New Zealand Agricultural &
NZARES Resource Economics Society (Inc.)

Examining Patterns in and Drivers of Rural Land Values

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Motu Economic and Public Policy Research

Paper presented at the 2013 NZARES Conference
Lincoln University – Canterbury, New Zealand. August 28-30, 2013

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Draft paper – not for quotation
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7/08/2013

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Acknowledgements

We thank the Kelliher Trust for a grant which enabled this research to be conducted. We also thank Richard Deakin from Property IQ and David Nagel from Quotable Value New Zealand for useful discussions about the data and the valuation process for rural properties, and participants at the New Zealand Climate Change Centre Conference 2013 and Motu colleagues for useful suggestions on earlier presentations of this material. However, the authors' are solely responsible for the analysis and views expressed.

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 ISSN 1176-2667 (Print), ISSN 1177-9047 (Online).

Abstract

This paper uses a national dataset from 1980 to 2010 of valuations and sales data by land use category from Quotable Value New Zealand to explore patterns in and potential drivers of values of rural land in New Zealand over time. Increasing our understanding of the drivers of rural land values will aid in informing how climate change and environmental policy may influence these values. Climate change brings with it an increased likelihood of extreme weather events, for example drought conditions and severe storms, which could plausibly influence the value of rural land through their impacts on the productivity of land. It is also likely to have profound impacts on global commodity prices. Efficient climate change policy could have significant impacts on the profitability of ruminant agriculture. Who bears the losses depends critically on how land values respond to the profitability of different land uses.

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1. Introduction

Climate change could have significant impacts on New Zealand's agricultural sector. Changing temperature and rainfall patters, changes in climatic variability and increased CO_2 concentrations could all have impacts on the productivity of agricultural land. Also, climate change and other environmental policies (such as policies surrounding water quality) could impose significant costs on farmers. This paper seeks to increase understanding of the drivers of agricultural land values in New Zealand in order to inform estimates of how climate change and environmental policies may impact the long run profitability of the agricultural sector, as reflected in land values.

We do this by examining how the value of rural land varies with general economic conditions and then explore to what extent agricultural profitability and commodity prices explain variation in land values. General economic conditions may influence rural land values through a variety of channels. For example, rising incomes may increase demand for amenities, increasing the amenity value of rural land. Credit availability could impact on the demand for rural land by making it harder (easier) to access the required capital to purchase rural land.

Hargreaves and McCarthy 2010 argue that the availability of cheap credit and increased demand for agricultural commodities resulted in a bubble in farmland values over the mid-to-late 2000s. The value of farmland rose above those suggested by fundamental price-earnings ratios[1]. While we find evidence that the sale price of agricultural land can remain elevated relative to profitability, rational explanations exist which could plausibly explain this behaviour. It is also possible that factors unrelated to agricultural profitability are also influencing the value of agricultural land. Stillman 2005 finds that rural land values in areas with favourable climates and good local grew faster, relative to areas with less favourable climates and lower levels of local amenities.

This paper is set out as follows. Section 2.1 outlines the conceptual framework for rural land values; section 2.2 outlines previous literature examining potential impacts of climate change on the agricultural sector, the likely impact of environmental policies and previous research into the drivers of rural land values in New Zealand. Section 3 discusses the data used in this paper, while section 4 presents descriptive results. Section 5 concludes.

[1] Eves and Painter 2008 estimated an average price-earnings ratio of 40 over the period 1990-2005.

2. Background

2.1. Conceptual Framework

A basic theory of rural land values relates the value of rural land to the profitability of the land in its highest and best use. This Ricardian theory posits that the value of rural land is equal to the discounted sum of expected economic profits (rents) from production (Capozza and Helsey 1989). This can be expressed formally as:

$$LV_{ijt} = \sum_{s=0}^{\infty} \frac{\pi^*_{ij,t+s}}{(1+r)^s}$$

Where *i* denotes the land parcel and *j* denotes the land use. Profit is determined by a basic profit function:

$$\pi^*_{ijt} = p_{jt}Q_{ijt} - c_{ijt}(Q_{ijt})$$

Where p_{jt} is the output price of commodity *j* in time *t*, Q_{ijt} is the output of commodity *j* from land parcel *i* in time *t*, and c_{ijt} is the input cost of producing commodity *j* on land parcel *i* in time *t*. The input cost is expressed as an increasing function of output produced. * indicates that profit is maximised at each point in time by optimally choosing land use and the level of output and inputs.

Output, Q_{ijt}, is determined by an agricultural production function:

$$Q_{ijt} = f(A_{ij}, x_{ijt})$$

Where

$$Q_A > 0$$

$$Q_x > 0, Q_{xx} < 0$$

A_{ij} is the productivity of the land parcel *i* in producing commodity *j*, and x_{ijt} is a composite bundle of inputs used to produce commodity *j* on land parcel *i* in time *t*. Combining equations 1-3 gives the following expression for land values:

$$LV_{ijt} = \sum_{s=0}^{\infty} \frac{p_{j,t+s}f(A_{ij}, x_{ij,t+s}) - c_{ij,t+s}(f(A_{ij}, x_{ij,t+s}))}{(1+r)^s}$$

This theory of land values does not assume that the land use, *j*, is constant through time. As output and input prices change, or as the productive characteristics of the land change (due to past management practices, increased drought due to climate change etc.), the highest and best use of the land will change. Mendelsohn et al. 1994 provides an explanation of this phenomenon using temperature as an example. As the temperature in a region rises, the climate becomes less conducive to growing wheat, reducing the profitability to growing wheat on a particular land parcel. However, the higher temperature means that the land may be better suited to growing corn or grazing livestock. At some point, a rational land owner will switch land use when the benefits to switching (higher discounted future profits) outweigh the costs of switching (conversion costs and profit foregone). This can formally be expressed as:

$$j_t^* = \text{argmax}_{\text{j}} \left\{ \sum_{\text{s}=0}^{\infty} \pi_{\text{ij,t+s}}^* : j \in \{\{ D, SB, F, C, H, U \} | \, E_t(\boldsymbol{P}, \boldsymbol{A})\} \right\}, \forall \text{ t}$$

Where *D, SB, F, C, H, U* denote dairy, sheep/beef, forestry, crops (arable), horticultural and urban uses, respectively. A land owner chooses the land use which maximises the stream of discounted future profits, given expectations around future commodity prices (***P***) and the future suitability of land for different uses (***A***). All of these factors influence the relative profitability of the land in different land uses. We include an urban use in this framework to account for the fact that it may be optimal to convert land which is currently in an agricultural use to an urban or residential use at some point in the future.

This simple Ricardian theory of the value of rural land views rural land as a productive asset which is an input into the agricultural production function. However, rural land offers the land owner more than an input in production. Ma and Swinton 2012, in their hedonic analysis of the drivers of farmland values in the US, extend this conceptual framework beyond the sole focus on profits. They note that, as well as being an important input in agricultural production, rural land also functions as a home site for the farmer and their family. A parcel of land with a higher level of local amenities may be a more attractive home site for a farmer and their family than an otherwise identical parcel of land with fewer amenities. Location specific characteristics may mean an individual is willing to pay more (or less) for a particular parcel of land than is implied by the profitability of the land in its highest and best use. The value of rural land can therefore be expressed as:

$$LV_{ijt} = \sum_{s=0}^{\infty} \frac{\pi_{ij,t+s}^*}{(1+r)^s} + V(M_{ijt})$$

Where M_{ijt} is a bundle of amenities which land parcel *i* possesses, and $V(.)$ is a value function which places a dollar value on the level of local amenities from the perspective of the buyer[2]. The function $V(.)$ is derived from the farmer's utility function defined across the bundle of amenities. M_{ijt} contains both natural and built amenities which make a particular parcel of land an attractive (or otherwise) home site (amenities do not necessarily increase the value of rural land. For example, being located near a manufacturing site which produces foul smells would generate a negative amenity value, or disamenity.). These amenities could include access to the coast or rivers, proximity to schools and other urban amenities (e.g. supermarkets, entertainment venues), or proximity to native bush or conservation land.

2.2. Previous Literature

2.2.1. Direct Impacts of Climate Change on Agriculture

Wratt et al. 2008 and Baisden et al. 2010 considered the impact of climate change on agricultural production in New Zealand. Their methodologies included projecting the impacts of climate change of the productivity of New Zealand's pastoral land, allowing for land use change and changes in productivity (such as intensification). The two studies differed in the time horizon of their projections, with Wratt et al. 2008 considering the impact on production in 2020-2049 and 2070-2099 while Baisden et al. 2010 considered a shorter time horizon of 2020 and 2050. Despite these differences in projection horizons, both studies found little impact of climate change on national dairy and sheep/beef production over the coming century. Wratt et al. 2008 also considered the impact of one kind of climate extreme, namely drought. While they found little impact on agricultural production in an average year compared to baseline, their results show that production is likely to be lower in the driest "scenario years" than in the driest years in the baseline period (1972-2002). While the national level results suggest little impact of climate change on agricultural production, both studies find significant regional variation in the impacts. Production was projected to fall in East Coast locations (Canterbury, Bay of Plenty, Gisborne), while Southland and the West Coast were projected to see an increase in production, as these regions remained moist while warming.

Mendelsohn et al. 1994 empirically examined the implicit price premium of a favourable climate on agricultural land values in the United States, using a hedonic approach[3]. The authors linked variation in current climate to variation in agricultural land values, and used their estimates of the value of climate to produce estimates of the impact of a climate change scenario on land

[2] We include a j subscript on the bundle of amenities as the land use may impact on the value placed on certain amenities possessed by the land parcel e.g. effluent run-off into a river or creek reduces the opportunities for swimming or fishing, reducing the amenity value placed on the body of water.

[3] The United States, like New Zealand, has a temperate climate. Although the two countries differ in the main agricultural products produced, the impacts of climate change on agriculture are likely to be comparable between the two countries.

values. According to their estimates, the impact of climate change on agricultural land values was smaller than previous estimates; some areas actually saw their land values increase as a result of climate change. The major innovation of this study is the methodology used. Agricultural land values reflect the long run profitability of the agricultural sector, taking into account adjustments to expected future conditions. A changing climate may change regions suitability for producing different agricultural goods. Rational land owners will adjust to the changing climate and these adjustments will be reflected in current land values in a properly functioning land market.

Schlenker et al. 2005;2006 refine the analysis conducted in Mendelsohn et al. 1994 by restricting their analysis to non-irrigated farmland in the US. The authors argue that irrigated and non-irrigated land have distinct hedonic equations. In the absence of appropriate data to estimate a hedonic equation for irrigated land, the authors focus on non-irrigated farmland. Their estimates suggest that the value of non-irrigated land will decrease by around 10-25% by 2049[4].

Deschenes and Greenstone 2007 also empirically examine the effect of climate on agricultural outcomes in the US, but use a different methodology to Mendelsohn et al. 1994. They exploit random year-to-year variation in temperature and precipitation to estimate their impact on agricultural profits. The 95% confidence interval for their estimate included zero, indicating that their estimated impact of climate change on agricultural profits is statistically (and economically) small. Their results suggest that agricultural profits will increase by 4% in response to predicted climate change impacts. Since the value of farmland reflects the profitability of agricultural production, their results suggest there will be little impact on land values.

