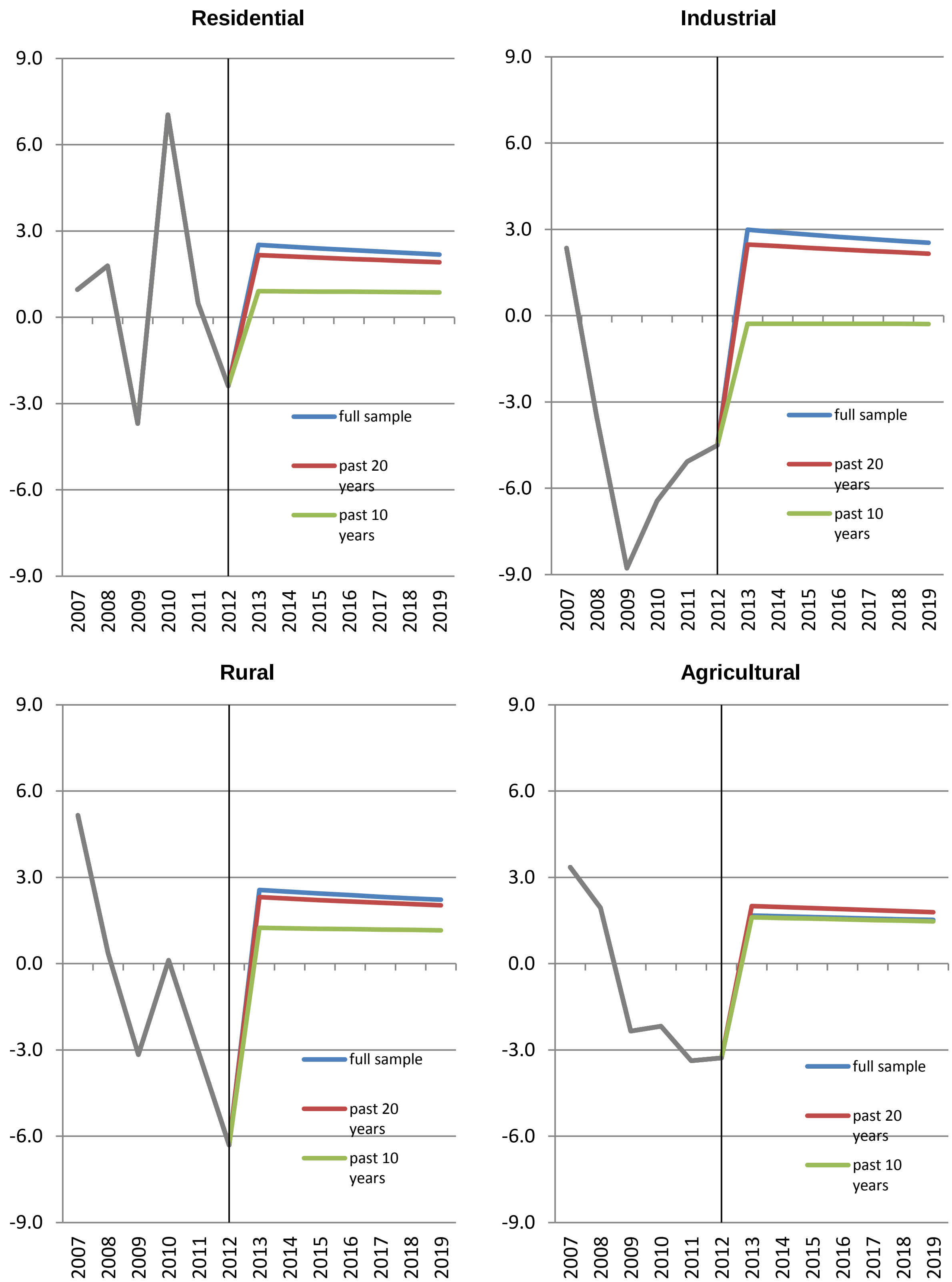
Chart 3.1: Future real property value escalations, trend analysis (full sample) (%ch)



Year ended June

Source: NSW Land and Property Information, BIS Shrapnel

Chart 3.2: Real property value escalations, trend analysis (full sample) (%ch)



Year ended June

Source: NSW Land and Property Information, BIS Shrapnel

The calculated linear trend escalations for all 4 property classes/geographies are relatively similar. They range in magnitude from a minimum of 1.5% to a maximum of 3%, with 2013 still being a forecast. The highest average escalations are predicted for large industrial sites in the Sydney metropolitan area, the weakest for agricultural land in regional NSW. All escalations are in real, inflation adjusted, terms.

Given that the long term trend is positive for all 4 categories, the trend estimate has growth reverting to average in 2013. We think that this is highly unlikely.

3.2.2 Comments and sensitivity testing

Trend analysis using a historical mean is the most commonly used method of predicting future events. It has well documented advantages and disadvantages: its biggest advantage is its ease of use, its biggest disadvantage the complete lack of explanatory power. It simply assumes that the future will be the same as the past.

Another concern is the choice/length of the historical period on which the average, or trend, is based, particularly in highly cyclical markets such as property. A short reference period/history can lead to highly dubious predictions and subsequent decisions.

Chart 2.3 shows the sensitivity to the choice of reference period for the 4 different categories. In 3 out of 4 cases, a 10 year reference period would deliver much weaker future escalations using linear trend analysis compared with a 20 year reference period. In the case of industrial sites, future escalations would be negative due to the large fall in land values post GFC. In all cases bar agriculture, the longest reference period delivers the highest escalations, although even this cannot hide the shortcomings of this technique.

Only agricultural land appears to be immune to the change in reference period. However, this is more of a coincidence than proof that the trend analysis technique is immune to choice of reference period. Chart 2.1 shows that the value of agricultural land is also highly cyclical.

3.3 ARIMA

3.3.1 Escalations

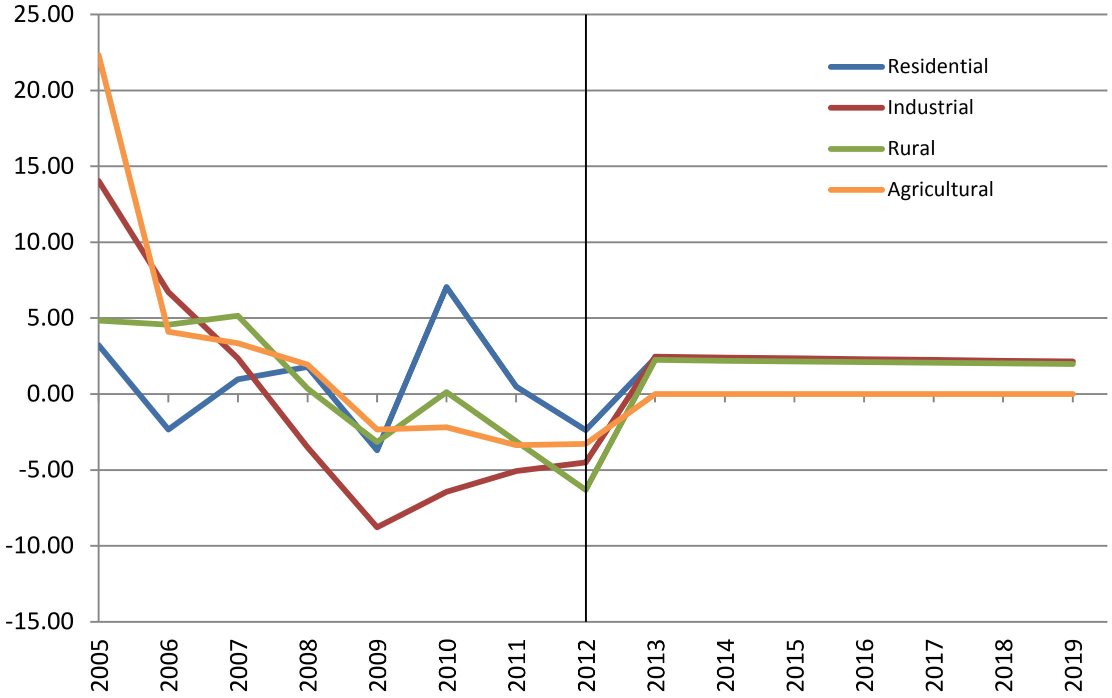
The ARIMA model resulted in future value escalations that are comparable to trend analysis in three out of the four property categories. Only agricultural land showed significant difference in predicted escalations between the two techniques. See Table 3.3 and Chart 3.3.

Table 3.3: Future real property value escalations, ARIMA

As at June	*Residential*	*Industrial*	*Rural*	*Agricultural*
		% ch		
2012	-2.4	-4.5	-6.3	-3.3
forecast				
2013	2.4	2.5	2.2	0.0
2014	2.3	2.4	2.2	0.0
2015	2.3	2.4	2.2	0.0
2016	2.2	2.3	2.1	0.0
2017	2.2	2.2	2.1	0.0
2018	2.1	2.2	2.0	0.0
2019	2.1	2.1	2.0	0.0

Source: NSW Land and Property Information, BIS Shrapnel

Chart 3.3: Future real property value escalations, ARIMA (%ch)



Year ended June

Source: NSW Land and Property Information, BIS Shrapnel

The residential series is represented by a ‘random walk with drift’ model, i.e. changes in residential land values are a function of the average differences in residential land values. The series has an upwards trend, with the constant reflecting the slope of the trend. The forecast escalations are, not surprisingly, very similar to those predicted by the trend analysis.

The industrial and rural series are represented by an ‘exponential smoothing with growth’ model. The forecasts generated by the model have a high variance proportion suggesting that the forecasts do not track the actual data very well. Plotting the forecasts against the actuals shows that the forecasts equate to the long run trend in the series and fail to pick up fluctuations over time.

The forecasts generated for the agricultural series also show a reasonably high level of variance proportion. Some growth is evident in the beginning of the sample but this soon converges to zero.

3.3.2 Comments

Forecast escalations from the ARIMA models are generally on par with those obtained from trend analysis, and range between 2% and 2.5% for residential, industrial and rural. In the case of the agricultural series, the model suggests zero escalations over the forecast horizon, which appears unrealistic. This suggests that more information is needed to be able to better predict movements in agricultural land values.

We caution that results from the ARIMA modelling are indicative only, given the relatively small sample size of 36 observations. ARIMA has been shown to perform better with large samples. For small samples and in general, multivariate regression analysis has greater explanatory power due to the inclusion of additional variables potentially related to the dependent variable.

3.4 Comparison with ABS data series

Table 3.4 shows the results of trend analysis performed on historical ABS data for New South Wales. The main difference between the LPI and the ABS data series is the level of aggregation and how many years of history they provide. However, the ABS data set also originates from the LPI.

Table 3.4: Future real property value escalations, trend analysis, ABS data

As at June	*Residential*	*Variance from LPI*	*Commercial*	*Variance from LPI*	*Rural*	*Variance from LPI*
	% ch	%	% ch	%	% ch	%
2012	-8.2	-5.9	0.9	5.4	-1.8	n.a.*
forecast						
2013	3.2	0.7	2.3	-0.7	3.5	n.a.*
2014	3.1	0.7	2.2	-0.7	3.4	n.a.*
2015	3.0	0.6	2.2	-0.7	3.3	n.a.*
2016	2.9	0.6	2.1	-0.6	3.2	n.a.*
2017	2.9	0.6	2.1	-0.6	3.1	n.a.*
2018	2.8	0.5	2.0	-0.6	3.0	n.a.*
2019	2.7	0.5	2.0	-0.5	2.9	n.a.*

Source: Australian Bureau of Statistics (Cat. 5204.061), BIS Shrapnel

*ABS 'Rural' not defined, hence not directly comparable w ith BIS Shrapnel 'Rural' or 'Agriculture'

Using the full-length ABS data series results in higher land value escalations for residential land, but lower estimates for industrial site values. Both ABS data series start in 1989, whereas the LPI/BIS Shrapnel series go back to 1977 in the case of residential sites.

As mentioned above, we believe that the 4 individual LPI/BIS Shrapnel data series provide a better separation of property classes and better coverage of the NSW geography, as well as providing more data points (except for industrial) for entry into the modelling process.

