# THE EFFECT OF ECONOMIC FACTORS on RURAL LAND VALUES

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***ABSTRACT***

*Despite continuing world discussions in relation to free trade the majority of first world countries still have a very heavily subsidised rural economy. Over the past twenty years countries such as Australia and New Zealand have been reducing farm support schemes to the point where now these rural industries are competing on a free world trade market basis.*

*The reduction in farm commodity and input support has placed significant managerial pressure on Australian farmers to compete and survive in a market that fluctuates from periods of high commodity prices to low prices based on total world supply and demand.*

*This paper will examine the change in rural land prices within an area of New South Wales to determine the extent of rural land price change and returns over a twenty year period. The paper will also examine the change in major rural input and output costs over the same time. This analysis will examine the influence of these factors on rural land prices.*

**Key words**

*Rural land, rural economics, rural land values, farm management, land use*

## Introduction

Rural land in Australia is the most extensive property class based on total area occupied, with the total area of land dedicated to agricultural production being 465 million hectares in 1996. Since 1956, the area of land in Australia used for agricultural production has ranged from a low of 459 million hectares in 1958 to a high of 501 million hectares in 1975 (Australian Bureau of Agricultural and Resource Economics [ABARE], 1997).

The Australian rural sector has developed from a heavily supported and subsidised industry, which is still the case with the majority of first world countries, to a virtual free trade market.

Despite the overall size of the rural property market and the continuing importance of agricultural land to the Australian economy, it does not appear to have received the same level of research or attention by the property and valuation profession that has been received by commercial and residential property. It was not until the mid 1950's that Collins (1959) and Wadham (1955) provided some explanation of the impact of commodity prices on rural land values. A study by Kelly (1958) linked changing land prices to prevailing seasonal conditions, however this study was limited in both the small size of the study area and the relatively short time period. Kelly did link confidence in the rural land market to the level of government support.

Further work by Treseder, 1972; McEwen, 1962 and Coombs, 1959 suggested a correlation between increases in commodity prices and increases in rural land prices but did not substantially test this theory. From the period of 1970 to 1994 there was limited study in relation to rural land prices in Australia. The work carried out by MacPhillamy (1969) and Hammersley (1987) provided limited results in respect to price movement but these results were based on a small sale data base and a very restricted geographic area. The first substantive work in Australia to determine the factors that influence rural land prices was carried out by Edwards (1994). This review of rural land prices in South Australia indicated that commodity prices appear to affect rural land prices (two year lag) and that levels of general economic indicators do not closely match levels of rural land price. A substantial analysis of rural land prices carried out by Eves (1998) showed a correlation between rural land prices in mixed farming areas to changes in the price for wool and wheat. This study also found that this correlation was more significant in areas located away from main regional city influences

In addition, the limited research into the rural property market can be explained by the ownership of rural land. In the 1997 Farm Survey carried out by ABARE, it was stated that private ownership of rural land was 99.6% of total farm numbers. Corporate ownership as a percentage of total farms is only 0.4%, but actually accounts for 6.9% of total Australian agricultural production (Thomas, 1995).

To date, the analysis of rural land markets in Australia has been limited to the investigation of annual price trends based on limited data sets. There has also been very limited analysis to determine what key factors are associated with changing rural land prices and the actual extent that these factors are associated with annual change in rural land prices. This paper will attempt to analyse a large sales database and the major rural input and output costs over the same period to determine if these factors have a significant influence on the rural land market.

## RESEARCH OBJECTIVES

The purpose of this paper is to:
Determine the influence and association of the main rural economic and financial factors on land price movements in rural property markets;

Consider the implications of these factors on rural land prices and valuation practice.

**Figure 1: Study Area**

**NEW SOUTH WALES LOCAL GOVERNMENT AREAS**

## STUDY AREA

This study of rural land prices has been based on the Central West and Far West regions of New South Wales. In total, seven Local Government Areas (LGAs) have been selected for the analysis.

These areas have been selected as they represent the developed, developing and marginal mixed farming industry in NSW and include the LGAs of Forbes, Parkes, Weddin, Bland, Lachlan, Cobar and Carrathool.

Three of the LGAs, Forbes, Parkes and Weddin, are in traditional mixed farming areas of the State. Cropping has been a major rural enterprise in these areas since the 1860s.
All these LGAs are considered to be safe cropping areas.

Until the late 1960s and early 1970s, the main agricultural enterprise in the Bland and Lachlan LGAs was grazing for medium strength merino wool. Following the development of dwarf wheat varieties that required less rainfall for growth, these areas began to develop as mixed farms rather than pure grazing.

Both the LGAs of Cobar and Carrathool are in marginal cropping areas. The development of larger scale cropping enterprises in both these areas did not commence until the early 1980s

Figure 1 provides location details of the seven LGAs. As can be seen, all the LGAs adjoin at least two other LGAs in the study and in the case of Lachlan LGA, it actually adjoins all the other LGAs in the study.
Although many of the LGAs are adjoining, the climatic, topographic and soil types can vary both between and within the LGAs. However the close proximity of the LGAs does limit this variation for comparative purposes.

In summary, three of the LGAs in the comparison are traditional mixed farming areas, in what is considered to be relatively safe rural country with reliable rainfall and fertile soils. With these three areas the main rural enterprises for the majority of properties are winter cereals (wheat, oats and barley), canola and grain legumes. All areas run medium wool merinos as well as prime lambs and beef cattle. Changes in the prices for these commodities should have a similar impact on land values.

In contrast Lachlan, Bland, Carrathool and Cobar LGAs are all located in the central west\Southwest regions of NSW and as both Bland and Cobar adjoin Lachlan Shire they are considered to be geographically close with similar climatic, topographical and soil features. Until the early 1970's these areas had been traditional grazing areas with very limited farming production. Since the 1970's all LGAs have seen an increase in cropping. This is particularly the case with the higher rainfall areas of the Bland and Lachlan Shires. The lower rainfall of these areas compared to Forbes, Parkes and Weddin does not allow the same flexibility in the types of crops that can be sown and the types of pasture that can be established and maintained. The reliance on native pasture species also reduces the livestock options in these shires that are drier and with less fertile soils. (NFF, 1993)

## RESEARCH PARAMETERS

Land and property sales were collected for the seven LGAs for the period 1975 to 1996.

Major economic data has been sourced from the following:

Australian Bureau of Statistics (ABS)
Australian Bureau of Agricultural and Resource Economics (ABARE)
Reserve Bank of Australia (RBA)
Winter Cereal Production Statistics (Australian Institute of Agricultural Science)

Farm production data has been based on Australian Standard White (ASW) wheat price, as this is the wheat type grown in all LGAs and the 22-micron wool indicator for the LGAs of Weddin, Forbes, Parkes, Bland and Lachlan. The 24-micron wool indicator was used for Cobar and Carathool LGAs.

Details of yields, costs and commodity prices were obtained from NSW Agriculture Department, ABARE and Australian Institute of Agricultural Science (AIAS).

The analysis has been carried out using the analysis tools provided in Microsoft Excel.

## SALES DATA

For all seven shires, all sales for the period of 1975 to 1996 have been collected and analysed. This 21-year period includes the rural boom periods of 1975 to 1980 and 1985 to 1989\90 and the rural recession of 1990 to 1993. This period also covers the abolition of the Reserve Floor Price scheme for wool (a major commodity in all areas) and the lowest real price for wheat (and other winter cereals) that have been received by farmers in NSW during this post war period.

All land transfers were collected for these LGAs, with the initial sort removing all zero value transfers (transfer by will and Family Court actions) as well as same name transfers and family sales.