The hedonic approach to estimating the impact of climate change on land values, as pioneered by Mendelsohn et al. 1994, considers the long run equilibrium cost of climate change once farmers have fully adapted to the new climate conditions. Quiggin and Horowitz 2003 argue that the hedonic approach assumes that adjustment is costless. They argue that adjustment costs will be the main costs associated with climate change. In their framework, adjustment costs are positively related to the rate at which the climate is changing. These costs arise for two main reasons: the optimal location for producing agricultural products will shift as a result of climate change and if existing capital depreciates more slowly than required for easy adjustment

[4] Schlenker et al 2005;2006, in their projections of the impact of climate change on the value of non-irrigated land, use climate change scenarios based on more recent climate projections. Climate science has advanced a lot since 1994, so the later estimates are likely to be better.

to a changing climate. If climate change happens relatively slowly, this allows farmers to gradually adjust their production (production technology or changing land use), reducing adjustment costs. If this change were to happen relatively quickly, then farmers must change their production technology or land use much faster. Also, the existing infrastructure which supports agriculture (such as storage facilities, processing plants, irrigation schemes etc., which are relatively long lived) would decrease in value (what is the value of a grain storage facility if the surrounding area is no longer suitable for growing grain?). New infrastructure investments may be necessary to support the new spatial distribution of agricultural activities, within the useful life of existing investments. These adjustment costs are likely to be increasing in the rate of climate change and in the variability of the changes (Quiggin and Horowitz 2003).

The above papers have all examined the impact that a changing climate may have on agriculture, using a variety of methods. Wratt et al. 2008 and Baisden et al. 2010 projected the impact on agricultural production by considering how climate change could affect the productivity of New Zealand's pastoral land. They find that the national level impacts will likely be minor; however there is significant regional variation. This finding is echoed in the US studies. Mendelsohn et al. 1994, Schlenker et al. 2005;2006 and Deschenes and Greenstone 2007 all employ some variant of the hedonic approach to estimate the impact of climate change on agricultural land values. As discussed in section 2.1, agricultural land values reflect the profitability of agricultural land in its highest and best use. The hedonic approach estimates the implicit price premium of a favourable climate, using cross-sectional variation in current climate. The resulting estimates are then applied to a climate change scenario in order to estimate the impact of the scenario on land values. The main results from the hedonic approach also point to relatively small aggregate impacts; albeit with a large degree of regional variation. Quiggin and Horowitz 2003 argue that the most important costs imposed by climate change are adjustment costs, which are ignored in the hedonic approach. They argue these costs will likely be significant, particularly if climate change is a highly variable process.

2.2.2. Impact of Environmental Policies on Agriculture

Kerr and Zhang 2009 and Timar and Yeo 2013 considered the potential impacts of environmental policies on New Zealand agriculture in terms of the liability imposed on farmers by the introduction of policies, particularly an emissions trading scheme (ETS). Both studies find that farmers will face significant liabilities as a result of environmental policies. Under a $25 carbon price where agriculture does not receive a free allocation of permits, Kerr and Zhang 2009 estimate that the liability faced by sheep/beef farmers is equal to 33% of the average economic profits of the sector over the period 2001-2008. Dairy farmers are estimated to face a lower liability as a fraction of economic profits, at 17%. Timar and Yeo 2013 find that the net cost per hectare faced by different sectors depends on the way permits are initially allocated. Overall, they find that dairy farms face the highest net cost per hectare. Both studies find that there is significant regional variation. The liability imposed was also found to vary by farm type (extensive vs. intensive farms).

Based on the literature discussed in sections 2.2.1 and in this section, it appears that the biggest impact of climate change on land values will be from the imposition of policies designed to limit emissions (or other environmental impacts, such as nutrient leaching). The studies cited in section 2.2.1 found little direct impact of climate change on agricultural production in New Zealand, and the US based studies suggest the aggregate impact on land values will also be minor.

2.2.3. Drivers of Rural Land Values in New Zealand

Grimes and Aitken 2008 used property level sales and valuation information for the Mackenzie District (Canterbury, New Zealand) to estimate the value of irrigation in a drought prone farming region. Using a hedonic framework, the authors empirically estimate the implicit value placed on irrigation through farm sales prices and valuations. Under the Resource Management Act (RMA), water rights are attached to the property, meaning that the rights to water extraction are sold when the farm is sold. Their results showed that irrigated properties receive a price premium of between 15-50% compared to an otherwise similar, unirrigated property. The size of the estimated price premium depended on whether or not sales or valuations data were used in the estimation.

Stillman 2005, also using a hedonic framework, estimated the drivers of rural land values at the meshblock level in New Zealand. Using an earlier version of the data used in this paper, he found that meshblocks with more favourable climate (more annual sunshine hours, less annual rainfall) and better local amenities (access to the coast, schools, ports, airports and ski fields) tended to have higher land values. He also found that land in these areas experienced larger increases in value over the period 1989-2003, relative to areas with less favourable climates and lower levels of local amenities.

3. Data

3.1. QVNZ Sales and Valuations Data

The source of our data on land values is comprehensive property valuations and sales databases from Quotable Value New Zealand (QVNZ). QVNZ is New Zealand's largest valuation and property information company and has conducted legally required property valuations for the majority of local councils (they collect the information from the councils for which they don't conduct valuations to form a complete national sample) since 1989. These valuations are used by councils for the purposes of local government property taxes (rates). Each local council is typically valued on a three year valuation cycle. This valuation cycle means that each property in New Zealand will be re-valued at least once in a given three year period. Longitudinal records of all valuations are kept for each property and these are mapped by QVNZ to Statistics New Zealand (SNZ) 2006 meshblocks (MBs). We drop the first valuation cycle (1989-1991) as many MBs do not have valuations data for this cycle. Thus, our valuation sample runs from 1992-2009.

The QVNZ valuations database provides MB level information on the number of assessments, capital, land and improved value, and the land area assessed by land use category over the period 1989-2009[5]. This land use category is intended to reflect the land's "highest and best use", or the purpose for which the property would be sold. This is assessed by property valuers and depends on the physical characteristics of the property and the economic conditions prevailing at the time (David Nagel 2013, pers. comm.). The land use categories we focus on in this paper are arable, dairy, pastoral grazing, pastoral fattening, exotic forestry and horticulture[6].

For rural sales, we use the QVNZ sales database[7]. The sales data contain MB level information on the number of sales, sales price and land area sold by land use category. This dataset is available for a longer sample period, from 1980-2009[8]. This is important, as the sales data cover the period of major economic reform in New Zealand. One feature of the reforms was the removal of subsidies to agriculture beginning in 1984, which had a significant impact on agricultural profitability (Evans et al. 1996).

There are some fundamental differences between the QVNZ sales and valuations data. The sales data are based on market transactions and reflect actual decisions made by buyers and

[5] Quotable Value New Zealand (QVNZ) 2010

[6] We combine pastoral grazing and pastoral fattening into one category – pastoral.

[7] Quotable Value New Zealand (QVNZ) 2009

[8] We include national level rural sales data for 2010 and 2011 to the national series based on the MB level data to extend our sample period. We thank Richard Deakin from Property IQ for providing these. The national level data excludes forestry, so data for 2010-2011 are not strictly comparable to earlier data.

sellers. The valuations data are based on recent sales in the area, but reflect the valuer's best estimate of what the property would sell for given current market conditions.

The scope of the two data sources also differs. The valuations data encompasses the universe of properties in New Zealand. The sales data, on the other hand, only records information when a sale takes place. Only a sub-sample of the universe of properties is actually sold during a particular time period, and these are not necessarily representative of the universe of properties. This is more of an issue when considering rural properties, as these are sold less frequently than residential properties. We examine some differences between the sales and valuations data characteristics in section 3.2.

Our focus in this paper is on the value of rural land. However, the variables we use are the capital value and sale price, which include the value (or price paid) for the land as well as the improvements (such as houses, milking sheds, barns etc.). While the sales data does include information on the land value of the properties sold, this value is taken from the last valuation of the property. This valuation could be up to three years old and may not accurately reflect the price paid for the land at the time of sale. We focus on capital value for two reasons. Since capital value is an estimate of what a property would sell for, this measure is most directly comparable to the sale price information. The second reason is motivated by uncertainty surrounding exactly how the value of improvements is assessed. We would expect the ratio of land value to capital value to be lower for dairy farms compared to sheep/beef farms, given that dairy farming is more capital intensive. However, this is not what we see in the data. For the land uses we are interested in (dairy, arable, pastoral, forestry and horticulture), the majority of assessed capital value is assigned to land value. Also, the movements in capital value seem to be largely driven by changes in land value (see Figure 11 in the appendix).

3.2. Comparing the sales and valuations data

Table 1 compares the characteristics of the valuations and sales data. We are looking for differences between the sales and valuation data that may indicate a systematic selection bias in the sales data. We compare the two datasets by examining the average size of a property and the average proportion of sales/assessments by QV use category[9].

[9] Figure 12 in the appendix plots the proportion of sales and assessments by QV use category.

Table 1: Comparing the Sales and Valuations Data

	Sales	Valuations
Average Size (ha)		
All uses	111.4	170.3
Arable	71.7	72.4
Dairy	67.8	69.7
Pastoral	154.2	214.3
Forestry	135.8	457.6
Horticulture	11.2	14.6
Proportion of Sales/Assessments		
Arable	3.7%	3.7%
Dairy	25%	25.7%
Pastoral	56%	60%
Forestry	2%	4%
Horticulture	13%	6.9%
Average Growth Rate in Sale Price/Capital Value	4.1%	11%

As can be seen Table 1, there are some differences between the sales and valuations data. We see that the average rural property sold tends to be smaller than the average rural property by approximately 60 hectares. This is primarily driven by the difference in pastoral and forestry categories. The average size for a pastoral property in the sales data is almost exactly 60 hectares less than the average pastoral property from the valuations data. For forestry, the difference is more extreme. The average forestry property sold is over 300 hectares smaller than the average forestry property. For the other land uses, the differences are very minor.

There are also some differences between the proportion of rural properties sold and assessed by QV use category. Pastoral properties are slightly under-represented in the sales data, while horticultural properties are slightly over-represented. Forestry is also slightly under-represented in the sales data.

We do see a large difference in the average growth rates between the sales and valuations data. However, this is most likely due to the differences in sample size between the two datasets. Our valuations sample begins in 1992, well after the large drop in the sales price which occurred during the 1980s. There are very many more instances of negative annual growth rates in the sales data compared to the valuation data. This could explain the observed difference.

To partially correct for any selection bias in the sales data, we use the proportion of land within each QV use category from the valuations data to weight the sales data when constructing the national average.

3.3. Defining rural areas

In defining rural areas, we employ an update of the approach employed by Stillman 2005. His approach classifies individual MBs as either urban areas, rural areas or areas outside the urban/rural dichotomy (these include water MBs which are used to capture people who live in houseboats and production which occurs on the water and MBs which are predominantly conservation land). In our analysis, we drop the MBs classified as water, MBs where more than 50% of the land area is managed by the Department of Conservation (DOC), and MBs where more than 50% of the land value is assigned to an urban use by QVNZ. His original analysis was based on 2001 MB groupings; we use an updated version of his approach which classifies 2006 MBs. Out of the 41,392 MBs defined using 2006 boundaries, our rural sample includes 9,238 MBs in 2008.