3.5 Conclusion

After preforming both trend and ARIMA analyses we reached the following conclusions:

- Both techniques produce comparable projections of future residential, industrial and rural site values. However, there is a marked difference in the case of agricultural land.
- Neither technique has any real explanatory powers and is thus deemed unsuitable for the purpose of determining future land values.
- Performing trend analysis on ABS instead of LPI/BIS Shrapnel data produces higher escalations for residential sites and weaker results for industrial land. We believe that the split into 4 LPI/BIS Shrapnel data series provides a better separation of property classes as well as geographical coverage.

4. PART 2: REGRESSION ANALYSIS

4.1 Summary

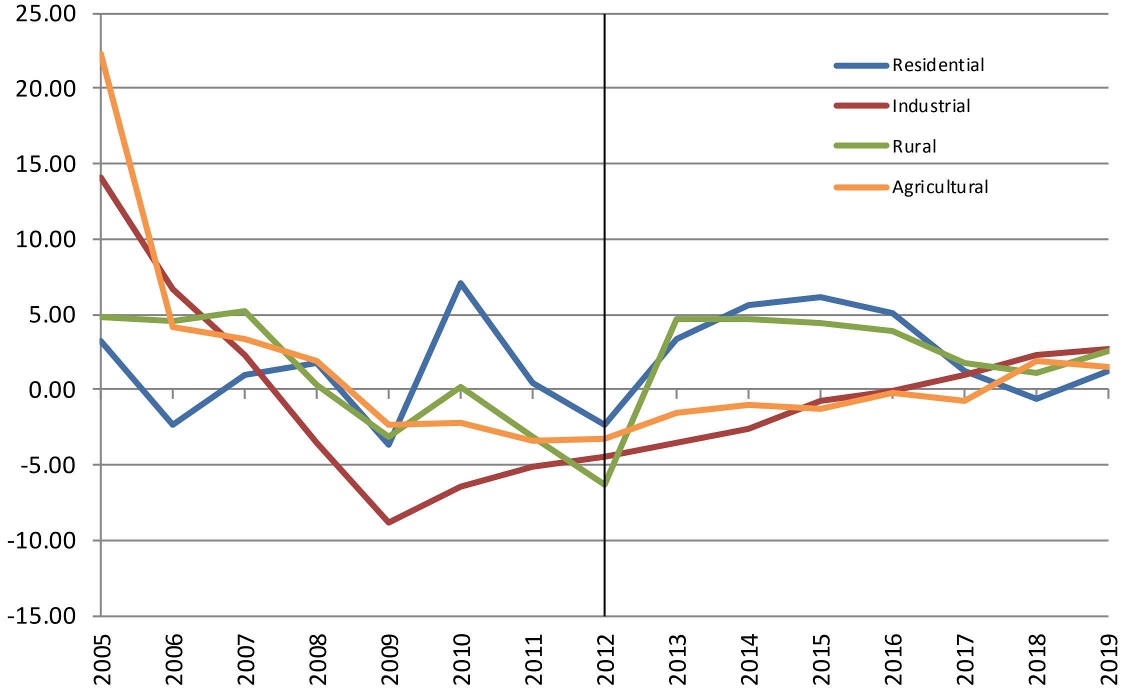
The outcomes for future land value escalations using multivariate regression analysis are summarised in Table 4.1 and Chart 4.1.

Table 4.1: Real property value escalations, regression analysis

As at June	*Residential*	*Industrial*	*Rural*	*Agricultural*
	% change per annum			
2012	-2.4	-4.5	-6.3	-3.3
forecast				
2013	2.4	-3.5	3.8	-1.5
2014	4.5	-2.6	3.6	-1.1
2015	5.6	-0.8	3.7	-1.2
2016	5.0	-0.1	3.7	-0.2
2017	1.9	1.0	2.3	-0.7
2018	0.3	2.3	2.0	2.0
2019	1.6	2.7	3.0	1.5

Source: NSW Land and Property Information, BIS Shrapnel

Chart 4.1: Future real property value escalations, regression analysis (%ch)



Year ended June

Source: NSW Land and Property Information, BIS Shrapnel

- Residential property in metropolitan Sydney is in the early stages of an upswing—the beginnings of which have already been observed this year—that is expected to last until FY2016.
- Industrial property has been struggling with an oversupply of land in the Sydney metropolitan area. Land values continued their post-GFC decline through 2012, but have since stabilised or even risen slightly. Competition for tenants is causing landlords to raise leasing incentives, offsetting moderate growth in face rents. A slight firming in yields has boosted capital values (in both nominal and real terms), but rising construction costs have prevented its translation to residual land values.[2] We do not foresee much improvement until the second half of the decade.[3]
- Rural (including rural home sites and hobby farms) property is forecast to follow in the steps of the metropolitan residential cycle, with our analysis suggesting a close relationship between (real) Sydney house prices and country property.[4]
- Agricultural land is expected to struggle with drought conditions over the coming few years, as well as weaker world demand/supply conditions.[5]

[2] Various commercial real estate agents
[3] BIS Shrapnel, Sydney Industrial Property Prospects 2013 to 2023 (forthcoming)
[4] See Section 4.2.3
[5] BIS Shrapnel, Long Term Forecasts, 2013 to 2028 (2013); BIS Shrapnel, Economic Outlook (2013)

4.2 Escalations

4.2.1 Residential land values

Table 4.2: Real residential land value escalations, multivariate regression vs trend and ARIMA analysis

As at June	*Regression*	*Trend*	*ARIMA*	*Regression*	*Trend*	*ARIMA*
	Index 2012=100			% ch		
2012	100.0	100.0	100.0	-2.4	-2.4	-2.4
forecast						
2013	103.4	102.5	102.4	3.4	2.5	2.4
2014	109.2	105.0	104.8	5.6	2.5	2.3
2015	115.9	107.5	107.2	6.2	2.4	2.3
2016	121.8	110.1	109.5	5.1	2.3	2.2
2017	123.3	112.6	111.9	1.3	2.3	2.2
2018	122.5	115.1	114.3	-0.6	2.2	2.1
2019	124.1	117.6	116.7	1.3	2.2	2.1

Source: NSW Land and Property Information, BIS Shrapnel

Residential land values in metropolitan Sydney are determined by real dwelling commencements (NSW) and real Sydney house prices. Together, the two variables account for 99% of the variation in residential land values.

The preferred equation is specified as:

$$\underset{}{res\_syd_{(t)}} = \underset{(-6.305)}{-74{,}085.47} \; + \underset{(16.376)}{0.69\, res\_syd_{(t-1)}} \; + \underset{(3.801)}{0.03\, real\_res\_comm\_nsw_{(t)}}$$

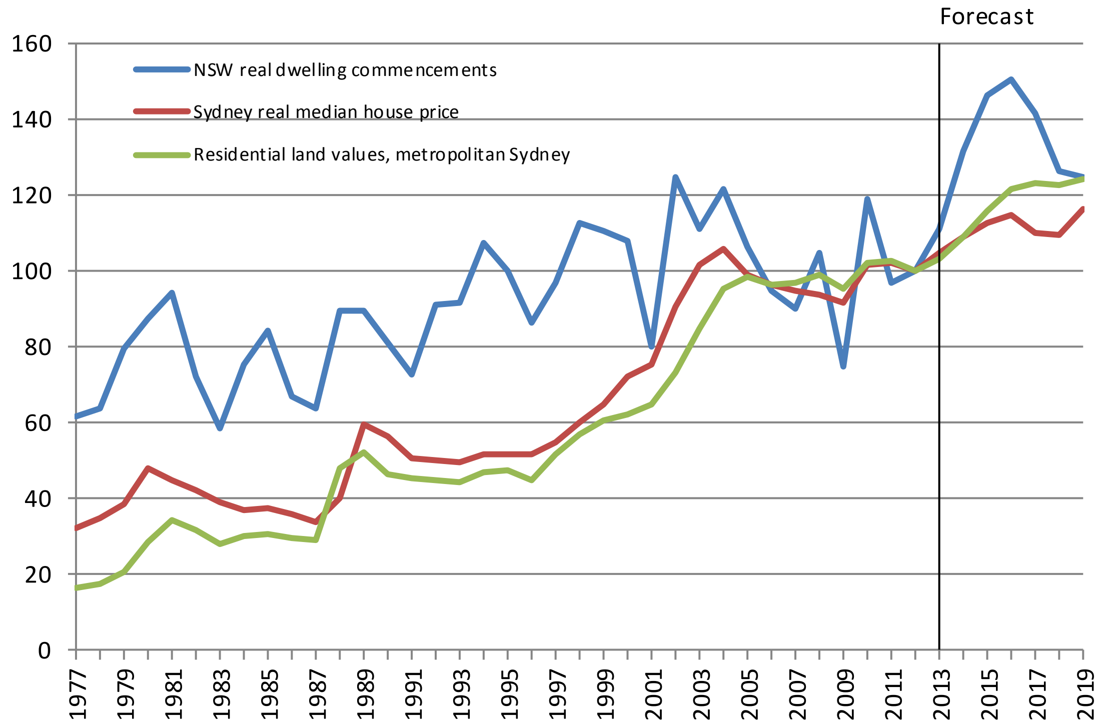
$$+ \underset{(6.323)}{328.29\, real\_hprice\_syd_{(t)}} \; + \underset{(8.586)}{109{,}593.90\, dum\_88}$$

$\overline{R}^2 = 0.995$ DW = 2.131 (The figures in brackets below the coefficient values are the t-statistics)

Where: t = time, t-1 = lag of 1 year
res_syd = Sydney residential land value
real_res_comm_nsw = real value of NSW residential commencements
real_hprice_syd = real house prices, Sydney
dum_88 = dummy variable for 1988

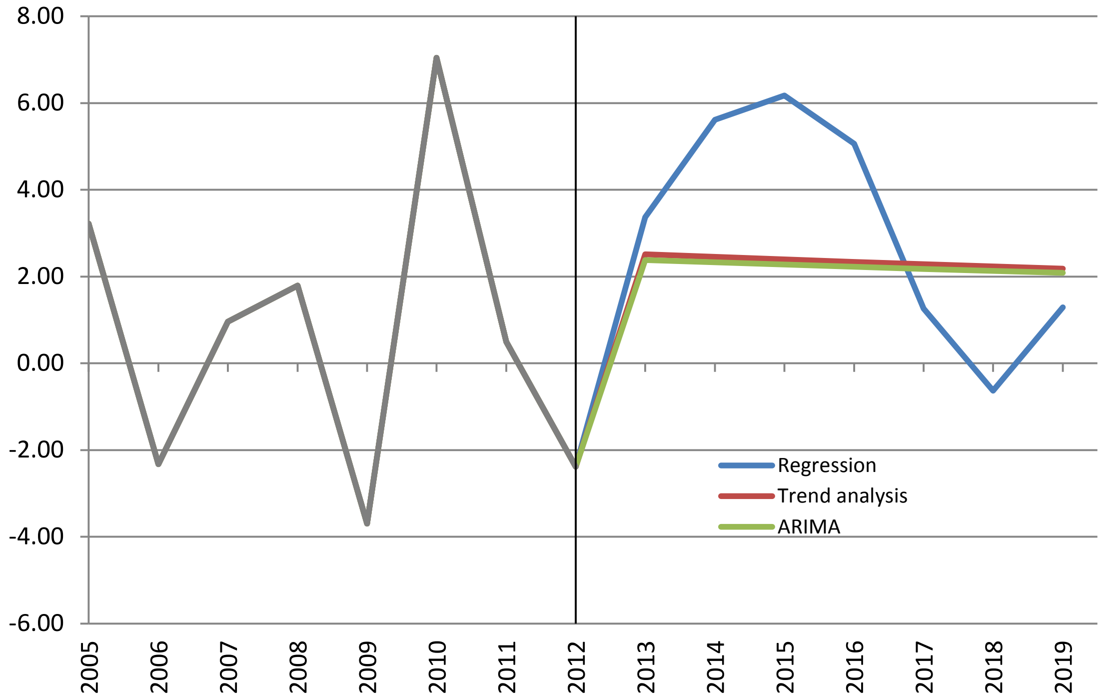
On the supply side, increases in the real value of residential (dwelling construction) commencements reduce the supply of available residential land for development, which in turn causes the value of existing land holdings to rise. Increasing the supply of residential property serves to partially alleviate demand. In a market such as NSW, where there has been a sustained shortage of residential stock for a long time, significant underlying demand is likely to persist (especially given supply lags). Therefore, upward pressure on residential prices and the underlying land values is likely to remain positive. Reflecting the demand side influence, the coefficient on housing prices is positive and statistically significant. The dummy variable for 1988 captures the impact of the late 1980s housing bubble.