Sales that were of a smaller area (less than 40 hectares) were also removed from the data set as rural residential blocks were not considered to be representative of land values for operating farms. The size of such rural residential blocks depended on the LGA.

Any sales transactions that were abnormally low based on the analysed rate per hectare, indicating a family sale, were also excluded from the data set.

In all cases the various sales could be either vacant rural land or improved sales. The data base information does not differentiate between the two classes of property. This information could only be confirmed by physical inspection. This differentiation was not possible with such an extensive data base.

In summary, there are 4505 actual transactions in the data set. Forbes and Lachlan LGAs had the highest number of sale transactions over the study period, with 865 and 793 sales respectively. For the twenty-one year period, Cobar LGA had the lowest per annum number of sales transactions.

## RURAL LAND RETURNS

The initial data analysis provided an assessment of the average annual capital returns (nominal) and volatility for the LGAs in the study area. These results are shown in Table 1.

Although the mean annual capital returns for the closer settled LGAs were reasonably similar, the annual capital returns for the two marginal cropping LGAs were considerably higher, with a significantly higher volatility.

A previous study by Eves (1998) confirms that the average annual capital returns from rural land are considerably higher, with greater risk, in comparison to both commercial and residential property in the same or similar LGAs. Both Cobar and Carrathool had their lowest sales volumes in the mid 1980s. Both areas had high levels of transactions in the late 1970s, early 1980s, which was the period that cropping became more prevalent in these marginal areas.

The highest rural land sales volume for both Bland and Lachlan LGAs was in the period 1975 to 1980, again the period when the area was developing away from grazing to cropping. The years with the lowest number of sales for both these areas were 1990 and 1991; a period of rural recession in which land prices decreased significantly despite the lower volume of sales. Sale transactions at a level to previous years may have seen prices fall further than those recorded

Sales transactions in the traditional cropping areas have been relatively similar with a greater number of transactions in the period 1975 to 1985 compared to the later ten years.

The contrary relationship between Cobar and Carrathool LGAs can be partly explained by the influence of non agricultural industries in the Cobar LGA. According to Eves (1997) the mining industry has been an artificial influence on the rural market, as properties are often purchased for lifestyle purposes.

**Table 1: Average Annual Nominal Return for Rural Land (All LGAs): 1975-96**

| LGA | Average Annual Return (%) | Volatility (Risk) (%) | Risk-Return Ratio |
|---|---|---|---|
| **Forbes** | 8.0 | 21.14 | 2.6 |
| **Parkes** | 9.5 | 25.47 | 2.7 |
| **Weddin** | 9.6 | 17.66 | 1.8 |
| **Bland** | 9.4 | 24.40 | 2.6 |
| **Lachlan** | 8.7 | 25.95 | 3.0 |
| **Carrathool** | 19.6 | 47.04 | 2.4 |
| **Cobar** | 34.4 | 66.90 | 1.9 |

## ECONOMIC FACTORS AND RURAL LAND PRICES

The two main commodities grown in the seven LGAs are wheat and wool. Although other crops are grown, they are predominantly used to extend the crop rotation, as a break to control disease or a final crop in the rotation.

For comparative purposes the following analysis includes both nominal changes in commodity and input costs as well as the changes in costs and prices after adjustment for inflation (real prices).

### Wheat Price

Wheat prices paid to Australian farmers are based on the world market price. Australia produces an average of 13 million tonnes of wheat per annum.

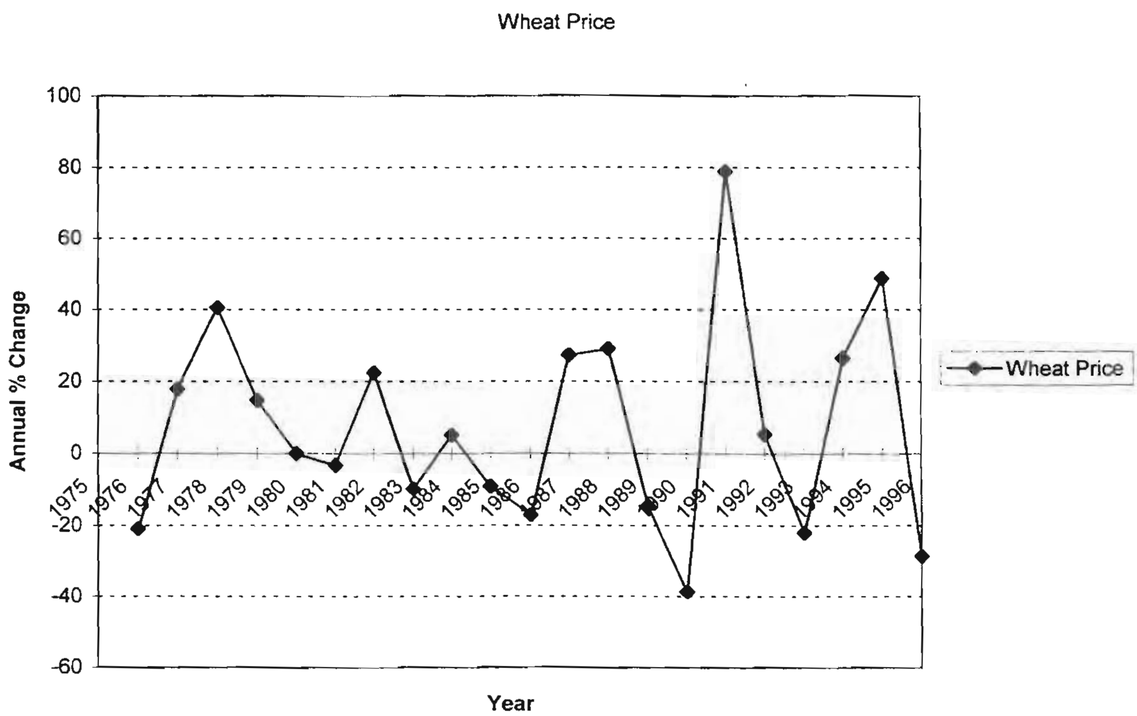
Although Australia is not one of the largest producer of wheat, it is a major exporter of wheat as only approximately 30% of the annual crop is consumed domestically. (National Farmers Federation, 1993).

Based on this reliance on export prices, supply and demand for wheat in Australia is not an indicator for prices received by Australian farmers. The average nominal Australian Standard White (ASW) wheat price over the period of the study (1975-1996) was $131.13 ($122.52 real).

As shown in Figure 2, the annual variation in the price of wheat is high with a volatility in the nominal price being 36.89% (37.22% real).

Over the 21 year period, the highest price for this commodity was $237.91 per tonne in 1995 with the lowest recorded price being $69.25 per tonne in 1976. A low price of $86.95 per tonne was recorded in 1990 which was also a year of extreme drought with very low yields. The combination of a low commodity price and low yields has significant impact on farm profitability.
These effects will be discussed in more detail later in this paper.