We construct a national level weighted average of the per hectare sale price and capital value. We first estimate the average per hectare sale price at the national level by land use category and then weight these by the proportion of land within each land use category in the valuations data (this is for both the sales and valuations data). We have valuations data only from 1992 onwards, so we need another source of land areas in order to construct this average for the sales data. We use the Statistics New Zealand (SNZ) based land use shares data from Kerr and Olssen 2012 to construct the weights for the earlier part of the sales data[10].

[10] Kerr and Olssen 2012 have data on dairy, sheep/beef and forestry areas. We do not have a sheep/beef category, but this category shows strong correlation with our pastoral category, so we use the sheep/beef category to construct the weights for pastoral land. For arable and horticultural, we extrapolate the weights by using the mean of their share over the period which we have valuations data.

Figure 1: 3-year Moving Average of National Rural Sale Price and Capital Value per Hectare

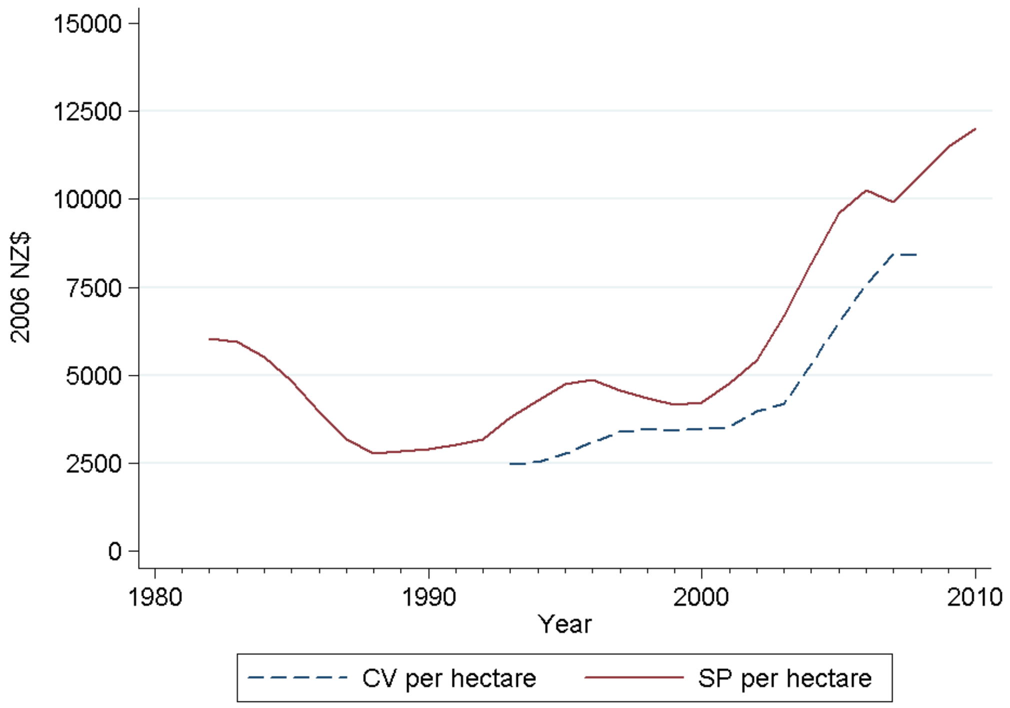


Figure 1 plots the 3-year moving average of the national average per hectare sale price and per hectare capital value for rural properties. The per hectare sale price is uniformly greater than the per hectare assessed capital value. This could be due a systematic negative bias in the estimated capital value of each property, or because higher value properties within each land use category tend to be sold more frequently. Nevertheless, the two series show a high degree of co-movement. This is expected, given that recent sales inform the valuation estimates.

3.4. Additional Variables

We are considering the extent to which agricultural land values are influenced by general economic conditions and what role agricultural commodity prices and profitability play over and above the influence of general economic conditions.

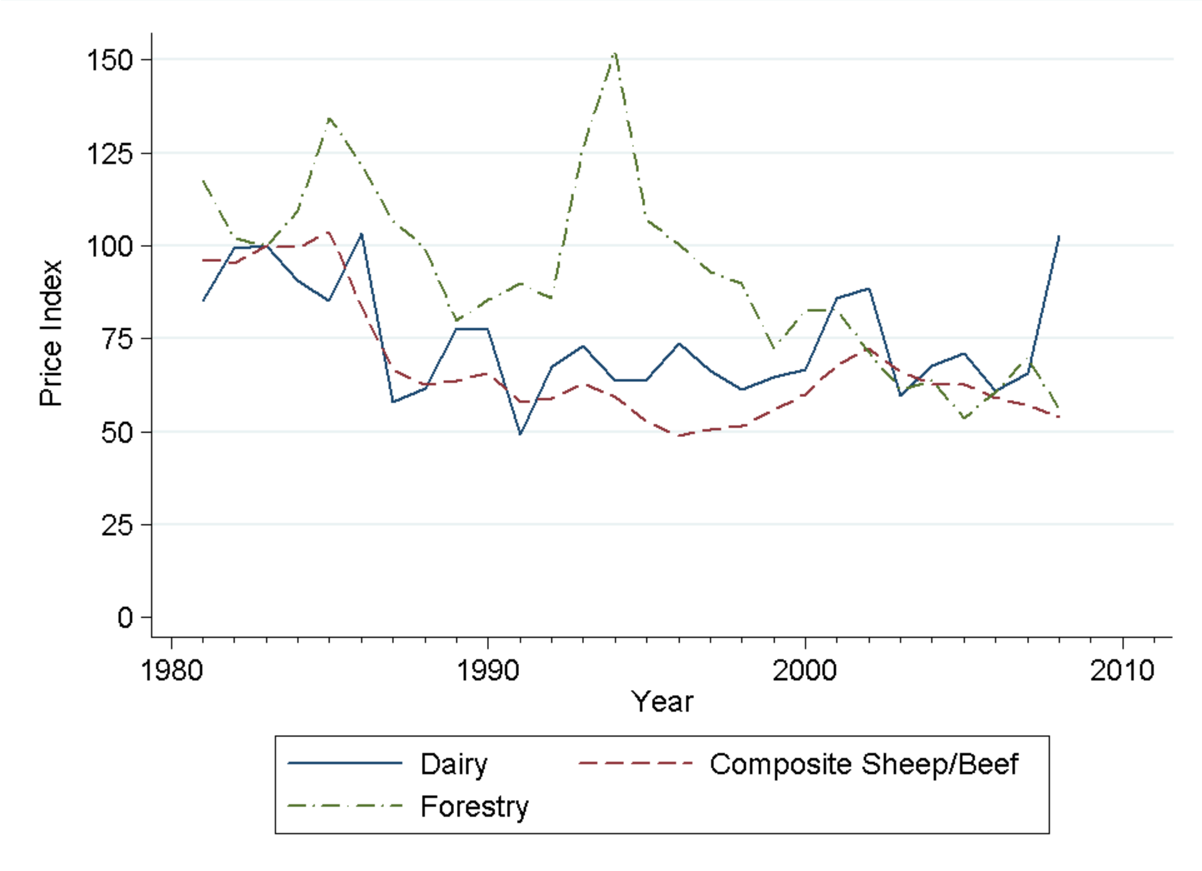
We use residential house prices as our measure of general global economic conditions which affect general asset prices. We use residential house prices to see if the factors that drive residential house price growth also drive agricultural land values. Grimes and Hyland (forthcoming) show that New Zealand house prices are influenced by agricultural commodity price shocks. To avoid confusing macroeconomic factors with the influence of agricultural commodity prices, we instead use an index of Australian house prices from the Australian Bureau of Statistics (ABS). Grimes et al. 2010 show that there is a common trend between New

Zealand and Australian residential house prices, showing that the same international macroeconomic factors are driving house prices in both countries. Australian house prices may well be affected by international commodity prices, however the mix of commodity prices which matter in Australia are likely to be different to those which matter for New Zealand. We use the Australian house price series as it provides an exogenous source of variation in international macroeconomic factors which could influence markets for both residential and rural properties.

Our agricultural commodity price data come from the export price series constructed in Kerr and Olssen 2012. The authors construct an export unit value for sheep meat, beef meat, wool and logs using SNZ overseas merchandise trade data. To create a composite meat/wool price, they create a trade weighted average of the sheep-meat, beef and wool prices. Milk solid prices are from the Livestock Improvement Corporation. Given the history of agricultural support, the authors adjust these export unit prices for the amount of assistance given to each agricultural sector, using estimates on the extent of support from Anderson et al. 2007. Therefore, we have three commodity price series: a composite meat/wool price, a dairy price and a forestry price. In the analysis in section 4, we create a composite agricultural commodity price. This is a simple average of the three commodity prices, weighted by that commodity's share of agricultural exports. Figure 2 plots the three commodity price series used in this paper in index form.

Woods and Coleman 2012 provide evidence that, despite New Zealand being a major exporter of agricultural products, we have very little influence over the commodity prices received by our farmers. That is, the actions of New Zealand's farmers or consumers are too small to affect the international markets. Because the actions of New Zealand farmers have a negligible impact on commodity prices, these can be viewed as an exogenous shock to agricultural profitability.

Figure 2: Agricultural Commodity Price Indices (Base 1983=100)



Our profitability data come from two sources. We focus our attention on dairy and sheep/beef profitability, as we have good data over a long time horizon for these two agricultural activities. Dairy and sheep/beef farming also account for a vast majority of agricultural exports and account for the majority of rural land in New Zealand. Our sheep/beef profit data come are from Beef and Lamb New Zealand[11]. We use the earnings before interest and tax (EBIT) per hectare for Beef and Lamb's average sheep/beef farm. This series runs from 1984-2011. Our dairy profit data come from the MAF Monitor Farm Reports. We use the estimated economic farm surplus for their nationally representative dairy farm[12]. Our dairy profit data are available from 1987. In our analysis in section 4, we construct an average of the two profit series, weighted by each farm type's share of land area. Following our conceptual framework, we construct a present value of profits series. The results presented in section 4 use a 5.5% discount rate, consistent with Treasury recommendations (New Zealand Treasury 2013). Figure 3 plots the per hectare profit data for sheep/beef and dairy farms.

