Examining Changes in the Value of Rural Land in New Zealand between 1989 and 2003

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Abstract

This paper uses valuation data from Quotable Value New Zealand to examine changes in the value of the rural land in New Zealand between 1989 and 2003. The value of rural land reflects the profitability of agriculture as well as the returns to alternative land uses, and has a large impact on the prosperity of rural areas. The paper highlights the importance of both changes in land use and changes in the value of land in different uses in explaining overall changes in land values. It also examines the relationship among productive characteristics of the land, the local climate, various local amenities, and changes in land values and land use to better understand what factors have been driving overall changes in the value of rural land across New Zealand.

We find that the real value of rural land in all uses increased substantially over the years being examined. Land use in rural areas also changed considerably during this period, but these changes in land use were essentially uncorrelated with changes in land values. Our regression results indicate that rural land values increased the most in less populated areas with good climates and local amenities. Initial land use also plays an important role in explaining the variation in changes in rural land values with greater increases in land values found in areas with more land initially devoted to urban uses and commercial forestry, and less land initially devoted to horticulture and lifestyle uses.

JEL classifications: R14, R22, Q15

Keywords: Land Use, Land Value, New Zealand, Rural Areas

1 Introduction

Property and land holdings represent the largest single source of wealth in New Zealand (Statistics New Zealand, 2002). In contrast to most other Organisation for Economic Co-operation and Development countries, New Zealand has a small population, roughly 4 million, and a large quantity of productive land, with about 15 million hectares used in agriculture, horticulture, and forestry (Sandrey and Reynolds, 1990).[1] Rural production is New Zealand's largest industry, with exported goods, including processed products, contributing over 60% of total export earnings. New uses for rural land, which can turn worthless land into a valuable asset, are arising all the time. For example, large areas of previously marginal farm land have become home to vineyards; tourist resorts and private homes have sprung up in formerly desolate coastal areas; and large sheep stations have been subdivided into lifestyle farm blocks.

This paper uses valuation data from Quotable Value New Zealand (QVNZ) to examine changes in the value of rural land in New Zealand between 1989 and 2003. The value of rural land reflects the profitability of agriculture as well as the returns to alternative land uses and has a large impact on the prosperity of rural areas. The paper highlights the importance of both changes in land use and changes in the value of land in different uses in explaining overall changes in land values. It also examines the relationship between productive characteristics of the land, the local climate, various local amenities, and changes in land values and land use to better understand what factors have been driving overall changes in the value of rural land across New Zealand.

We find that the real value of rural land in all uses increased substantially over the years examined, with land uses that were initially the least valued (commercial forestry, intensive

[1] New Zealand has 27 million hectares of land, with 11.6 million hectares on the North Island, 15 million hectares on the South Island, and the remainder on outlying islands. One-third of this area is set aside as conservation land.

and extensive pastoral, and arable) increasing the most (240–300%), but with even the highest valued uses (urban, horticulture, pig/chicken, and lifestyle) increasing by 125–165%. Land use in rural areas also changed considerably during this period, with large increases in the percentage of land used for deer/horse, pig/chicken, and commercial forestry uses, smaller increases in land used for lifestyle and dairy uses, and a moderate decline in land used for intensive and extensive pastoral, arable, horticulture, and urban uses (residential, commercial and industrial properties combined). Perhaps surprisingly, these changes in land use were essentially uncorrelated with changes in land values. For example, a decomposition shows that only 2% of the approximately 235% increase in overall land values is explained by changes in land use.

Our regression results indicate that rural land values increased the most in less populated areas with good climates and local amenities. Initial land use also plays an important role in explaining the variation in changes in rural land values with greater increases in land values found in areas with more land initially devoted to urban uses and commercial forestry, and less land initially devoted to horticulture and lifestyle uses. On the other hand, land use changed to increasingly higher value uses in areas with higher population density, good amenities, and increasing population density. Overall, the characteristics of local areas explain 15% of the change in rural land values and 8% of the change in rural land use during the period under investigation.