**Figure 2: Annual % Variation in Wheat price: 1975-96**




## Wool Price

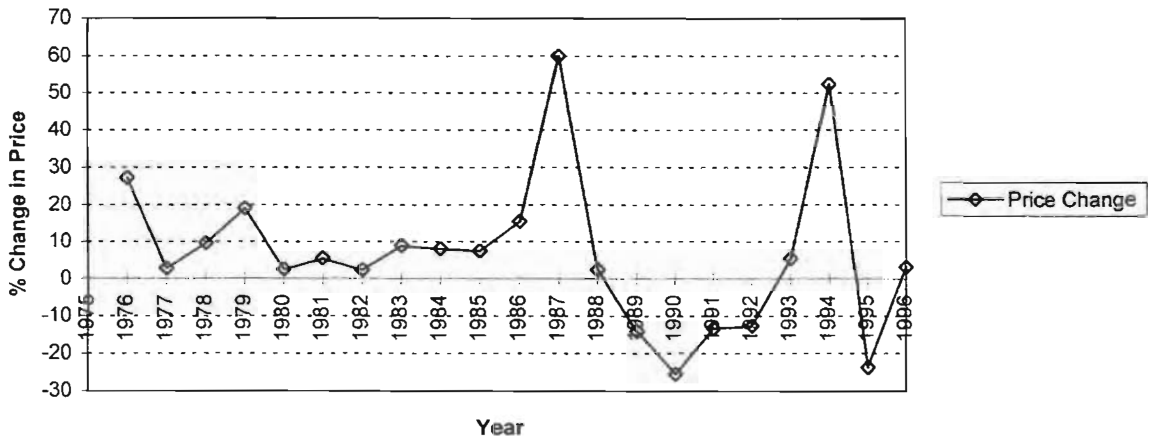
Unlike the wheat price, the wool price used in this study had to be varied to suit the actual situation in the various LGAs. As such, the basis for the wool price had to be varied to correctly represent the type of wool grown in the various LGAs. The closer settled LGAs of Forbes, Parkes and Weddin are in better climatic areas, compared to the other LGAs in the survey. As such, the wool grown in these areas is finer (21 to 22 micron). Mixed farms in the LGAs of Bland and Lachlan grow slightly stronger wool at 23 microns. Wool grown in the more western LGAs of Cobar and Carrathool are regarded as strong wool, having a thickness of 25 microns.

The actual price for the various grades of wool (based on micron thickness) was used to determine the adjusted net profit per hectare for the individual LGAs. However,
for the overall analysis and the graphs relating to wool, prices have been based on the 22 micron indicator price.

The trend in the wool price has been different to that discussed for the wheat price. Wool has shown a steady increase in price from 1975 to 1986. During this period the nominal price per kilogram for 22 micron wool rose from 143 cents (125 cents real) to 395 cents (358 cents real). There was a very significant increase in the wool price from 1986 to 1988 (refer to Figure 3). At the end of the 1988 selling period, the wool price for this particular type of wool had risen to a record high of 647 cents per kilogram (600 cents real).

Since 1989, the wool price has fallen to a low of 313 cents and the volatility of the commodity has also increased significantly to 25.31 % compared to the volatility from 1975 to 1988 of 15.27 %.

**Figure 3:** **Annual % Change in Wool Price: 1975-96**




## Interest Rates

For the purposes of this study, the interest rate chosen was the reference rate products (rural overdraft or variable term loan) issued by the has been no risk margin added to this rate, as the risk margin is calculated on the individual farmer, not location of the rural property alone.

However, the trend for the real interest rate did not match the nominal trend line. Real rates increased from a negative position until 1978 when the rate had moved from 7.65% to 2.15%. After a fall in 1979, the real interest rate also increased to a high in 1990 (the nominal rate peaked in 1989) of 14.3 %. With the low inflation rates from 1990 to 1996, the difference between the nominal and real interest rate was not as significant.

With a range in nominal interest rate of 9.15% to 20.88%, there has been significant volatility in this input cost. This volatility is indicated in Figure 4 which shows ten years when rates decreased and eleven years of increases in the reference interest rate. As a percentage figure, major trading banks. These products include the standard operating overdraft and the variable rate term loan. The analysis has been based only on the reference rate. There these changes in interest rate were as high as 28%.

### Fuel Cost

Two of the major variable costs for crop production are fuel and fertiliser. Both costs are essential for the optimum crop yield. As major cropping inputs, it can be assumed that an increase in these vital inputs should have some impact on land prices, due to their impact on land use. The fuel price is based on the cost of Diesel, which is a full tax deductible item for Australian farmers. The price per litre also reflects the fact that Australian farmers do not pay any sales tax on the fuel they use for agricultural production.

The cost of fuel increased significantly in price from 1975 to 1985 (refer to Figure 5), with a rise in cents per litre from 5.97 (5.20 real) to 36.11 (33.1 real). After 1985, prices tended to fall until a peak in 1991 of 36.37 cents per litre (35.7 cents real). Since 1991 prices have tended to be more stable.

**Fertiliser Cost**

As previously mentioned, fertiliser is a major cost for the production of crops and to a lesser extent for wool production (particularly in the Far West LGAs). Although this input is not required for crop production, it is essential for optimum crop production and longer term soil fertility. In the subject area, due to poor natural soil fertility, a reduction in this input will result in an immediate reduction in crop yields.

The fertiliser price adopted is the cost of single superphosphate quoted at a rate of $/tonne (ABARE, 1998). Unlike the fuel price, fertiliser prices have virtually been increasing from 1977 with only a short period in the early 1990s when the price decreased slightly and stabilised.

During the period 1975 to 1996, the price of fertiliser has increased from $54.6 to $184 per tonne (nominal). This is the only variable in the analysis that has a continuing positive increase trend in price.

Although this input cost has a trend of continuing increasing prices, the volatility of these increases has also been relatively low compared to other variables in the analysis which is shown in Figure 6. The largest annual fall or increase in the fertiliser price occurred in 1990 (approximately 27%).

**Adjusted Net Farm Profit**

The adjusted net farm profit is based on the sustainable cropping program for each of the areas. Net price for the commodities is after the deduction of freight, taxes and levies. From this net income figure, the actual costs of production only have been deducted to arrive at an adjusted net farm profit per hectare. No allowance has been made for interest and financial charges, depreciation, replacement stock or capital purchases and owners labour (ABARE, 1998; Fitzsimmons, 1997). Appendix 2 provides the annual adjusted net income per hectare for each LGA for the entire study period together with overall statistics.

As can be seen from Appendix 2, the traditional cropping areas have had fewer years of lower income, recording less annual losses compared to the marginal cropping areas. Cobar LGA had eight years when a negative profit was recorded on a per hectare basis and a further 6 years when adjusted net profit was less than $15 per hectare.

In these years, if the property had any form of debt level, the income per hectare would also have been negative. A previous study (Eves, 1997) concluded that a greater income per hectare would have been achieved in the Cobar LGA if no cropping had been carried out and the land used only for grazing.

The traditional cropping areas had only a maximum of three years when the income generated per hectare was negative. For the entire 21 years of the study, the highest calculated adjusted net profit per hectare was Weddin LGA in 1995 when the per hectare figure was $310.37. The variability in agricultural production is also evidenced in the fact that during 1995, the other LGAs did not produce a similar level of income, despite both Forbes and Parkes LGAs being similar in location, soils and physical attributes of rural land. Although the levels of incomes, for the traditional cropping areas, were vastly different in relation to the best years for income they were relatively similar results in the poorer years, 1982 and 1994, as shown in Appendix 2.

The average annual profits for the seven LGAs are also shown in Appendix 2. Although the lowest average annual adjusted net profits are in the marginal cropping LGAs, these areas also have the lowest volatility in relation to income. Weddin LGA had the highest average annual adjusted net profit, $88, but also the highest volatility at 79.55%.

Although Bland LGA had a higher average annual adjusted net profit, both Bland and Lachlan LGAs show a similar trend in both adjusted net profit and volatility. This was expected due to the significant correlation (r =0.63) between these two areas in relation to land price (Eves, 1997).