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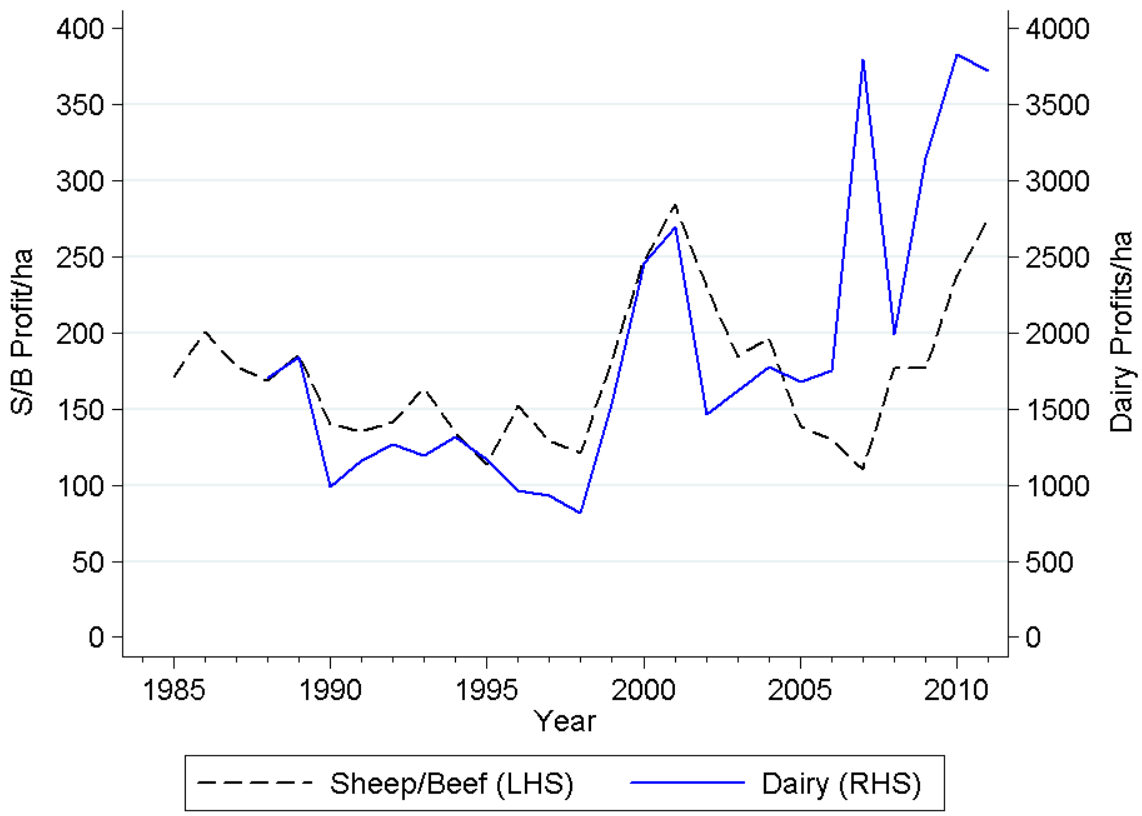
[11] Formerly Meat and Wool Economic Service.

[12] The MAF Monitor Farm Reports only report the economic farm surplus from 1999. To obtain the estimates used prior to this, we take the cash farm surplus (before interest) and deduct personal drawings. Given the information provided pre 1999, this is the closest approximation to the economic farm surplus.

Figure 3: Profits per Hectare for Sheep/Beef and Dairy Farms



As can be seen from Figure 3, dairy profits per hectare are in the order of 10 times those of sheep/beef profits. The two series moved together quite closely until the early to mid 2000s.

4. Descriptive Statistics

4.1. National and regional trends

We first present and discuss national level trends in the per hectare sale price for rural properties. We then examine the extent to which regional trends in rural land values differ from the national trend.

We focus on national trends to provide a descriptive account of how rural land values have moved over the period and how these movements coincide with various economic events over the period. Economic conditions could influence land values through their impact on agricultural profitability. For example, the removal of agricultural subsidies during the 1980s impacted agricultural profits directly, and may have lowered farmers' expectations about future profits. Similarly, a contraction in the availability of credit (as occurred during the GFC) could impact the demand for rural properties by making it harder to access the capital necessary to purchase a rural property. There may also be a kind of income effect, whereby increasing incomes increases the demand for, and hence price paid, for the amenities possessed by rural properties. This could be independent of any impact on agricultural profitability.

Figure 4: National Rural Sale Price per Hectare

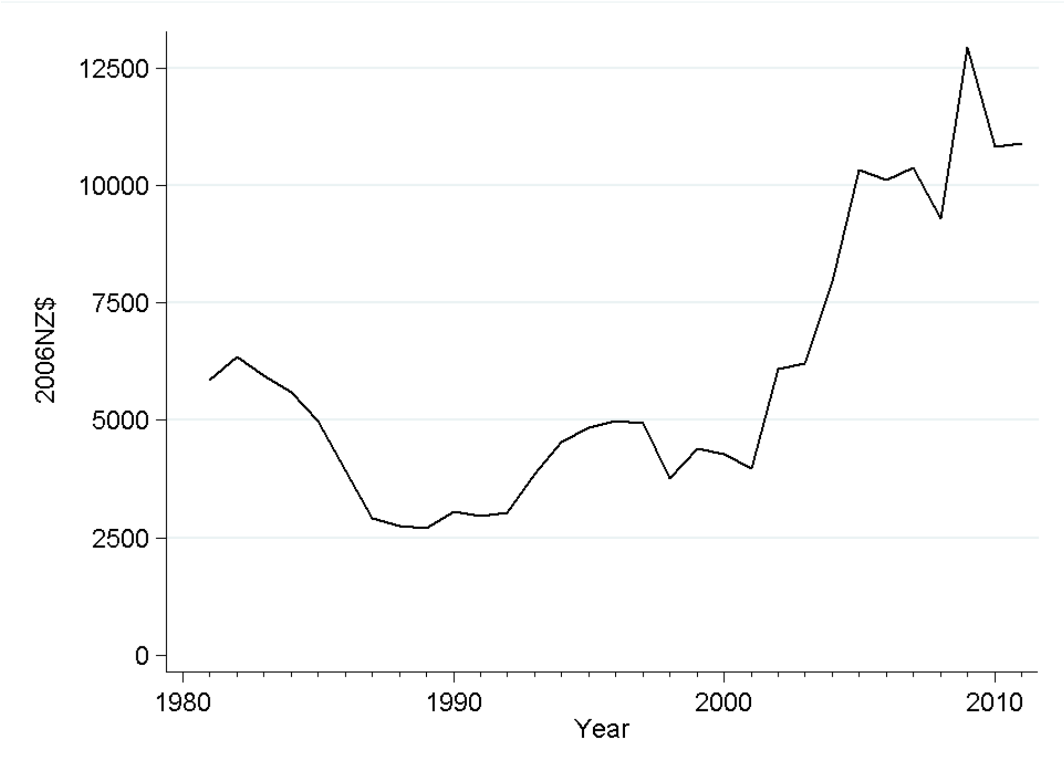


Figure 4 plots the national average per hectare sale price for rural properties over the period, expressed in 2006 $NZ[13]. One of the most striking features of the average rural sale price series is the sharp decline which occurred during the early 1980s. New Zealand began a period of major economic reforms in 1984. These included the removal of interest rate controls and the floating of the exchange rate, removal of tariffs, implementation of the Reserve Bank Act and the privatisation of many state-owned enterprises. However, the removal of agricultural subsidies, beginning in 1985, is the likely driver of this fall. By 1988, the per hectare sale price was less than 50% of its value in 1983. The removal of these subsidies represents the single biggest exogenous shock to agricultural profitability over the sample period. Evans et al. 1996 display information about the impact of the subsidy removal on the profitability of sheep and beef farming. The net revenue per stock unit declined by a similar order of magnitude as land values following the removal of subsidies. The sheep/beef sector bore the brunt of the reforms

[13] Figure 13 in the appendix shows the percentage contribution to the national average by QV use category. Also, Figure 14 displays the (normalised) per hectare sale price series for the use categories which make up the national average.

in the agricultural sector (Rae et al. 2004). In 1984, this sector accounted for 44% of the value of total agricultural output, as well as nearly 75% of rural land in New Zealand. It was also the most heavily protected of the agricultural sectors.

The per hectare sale price remained relatively flat for the remainder of the 1980s, before recovering over the early 1990s. In 1996, the sale price was almost double its level in 1988, but had failed to reach the level seen immediately prior to the reform period. These gains were not maintained, with the sale price falling slightly over the remainder of the 1990s. This fall may reflect the impact of the Asian Financial Crisis and the drought in 1997/98, which particularly affected the East Coast of the country.

The sale price finally reached pre-reform levels in 2003, and continued to grow strongly until 2007. Wilson 2013 notes that overall confidence during this period was high, and annual credit growth had returned to double digit figures not seen since the early 1990s. In 2008, we see a small fall in the sale price, which coincides with the onset of the Global Financial Crisis. Wilson 2013 argues that this fall was initiated by a rapid slowdown in credit availability, a downward correction in dairy product prices and gloomy dairy payout forecasts. These factors, coupled with drought conditions experienced in parts of the country, lead to a fall in confidence by all actors in the rural sector – land buyers, sellers and banks.

The fall in the sales price, however, was relatively short lived. The price rebounded strongly in 2009, reaching its highest level over the sample period. Interest rates were cut rapidly in response to the crisis, while the dairy payout was significantly higher than initially forecast (MAF 2010). In 2010, however, the sale price returned to a level slightly above that seen before the GFC. Variable weather and continued uncertainty around the path of the global economy may have contributed to rural land prices falling from their levels in 2009.