2 Background

New Zealand underwent economy-wide reforms in the 1980s and early 1990s and is now one of the most open countries in the Organisation for Economic Co-operation and Development (Evans et al, 1996). As part of these reforms, a complex system of agricultural subsidies and controls aimed at protecting pastoral farming was dismantled and the state-owned plantation forestry estate was sold. Before the dismantling of this system, the value of these subsidies and controls was capitalised into the value of rural land (Johnson, 1989). The removal of subsidies, which began in 1984, led to a 50% decline in the real value of agricultural land over a short period. This impact was compounded by the post-reform appreciation of the now floating New Zealand dollar and by a major drought in 1988/89. Even by 1995, farmland values had recovered to only around 85% of their pre-reform real value (New Zealand. Ministry of Agriculture and Forestry, 1996).

Reform also led to large changes in land use in rural areas. There was a large diversification of production, with an expansion of high value horticultural production and plantation forestry, and a contraction of traditional agricultural uses of sheep and beef farming (Bradshaw, 1998). Marginal farmland, cleared through land development subsidies, was abandoned to revert back to indigenous forest.[2] Tourism also became a larger share of rural economic activity and the number of small lifestyle farm blocks increased.

Almost all privately owned land in New Zealand is held under the land title system of the Land Transfer Act 1952. All property rights are derived from the Crown and title to land in private ownership is a matter of public record. Restrictions on resource and land use are determined at the local government level. Before 1991, the management of natural and physical resources was subject to more than 20 separate statutes, sometimes invoking contradictory rules and thought to have a poor effect on the environment and to hinder development. The Resource Management Act 1991 was brought in to replace these statutes, shifting local government controls away from zoning and toward a sustainable management approach. With the Resource Management Act, emphasis was placed on the consequences of resource use and full community involvement in decision making.

[2] About 1.5 million hectares of pasture became regarded as marginal or uneconomic land for continued agricultural production (New Zealand. Ministry of Agriculture and Forestry, 1996).

3 Data

3.1 Quotable Value New Zealand Database

The primary data source used in this paper is a comprehensive property valuation database created by Quotable Value New Zealand (QVNZ) for 1989–2003.[3] QVNZ is New Zealand's largest valuation and property information company and currently conducts legally required property valuations for rating (tax) purposes for over 80% of New Zealand local government areas (councils)—in earlier years QVNZ had conducted valuations in all councils. The remaining councils use competing valuation companies to conduct their property valuations, but these data are purchased by QVNZ to create a complete database of all New Zealand properties. Valuations in each council are generally carried out on a three-year cycle, the timing of which differs across geographic areas with some five-year cycles occurring prior to 1995. These valuations occur continuously throughout the year and longitudinal records of all valuations are kept for each property.[4]

The property valuation database was matched by QVNZ to Statistics New Zealand (SNZ) 2001 meshblocks (MBs).[5] MBs are the smallest geographic area used by SNZ in the collection and processing of data, are typically aligned to cadastral boundaries, and are used to define administrative areas such as electoral districts and local government areas.[6] QVNZ

[3] Sales prices provide the most accurate information on market land values. However, rural land sales are quite infrequent making it difficult to use sales data for this type of study. Legally, valuations are supposed to reflect the market price for a particular property, and the ability of individuals to request a revaluation should provide a check on the system since local governments clearly have incentives to overvalue properties while owners typically want properties to be undervalued (e.g. to reduce rates).

[4] Valuations can occur off the three-year cycle because a property owner has requested a revaluation, a building consent has been issued for the property, the property has been subdivided or has otherwise changed its usage category, or because a mistake has been found in the record (private communication with Richard Deakin, QVNZ).