The volatility of these input and output costs are illustrated in Figure 7. The index for the input variables shows that the highest increases in prices over the period 1975 to 1996 have been with the fuel and fertiliser costs. The price for the commodity prices, wheat and wool, have not increased at the same level. This is reflected in the overall declining terms of trade for Australian farmers and the variations in the average annual adjusted net profits for all LGAs. Although the index for interest rates does not appear to have increased at the same levels as some of the other input variables, it should be noted that the volatility of this input was still reasonably high.

## Effect of Economic Factors on Rural Land Prices

Previous rural land studies by Eves (1998) and Edwards (1994) identified some association between changes in land prices within the LGAs and changes in commodity prices, input costs and adjusted net farm profit. The correlation between change in commodity price and land prices was more significant in the traditional cropping LGAs and the marginal cropping areas had a significant correlation between changes in net profit and changes in rural land prices.

To further test this identified relationship between economic factors and rural land price change a multiple regression analysis has been carried out using the excel spreadsheet package. This regression analysis of the LGA land price movement (dependent variable) to the various independent variables (listed below) was carried out to examine the relationship between these factors and rural land prices:

Wheat price
Wool price
Interest rate
Fertiliser cost
Fuel cost

Adjusted net profit (Summary of values included as Appendix 2),

Regression analysis has been carried out for both the annual percentage change in the variables, as well as the actual price of the variables. This second regression analysis has been carried out to determine the ability of these variables to predict rural land prices.

In a previous rural land analysis by Eves (1997), it was noted that the volatility in rural land prices was greater in the period 1985 to 1996 compared to the earlier period of 1976 to 1985. During the period 1975 to 1985, there was considerable Government support for the rural industry in Australia. This support included subsidies, quotas and minimum commodity prices. After 1985, these support schemes were gradually reduced to the point when the final support for wool, the reserve price scheme, was abolished in 1989.

In order to test the influence of these support schemes on rural land prices, an additional regression analysis, both on price movement and actual prices, has been carried out with a dummy variable to represent these support levels. A value of 1 was included in the analysis for the years 1975 to 1985 and a value of 0 for the years 1986 to 1996.

Granger causality testing has also been carried out to investigate if there is a intertemporal relationship between the rural land market and the wool and wheat price, fuel and fertiliser costs and interest rates. This Granger causality testing has been carried out on the basis of lags of up to two years. Previous studies, using simple correlation analysis, in relation to rural land prices have shown a greater correlation to changes in rural land prices and commodity prices when lags of 1 to 2 years are used in the correlation analysis (Eves, 1998; Edwards, 1994).

Each of the LGAs will be discussed according to the three main categories already established in this paper, being Traditional Cropping, Developing Cropping and Marginal Cropping areas. Only summarised results are presented in this paper. Examples of significant models are attached as Appendix 1.

### Multiple Regression Analysis (Annual Percentage Change in Price)

### Traditional Cropping Areas

The following multiple regression analysis has been carried out to determine how the change in the price of the main commodities, input costs, interest rates and adjusted net profit is associated with the change in the price of rural land in the various LGAs. For this analysis the dependent variable is the percentage change in the average annual price of land, with the independent variables being the annual percentage change in the commodity price, input cost price, interest rate and adjusted net profit. Significant results for the various LGAs are attached as Appendix 1.

The regression model using the five independent variables was carried out on the basis of both the actual price movement from year to year, and secondly on the basis of the lag in the land price of 12 months. This was based on the assumption that changes in the price of major commodities, interest rates and adjusted net profit (which takes into account the input costs of fuel and fertiliser) would not fully impact on rural land prices until the following year.

Results show that the linear relationship between land price, in the traditional cropping areas, and the independent variables is positive but considered to be weak with the highest $R^2$ values of 0.33 for Weddin LGA and 0.22 for Parkes LGA. In the lowest result of 0.12 for the Forbes LGA only 12% of rural land price change is explained by the independent variables (refer to Appendix 1).

However, when the land price is lagged, the regression results are improved for two of the LGAs in this category. The $R^2$ square values for Forbes and Weddin LGAs have increased, indicating a higher correlation compared to the analysis with no price lag. Despite the improved results, with the lagging of prices, these three rural land markets are influenced by factors other than those that impact directly on farm profitability. Such factors as competition from hobby farmers or residential development may be a greater influence on the change in rural land prices in these areas.

### Developing Cropping Areas

With the developing cropping areas, the initial regression analysis on a contemporaneous basis was more significant than the traditional cropping areas. Appendix 1 shows that the $R^2$ are higher than the traditional cropping areas at 0.58 for Bland and the higher level of 0.70 for Lachlan LGA, these $R^2$ values are significantly higher than the results for Forbes LGA (0.12), Parkes LGA (0.22) and Weddin LGA (0.33). The coefficients of determination are also higher than the comparable results for the traditional cropping areas. The model for rural land price movement in the developing cropping areas indicates that the economic factors explain a greater percentage of change in rural land prices than the same model for the traditional cropping areas.

Although none of the $R^2$ values were significant for Bland LGA ($P<5\%$) both adjusted net farm profit and the wheat price were considered significant for Lachlan LGA with T-Stat and P Values of (3.61, 0.003) and (-1.84, 0.003) respectively.

As was the case with the traditional cropping LGAs, the lagging of the annual change in the rural land price has improved the model for one of the Developing Cropping LGAs (Bland). On this basis, as is shown in Appendix 1, the $R^2$ for Bland LGA has increased, but the $R^2$ for the Lachlan LGA decreases from 0.59 to 0.50 suggesting that association between changes in economic price factors tend to have a greater effect on rural land prices in the year such changes occur. For Bland LGA, 72% of the variation in the rural land price explained by the five independent variables.

However the results for the two sets of data are relatively similar for Lachlan LGA. This LGA actually has a greater $R^2$ based on the non-lagged data set compared to the lagged set. However this difference is minimal and in both cases, the linear relationship can be regarded as fair with up to 59% of the change in rural land price movement being explained by changes in the independent variables.

### Marginal Cropping Areas

The results for the LGAs in the marginal cropping areas, presented in Appendix 1, are quite mixed. Throughout this study, the trends and analysis for Cobar LGA have been out of line compared to the other LGAs. This has also continued in the modelling analysis.

Only Parkes and Cobar LGAs have had a smaller $R^2$, with the lagged data compared to the contemporaneous data. In the case of Cobar, the $R^2$ reduces from 0.27 to 0.21. All these figures suggest that this is not a strong model to determine the factors influencing rural land price change in this LGA. Additional factors have a greater influence on rural land prices than those directly related to farm profitability. This was not expected in an isolated marginal farming area. The fact that this LGA had several large multinational mining companies carrying out both exploration and mining operations during the study period could have had more impact on rural land prices than the selected independent variables.

The regression analysis results for Carrathool LGA are similar to the majority of LGAs in the study. Although the contemporaneous analysis is not as strong as the results recorded by Bland LGA, the correlation coefficients for the lagged data is very similar. The difference in the $R^2$ for the contemporaneous and lagged analysis suggests that in the Carrathool LGA changes in the economic factors will have greater association with changes in the rural land price in the year following such changes. This is the opposite situation to the traditional cropping areas.

**Multiple Regression Analysis (Actual Prices)**

The analysis above, has been used to analyse the rural land markets in the various LGAs to determine how changes in the price of major commodities and input costs impact on the change in rural land prices.