Figure 5: Rural Sale Price per Hectare by Region Relative to National

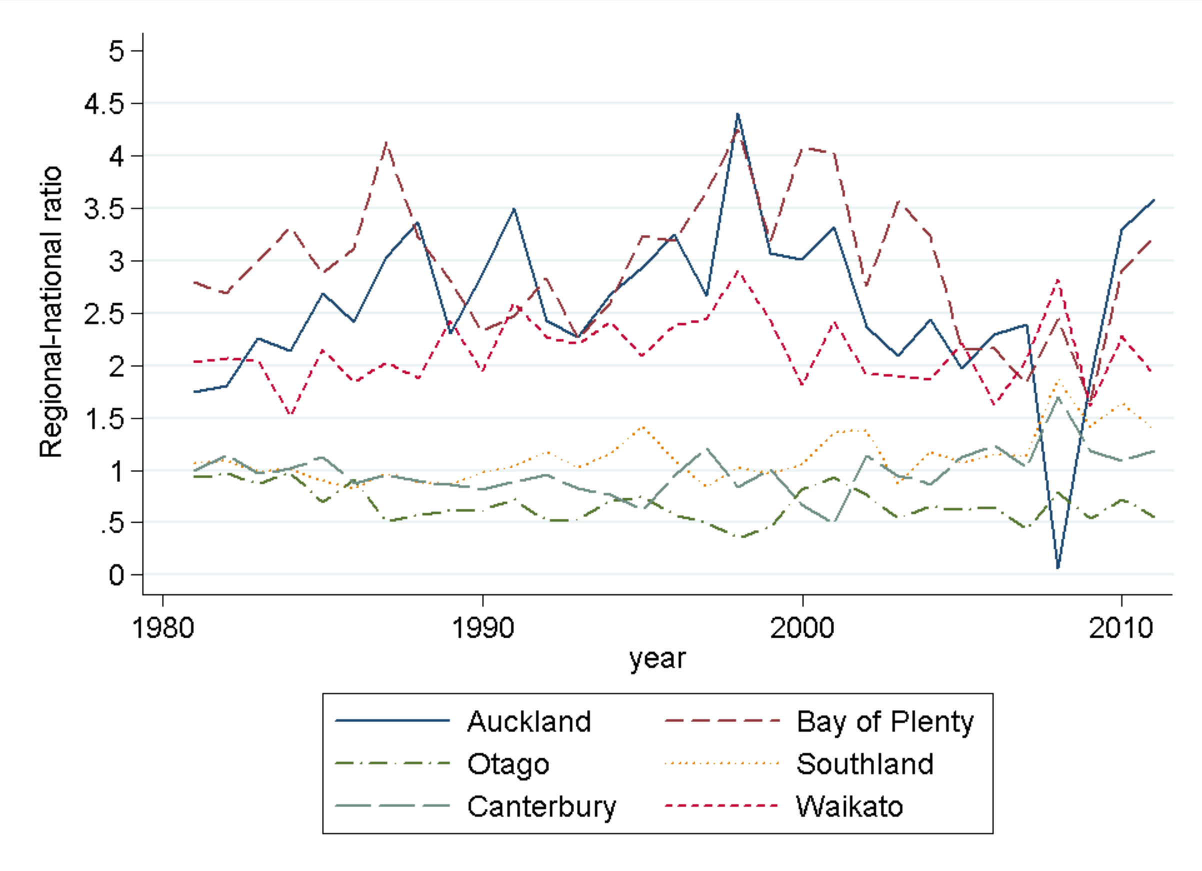
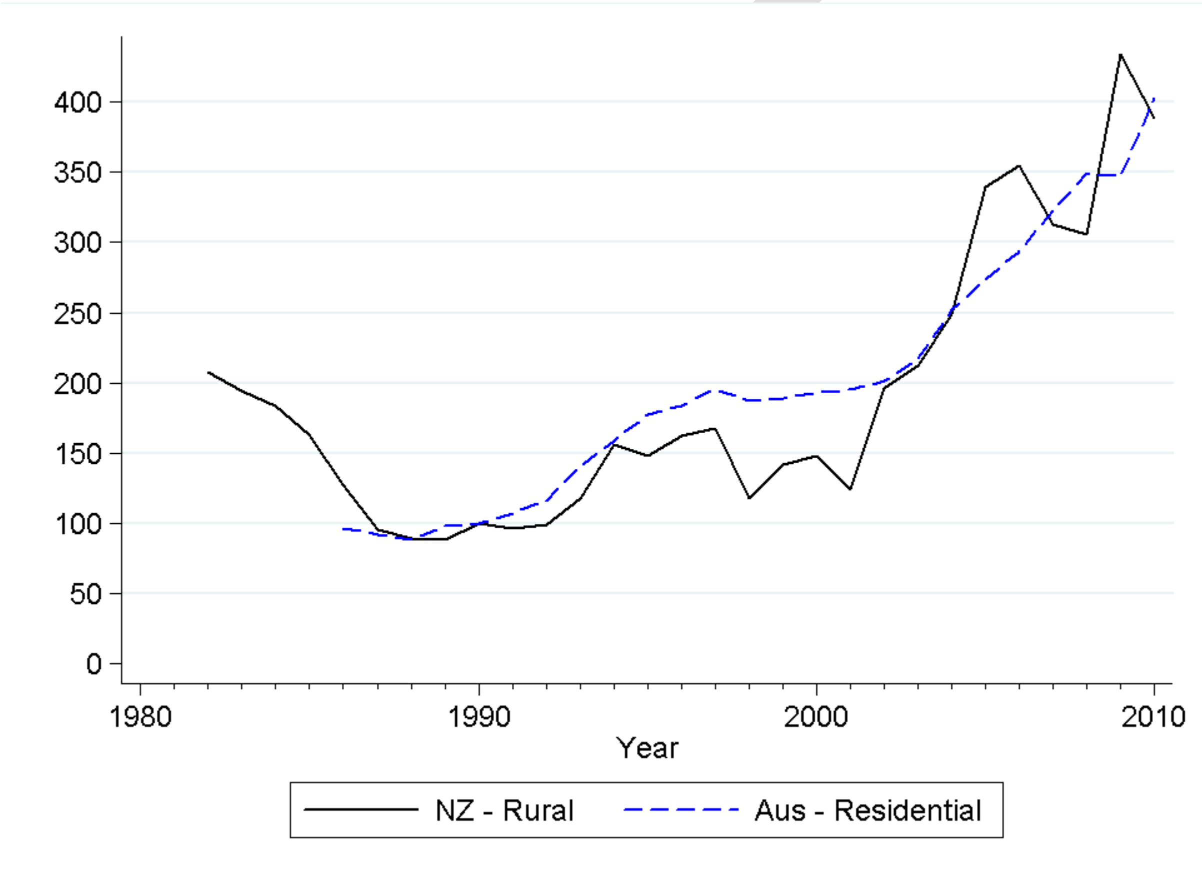


Figure 5 plots the regional average rural sale price per hectare for selected regions, relative to the national average. There is considerable heterogeneity in the levels of the per hectare sale price across regions, with rural land in Otago selling for between half and 75% of the national average. In the Bay of Plenty, on the other hand, rural land has regularly sold for more than three times the national average. Compared to the South Island regions, the price of rural land in the North Island regions is more volatile. The North Island regions also appear to be more volatile than the national average. One region suffered more from the GFC, namely Auckland. The price of rural land in Auckland fell strongly relative to the national average, with the other regions relatively unaffected.

Figure 6 plots the average per hectare sale price for rural properties (in index form) against the Australian residential price index. Residential house prices are driven by a variety of economic factors and the purpose of this comparison is to see if the factors which are driving residential property prices are also driving rural property prices, through one of the channels discussed previously in this section.

There is a high degree of co-movement between the rural price series and the Australian residential price series. Residential prices in Australia began rising in the early 1990s as rural property prices were beginning to recover from their 1980s slump. Rural property prices recovered gradually over the early 1990s, although didn't reach their pre-reform levels until 2003. Both series experienced a slowdown in growth over the latter half of the 1990s, plausibly caused by concerns surrounding the Asian Financial Crisis. From the year 2000, growth in both rural and residential property prices accelerates. Growth in residential house prices began to accelerate in 2002, reflecting the beginning of the housing boom which occurred in many advanced economies over the 2000s.

Figure 6: Property Price Indices for New Zealand and Australia (Base year 1990)



It is evident from and Figure 6 that general macroeconomic conditions have influenced rural land values over the sample period. However, there are also occasions when shocks specific to the agricultural sector have a separate influence over the value of rural land. The most evident example of this over the sample period is during the reform period of the 1980s. Rural property prices fell by half; residential property prices were relatively flat during this period. In section 4.2, we examine to what extent agricultural profitability explains movements in agricultural property prices, alone and after controlling for general economic conditions, as measured by house prices. We use both a direct measure of agricultural profits, as well as a measure of agricultural commodity prices. Because commodity prices are set on international markets, these can be viewed as exogenous shocks to profitability.

4.2. Relationship with Agricultural Profits

The descriptive results from section 4.1 suggest that general economic conditions play an important role in the determination of agricultural land values. Global conditions affecting the value of housing (such as rising incomes, credit availability) appear to have played a role in determining the value of agricultural land. We now examine impacts more formally by regressing the per hectare sale price an measures of agricultural profitability (a direct estimate of profits and agricultural commodity prices) and the Australian house price index.

Figure 7: National Rural Sale Price per Hectare and Present Value of Profits per Hectare

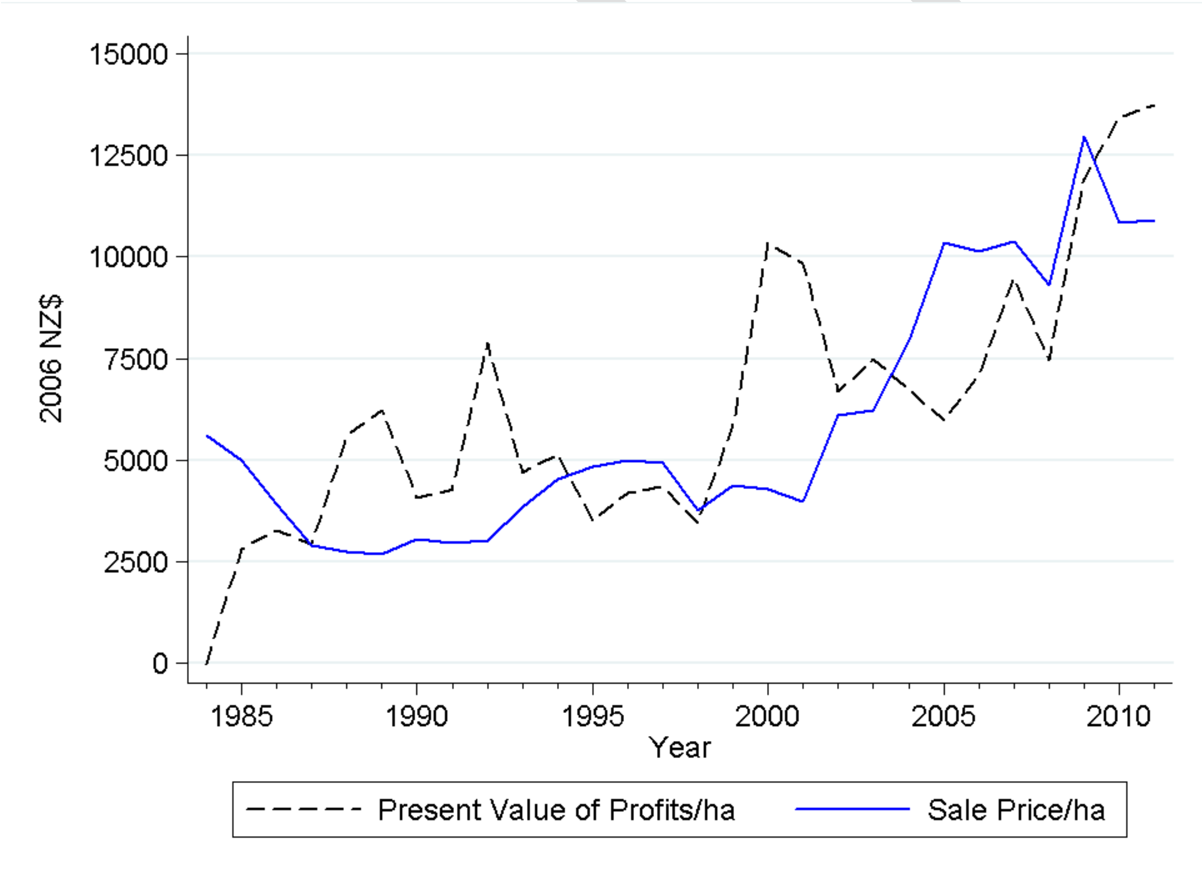


Figure 7 above plots the present value of agricultural profits against the national average sale price for rural properties. The two series show a high degree of co-movement; this is not surprising, given our conceptual framework. However, there are times when agricultural profits remain well above the sale price, such as during the mid late 1990s and early 2000s. There are also times when the sale price is well above the present value of agricultural profits, such as during the period 2004-2008.

To examine the influence of general economic conditions and agricultural profitability on the value of agricultural land, we run some simple regressions of the (log) per hectare sale price of agricultural land on a land area weighted average of dairy and sheep/beef profits ($\log PROFITS_{t}$), or a trade weighted average agricultural commodity price ($\log ACPI_{t-1}$) (as described in section 3.3). The main reason for using composite indices is to preserve degrees of freedom in the estimating equations. We use the Australian house price index ($\log HPI\_AU_t$) to estimate the impact of general economic conditions. We have a very small sample size, so these results should be regarded as illustrative.