Chart 4.2: Real residential land value escalations, regression variables, Index 2012=100



Year ended June Source: NSW Land and Property Information, BIS Shrapnel

Chart 4.3: Real residential land value escalations, multivariate regression vs trend and ARIMA analysis (%ch)



Year ended June Source: NSW Land and Property Information, BIS Shrapnel

In terms of the forecasts, the regression suggests average annual growth of 3.1% over the 2014 to 2019 period. This is driven by forecast strong growth in residential commencement activity and house prices over the initial 3 years. An expected slowdown in residential building and lower house price growth mutes escalations in the second half of the period.

The 3.1% average growth over the 6 years to June 2019 is significantly higher than the 2.3% and 2.2% respectively resulting from projections using trend analysis and the ARIMA method. The cyclicality suggested by the regression model implies that the use of trend or ARIMA-derived escalations could result in a severe under-estimate of land value price rises over the coming three years. Beyond 2016, price rises would drop below trend.

4.2.2 Industrial land values

Table 4.3: Real industrial land value escalations, multivariate regression vs trend and ARIMA analysis

As at June	*Regression*	*Trend*	*ARIMA*	*Regression*	*Trend*	*ARIMA*
	Index 2012=100			% ch		
2012	100.0	100.0	100.0	-4.5	-4.5	-4.5
forecast						
2013	96.5	103.0	102.5	-3.5	3.0	2.5
2014	94.0	106.0	104.9	-2.6	2.9	2.4
2015	93.3	109.0	107.4	-0.8	2.8	2.4
2016	93.2	112.0	109.9	-0.1	2.7	2.3
2017	94.2	114.9	112.3	1.0	2.7	2.2
2018	96.3	117.9	114.8	2.3	2.6	2.2
2019	98.9	120.9	117.3	2.7	2.5	2.1

Source: NSW Land and Property Information, BIS Shrapnel

The value of large industrial sites in metropolitan Sydney is strongly linked to the capital value of industrial property. Large vacant sites are almost exclusively found in Sydney's Outer industrial region, in a corridor that stretches from Richmond in the north to Camden in the south, and is flanked by Sydney's Central West to the east and the Blue Mountains in the west. As a result, BIS Shrapnel's series of industrial property capital values for the Outer Sydney region supplied the best result. In conjunction with lagged land values—signifying a partial adjustment—Outer Sydney industrial capital values explain around 96% of the variation in large industrial values in metropolitan Sydney.

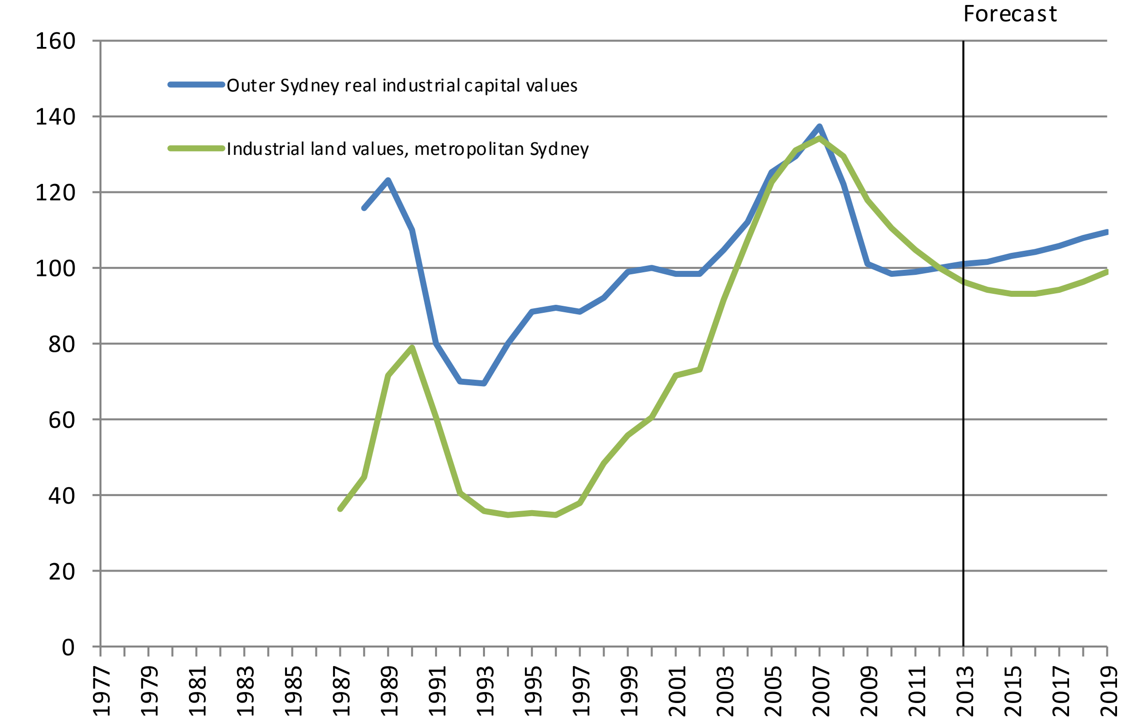
The preferred equation is specified as:

$$\text{ind\_syd}_{(t)} = \underset{(-5.495)}{-2{,}275{,}570.00} + \underset{(19.097)}{0.76\ \text{ind\_syd}_{(t-1)}} + \underset{(6.750)}{2{,}611.95\ \text{real\_values\_owsyd}_{(t)}}$$

$\overline{R}^2 = 0.968616$ DW = 1.213

Where: t = time, t-1 = lag of 1 year
ind_syd = Sydney industrial land value
real_values_owsyd = real values of outer western Sydney property

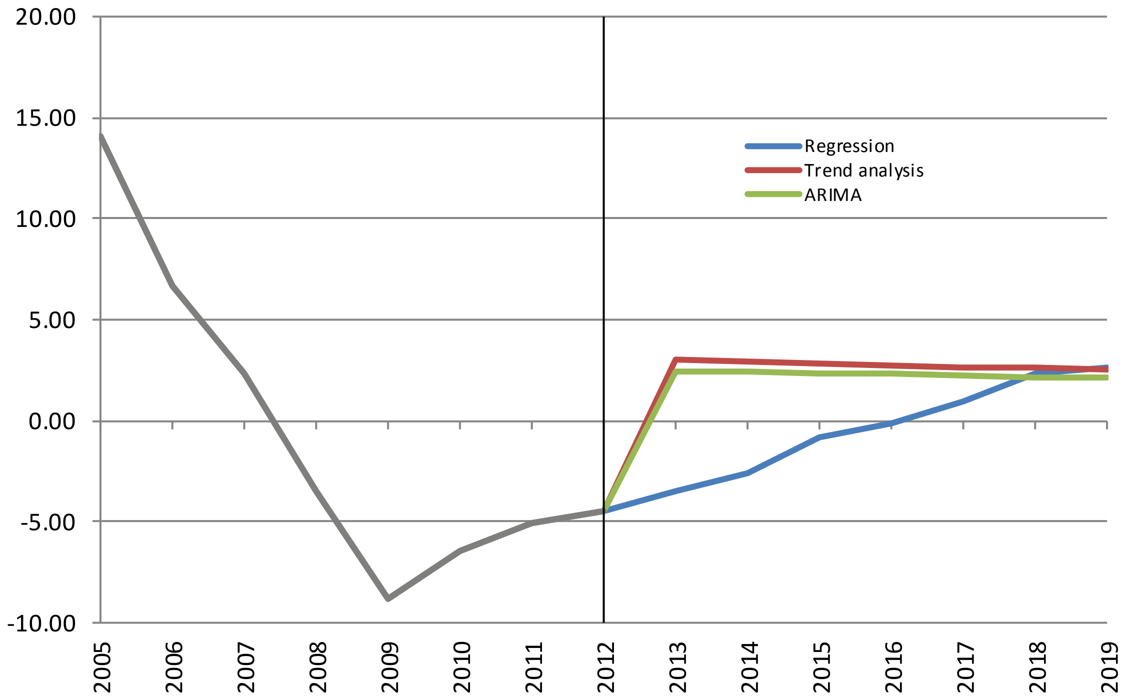
Chart 4.4: Real industrial land value escalations, regression variables, Index 2012=100



Year ended June

Source: NSW Land and Property Information, BIS Shrapnel

Chart 4.5: Real industrial land value escalations, multivariate regression vs trend and ARIMA analysis (%ch)



Year ended June

Source: NSW Land and Property Information, BIS Shrapnel

The regression suggests that industrial land values will continue to fall (in real terms) over the first few years before recovering late in the period. Industrial property remains in favour with investors, but intense competition for tenants and a surplus of land is restricting rental growth. Construction will remain challenging in the near term, with developers other than the big A-REITs[6] struggling to make an acceptable return. With rents, investment yields and construction costs beyond a developer's control, financial feasibility calculations determine the amount of money that can be spent on land, i.e. it determines residual land values. With rising construction costs, weak rental growth and moderate, if any, firming in investment yields, (residual) land values will remain under pressure for over the next three years.

Overall, zero average growth is forecast for the 2014 to 2019 period.

The average growth suggested by the above equation is well below the 2.7% and 2.3% respectively derived from trend analysis and ARIMA. Both trend and ARIMA techniques are affected by structural changes that occurred during the 1990s, when capital values surged as a result of industrial property becoming a recognised asset class for institutional investors. Moreover, warehouses became more generic in nature, reducing the leasing risk at the end of the initial lease period. Both trends led to a structural lowering of yields, and hence price rises, that are unsustainable.

4.2.3 Rural land values

Table 4.4: Real rural land value escalations, multivariate regression vs trend and ARIMA analysis

As at June	*Regression*	*Trend*	*ARIMA*	*Regression*	*Trend*	*ARIMA*
	Index 2012=100			% ch		
2012	100.0	100.0	100.0	-6.3	-6.3	-6.3
forecast						
2013	104.7	102.6	102.2	4.7	2.6	2.2
2014	109.5	105.1	104.5	4.6	2.5	2.2
2015	114.4	107.7	106.7	4.4	2.4	2.2
2016	118.9	110.3	109.0	3.9	2.4	2.1
2017	120.9	112.8	111.2	1.7	2.3	2.1
2018	122.3	115.4	113.5	1.1	2.3	2.0
2019	125.5	118.0	115.7	2.6	2.2	2.0

Source: NSW Land and Property Information, BIS Shrapnel

Values of rural home sites and hobby farms show a high correlation with metropolitan house prices. As the dominant market in NSW, Sydney sets the tone for house price formation, with regional towns/centres following suit. The value transmission mechanism works through housing affordability—itself the outcome of the balance between supply and demand— relative investment returns, as well as the purchase of property for recreational purposes in regional areas by Sydney-siders.

Using a partial adjustment mechanism, the 'Sydney reference cycle' equation explains 98% of the variation in rural land values, although a degree of auto-correlation is present.