The following multiple regression analysis has been carried out to determine how the price of the main commodities, input costs, interest rates and adjusted net profit can potentially predict the price of rural land in the LGAs. For this analysis, the dependent variable is the average annual price of land on a per hectare basis, with the independent variable being the actual commodity price, input cost price, interest rate and adjusted net profit on a rate of $ per hectare.

The initial discussion of this analysis will focus on the correlation coefficient, coefficient of determination and the standard error. The analysis has also been carried out on the basis of the rural land price being contemporaneous and lagged.

**Traditional Cropping Areas**

All traditional cropping LGAs had a higher positive $R^2$ when the prices were lagged, however the difference between the lagged and contemporaneous analysis were not as large which is shown in Appendix 1.

Significant $R^2$ in Forbes LGA were wheat (WT) and fertiliser (FT). There were no significant regression coefficients in Parkes LGA. Significant regression coefficients for

The lagged analysis resulted in both a higher correlation co-efficient and a lower standard error indicating that the lagged model is a better model than the contemporaneous model as a predictor of rural land prices.

Significant $R^2$ results in Forbes LGA Wheat. In Parkes LGA significant regression coefficients were net profit (NP)and Fuel (FL). Significant regression coefficients Weddin LGA analysis were wool (W), fertiliser and fuel.

**Developing Cropping Areas**

Although the developing cropping LGAs of Bland and Lachlan do not have as strong correlation coefficient as the traditional cropping areas, the standard error is lower at 62 and 36 for the contemporaneous analysis and 43 and 36 for the lagged analysis.

In both Bland and Lachlan LGAs fuel price was the only significant regression co-efficient.
The effect of the price lag is more prominent in Bland LGA with the second analysis increasing both the correlation coefficient and the coefficient of determination as well as decreasing the standard error.
Lachlan LGA, again had a positive linear relationship when the variable prices were not lagged. The standard error remained at a similar level for both of the regression analysis.

The significant regression coefficients for Bland LGA were fuel and fertiliser. In Lachlan LGA the significant regression coefficients were wheat and fuel.

The model, for the developing cropping areas, is a better predictor of rural land prices compared to the traditional cropping areas.

**Marginal Cropping Areas**

In relation to the contemporaneous regression analysis of prices, the marginal cropping LGA show a positive linear relationship, particularly Carrathool with a correlation coefficient of 0.94, with 89% of the variation in the actual rural land price being explained by the independent variables. The correlation coefficients for the Cobar LGA is also greater standard error than the other five LGAs in the study.

In both Cobar and Carrathool LGA the only significant regression co-efficient was fertiliser.

Lagging the prices for both these LGAs has resulted in a better model in each case. It is again noted that in the first regression analysis Cobar LGA had better results with the non lagged data but in this regression analysis the reverse has occurred, with the better results occurring when the prices are lagged.

Significant regression coefficients with this lagged model were fertiliser for both LGAs. In Carrathool LGA, the fuel regression co-efficient was also significant.

**Multiple Regression Analysis Incorporating Dummy Variable**

As stated earlier in the paper, the volatility in rural land prices was greater in the period 1985 to 1996 compared to the earlier period of 1976 to 1985. During the period 1975 to 1985, there was considerable Government support for the rural industry in Australia.

In order to test the influence of these support schemes on rural land prices an additional regression analysis, both on price movement and actual prices, has been carried out with a dummy variable (D) to represent these support levels. A value of 1 was included in the analysis for the years 1975 to 1985 and a value of 0 for the years 1986 to 1996.

The summarised results of these models are presented in Table 2 which compares the R square values for both the models with and without the dummy variable.

**Table 2: Comparison of Regression Models: $R^2$ values**

| LGA | $R^2$ (Contemporaneous) | $R^2$ (Dummy ) (Contemporaneous) | $R^2$ (Lagged) | $R^2$ (Dummy ) (Lagged) |
|---|---|---|---|---|
| Forbes | 0.12 | 0.12 | 0.50 | 0.51 |
| Parkes | 0.22 | 0.23 | 0.22 | 0.23 |
| Weddin | 0.33 | 0.33 | 0.48 | 0.56 |
| Bland | 0.34 | 0.44 | 0.72 | 0.75 |
| Lachlan | 0.59 | 0.61 | 0.50 | 0.51 |
| Cobar | 0.21 | 0.31 | 0.17 | 0.17 |
| Carrathool | 0.30 | 0.38 | 0.70 | 0.72 |

The inclusion of the dummy variable in the analysis generally improved the model as can be seen by the increase in R square values in Table 2. Again the impact of this variable is greater in the developing and marginal cropping areas, suggesting that the impact of subsidies and support schemes had a greater impact on rural land prices in these areas compared to the safer traditional cropping areas.

The models for this analysis are:

**Contemporaneous**

| | | |
|---|---|---|
| **Forbes** | LP = 3.41 + 0.001NP- 0.01WT + 0.28WL + 0.33IN + 0.17FT - 0.02FL + 3.33D | $R^2$=0.12 |
| **Parkes** | LP = 8.57 + 0.003NP + 0.11WT - 0.12WL -0.04IN -1.21FT +0.42FL + 7.18D, | $R^2$=0.22 |
| **Weddin** | LP = 1.40 - 0.002NP + 0.22WT + 0.11WL + 0.34IN + 0.66FT + 0.13FL +0.40D | $R^2$=0.33 |
| **Bland** | LP = -4.36 - 0.01NP + 0.20WT -0.02WL +0.29IN +1.26FT -0.10FL + 21.80D | $R^2$=0.34 |
| **Lachlan** | LP = 1.46 + 0.01NP - 0.31WT -0.10WL + 0.21IN + 0.17FT - 0.06FL + 11.23D | $R^2$=0.59 |
| **Cobar** | LP = 29.17 - 0.01NP - 0.57WT - 0.66WL +2.07IN +1.61FT -1.93FL + 62.75D | $R^2$=0.21 |
| **Carrathool** | LP = 18.03 - 0.004NP - 0.07WT -0.51WL -1.67IN -1.67FT -0.37FL + 38.37D | $R^2$=0.30 |

Where LP = land price;
NP = adjusted net farm profit;
WT = wheat price;
WL = wool price;
IN = interest rate;
FT = fertiliser price;
D = dummy variable;
FL = fuel price.

Significant regression coefficients in these models were Net Profit for both Bland and Lachlan.

**Models (Lagged)**

| | | |
|---|---|---|
| Forbes | LP = -0.14 + 0.001NP + 0.42WT - 0.05WL - 0.41IN + 0.07FT + 0.54FL - 2.47D | $R^2$=.51 |
| Parkes | LP = 1.95 + 0.003NP - 0.28WT +0.42WL +0.43IN +0.61FT -0.22FL + 9.61D | $R^2$=.23 |
| Weddin | LP = 8.60 - 0.001NP + 0.17WT + 0.28WL - 0.38IN - 0.74FT - 0.95FL - 15.04D | $R^2$=.56 |
| Bland | LP = 7.78+ 0.01NP + 0.13WT - 0.08WL - 0.32IN -2.17FT + 0.37FL + 13.65D | $R^2$=.75 |
| Lachlan | LP = -1.43 - 0.01NP + 0.37WT - 0.08WL - 0.17IN + 0.80FT + 0.43FL + 9.73D | $R^2$=.51 |
| Cobar | LP = 30.35 + 0.02NP + 0.24WT - 0.06WL +0.13IN +1.09FT -0.13FL - 17.10D | $R^2$=.17 |
| Carrathool | LP = -8.98 + 0.03NP - 0.08WT +0.14WL +0.74IN +1.39FT -0.54FL +21.44D | $R^2$=.72 |

With the lagged analysis, there were a greater number of significant regression coefficients. These significant regression coefficients in this model were Forbes WT, Bland FT and NP, Lachlan NP and Carrathool NP.