Table 2: Influence of Residential House Prices and Agricultural Profitability on Agricultural Land Prices

	(1)	(2)	(3)	(4)	(5)
$\log ACPI_{t-1}$	-.4243072			.6013519**	
	(.4282105)			(.2658024)	
$\log PROFITS_{t}$		0.4435427*			-0.1053904
		(0.2299066)			(.1217621)
$\log HPI\_AU_t$			.9431603***	1.019344***	1.03866***
			(.103797)	(.0903071)	(.0710678)
Constant	10.39502***	4.768511**	3.618838***	.64513	4.052728***
	(1.889761)	(1.946012)	(.5191878)	(1.22108)	(.9655368)
EG τ-stat	-1.549	-1.388	-4.631 ***	-4.350**	-3.345*
N	30	27	26	26	27
R^2	0.0226	0.1168	0.7989	0.8210	0.8882

Notes: Estimation is conducted using OLS. Robust standard errors are in parentheses. The estimation sample for columns 2 and 3 are shorter due to the Australian house price index series being available from 1985. EG τ-stat is the test statistic for the Engle-Granger two step procedure for testing cointegration. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 2 reports the results for the regressions of the (log) per hectare sale price on (log) commodity prices, (log) agricultural profits and the (log) Australian house price index. Column 1 reports the result for the regression of the per hectare sale price on commodity prices, column 2 reports the result for the regression of the per hectare sale price on agricultural profits, column 3 reports the regression results for the regression of the per hectare sale price on the Australian house price index. Columns 4 and 5 add the commodity price index and agricultural profits to the regression in column 3, respectively. Also reported in Table 1 is the test statistic from an Engle-Granger test for cointegration (Engle and Granger 1987). These are to check the statistical adequacy of the regressions. We are dealing with non-stationary time series, so there is a risk that the regressions may be invalid if the residuals are also non-stationary. Rejecting the null hypothesis of no cointegration provides confidence that the regression results represent a valid relationship.

The results from column 1 are not particularly surprising, given the behaviour of the series over time (see Figures 2 and 3). The coefficient estimate on the agricultural commodity price index is of the wrong sign, and actually smaller than its standard error (in absolute value). The per hectare sale price displays an obvious positive trend over the sample period, whereas the commodity price series display no such trend. The R^2 of the regression is very low; variation in our commodity price index can only explain 2% of the variation in rural land values. The value of the EG test statistic is also very low, indicating that this regression is likely invalid as the residuals contain a unit root.

The results in column 2, however, are more promising. Agricultural profits enter the estimating equation positively and significantly, with an elasticity of 0.44. However, the R-squared for this regression is relatively low; variation in agricultural profits explains only 11% of the variation in rural land prices. The EG test statistic is also quite low, indicating that this regression may not be valid.

The third column of Table 2 reports the results for the regression of the per hectare sale price on the Australian house price index. These results are much more promising. The Australian house price index is very strongly positively related to the per hectare sale price of rural properties. The null hypothesis that the coefficient is equal to one cannot be rejected at standard levels of significance. A 1% rise in the Australian house price index is associated with a 1% rise in the per hectare price of rural land. The EG test statistic is also more promising; we cannot reject the null hypothesis of no-cointegration at the 1% level.

Column 4 reports the results from the regression of the per hectare sale price on agricultural commodity prices, controlling for international macroeconomic factors reflected in Australian house prices. Australian house prices appear to account for the majority of the variation in rural land prices, with the R-squared increasing only slightly from the regression in column 3 (0.79 vs. 0.82). The coefficient on the Australian house price index actually increased, but the null hypothesis that the coefficient is equal to one cannot be rejected. Agricultural commodity prices, which represent exogenous shocks to agricultural profitability, enter this equation positively and significantly. A 1% increase in the agricultural commodity price index is associated with a 0.6% increase in rural land prices. The EG test statistic is significant at the 5% level

Finally, column 5 reports the results from the regression of the per hectare sale price on agricultural profits, controlling for Australian house prices. The difference between this regression and that reported in column 4 is striking; agricultural profits enter the regression with the opposite sign as in the regression in column 2 (albeit insignificantly). General economic conditions could have a direct affect on agricultural profitability, which could account for the insignificance of the profitability measure in this regression. Australian house prices again enter positively and significantly with a coefficient that is statistically indistinguishable from one.

The results in this section indicate that general macroeconomic conditions play a major role in determining rural land values. After controlling for these, a direct measure of agricultural profitability has an insignificant association with rural land prices. However, we have found a positive association between agricultural commodity prices and rural land prices, controlling for general macroeconomic factors. This would indicate that it is the exogenous shocks to profitability which influence land values, rather than the direct level of profitability.

4.3. Are there bubbles in rural land values?

Figure 8 plots the residuals from the regression described in column 4 of Table 2. Here, we are looking for suggestive evidence of a bubble in agricultural property prices. Case and Shiller 2003 define a bubble in the housing market as "a situation in which excessive public expectations for future price increases cause prices to be temporarily elevated". In our context, a bubble could be defined as excessive expectations around future profitability and capital gains from landholdings which cause the price of rural land to be temporarily elevated. Looking particularly at the period 2003-2007, we see that the per hectare sale price remains well above the level implied by general asset prices and agricultural commodity prices. This is the period associated with the boom in dairy prices and with the global housing boom which preceded the GFC[14]. In 2008, we see a correction in the per hectare sale price, with the sale price falling back to the level implied by the regression in Table 2. The sale price then quickly returns to an elevated level in 2009, before moving back to the level implied by the long run relationship.

[14] We tested the sensitivity of the regression coefficients to the inclusion of the period of the GFC. We re-estimated the regression, excluding the period 2008-2011; the coefficient estimates remained remarkably similar. As a result, the residuals from the regression estimated over the pre-GFC period are very similar to those shown in Figure 7.

Figure 8: Residuals from a regression of the rural sale price on Australian house prices and commodity prices

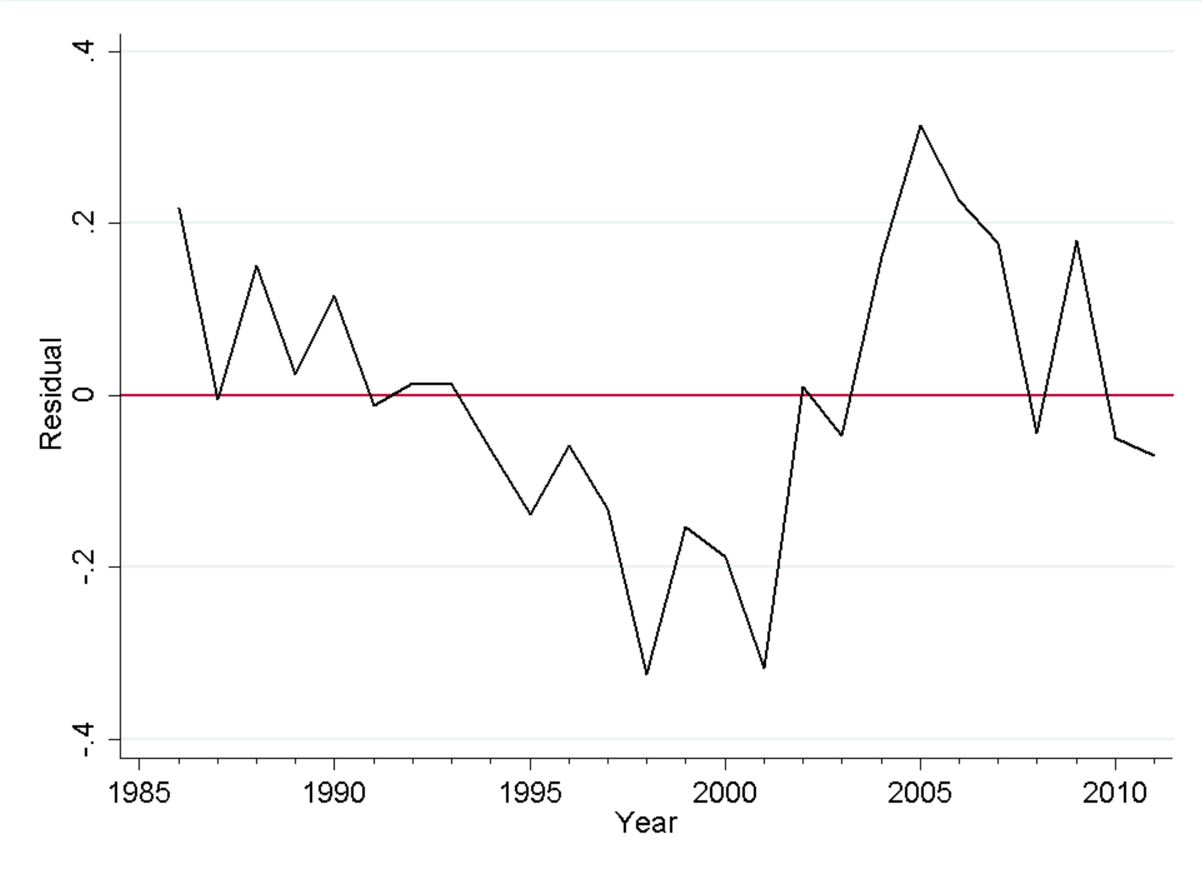
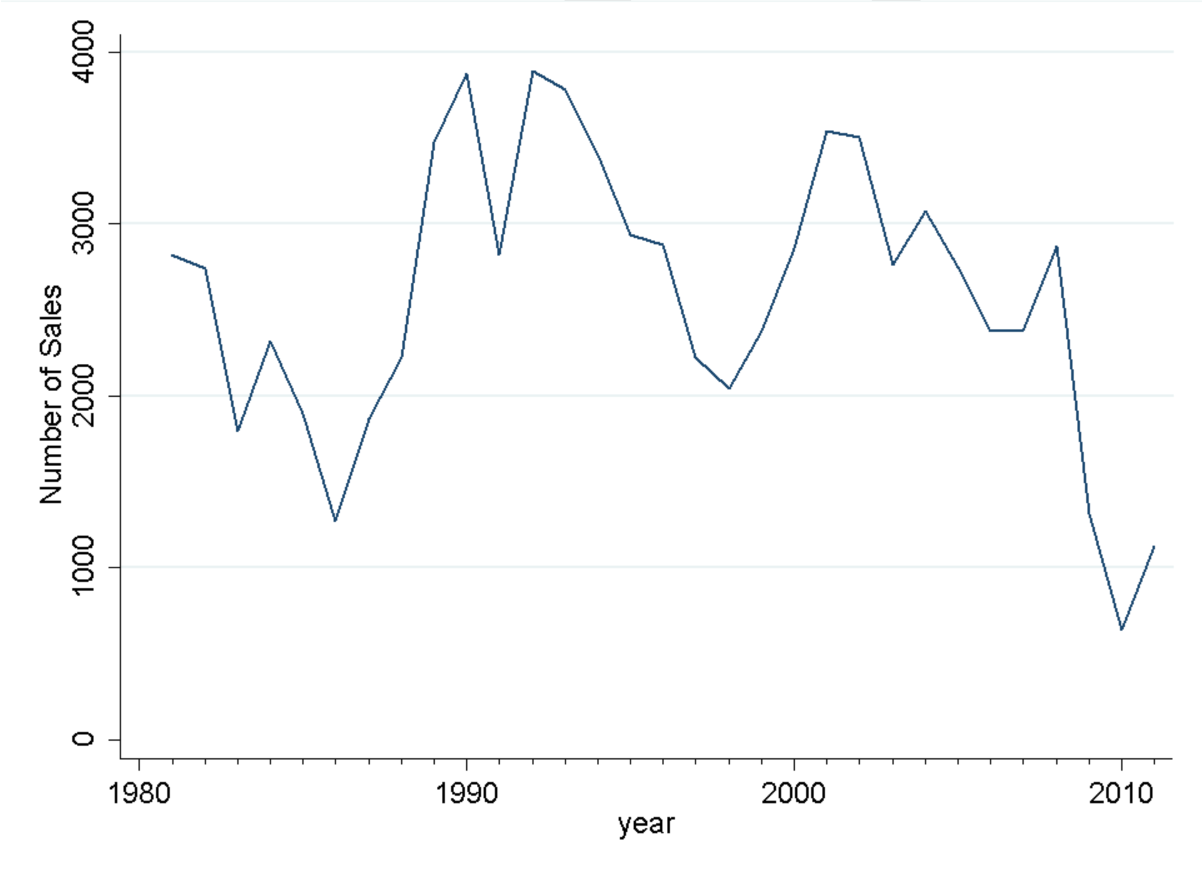


Figure 9 plots the total number of sales of rural properties over the sample period. Our motivation for looking at the number of sales is to see how market activity responds to price shocks in the market for rural properties. Grimes et al. 2004, for New Zealand house prices, find that sales activity in a region is positively related to house prices. When property prices fall, sellers may become reluctant to sell and realise a capital loss (Genesove and Mayer 2001). Grimes et al. 2004 find that the sales activity acts as an equilibrating mechanism when house prices are below their equilibrium value by restricting the supply of available properties. While we cannot estimate whether or not sales activity plays a role in equilibrating the rural property market, we can at least provide a descriptive account of how sales volumes have changed in relation to changes in the sale price of rural properties.