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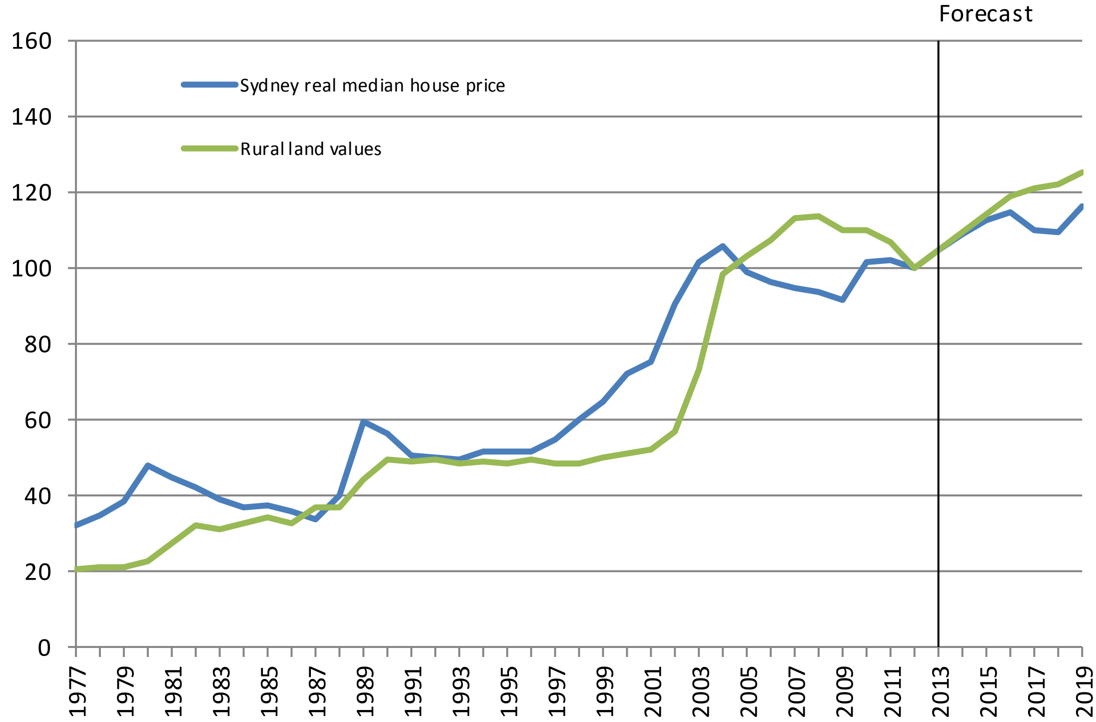
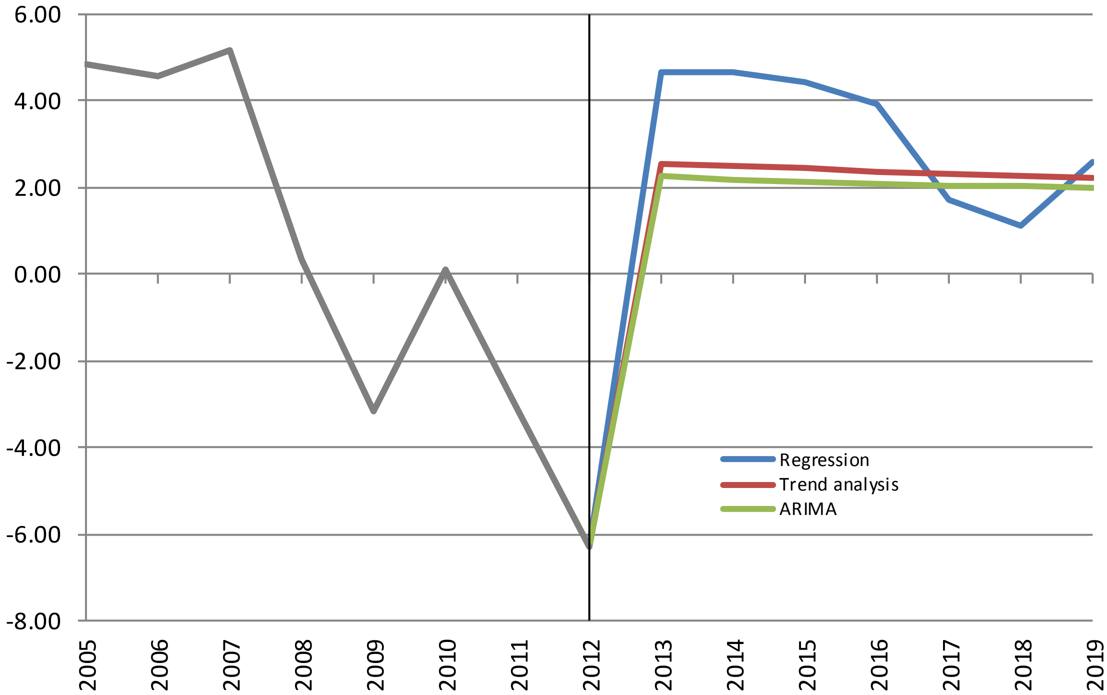
[6] Australian Real Estate Investment Trusts; formerly known as Listed Property Trusts (LPTs)

Chart 4.6: Real rural land value escalations, regression variables, Index 2012=100



Year ended June | Source: NSW Land and Property Information, BIS Shrapnel

Chart 4.7: Real rural land value escalations, multivariate regression vs trend and ARIMA analysis (%ch)



Year ended June | Source: NSW Land and Property Information, BIS Shrapnel

The preferred equation is specified as:

$$\text{rural\_country}_{(t)} = -35{,}604.89 + 0.77\ \text{rural\_country}_{(t-1)} + 367.68\ \text{real\_hprice\_syd}_{(t)}$$
$$(-5.495) \qquad (19.097) \qquad (6.750)$$

$\overline{R}^2 = 0.981$ DW = 1.049

Where: t = time, t-1 = lag of 1 year
ind_syd = Sydney industrial land value
real_values_owsyd = real values of outer western Sydney property

Multivariate regression modelling suggests an average annual growth rate in the category of rural (residential) land values of 3.1% for the financial years 2014 to 2019. As in the case of metropolitan residential land, house price is the most significant variable in land value determination. Sydney's upswing in the residential property cycle will set the tone for house prices for the rest of NSW, with a slight reduction in the magnitude of cyclical changes.

The average growth rate of 3.1% over the 6 years to June 2019 is well above the 2.4% and 2.1% suggested by trend analysis and ARIMA. The regression model suggests that use of trend or ARIMA-derived escalations would result in a severe under-estimation of land value price rises over three years to June 2016. Over the following 2 years, the regression model suggests below-trend growth, before returning to above trend during 2019.

4.2.4 Agricultural land values

Table 4.5: Real agricultural land value escalations, multivariate regression vs trend and ARIMA analysis

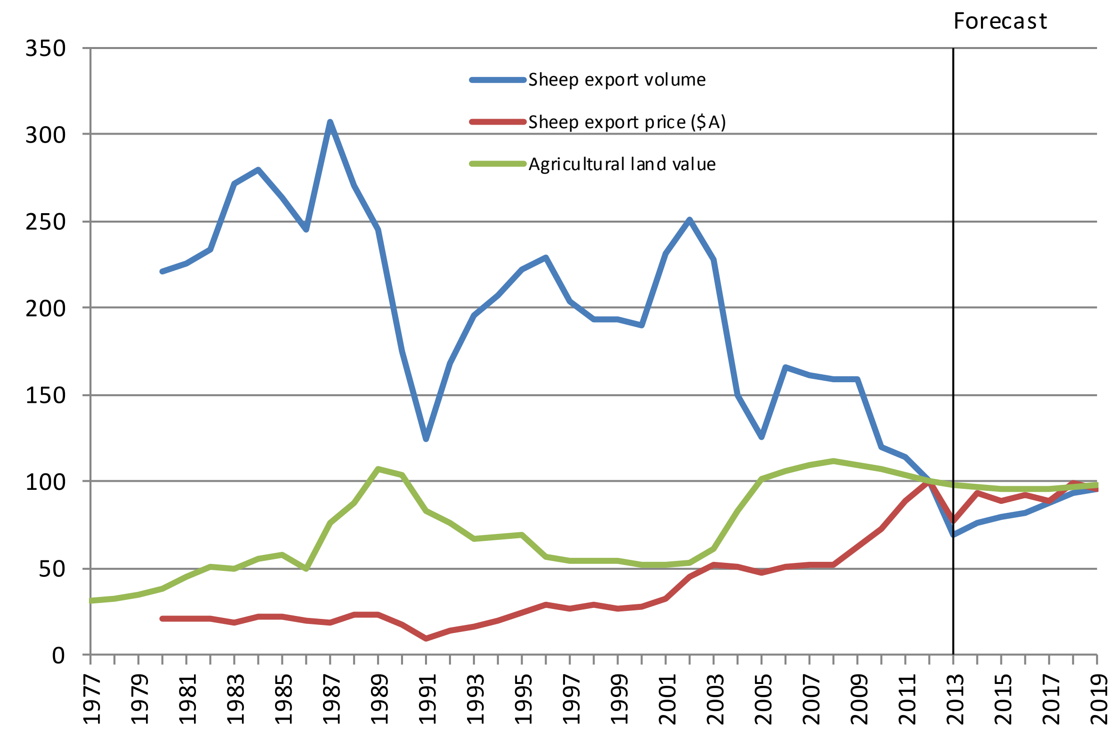
As at June	*Regression*	*Trend*	*ARIMA*	*Regression*	*Trend*	*ARIMA*
	Index 2012=100			% ch		
2012	100.0	100.0	100.0	-3.3	-3.3	-3.3
forecast						
2013	98.5	101.7	100.0	-1.5	1.7	0.0
2014	97.4	103.3	100.0	-1.1	1.6	0.0
2015	96.2	105.0	100.0	-1.2	1.6	0.0
2016	96.0	106.7	100.0	-0.2	1.6	0.0
2017	95.3	108.4	100.0	-0.7	1.6	0.0
2018	97.2	110.0	100.0	2.0	1.5	0.0
2019	98.6	111.7	100.0	1.5	1.5	0.0

Source: NSW Land and Property Information, BIS Shrapnel

The value of agricultural land in NSW is correlated to farm incomes. However, when modelled with survey data from NSW, farm incomes were found to be not significant at an acceptable level. Instead, we used sheep export volumes and prices (in A$) as a proxy for farm income. Both variables were statistically significant at the 5% level. Wheat volume[7] was also found to be significant on its own, but not in combination with sheep exports, nor was the explanatory value as high.

[7] Australian exports in kilo-tonnes

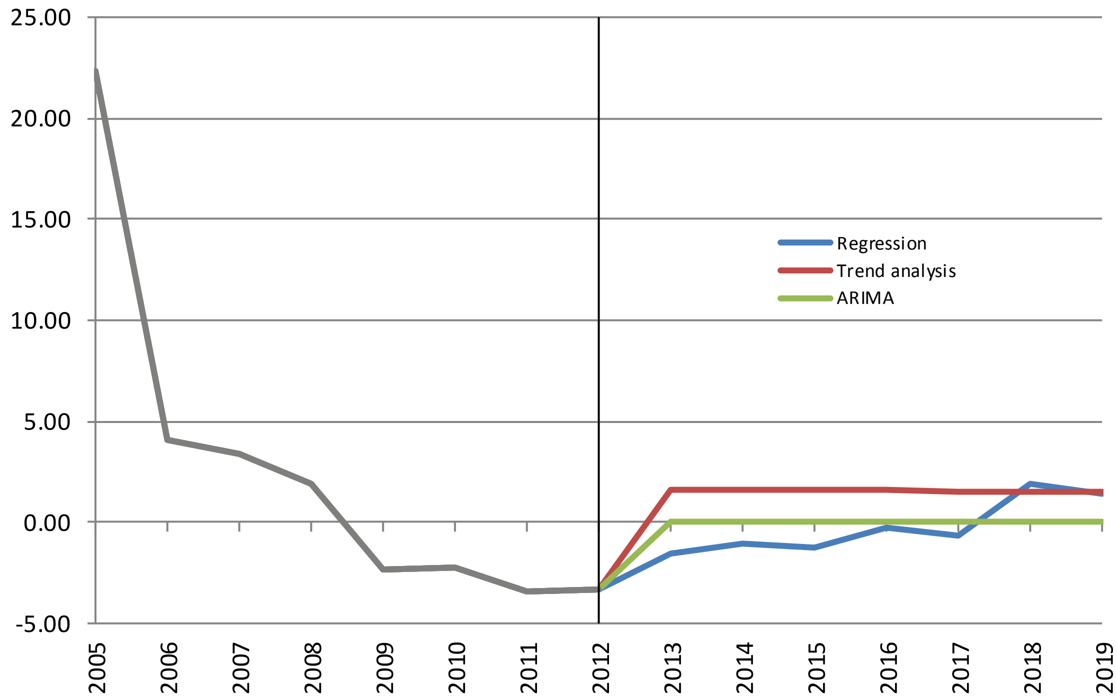
Chart 4.8: Real agricultural land value escalations, regression variables, Index 2012=100



Year ended June

Source: NSW Land and Property Information, BIS Shrapnel

Chart 4.9: Real agricultural land value escalations, multivariate regression vs trend and ARIMA analysis (%ch)



Year ended June

Source: NSW Land and Property Information, BIS Shrapnel

The preferred equation is specified as:

$$agri\_country_{(t)} = \underset{-(1.503)}{-624{,}182.80} + \underset{(16.620)}{0.91\ agri\_country_{(t-1)}}$$

$$+ \underset{(2.207)}{5{,}631.56\ sheep\_export\_price_{(t)}} + \underset{(2.156)}{136.55\ sheep\_volume_{(t-1)}}$$

$\overline{R}^2 = 0.844$ DW = 1.547

Where: t = time, t-1 = lag of 1 year
agri_country = Agricultural land value (wheat and grazing), country market
sheep_export_price = export price of live sheep, $A/sheep, Australia
sheep_volume = number of live sheep ('000), Australia

The 'sheep' variables represent demand side impacts of productive use of the land. Western grazing and tablelands grazing land, which are dominated by sheep related production, make up over 50% of the average agricultural land series. A higher price and/or quantity of sheep should raise the value of land used for sheep farming. This is evidenced by the positive coefficients on these variables.