**Granger Causality Analysis**

Granger causality analysis has been carried out to investigate whether there is an intertemporal relationship between the rural land market and the wool and wheat price, fuel and fertiliser costs and interest rates. This Granger causality analysis has been carried out on the basis of lags of one and two years. This analysis will test if the change in land price results in the change in input or output costs. A negative result in the Granger Causality analysis will confirm that rural land price change is influenced by changes in input and output costs.

Appendix 1 includes selected examples of the Granger causality analysis with both the dependent variable being % change in rural land price and the results of the Granger causality tests with the various economic factors being the independent variables.

As can be seen in the results of the Granger causality tests, there are very few regression coefficients that are significant (P<5%). Cobar LGA showed a significant negative regression coefficient (-0.47 and -1.29) for wool for both the 12 and 24 month lag periods. Lachlan LGA was the only other area in the study recording a significant regression coefficient for a commodity price (wool) in this Granger causality analysis. As both these areas tend to be more reliant on wool based income compared to the other LGAs in the study, it was anticipated that wool prices could be a predictor of land prices in these areas. However, a negative regression coefficient for both Cobar and Lachlan LGA, indicating a drop in wool price predicting an increase in land price, was not expected nor can it be explained from this analysis alone.

Despite the increased reliance of wheat production for the farms in the study area, there was a very limited intertemporal relationship between the ASW wheat price and rural land prices. The earlier correlation analysis suggested that wheat prices should actually be a reasonable predictor of rural land prices, but this is not reflected in the Granger causality analysis

With Cobar LGA (fuel: -0.39), Bland LGA (fuel: -0.62; fertiliser: -1.27) and Parkes LGA (fuel: -0.42; Interest: -0.41) the regression coefficients for these three input costs were significant in these isolated instances, suggesting a fall in the price of these particular input costs could be a predictor for increased rural land prices. However, in the cases where the regression coefficients are significant, they are not consistent throughout both the individual LGAs and in relation to the overall seven LGAs.

Based on these results, the economic factors are not considered to "Granger cause" rural land returns, nor did rural land returns "Granger cause" the main rural economic factors included in the tests.

Rural land price is potentially influenced by the prevailing commodity prices, interest rates and the cost of the major farming inputs. This relationship applied both for the analysis carried out on the actual prices and the percentage change in prices.

The traditional cropping areas, especially Weddin LGA, are closer to major rural towns and cities as well as closer to Sydney. Based on these locational factors, the rural land markets in these areas may be influenced by factors other than agricultural production.

If some of the participants in the rural land market are considering the purchase of the rural land for reasons other than the income that can be produced from the land, for example scenic appeal or lifestyle, then the independent variables directly related to production would have less impact on the change in rural land prices.

This assumption is also supported by the results recorded for Cobar LGA which had smaller $R^2$ values compared to Carrathool LGA which is the other marginal cropping area in the study. In a previous study by Eves (1997), it was determined that the rural land market in parts of the Cobar LGA was dominated by rural land purchasers who had employment in the mines and the farms were used as an investment. This opportunity is not available in the other marginal cropping LGA of Carrathool, which had the strongest $R^2$ values in the study linking the association between rural economic factors and rural land prices.

## CONCLUSIONS

Rural land prices have always been considered to be a function of the agricultural land use based on climate, soil type and topography; the assumption being that the greater the income producing capacity of the land because of these factors, the higher the rural land price. Although this study supports this long held theory, it found that although rural land in two areas can have a similar agricultural productive capacity, the average annual returns for the land in the two locations can be very different.

Such differences between areas of very similar rural land use are not only reflected in differences in the average annual return, but also the actual trend for annual increases and decreases in the rural land price.

Based on this analysis, it is considered that rural land price movements in one location may not be suitable as a general measure of change for another location, regardless of the proximity and similarity of land use, especially in rural areas where there is alternate use available for rural land other than viable agricultural production. However, the results of the analysis does suggest that rural land price movement is more uniform in the remote marginal cropping areas where there are both limited agricultural and non agricultural land uses. In such cases, the variation in rural land price in one location, from one year to the next, may be applicable to another location.

Previous studies have linked changes in rural land prices to changes in rural commodity prices. The correlation analysis and regression modelling carried out in this paper suggest that although commodity price changes do impact on the change in rural land prices, the effect of commodity prices varies between agricultural areas.

In marginal agricultural areas, the relationship between changes in commodity price and the rural land price was greater than the same relationship in closer settled and more established agricultural areas. This suggests that the impact of commodity prices on rural land prices also decreases as the availability of alternate uses for agricultural land increases. In some areas, although still considered to be agricultural , non-agricultural factors could be influencing the rural land market. In such cases the trends in these markets can not be applied to another rural land market, particularly for valuation purposes.

Models to predict rural land prices will be more reliable in marginal agricultural areas, where changes in rural land prices are associated with changes in farm profit.
As farm profit is a function of commodity yields, commodity price and the cost of farm inputs, the changes in these factors could be used to determine changes in rural land prices in these particular marginal cropping areas. However, the reliability of these prediction models for rural land will decrease significantly if there is any factor, other than an agriculture based factor, influencing the specific rural land market.