We have three major negative price shocks in our sample period (1984-1988, 1996-2000 and 2008). All of these periods are associated with a relatively large fall in the number or rural properties sales per year. The average number of rural sales per year is around 2500. Prior to the reform period, the number of sales was hovering around this value, before falling sharply in 1985. The number of sales hit a low point of just over 1200 in 1986. We see a similar, albeit less extreme, fall in sales activity around the time of the drought in 1997/98 and the Asian Financial Crisis. The number of sales fell to just over 2000 a year in 1998.

The biggest shock to sales activity in the market for rural properties occurred following the onset of the GFC in 2008[15]. In 2009, number of rural sales plummeted from its level in 2008, reaching a historical low in 2010 of only 639 sales. This is a decline of around 77% from the 2008 level. This possibly reflects the tightening of credit conditions which made purchasing a rural property more difficult. While this descriptive account is unable to test whether or not the fall in sales volume contributed to the recovery of prices in 2009 (or in any of the other periods of decline), the pattern in sales volume is consistent with a reluctant seller story[16].

Figure 9: Total Number of Rural Sales 1981-2011



[15] The fall in sales activity is much larger than previous falls, despite the fall in sales price being relatively minor. This could plausibly due to a decline in credit availability, which simply made it harder to purchase a rural property.

[16] There are a multitude of other factors which could explain the quick recover in sales prices following the GFC, such as the composition of properties sold, higher than expected commodity prices/profits, or increased expectations about future profits (possibly resulting from the signing of a Free Trade Agreement with China in 2008).

Figure 10: Ratio of Sale Price to Present Value of Profits

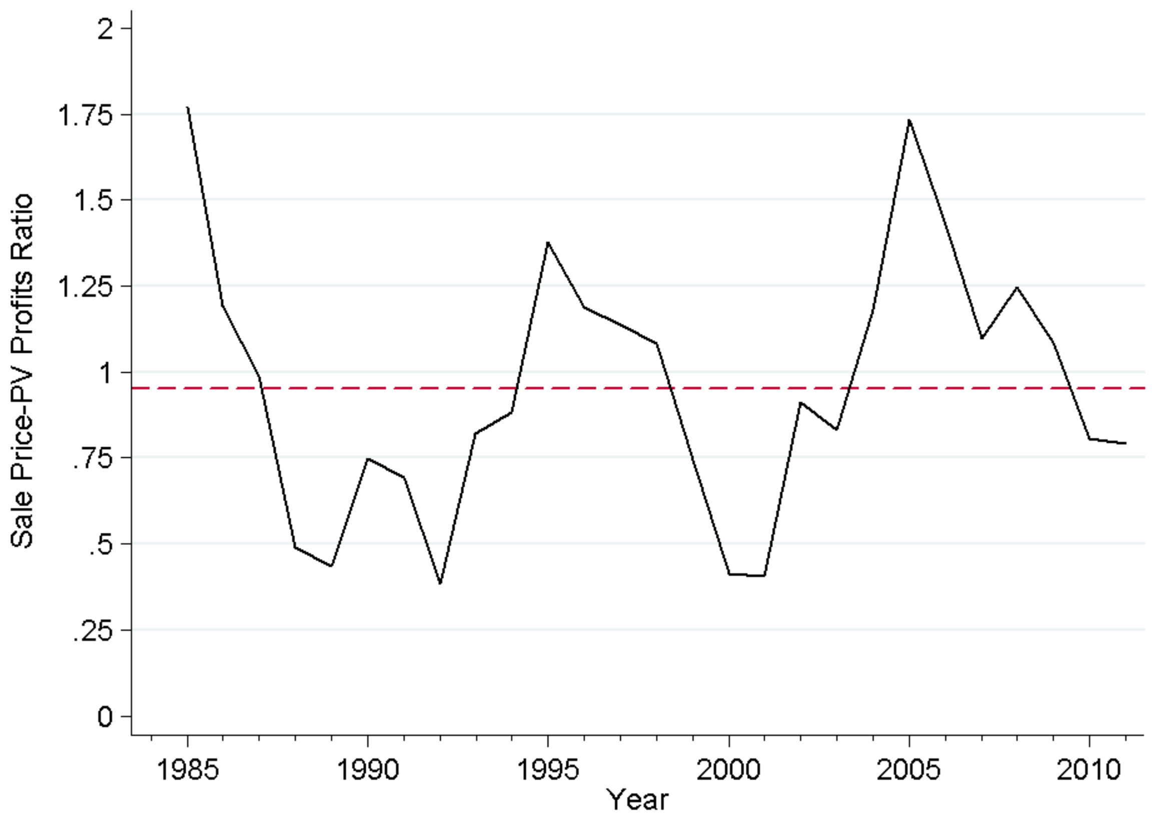


Figure 10 plots the ratio of the per hectare sale price to the present value of per hectare profits. The dotted line on the figure is the mean ratio over the sample period. At 0.95, this value is remarkably close to one. Looking at the figure, there appears to be some degree of mean reversion in the sale price-present value of profits ratio. There is no systematic tendency for the sale price of rural land to remain well above (or below) agricultural profitability. The sale price does remain elevated against profitability for some periods, such as during the mid-1990s and the 2000s. Temporary shocks to profitability, such as droughts, could partially explain why the sale price appears elevated relative to profitability. A well-functioning land market should see through these temporary shocks and reflect the long run profitability of the sector. Expectations could also play a role. After experiencing several years of growing profits, farmers may expect similar increases in profits moving forward. These would be built into current land prices. Rational explanations exist for why the sale price is elevated relative to agricultural profitability for certain periods.

5. Conclusions

This paper seeks to increase understanding of the drivers of rural land values in New Zealand. This is motivated by the need to understand how climate change and environmental policies may affect the long run profitability of the agricultural sector, which is reflected in the value of the land. Climate change could influence these values through impacts on the productivity of the land in different uses, which could also flow through to commodity prices. Environmental policies could impose significant costs on farmers. These could adversely affect the profitability of certain agricultural sectors if farmers are unable to pass on these increased costs to consumers.

We use QVNZ sales and valuations data over the period 1980-2009 to examine how rural land values may be influenced by a variety of macroeconomic factors. We also explore to what extent agricultural profitability explain land values over and above general macroeconomic trends. We find that general economic conditions, as reflected in by Australian house prices, explains a large part of the variation in agricultural property prices over time. We also find that agricultural commodity prices, which represent exogenous shocks to agricultural profitability, have an impact over and above the affect of general economic conditions. While factors which influence the level of general asset prices explain the majority of the variation in agricultural land prices, we do find an impact of agricultural specific factors

We also find some suggestive evidence of a bubble in rural property prices. From 2003-2007, rural property prices remained elevated relative to the level suggested by the relationship between international macroeconomic factors (summarised by Australian house prices) and agricultural commodity prices. After a correction in the rural property market in 2008, rural property prices returned to an elevated level in 2009.

However, we find suggestive evidence of mean reversion in the ratio of the price of rural land and the present value of profitability in the rural sector. Our conceptual framework shows that there should be a strong relationship between land prices and profitability. While the sale price may remain elevated relative to profitability for a few years, there are rational explanations of why this can occur. Temporary shocks to profitability (such as droughts), which lower profit in the short term, should not influence the sale price in a well functioning land market. Likewise, expectations about future profitability could explain an elevated sale price. After several years of growing profits and land values, it may be reasonable to expect a continuation of these past trends ex ante. We find evidence of a correction in the sale price-profitability ratio, which indicates that these departures are not systematic.

To summarise, we find that rural land values are driven by a variety of factors. General economic factors, which influence the price for all types of property, seem to be the main driver of rural property prices. However, agriculture specific factors also appear to play a role. This is evident from the regression results concerning agricultural commodity prices. Once global economic conditions are controlled for, agricultural commodity prices have a positive influence on the value of rural land. Based on these results, it appears that the impact of climate change or environmental policies on rural property values will depend on the impacts on the wider economy and the extent to which farmers can pass on any extra costs imposed on them.

6. Appendix

Figure 11: Ratio of Land Value to Capital Value by QV Use Category

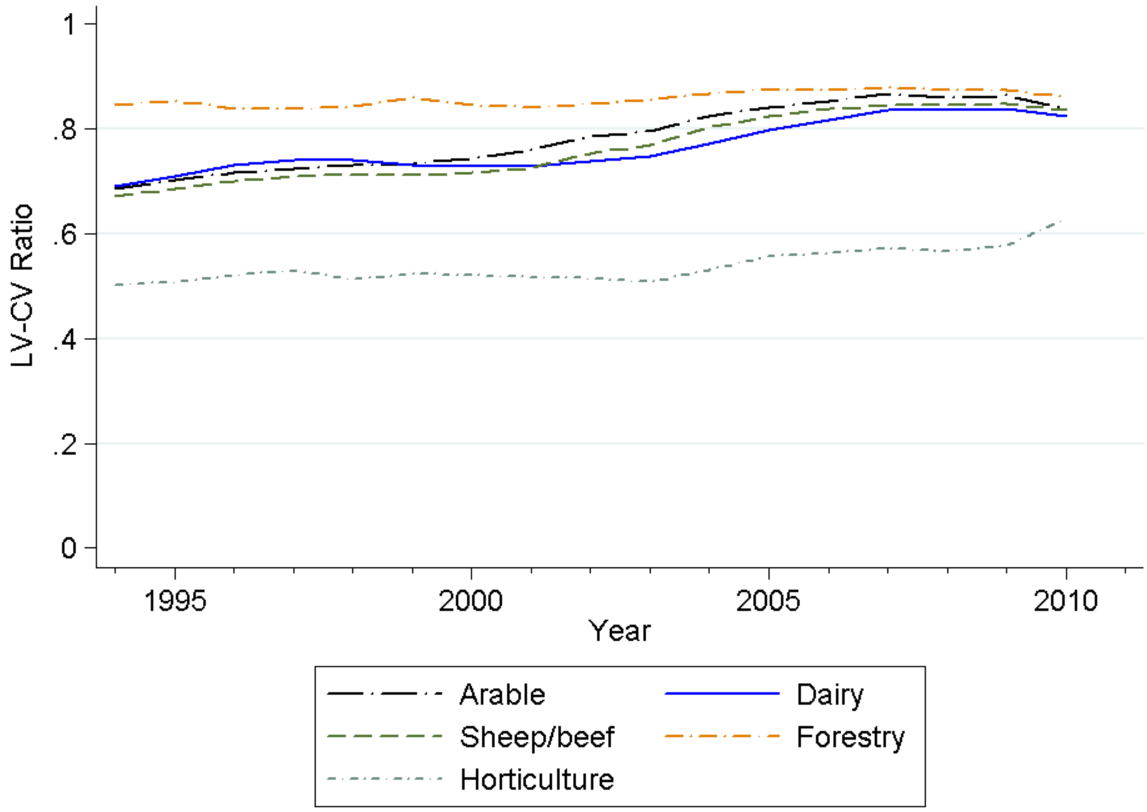


Figure 12: Proportion of Rural Sales (LHS) and Rural Assessments (RHS) by QV Use Category