The regression suggests zero average annual growth (non-compounding) over the 2014 to 2019 period. This is initially driven by a drop in sheep volumes, followed by slower growth due to emerging drought conditions. Sheep export prices are expected to remain highly cyclical, with year-to-year fluctuations caused by alternating under and oversupply.[8]

The suggested zero growth rate is identical to that of the ARIMA model, but substantially below trend (1.6%). The regression model suggests the continuation of the current downturn in agricultural land values, whereas the trend analysis suggests an immediate return to average growth.

[8] BIS Shrapnel, Long Term Forecasts 2013 to 2028 (2013)

5. CONCLUSION

Table 5.1shows the results gathered using equations that were obtained by way of multivariate regression. The escalations reflect real, CPI-adjusted, growth rates.

Table 5.1: NSW real land value escalations, multivariate regression, 2012 to 2019

As at June	*Residential*	*Industrial*	*Rural*	*Agricultural*
	% change per annum			
2012 forecast	-2.4	-4.5	-6.3	-3.3
2013	3.4	-3.5	4.7	-1.5
2014	5.6	-2.6	4.6	-1.1
2015	6.2	-0.8	4.4	-1.2
2016	5.1	-0.1	3.9	-0.2
2017	1.3	1.0	1.7	-0.7
2018	-0.6	2.3	1.1	2.0
2019	1.3	2.7	2.6	1.5

Source: NSW Land and Property Information, BIS Shrapnel

- Metropolitan *residential* and *rural* residential land values are expected to witness the strongest growth over the financial year 2014 to 2019. Both will be underpinned by the long-awaited upswing in the residential building and investment cycle.
- In contrast, large industrial sites in the Sydney metropolitan area and agricultural land are likely to experience lower, partly negative, escalations over the same period. Growth in industrial land values will be held back by a very competitive development market that is restricting rental growth, while agricultural land values will be affected by falling farm incomes in response to emerging drought conditions and a competitive world environment.
- Compared with trend and ARIMA techniques, regression models suggest stronger average growth in both residential categories (metropolitan and rural), mostly over the three years to June 2016. In contrast, regression modelling resulted in weaker growth rates for metropolitan industrial land and lower/equal escalations in the case of agricultural land.
- We consider regression analysis to be the most appropriate methodology for forecasting property value escalations in New South Wales. Among the three approaches tested, i.e. trend analysis, ARIMA and multivariate regression, it is the only one that possesses acceptable explanatory value/powers.
- All modelling was performed using four data series constructed from dozens of sets provided by the New South Wales government's Land and Property Information (LPI) division of the Department of Finance and Services. The data set were preferred to aggregates published by the ABS due to a clearer distinction between property classes and geography. The four sets comprise:
  - Residential (Sydney region, covering the highly urbanized metropolitan core),
  - Industrial (large sites in the Sydney region to represent the metropolitan fringe),
  - Rural (home sites and hobby farms in lieu of regional centres and their surrounds), and
  - Agricultural (wheat and grazing land to represent the rest of the state).

APPENDIX

APPENDIX

DATA

Table A1: NSW real land values, 1977 to 2012 ($2011–12)

As at June	*Residential*	*% ch*	*Industrial*	*% ch*	*Rural*	*% ch*	*Agricultural*	*% ch*
1977	107,370				164,847		1,336,283	
1978	113,139	5.4			168,463	2.2	1,360,951	1.8
1979	135,441	19.7			168,562	0.1	1,447,529	6.4
1980	183,894	35.8			178,315	5.8	1,586,538	9.6
1981	222,017	20.7			215,669	20.9	1,897,473	19.6
1982	205,997	-7.2			254,155	17.8	2,153,454	13.5
1983	182,170	-11.6			247,430	-2.6	2,073,939	-3.7
1984	194,938	7.0			256,619	3.7	2,329,256	12.3
1985	198,679	1.9			271,962	6.0	2,436,942	4.6
1986	192,633	-3.0			256,261	-5.8	2,069,562	-15.1
1987	189,788	-1.5	1,973,329		291,562	13.8	3,187,070	54.0
1988	312,245	64.5	2,444,921	23.9	292,745	0.4	3,662,593	14.9
1989	336,528	7.8	3,881,383	58.8	351,096	19.9	4,476,219	22.2
1990	301,816	-10.3	4,283,391	10.4	391,193	11.4	4,348,847	-2.8
1991	294,161	-2.5	3,280,025	-23.4	387,788	-0.9	3,459,814	-20.4
1992	289,456	-1.6	2,206,826	-32.7	392,368	1.2	3,170,190	-8.4
1993	287,423	-0.7	1,956,161	-11.4	384,221	-2.1	2,825,969	-10.9
1994	302,821	5.4	1,902,288	-2.8	386,217	0.5	2,828,731	0.1
1995	308,960	2.0	1,911,820	0.5	382,465	-1.0	2,884,060	2.0
1996	290,162	-6.1	1,882,206	-1.5	390,654	2.1	2,380,093	-17.5
1997	334,619	15.3	2,078,369	10.4	383,398	-1.9	2,271,508	-4.6
1998	368,925	10.3	2,625,508	26.3	384,250	0.2	2,275,502	0.2
1999	392,343	6.3	3,046,145	16.0	395,542	2.9	2,292,858	0.8
2000	403,323	2.8	3,303,686	8.5	403,980	2.1	2,201,678	-4.0
2001	420,137	4.2	3,897,722	18.0	412,134	2.0	2,200,463	-0.1
2002	475,882	13.3	3,973,323	1.9	448,591	8.8	2,240,752	1.8
2003	548,702	15.3	4,970,039	25.1	577,709	28.8	2,568,478	14.6
2004	618,230	12.7	5,839,458	17.5	774,283	34.0	3,490,271	35.9
2005	638,147	3.2	6,659,371	14.0	811,712	4.8	4,269,704	22.3
2006	623,293	-2.3	7,106,990	6.7	848,793	4.6	4,445,193	4.1
2007	629,290	1.0	7,274,010	2.4	892,586	5.2	4,594,329	3.4
2008	640,555	1.8	7,018,018	-3.5	895,763	0.4	4,683,416	1.9
2009	616,866	-3.7	6,401,642	-8.8	867,430	-3.2	4,573,826	-2.3
2010	660,336	7.0	5,989,397	-6.4	868,492	0.1	4,474,181	-2.2
2011	663,588	0.5	5,685,875	-5.1	841,527	-3.1	4,323,267	-3.4
2012	647,756	-2.4	5,429,585	-4.5	788,425	-6.3	4,181,479	-3.3

Source: NSW Land and Property Information division, BIS Shrapnel

Table A2: NSW real land values, 1977 to 2012 (Index 2012=100)

As at June	*Residential*	*% ch*	*Industrial*	*% ch*	*Rural*	*% ch*	*Agricultural*	*% ch*
1977	17				21		32	
1978	17	5.4			21	2.2	33	1.8
1979	21	19.7			21	0.1	35	6.4
1980	28	35.8			23	5.8	38	9.6
1981	34	20.7			27	20.9	45	19.6
1982	32	-7.2			32	17.8	51	13.5
1983	28	-11.6			31	-2.6	50	-3.7
1984	30	7.0			33	3.7	56	12.3
1985	31	1.9			34	6.0	58	4.6
1986	30	-3.0			33	-5.8	49	-15.1
1987	29	-1.5	36		37	13.8	76	54.0
1988	48	64.5	45	23.9	37	0.4	88	14.9
1989	52	7.8	71	58.8	45	19.9	107	22.2
1990	47	-10.3	79	10.4	50	11.4	104	-2.8
1991	45	-2.5	60	-23.4	49	-0.9	83	-20.4
1992	45	-1.6	41	-32.7	50	1.2	76	-8.4
1993	44	-0.7	36	-11.4	49	-2.1	68	-10.9
1994	47	5.4	35	-2.8	49	0.5	68	0.1
1995	48	2.0	35	0.5	49	-1.0	69	2.0
1996	45	-6.1	35	-1.5	50	2.1	57	-17.5
1997	52	15.3	38	10.4	49	-1.9	54	-4.6
1998	57	10.3	48	26.3	49	0.2	54	0.2
1999	61	6.3	56	16.0	50	2.9	55	0.8
2000	62	2.8	61	8.5	51	2.1	53	-4.0
2001	65	4.2	72	18.0	52	2.0	53	-0.1
2002	73	13.3	73	1.9	57	8.8	54	1.8
2003	85	15.3	92	25.1	73	28.8	61	14.6
2004	95	12.7	108	17.5	98	34.0	83	35.9
2005	99	3.2	123	14.0	103	4.8	102	22.3
2006	96	-2.3	131	6.7	108	4.6	106	4.1
2007	97	1.0	134	2.4	113	5.2	110	3.4
2008	99	1.8	129	-3.5	114	0.4	112	1.9
2009	95	-3.7	118	-8.8	110	-3.2	109	-2.3
2010	102	7.0	110	-6.4	110	0.1	107	-2.2
2011	102	0.5	105	-5.1	107	-3.1	103	-3.4
2012	100	-2.4	100	-4.5	100	-6.3	100	-3.3

Source: NSW Land and Property Information division, BIS Shrapnel

Table A3: Consumer price index (CPI), baseline, 1977 to 2019 (base year 2012)

As at June	*Index*	*% ch*
1977	20.1	
1978	21.7	8.0
1979	23.6	8.8
1980	25.4	7.6
1981	27.7	9.2
1982	30.8	10.9
1983	33.5	8.8
1984	35.6	6.2
1985	37.8	6.1
1986	41.5	9.9
1987	45.0	8.4
1988	48.3	7.3
1989	50.6	4.8
1990	53.2	5.1
1991	55.9	5.2
1992	58.2	4.0
1993	60.1	3.3
1994	61.8	2.8
1995	63.2	2.3
1996	65.2	3.1
1997	67.7	3.9
1998	69.3	2.4
1999	69.9	0.9
2000	71.7	2.6
2001	73.9	3.0
2002	76.3	3.3
2003	78.4	2.7
2004	80.0	2.0
2005	81.7	2.2
2006	83.9	2.6
2007	86.1	2.7
2008	89.2	3.6
2009	92.5	3.6
2010	95.0	2.7
2011	97.4	2.6
2012	99.2	1.8
2013	101.1	1.9
forecast		
2014	103.6	2.5
2015	106.4	2.7
2016	109.6	2.9
2017	112.8	2.9
2018	115.6	2.5
2019	118.4	2.4

Source: ABS, BIS Shrapnel

METHODOLOGY AND MODELLING RESULTS

ARIMA

ARIMA stands for "Auto-Regressive Integrated Moving Average", and it's a general class of model for forecasting time series data. Typically, a time series is analysed in terms of the relationship between it and other variables—multivariate analysis. However, if there is insufficient data on related variables or potential relationships between variables are not well founded, an examination of the relationship of the series with itself can be useful—univariate analysis.