[5] This match was done using active property codes in August 2002. QVNZ matched 99.57% of active properties. A property becomes inactive if, for example, a subdivision occurs creating several new properties. Thus, any property that became inactive prior to the match will not have a MB assigned even if that property was active at some point prior to August 2002. For example, 10% of active properties in 1993 are not matched to a MB. This match failure rate decreases as we move closer towards August 2002.

[6] Rural MBs, as defined by SNZ, generally contain on average 100–150 individuals, although some MBs have no population and some have over 500 individuals.

then produced yearly extracts by assigning every property in the database a record in each year using its most recent valuation. These yearly extracts were then aggregated at the MB level by QVNZ to form the data used in this paper.[7] For most of the analysis in this paper, these yearly MB samples are further aggregated into three-yearly groupings, with one unique valuation for each MB in each cycle.[8]

There are 38,366 MBs defined using 2001 boundaries. For each MB in each three-yearly grouping, the QNVZ data record the total number of assessments, the total land value of all assessments, the total improved value of all assessments, and the total land area assessed.[9] These variables are also available separately for 20 'rural' land types, 5 'urban' land types, and an 'other' category that includes educational institutions, religious institutions, health care facilities, sports grounds, wilderness and conservation reserves, and other like properties.[10] For tractability, we aggregate these land types into 11 land use groups, as summarised in table 1: non-tradable/non-land (aquaculture and mining), urban, horticulture, pig/chicken, lifestyle, dairy, deer/horse, arable, intensive pastoral, extensive pastoral, and commercial forestry. We refer to these groups in the remainder of our analysis.[11]

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[7] Property level data is not made available because of confidentiality and privacy reasons. Thus, there is a changing composition of properties over time when following each MB longitudinally.

[8] The groups are 1989–1991, 1992–1994, 1995–1997, 1998–2000, and 2001–2003. These are arbitrary in the sense that any grouping of three consecutive years will contain new valuations for all MBs in New Zealand. In practice, properties in the same MB can be valued in different years and, as discussed in footnote 4, can have multiple valuations in the same three-year cycle. In these cases, values are aggregated in constant dollar terms for the most recent valuation in that cycle and are assigned to the year in which most of the valuations occurred. Our regression analysis controls for the actual year property valuations were undertaken in each MB to control for arbitrary grouping effects.

[9] Land values pertain only to the physical land, while improved values pertain to buildings and other additions to the physical land. Total land area is also available from SNZ for each MB. There appears to be a significant measurement error in the land area data collected by QVNZ. We rely on SNZ measured land area in most of our analysis and use the QVNZ data only when necessary.

[10] These are a combination of the 1-digit and 2-digit categories used by QVNZ to assign a land type to each property in its database. Further disaggregated categories exist and are potentially available for certain land types. Properties are assigned to a land type based on the highest and best use, or the use for which the property would be sold based on current economic conditions.

[11] The main horticulture crops grown in 2002 were kiwifruit, wine grapes, and apples, with avocados and olives becoming increasingly important. Most extensive pastoral land is dedicated to grazing sheep, beef cattle, and dairy cattle. Other animals farmed include goats, ostriches, emus, and alpacas, which are typically raised on similar land as pigs and poultry.

Land types are aggregated if they encompass a land use that is similar both ecologically and in value. We subtract non-tradable/non-land land from the overall totals for each MB and drop this land type from all analyses.

3.2 Defining Rural Land Areas

SNZ officially defines an urban area as a concentrated urban or semi-urban settlement centred on a city, major urban centre, large regional centre, or smaller town with at least 1,000 people. Rural centres are also defined as rural settlements or townships with a population of 300–999. The remaining areas are classified as rural. This is a quite narrow classification of rural areas and an inspection of the data shows that many MBs classified as urban by SNZ have a majority of properties used for agricultural or other 'rural' uses. Instead of relying on the SNZ classification, we decided to define rural areas for the purpose of this paper using a variety of data sources with the goal of capturing all areas with a significant amount of 'rural' activity.