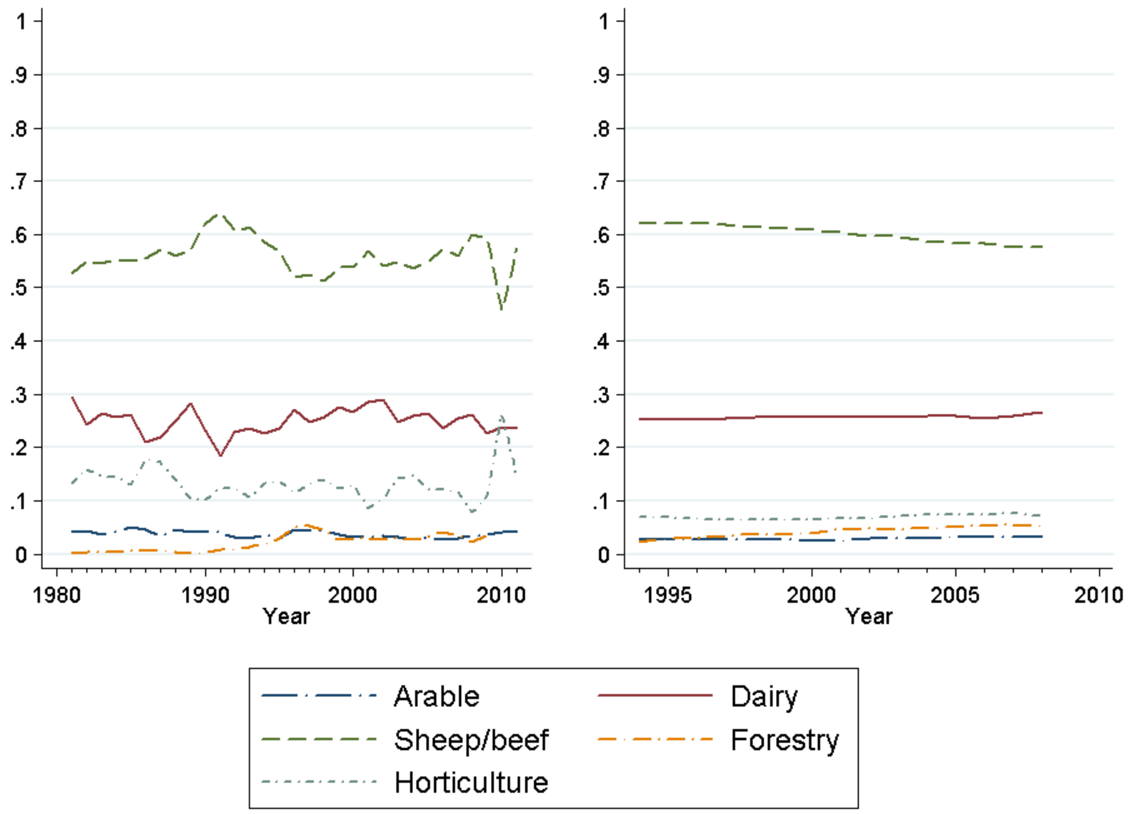


Figure 13: Percentage contribution of Sale Price to National Average by QV Use Category

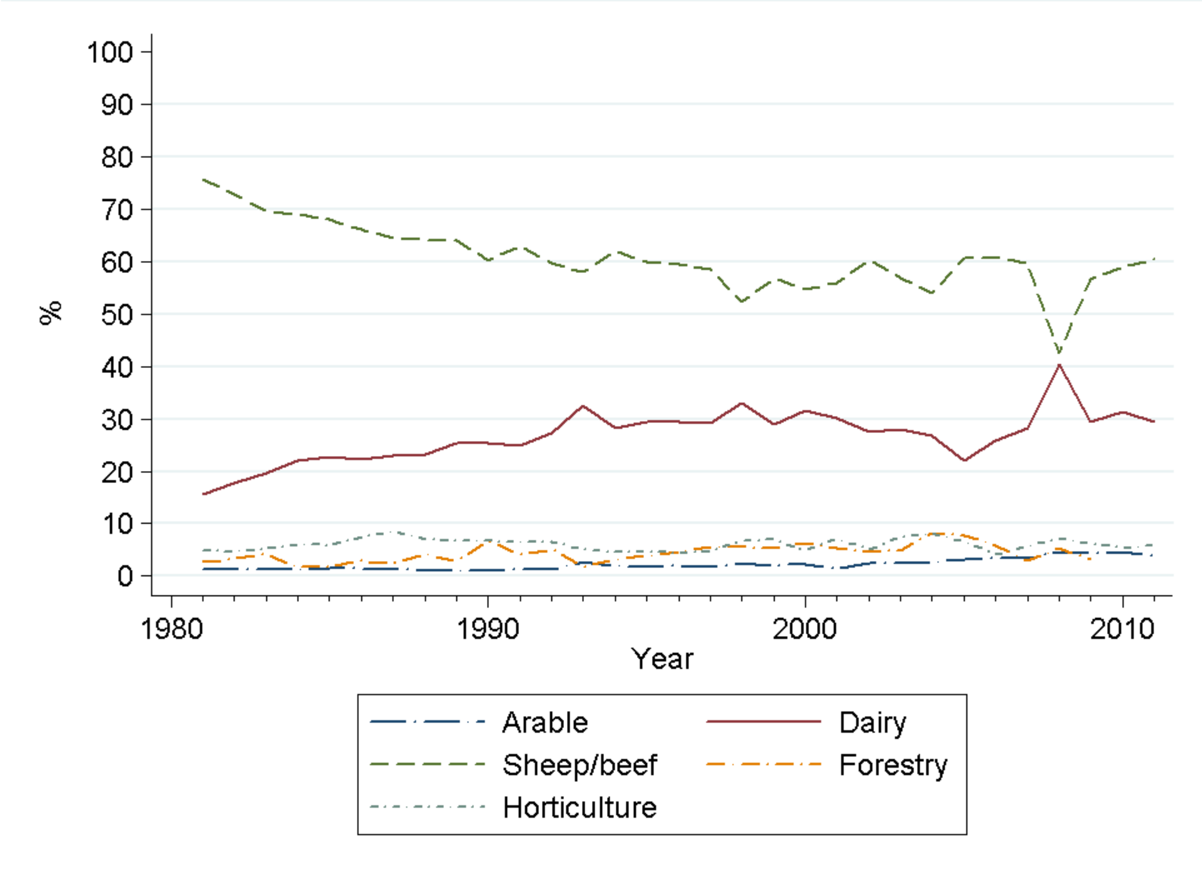
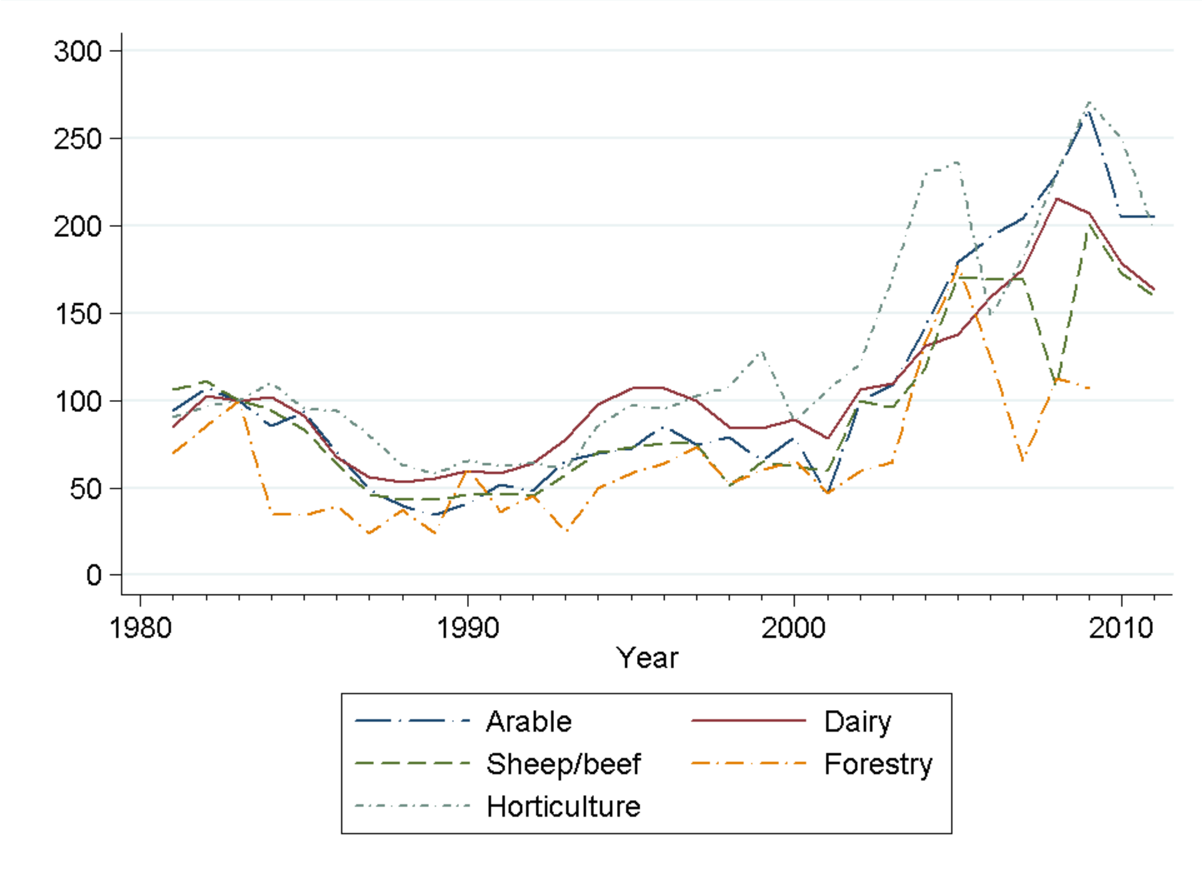


Figure 14: Average Sale Price Index by QV Use Category (Base 1983=100)



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