An ARIMA model is specified as ARIMA(p,d,q), where:

- d = the number of differences required for the series to be stationary
- p = the lag order of AR terms
- q = the lag order of MA terms

A data series which is non-stationary—that is, its mean, variance or covariance change over time—is unpredictable and modelling it can lead to spurious results. Therefore, transforming the series to a stationary one is desirable. Differencing a series is a common method for achieving stationarity. If a series is stationary after taking the first difference—$variable_{(t)}$-$variable_{(t-1)}$—it is said to be integrated of order 1, I(1), this forms the "Integrated" part of the ARIMA model. Lags of the differenced series are the "Auto-Regressive" (AR) terms, and lags of the forecast errors are the "Moving Average" (MA) terms. The specification can include AR terms only, MA terms only, or a combination of both (mixed model), with the number of lags indicated in brackets.

There are three steps in performing ARIMA analysis:

1. Check the stationarity of the series, and transform (difference) the series if needed;
2. Examine the autocorrelation properties of the series to choose autoregressive (AR) and moving average (MA) terms to include in the equation for testing;
3. After settling on an appropriate specification for the equation, estimate via regression, and generate forecasts.

The stationarity of each of the land value series was tested with Unit Root Tests—a standard statistical approach for such analysis. The residential series was found to be first difference stationary, the industrial and rural series were second difference stationary, and the agricultural series was stationary in level terms.

The autocorrelation properties of the series' were examined by inspection of a correlogram, which illustrates the correlation of a series with its lags—the autocorrelation function (ACF)—and the correlation of the current and lagged series after taking into account the predictive power of all the values of the series with smaller lags—the partial autocorrelation function (PACF). The correlations at each time lag are graphed and the pattern as lags increase suggests whether the series is best represented by an AR or MA process or if a mixed model may be appropriate.

If the ACF declines steadily and the PACF cuts off suddenly then this suggests an AR process. If the ACF cuts off suddenly and the PACF declines steadily then this suggests an MA process. If neither the ACF nor PACF cuts off suddenly then a mixed model may be appropriate.

Based on the results of the above tests, the ARIMA models were specified as follows:

Residential:	D(RES_SYD) C	ARIMA(0,1,0)
Industrial:	D(IND_SYD) C MA(1) MA(2)	ARIMA(0,1,2)
Rural:	D(RURAL_COUNTRY) C MA(1)	ARIMA(0,1,1)
Agricultural:	AGRI_COUNTRY C AR(1) MA(1) MA(2) MA(3)	ARIMA(1,0,3)

Where: D represents the difference operator. C is typically known as the constant, however, its interpretation differs when there are AR and MA terms in the model. In that case, it represents the mean of the dependent variable.

Standard diagnostic tests were performed to check the validity of the estimation results. The residuals of the estimated equation were confirmed as 'white noise', meaning they contain no additional correlation that may need to be modelled.

The forecasts were generated for the level of each series and Eviews displays a chart and some diagnostics. Looking at the bottom portion of the table, the bias proportion tells us how far the mean of the forecast is from the mean of the actual series, the variance proportion tells us how far the variance of the forecast is from the variance of the actual series and the covariance proportion measures the remaining unsystematic forecasting error. The bias, variance and covariance proportions sum to 1. If the forecast is "good" then the bias and variance proportion should be small, and the covariance proportion high.

We caution that results from the ARIMA modelling are indicative only, given the relatively small sample size of 36 observations. ARIMA has been shown to typically perform better with large samples. For small samples and in general, multivariate regression analysis has greater explanatory power due to the inclusion of additional variables potentially related to the dependent variable.

Residential

Table A4: ARIMA, residential estimation results

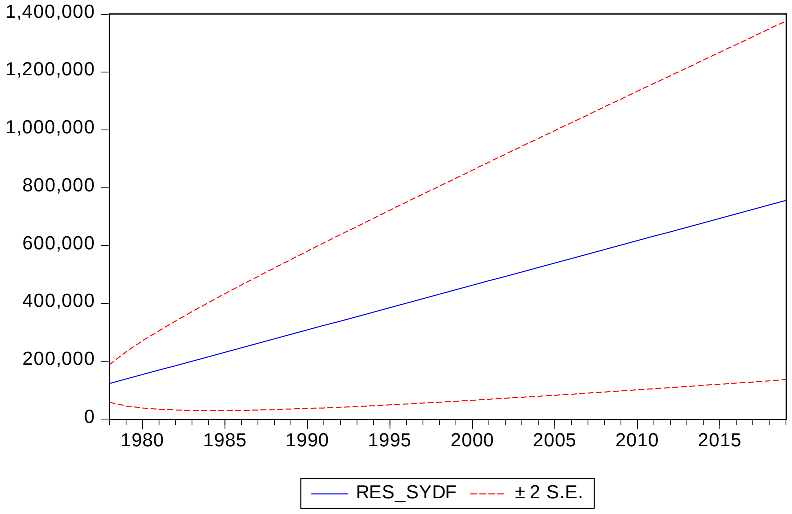
Dependent Variable: D(RES_SYD)
Sample (adjusted): 1978 2012
Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15439.600	5452.573	2.832	0.008

R-squared	0.000	Mean dependent var	15439.600
Adjusted R-squared	0.000	S.D. dependent var	32257.860
S.E. of regression	32257.860	Akaike info criterion	23.629
Sum squared resid	3.54E+10	Schwarz criterion	23.674
Log likelihood	-412.509	Hannan-Quinn criter.	23.644
Durbin-Watson stat	1.533		

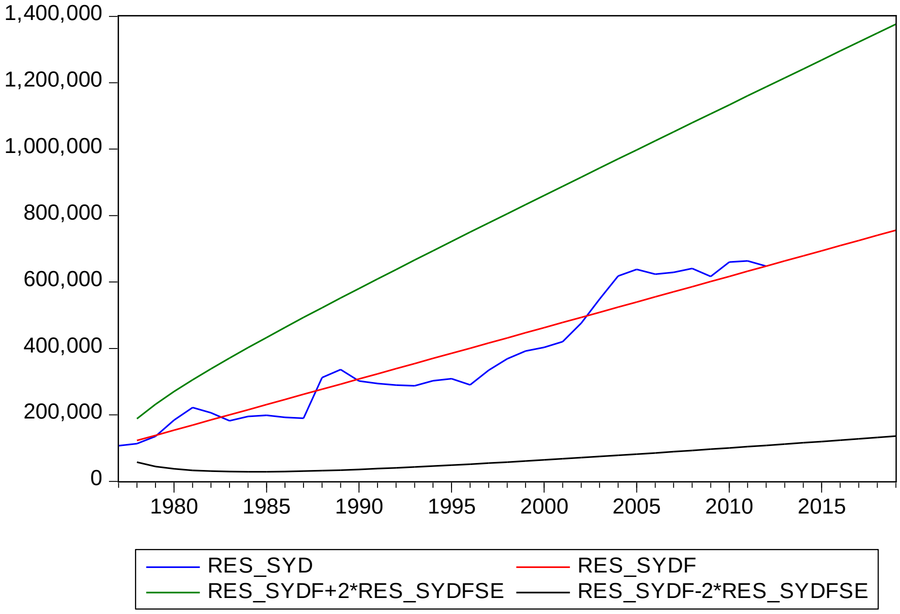
The residential series is represented by a 'random walk with drift' model, i.e. changes in residential land values are a function of the average differences in residential land values. The series has an upwards trend, with the constant reflecting the slope of the trend. The model lacks explanatory power owing to the absence of explanatory variables in the equation. The covariance proportion for the forecasts is high, and the chart shows the forecasts align with the long run trend in the data, but are unable to pick up the deviations around the trend.

Chart A1: ARIMA, real residential land values, forecast results



Forecast: RES_SYDF	
Actual: RES_SYD	
Forecast sample: 1977 2019	
Adjusted sample: 1978 2019	
Included observations: 35	
Root Mean Squared Error	54157.89
Mean Absolute Error	46728.51
Mean Abs. Percent Error	14.08978
Theil Inequality Coefficient	0.065017
Bias Proportion	0.018907
Variance Proportion	0.154778
Covariance Proportion	0.826316

Chart A2: ARIMA, real residential land values, actuals, forecasts and forecasts standard errors



Industrial

The industrial series is represented by an ‘exponential smoothing with growth’ model. The R-squared figure of over 40% is good for a model with a first difference as the dependent variable and the Durbin Watson statistic, which is a measure of serial correlation, has an acceptable value indicating no serial correlation. The forecast diagnostics indicate some bias and variance proportion suggesting that forecasts don’t fit the data well.

Table A5: ARIMA, industrial estimation results

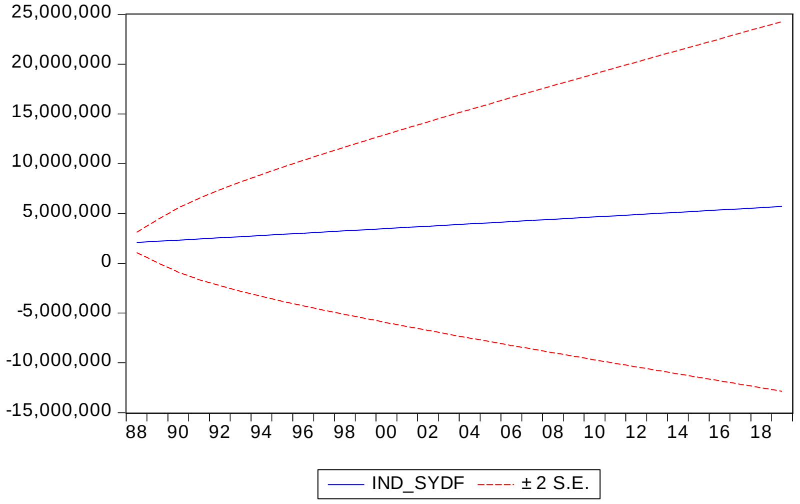
Dependent Variable: D(IND_SYD)
Sample (adjusted): 1988 2012
Included observations: 25 after adjustments
Convergence achieved after 14 iterations
MA Backcast: 1986 1987

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	116476.600	218310.300	0.534	0.599
MA(1)	0.924	0.170	5.433	0.000
MA(2)	0.482	0.176	2.740	0.012

R-squared	0.463	Mean dependent var	138250.200
Adjusted R-squared	0.414	S.D. dependent var	597130.600
S.E. of regression	457201.500	Akaike info criterion	29.016
Sum squared resid	4.60E+12	Schwarz criterion	29.162
Log likelihood	-359.698	Hannan-Quinn criter.	29.056
F-statistic	9.469	Durbin-Watson stat	2.012
Prob(F-statistic)	0.001		