**Figure 4:** **Annual % Change Interest rates**

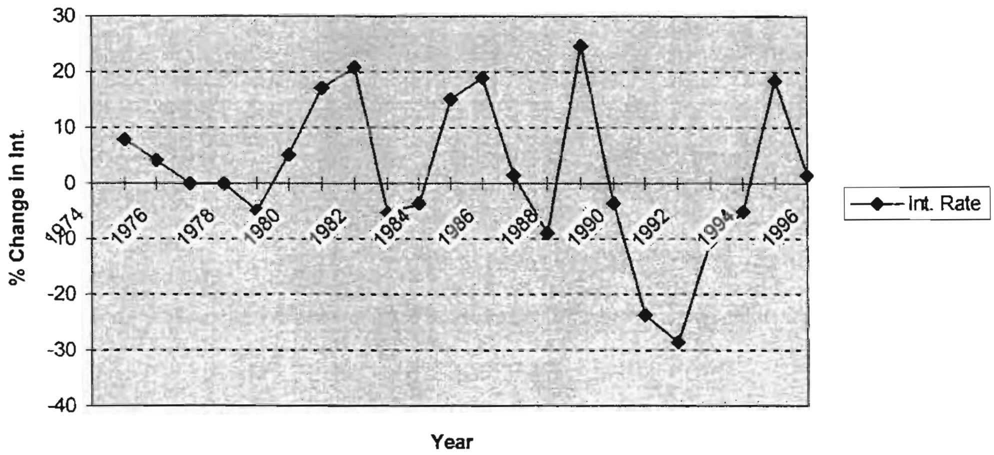



**Figure 5:** **Annual % Change in Fuel Price: 1975-96**

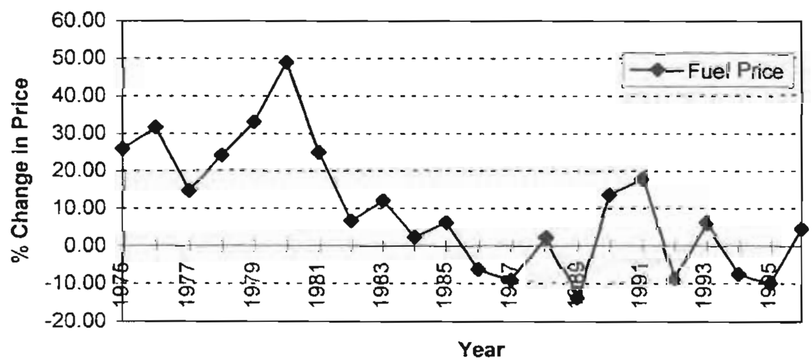



**Figure 6: Annual Change In Fertiliser Price 1975-96**

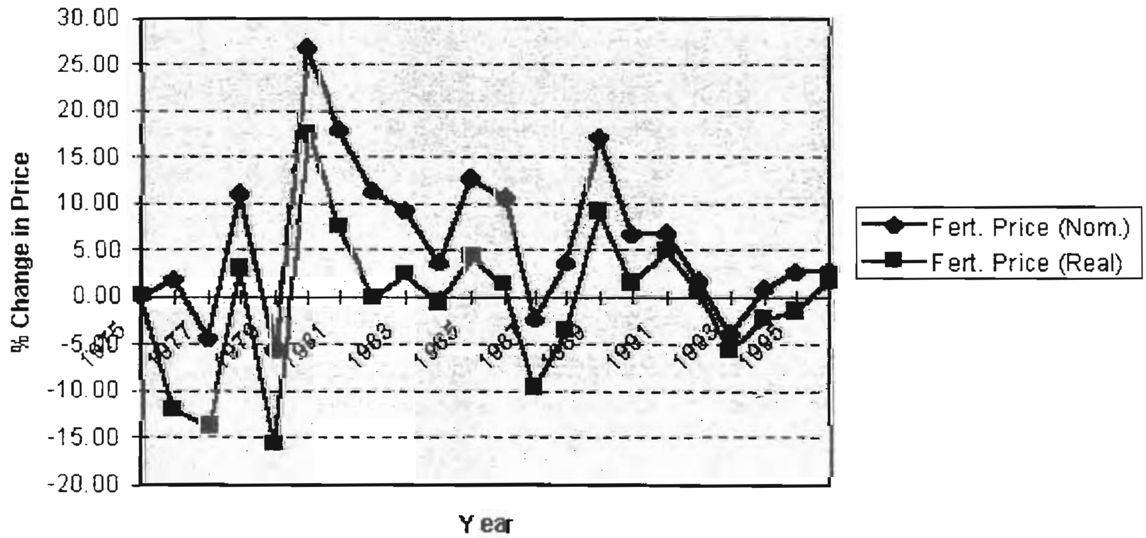
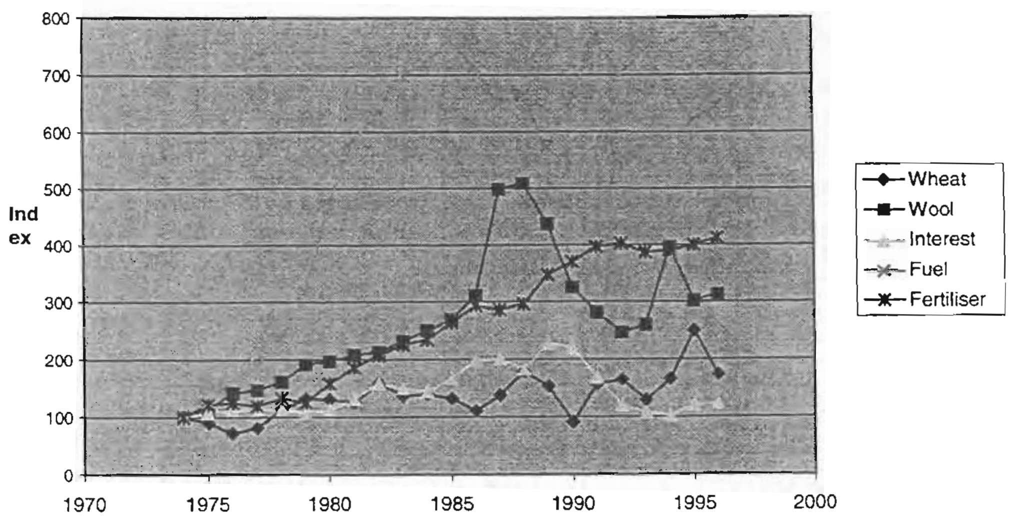


**Figure 7: Commodity Price and Input cost Index**




## APPENDICES

Appendix 1: Selected Models

**Price Movement: Traditional Cropping Areas**
**(Contemporaneous)**

**Forbes**

LP = 4.25 + 0.001NP -0.01WT + 0.29WL + 0.29IN + 0.15FT + 0.05FL, $R^2 = .12$
(0.43) (-0.04) (1.07) (0.63) (0.18) (0.14)

**Parkes**

LP = 10.39 + 0.003NP + 0.12WT -0.10WL -0.13IN -1.24FT +0.58FL, $R^2 = .22$
(0.63) (0.52) (-0.34) (-0.24) (-1.26) (1.44)

**Weddin**

LP = 1.50 +0.002NP +0.22WT + 0.12WL +0.33IN + 0.66FT +0.14FL, $R^2 = .33$
(0.69) (1.54) (0.59) (0.99) (1.04) (0.55)

**Price Movement: Traditional Cropping Areas** **(lagged)**

**Forbes**

LP = -1.02 + 0.002NP + 0.43WT - 0.06WL - 0.37IN + 0.07FT + 0.49FL, $R^2 = .50$
(0.66) (2.70) (-0.28) (-1.04) (0.11) (1.81)

**Parkes**

LP = 4.79 + 0.03NP - 0.29WT +0.44WL +0.32IN +0.56FT -0.01FL, $R^2 = .22$
(0.54) (-1.17) (1.39) (0.58) (0.54) (-0.03)

**Weddin**

LP = 4.15 -0.0003NP +0.18WT - 0.24WL -0.20IN - 0.66FT +0.62FL, $R^2 = .48$
(T-stat) (-0.11) (1.29) (1.35) (-0.65) (-1.13) (2.64)

**Price Movement: Developing Cropping Areas** **(Lagged)**

**Bland**

LP = 11.89 + 0.01NP + 0.12WT - 0.05WL - 0.48IN - 2.27FT + 0.67FL, $R^2 = .72$
(3.69) (0.86) (-0.25) (-1.54) (-3.82) (2.76)

**Lachlan**

LP = 1.44 - 0.01NP + 0.36WT -0.06WL -0.29IN +0.74FT +0.64FL, $R^2 = .50$
(-2.95) (1.85) (-0.22) (-0.66) (0.89) 1.90)

**Models: Price Movement: Marginal Cropping Areas**
**(Lagged)**

**Cobar**

LP = 45.14 - 0.01NP - 0.53WT - 0.50WL + 1.32IN + 1.35FT - 0.54FL, $R^2$ = .17
(-0.93) (-0.89) (-0.61) (0.95) (0.52) (-0.50)

**Carrathool**

LP = -2.64 + 0.03NP - 0.09WT +0.19WL +0.49IN +1.26FT -0.07FL, $R^2$ = .70
(4.73) (-0.33) (0.56) (0.83) (1.13) (-0.15)

Where LP = land price;
NP = adjusted net farm profit;
WT = wheat price;
WL = wool price;
IN = interest rate;
FT = fertiliser price;
FL = fuel price.
t statistics for each regression coefficient is given in brackets.