Table 2 presents the components of our classification scheme. First, we dropped 294 MBs that are outside the 74 territorial local authorities that encompass mainland New Zealand and the Chatham Islands; second, we dropped 225 MBs that are defined by SNZ as being in the water;[12] third, we dropped the 93 MBs that are off-shore islands other than Waiheke Island (which has a reasonably large population); fourth, we dropped 5 MBs that are defined by the New Zealand Land Resource Inventory (NZLRI) as being in water;[13] fifth, we dropped 763 MBs in which more than 50% of the land area is administered by the

[12] They are typically harbours, lakes, and estuaries. These areas are assigned to MBs to account for people who live in houseboats and production that takes place on the water.

[13] The NZLRI is a physical land resource map that includes about 100,000 map units. The database records towns, lakes, waterways, estuaries, quarries, and mines. Land use capability assessments are also recorded and we discuss these in further detail later in the text. The database was made available to us by Landcare Research, but is also publicly available.

Department of Conservation (DoC).[14] These five steps eliminate 54% of the total area assigned to MBs, but only 1% of the total population.

Our next step is to remove narrowly defined urban areas. First, we dropped 23,890 MBs in which more than 5% of the land area is defined by the NZLRI to be a town. Only downtown areas are defined by NZLRI as being towns, and an inspection of the data shows these to match up well with the areas where most of the land use is 'urban'. Second, we dropped an additional 2,637 MBs where more than 50% of both the land value and the land use in the area is 'urban' in the QVNZ data during the latest valuation cycle (2001–2003). These two steps eliminate only 1% of the total area assigned to MBs, but 80% of the total population. To contrast the difference between this classification and SNZ's, 2,663 of the 10,459 MBs we code as rural are classified as urban by SNZ (and 578 as rural centres).

Of the 10,459 MBs we identify as being rural, 388 are missing QVNZ data entirely and 60 have no tradable land. Thus, we are forced to drop these areas from all analyses, leaving an overall rural sample of 10,011 MBs, which cover 44% of the total area and 19% of the population of New Zealand. QVNZ data is missing in the latest cycle for only two of these MBs. However, most of our analysis concentrates on examining changes in land values and land use between the first valuation cycle in our data (1989–1991) and the most recent. Unfortunately, QVNZ data is missing for an additional 1,572 MBs in the first valuation cycle. Dropping these MBs from the analysis reduces our geographical coverage of rural New Zealand by 13% and population coverage by 17–18%. Later in this section, we examine whether these MBs with missing data appear to be a random sample of all rural MBs or if our coverage is non-representative.

[14] The DoC land register records DoC conservation boundaries. The register includes Crown land DoC administers under the Conservation Act 1987, the Reserves Act 1977, the National Parks Act 1980, the Wildlife Act 1953, the Marine Reserves Act 1971, the Marine Mammals Protection Act 1978, and any other relevant act. We overlaid the DoC boundaries with SNZ 2001 MB boundaries to calculate the percentage of DoC land in each MB.

3.3 Overall Variation in Land Values

Now that we have defined rural areas, we use the QVNZ data to calculate land values and land uses for each rural MB. We focus our analysis on these outcome variables. The average value of tradable land is defined for each MB as the total land value in 1999 dollars divided by the total area of tradable land (real dollars per hectare). The total area in tradable land is calculated by multiplying the SNZ measure of MB land area by the percentage of land in non-water areas, as calculated from the NZLRI, and by the percentage of land in tradable land uses, as calculated from QVNZ data.[15] Similarly, we calculate the average real value of land and the percentage of total tradable land in each of the 10 tradable land uses for each MB. There are, on average, 33 assessments of tradable land use per rural MB, with, on average, 20 assessments of urban land use in MBs with urban land use, 11 assessments of lifestyle land use, and 1–7 assessments of agricultural land uses in MBs with those land uses.