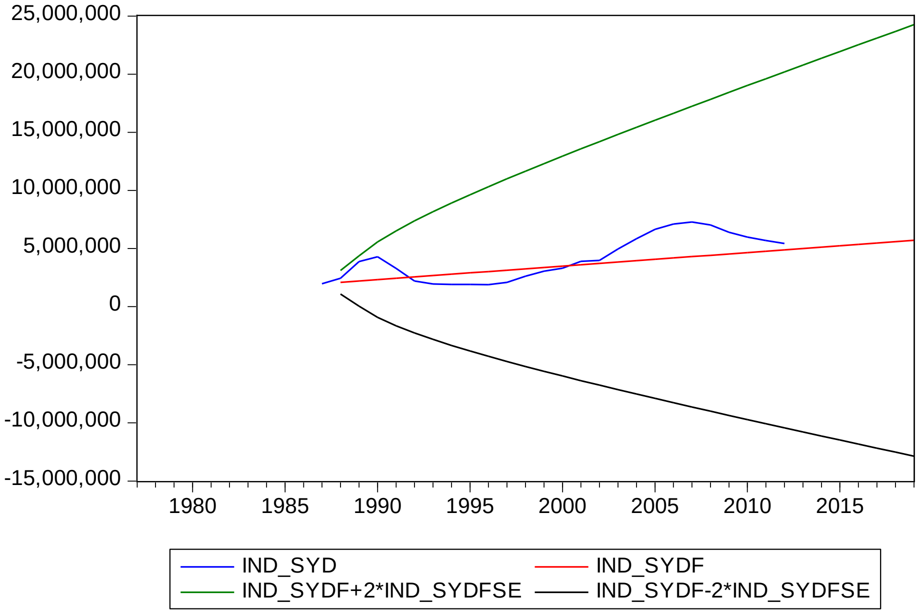
Inverted MA Roots	-.46+.52i	-.46-.52i

Chart A3: ARIMA, real industrial land values, forecast results



Forecast: IND_SYDF	
Actual: IND_SYD	
Forecast sample: 1977 2019	
Adjusted sample: 1988 2019	
Included observations: 25	
Root Mean Squared Error	1484049.
Mean Absolute Error	1216926.
Mean Abs. Percent Error	29.44975
Theil Inequality Coefficient	0.181502
Bias Proportion	0.231733
Variance Proportion	0.458935
Covariance Proportion	0.309332

Chart A4: ARIMA, real industrial land values, actuals, forecasts and forecasts standard errors



Rural

The rural series is also represented by an 'exponential smoothing with growth' model. The R-squared figure of around 25% is good for a model with a first difference as the dependent variable and the Durbin Watson statistic indicates no serial correlation. The forecast diagnostics indicate that there is some variance proportion suggesting that forecasts could fit the data better.

Table A6: ARIMA, rural estimation results

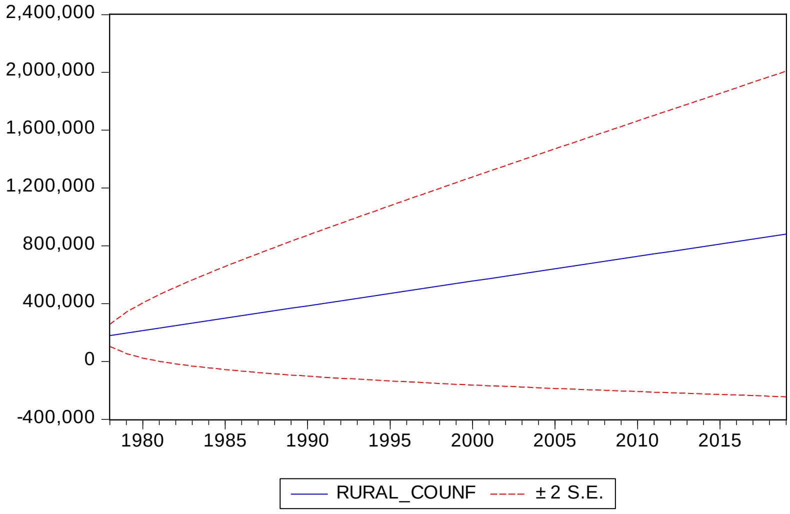
Dependent Variable: D(RURAL_COUNTRY)
Sample (adjusted): 1978 2012
Included observations: 35 after adjustments
Convergence achieved after 8 iterations
MA Backcast: 1977

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	17099.150	9933.228	1.721	0.095
MA(1)	0.568	0.143	3.967	0.000

R-squared	0.278	Mean dependent var	17816.510
Adjusted R-squared	0.256	S.D. dependent var	43705.460
S.E. of regression	37687.490	Akaike info criterion	23.967
Sum squared resid	4.69E+10	Schwarz criterion	24.056
Log likelihood	-417.431	Hannan-Quinn criter.	23.998
F-statistic	12.725	Durbin-Watson stat	1.825
Prob(F-statistic)	0.001		

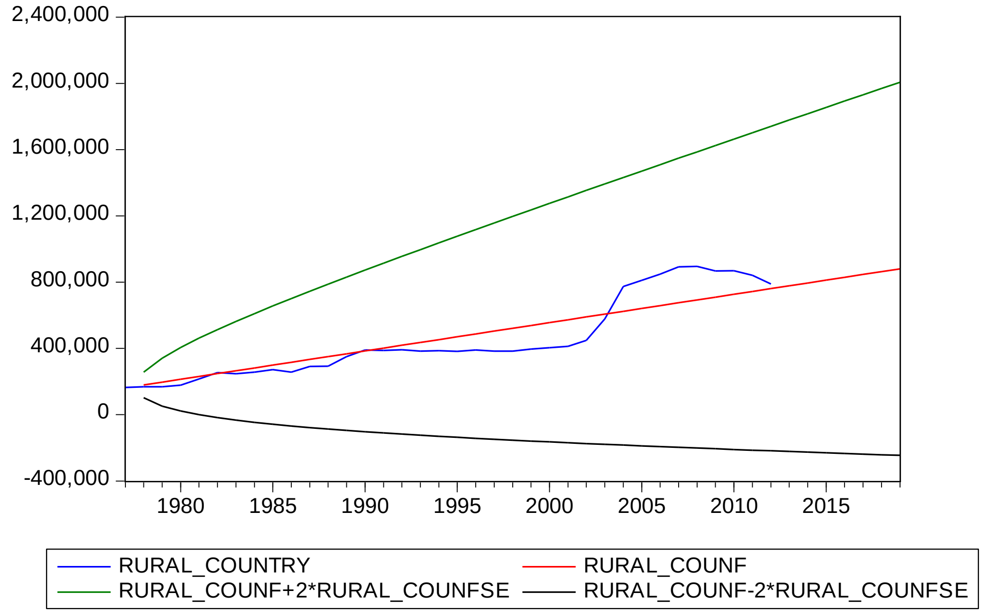
Inverted MA Roots	-0.57

Chart A5: ARIMA, real rural land values, forecast results



Forecast: RURAL_COUNF	
Actual: RURAL_COUNTRY	
Forecast sample: 1977 2019	
Adjusted sample: 1978 2019	
Included observations: 35	
Root Mean Squared Error	106051.4
Mean Absolute Error	83864.60
Mean Abs. Percent Error	17.40850
Theil Inequality Coefficient	0.103634
Bias Proportion	0.002899
Variance Proportion	0.385038
Covariance Proportion	0.612063

Chart A6: ARIMA, real rural land values, actuals, forecasts and forecasts standard errors



Agricultural

The model performs well with a high R-squared and acceptable Durbin-Watson statistic. However, the forecasts generated for the agricultural series also show a reasonably high level of variance proportion. Some growth is evident in the beginning of the sample but this soon converges to zero.

Table A7: ARIMA, real agricultural estimation results

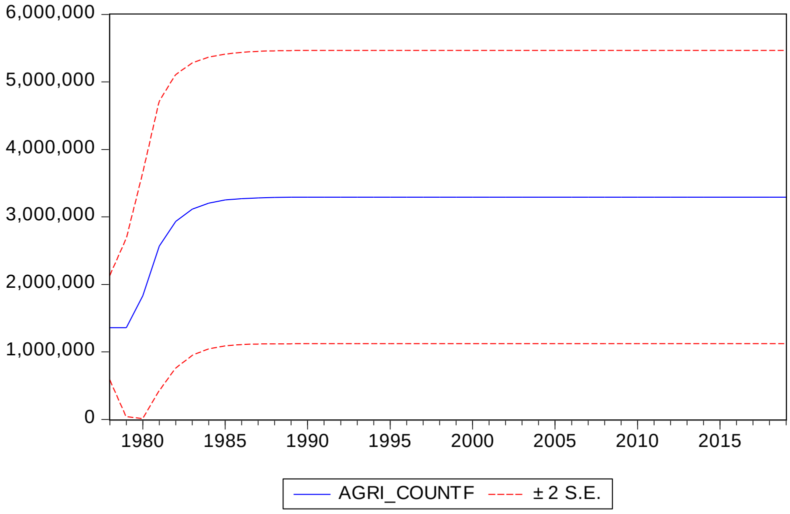
Dependent Variable: AGRI_COUNTRY
Sample (adjusted): 1978 2012
Included observations: 35 after adjustments
Convergence achieved after 14 iterations
MA Backcast: 1975 1977

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3293493.000	412819.900	7.978	0.000
AR(1)	0.496	0.163	3.047	0.005
MA(1)	0.917	0.132	6.947	0.000
MA(2)	1.045	0.050	20.738	0.000
MA(3)	0.731	0.114	6.393	0.000

R-squared	0.914	Mean dependent var	3019032.000
Adjusted R-squared	0.903	S.D. dependent var	1048577.000
S.E. of regression	327326.600	Akaike info criterion	28.367
Sum squared resid	3.21E+12	Schwarz criterion	28.589
Log likelihood	-491.420	Hannan-Quinn criter.	28.444
F-statistic	79.728	Durbin-Watson stat	2.045
Prob(F-statistic)	0.000		

Inverted AR Roots	0.5		
Inverted MA Roots	-.07-.97i	-.07+.97i	-0.78

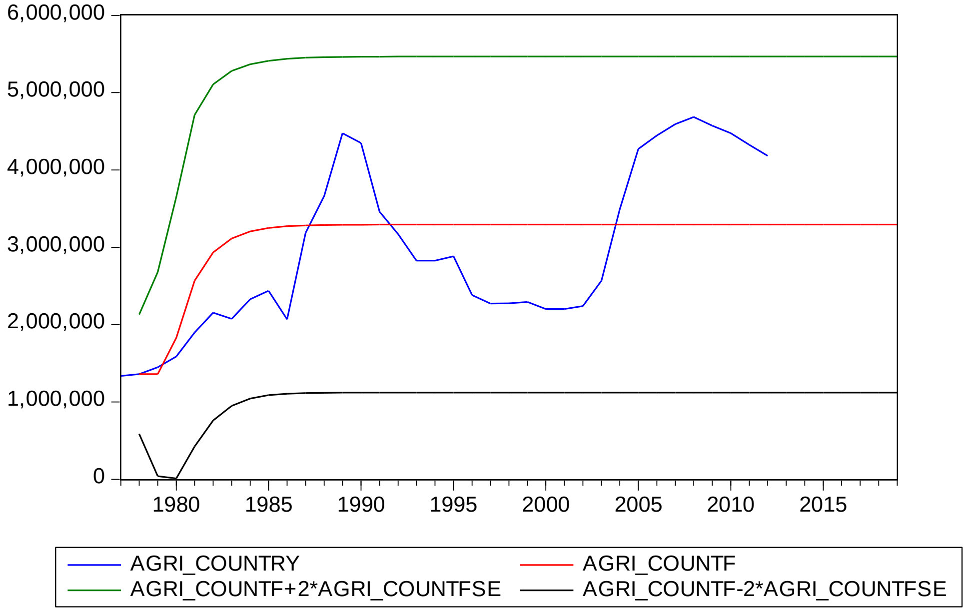
Chart A7: ARIMA, real agricultural land values, forecast results



Forecast: AGRI_COUNTF
Actual: AGRI_COUNTRY
Forecast sample: 1977 2019
Adjusted sample: 1978 2019
Included observations: 35

Root Mean Squared Error	880888.3
Mean Absolute Error	782010.6
Mean Abs. Percent Error	27.15189
Theil Inequality Coefficient	0.139110
Bias Proportion	0.008454
Variance Proportion	0.356640
Covariance Proportion	0.634907

Chart A8: ARIMA, real agricultural land values, actuals, forecasts and forecast standard errors



REGRESSION

The first step was to identify potential determinants of land values for each of the four series to be used as explanatory variables in the regression analysis. Numerous variables were chosen for testing and the available data was collated and inputted into Eviews econometric software for analysis.