**Models: Actual Prices: Traditional Cropping Areas**
**(Contemporaneous)**

**Forbes**

LP = 4.35 + 0.23NP + 0.25WT + 55.82WL - 5.00IN + 7.28FL + 1.98FT, $R^2$ = .90
(0.64) (0.29) (2.28) (-0.61) (3.35) (0.69)

**Parkes**

LP = -74.06 + 0.41NP - 0.39WT +48.87WL +0.02IN +6.69FL +1.46FT, $R^2$ = .84
(1.05) (-0.49) (1.97) (0.002) (2.00) (1.92)

**Weddin**

LP = -93.65 -0.01NP +1.65WT + 21.60WL -4.20IN +2.93FL +4.63FT, $R^2$ = .93
(-0.05) (2.18) (1.03) (-0.62) (4.35) (1.64)

**Models: Actual Prices: Developing Cropping Areas**
**(Lagged)**

**Bland**

LP = 37.75 + 0.35NP + 0.63WT + 7.62WL - 0.24IN + 12.24FL - 1.39FT, $R^2$ = .89
(1.35) (1.39) (0.62) (-0.06) (7.34) (-3.86)

**Lachlan**

LP = -23.09 + 0.09NP + 0.75WT -3.54WL +4.15IN +4.09FL -0.14FT, $R^2$ = .80
0.47) (2.28) (-0.36) (1.24) (2.96) (0.65)

**Models: Actual Prices: Marginal Cropping Areas**
**(Contemporaneous):**

**Cobar**

LP = 43.74 - 0.15NP - 0.28WT + 9.06WL - 7.16IN + 1.05FL + 0.62FT, $R^2$ = .74
(-0.39) (-1.18) (1.27) (-3.02) (1.07) (2.84)

**Carrathool**

LP = -88.46 + 0.57NP + 0.16WT +8.12WL +1.50IN +3.46FL +0.66FT, $R^2$ = .88
(1.32) (0.47) (0.85) (0.46) (2.59) (2.29)

Where LP = land price; NP = adjusted net farm profit; WT = wheat price; WL = wool price; IN = interest rate; FT = fertiliser price; FL = fuel price.
t statistics for each regression coefficient is given in brackets.

**Table 20: Granger Causality Analysis: Lachlan LGA**

**Lachlan: 12 month lag**

| Dep. | Ind. | Independent Variable lags (regression coefficients) 12m | Dependent Variable lags (regression coefficients) 12m | $R^2$ |
|---|---|---|---|---|
| LP | FT | -0.41 | 1.02 | 0.16 |
| FT | LP | -0.01 | 0.08 | 0.39 |
| LP | FL | -0.36 | 0.44 | 0.14 |
| FL | LP | 0.07 | 0.59* | 0.01 |
| LP | Int | -0.28 | 0.01 | 0.07 |
| Int | LP | 0.08 | 0.35 | 0.13 |
| LP | WT | -0.30 | 0.25 | 0.13 |
| WT | LP | -0.21 | -0.11 | 0.05 |
| LP | WL | -0.28 | 0.57* | 0.26 |
| WL | LP | -0.13 | 0.08 | 0.03 |

Notation: LP = Land Price FL = Fuel price FT = fertiliser Price Int. = Interest
WT = Wheat Price WL = Wool Price

* significant at the 5% level

**Lachlan: 24 month lag**

| Dep. | Ind. | Independent Variable lags (regression coefficients) 12m | 24m | Dependent Variable lags (regression coefficients) 12m | 24m | $R^2$ |
|---|---|---|---|---|---|---|
| Fuel | LP | 0.06 | -0.06 | 0.47 | 0.19 | 0.39 |
| LP | Fuel | 0.36 | 0.69 | -0.55 | -0.36 | 0.33 |
| Fert | LP | 0.06 | 0.14 | -0.04 | -0.13 | 0.15 |
| LP | Fert | 0.95 | -1.25 | -0.32 | 0.06 | 0.28 |
| Wheat | LP | -0.08 | 0.02 | -0.29 | -0.65* | 0.42 |
| LP | Wheat | 0.26 | 0.16 | -0.35 | -0.06 | 0.15 |
| Wool | LP | -0.12 | -0.05 | 0.10 | -0.13 | 0.04 |
| LP | Wool | 0.58 | -0.01 | -0.28 | -0.01 | 0.30 |
| Int. | LP | 0.14 | 0.20 | 0.42 | -0.36 | 0.36 |
| LP | Int. | -0.04 | 0.26 | -0.31 | -0.09 | 0.10 |

* significant at the 5% level

Appendix 2

**Production Summary-Adjusted Net Farm Profit ($/ha): 1975-96**

| Year | Forbes | Parkes | Weddin | Bland | Lachlan | Cobar | Carrathool |
|---|---|---|---|---|---|---|---|
| **1975** | 45.76 | 46.80 | 59.78 | 34.93 | 34.14 | 15.03 | 15.81 |
| **1976** | 41.02 | 38.52 | 57.64 | 35.59 | 28.86 | 12.32 | 10.66 |
| **1977** | 8.89 | 14.01 | 14.48 | 1.10 | -1.33 | -2.21 | 0.35 |
| **1978** | 90.83 | 81.81 | 143.64 | 73.35 | 83.78 | 35.29 | 38.19 |
| **1979** | 75.59 | 100.53 | 95.99 | 84.24 | 62.56 | 34.37 | 39.28 |
| **1980** | 1.54 | 6.03 | 35.95 | 29.14 | -10.58 | -2.14 | 11.32 |
| **1981** | 87.49 | 72.83 | 106.55 | 63.73 | 28.19 | 13.07 | 27.00 |
| **1982** | -34.64 | -45.54 | -36.46 | -15.81 | -46.55 | -19.57 | -12.30 |
| **1983** | 128.90 | 142.91 | 152.25 | 91.72 | 104.37 | 40.06 | 42.79 |
| **1984** | 62.86 | 46.15 | 66.04 | 63.34 | 40.67 | 3.60 | 26.27 |
| **1985** | 57.33 | 61.11 | 70.17 | 49.21 | 28.84 | 9.97 | 9.97 |
| **1986** | 22.14 | 12.65 | 44.92 | 22.24 | -16.27 | -15.54 | 5.97 |
| **1987** | 63.27 | 94.01 | 83.76 | 48.18 | 34.82 | 9.54 | 19.39 |
| **1988** | 125.09 | 127.13 | 134.28 | 87.62 | 106.93 | 35.28 | 46.00 |
| **1989** | 73.98 | 36.30 | 90.63 | 45.50 | 36.78 | 5.72 | 31.58 |
| **1990** | -4.83 | 0.91 | 2.47 | -2.91 | -10.77 | -7.09 | -0.05 |
| **1991** | 64.83 | 45.91 | 116.18 | 35.92 | -0.06 | -13.42 | 6.85 |
| **1992** | 161.10 | 127.24 | 216.59 | 90.69 | 43.31 | -4.94 | 29.39 |
| **1993** | 90.67 | 101.78 | 115.11 | 68.42 | 64.46 | 6.89 | 29.84 |
| **1994** | -62.33 | -56.63 | -52.83 | -49.07 | -60.33 | -0.37 | -26.50 |
| **1995** | 200.45 | 59.13 | 310.37 | 164.98 | 94.90 | 42.00 | 62.70 |
| **1996** | 136.18 | 57.91 | 109.41 | 62.17 | 14.10 | 11.67 | 19.10 |
| Average: 1975-96 | 65.28 | 53.25 | 88.04 | 49.29 | 30.04 | 9.52 | 19.71 |
| Volatility: 1975-96 | 63.02 | 52.18 | 79.55 | 44.61 | 45.14 | 18.13 | 20.44 |

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