Some variables were not statistically significant, or had the wrong coefficient sign (suggested the opposite influence to what theory or logic would suggest). Some variables were significant when included in isolation but when combined with other variables (to boost the explanatory power of the model) became not significant. In all equations a lagged dependent variable was included to capture partial adjustment towards an equilibrium level, where the land market is balanced. Lags of some of the variables were tested in addition to levels, to capture a delayed influence on the dependent variable.

Variables such as population and state final demand were tested for their broad influence on general state economic and market activity. However, these were not found to be significant for any of the equations.

All equations achieved a high R-squared suggesting good explanatory power. The agricultural regression had the lowest R-squared, the fit was reasonable but plotting the fitted values vs. the actuals showed that the regression misses various turning points.

Residential

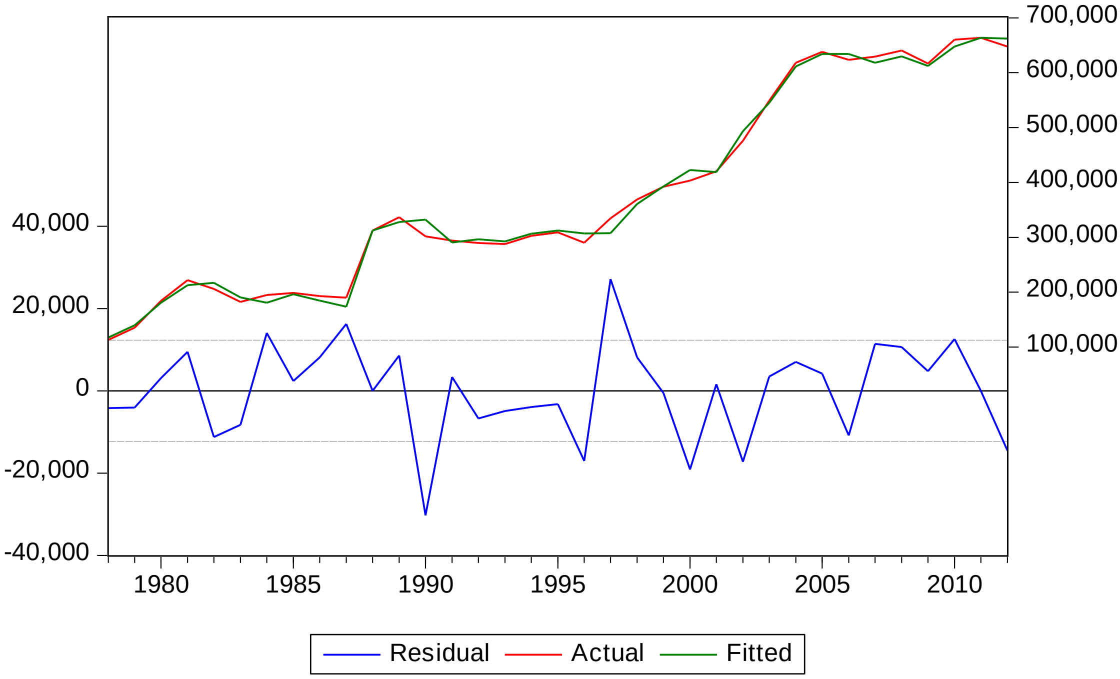
Table A8: Residential regression, estimation results

Dependent Variable: RES_SYD
Sample (adjusted): 1978 2012
Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-74085.47	11750.030	-6.305	0.000
RES_SYD(-1)	0.69	0.042	16.376	0.000
REAL_RES_COMM_NSW	0.03	0.007	3.801	0.001
REAL_HPRICE_SYD	328.29	51.922	6.323	0.000
DUM_88	109593.90	12764.330	8.586	0.000

R-squared	0.996	Mean dependent var	377836.000
Adjusted R-squared	0.995	S.D. dependent var	179826.600
S.E. of regression	12312.190	Akaike info criterion	21.806
Sum squared resid	4.55E+09	Schwarz criterion	22.028
Log likelihood	-376.607	Hannan-Quinn criter	21.883
F-statistic	1805.744	Durbin-Watson stat	2.131
Prob(F-statistic)	0.000		

Chart A9: Residential regression, actual, fitted and residual series



Industrial

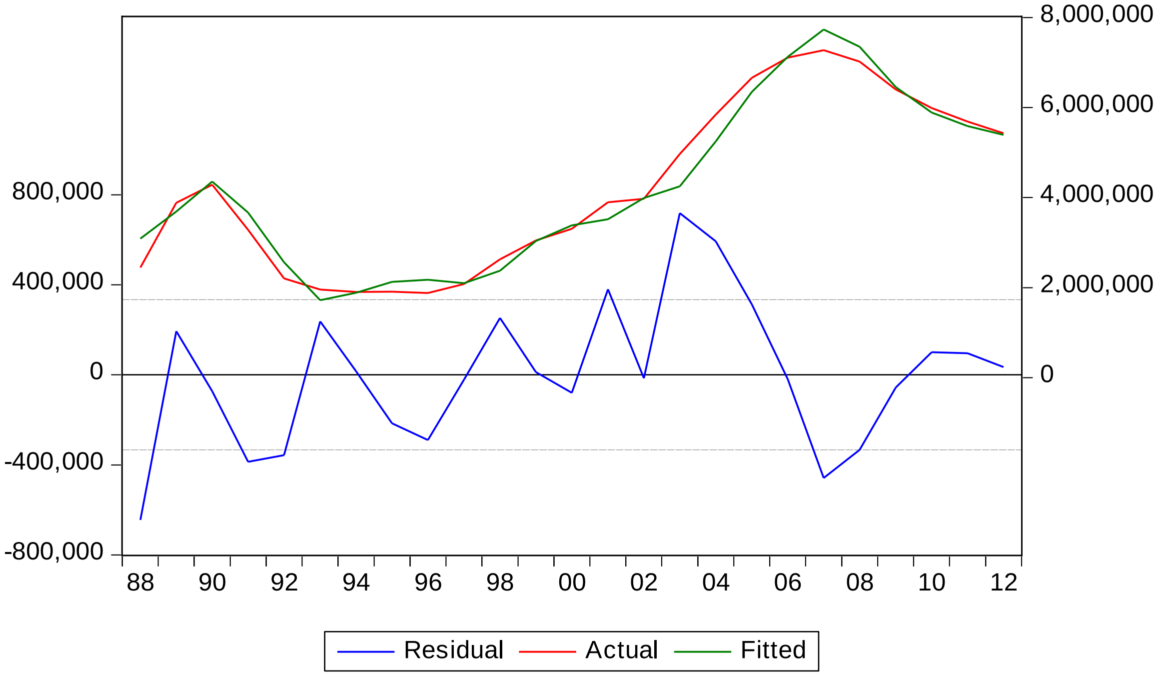
Table A9: Industrial regression, estimation results

Dependent Variable: IND_SYD
Sample (adjusted): 1988 2012
Included observations: 25 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 3.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2275570.000	414081.900	-5.495	0.000
IND_SYD(-1)	0.763	0.040	19.097	0.000
REAL_VALUES_OWSYD	2611.947	386.969	6.750	0.000

R-squared	0.971	Mean dependent var	4201926.000
Adjusted R-squared	0.969	S.D. dependent var	1883341.000
S.E. of regression	333642.300	Akaike info criterion	28.386
Sum squared resid	2.45E+12	Schwarz criterion	28.532
Log likelihood	-351.821	Hannan-Quinn criter.	28.426
F-statistic	371.364	Durbin-Watson stat	1.213
Prob(F-statistic)	0.000	Wald F-statistic	360.704
Prob(Wald F-statistic)	0.000		

Chart A10: Industrial regression, actual, fitted and residual series



Rural

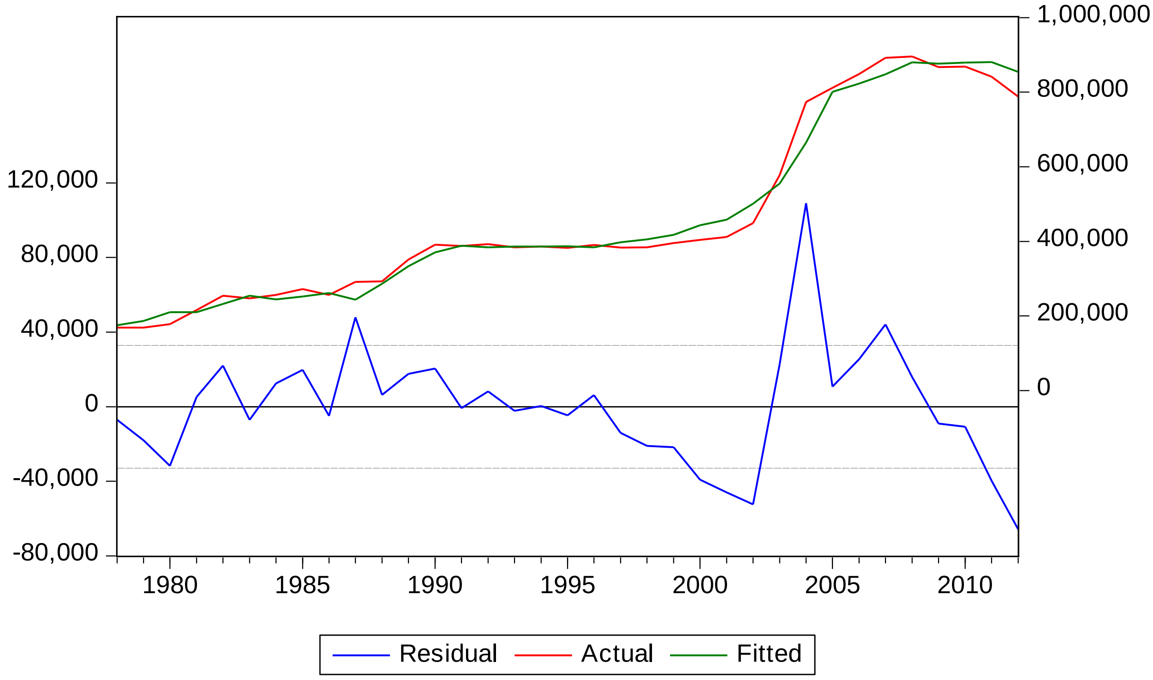
Table A10: Rural regression, estimation results

Dependent Variable: RURAL_COUNTRY
Sample (adjusted): 1978 2012
Included observations: 35 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-35604.890	21792.070	-1.634	0.112
RURAL_COUNTRY(-1)	0.774	0.064	12.152	0.000
REAL_HPRICE_SYD	367.680	111.048	3.311	0.002

R-squared	0.983	Mean dependent var	464638.900
Adjusted R-squared	0.981	S.D. dependent var	241981.300
S.E. of regression	32943.700	Akaike info criterion	23.725
Sum squared resid	3.47E+10	Schwarz criterion	23.858
Log likelihood	-412.184	Hannan-Quinn criter.	23.771
F-statistic	901.208	Durbin-Watson stat	1.049
Prob(F-statistic)	0.00	Wald F-statistic	465.604
Prob(Wald F-statistic)	0.00		

Chart A11: Rural regression, actual, fitted and residual series



Agricultural

Table A11: Agricultural regression, estimation results

Dependent Variable: AGRI_COUNTRY
Sample (adjusted): 1981 2012
Included observations: 32 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-624182.800	415313.000	-1.503	0.144
AGRI_COUNTRY(-1)	0.910	0.055	16.620	0.000
SHEEP_EXPORT_PRICE	5631.558	2552.160	2.207	0.036
SHEEP_VOLUME(-1)	136.553	63.337	2.156	0.040

R-squared	0.859	Mean dependent var	3164722.000
Adjusted R-squared	0.844	S.D. dependent var	974404.300
S.E. of regression	384316.900	Akaike info criterion	28.673
Sum squared resid	4.14E+12	Schwarz criterion	28.856
Log likelihood	-454.765	Hannan-Quinn criter.	28.734
F-statistic	57.093	Durbin-Watson stat	1.547
Prob(F-statistic)	0.000	Wald F-statistic	147.767
Prob(Wald F-statistic)	0.000		

Chart A12: Agricultural regression, actual, fitted and residual series