Figure 1 graphs the three-year moving average of the geometric mean of the average real value of land in each land use across all rural MBs with valuations in a particular sample year.[16] Land values have increased significantly across all land uses. The general pattern of these increases looks comparable for all land uses in percentage terms (the y-axis is in a log scale). Commercial forestry had a particularly strong upsurge in value in the early 1990s and deer/horse land use grew particularly slowly during the same period. There is a noticeable surge in values in 1999–2000 for all land uses, which corresponds to a known boom in the rural sector caused primarily by a large depreciation in the New Zealand dollar. The ranking of land uses by value is stable across the entire period, with urban by far the highest value use

[15] As discussed previously, there appears to be a serious measurement error in the land area data collected by QVNZ. However, for our use, we need only the relative land area in each land type and not the overall level to be accurate. We assume this to be the case, but have no direct way of testing whether this is true.

[16] The geometric mean is the exponent of the mean of log values. This reduces the impact of large outliers in the data and is an alternative to using the median value. A three-year moving average (e.g. for year X, the displayed results are the mean of the results for year X-1, X, and X+1) is used because only a non-random one-third of all MBs have valuations in each year.

followed in order by horticulture, pig/chicken, lifestyle, dairy, deer/horse, arable, intensive pastoral, extensive pastoral, and commercial forestry uses. Land used for dairy, deer/horse, and arable uses is of similar value, as is land used in extensive pastoral and commercial forestry uses.

Figure 2 maps the spatial variation in the overall average value of tradable land across rural MBs using data from only the 2001–2003 valuation cycle. The rural MBs are ranked by average value, divided into deciles, and the MBs with more valuable land are mapped in progressively darker shades of red. Areas on the map in white are excluded from our analysis as discussed above. The results conform to expectations; the most valuable rural land in New Zealand is in the urban fringe area of Auckland, and in the growing areas of the Waikato, Bay of Plenty, Taranaki, Horowhenua, Wairarapa, Canterbury, and Southland regions. Because of the predominance of DoC land, few MBs on the west coast of the South Island are included in our analysis sample.

3.4 Defining Additional Variables

We also incorporate into our analysis data from multiple sources on the productive characteristics of the land, the local climate, and various local amenities. We briefly describe here how these variables are created. All variables are calculated at the MB level, which in most cases involves translating geographic information system (GIS) spatial data. The SNZ 2001 MB level 2 digital boundaries database is used to calculate the centroid (geometric centre) for each rural MB and most variables are then calculated at the MB-level as the value of the variable at the centroid. All variables discussed in this section are measured only once during the sample period.

We use five climate layers provided by the National Institute of Water and Atmospheric Research to calculate climate variables at the MB-level using the centroid method. The five layers are median annual rainfall, median annual air temperature, median length of frost-free period, median annual sunshine hours, and median annual days of soil moisture deficit during a calendar year for 1971–2000.[17] We calculate the distance to eight amenities recorded in Land Information New Zealand's New Zealand Geographic Place Names Database in April 2004, including the nearest airport, beach, lake, port, large town, train station, school, and ski area.[18] Here, we measure distance by a straight line from the MB centroid to the nearest highway, then travel along the highway until the nearest point on a straight line to the amenity, and a straight line from that point to the amenity. We calculate the percentage of Māori-owned land in each MB by overlaying the Māori Land Information Database (MLIB) with the SNZ 2001 MB boundaries.[19]

The NZLRI spatial database records current land use capability (LUC) assessments for each parcel of land in New Zealand based on five factors: rock type, soil type, slope group, erosion, and vegetation. Land is ranked from class 1 to 8, with LUC class 1 being the land most amenable to sustained agricultural production.[20] We calculate the percentage of land in each LUC class in each MB by overlaying this database with the MB boundaries. We also create several disaggregated variables on the productive characteristics of the soil in each MB. Soil variables include acid soluble phosphorous, soil age, exchangeable calcium,

[17] These layers were chosen by the National Institute of Water and Atmospheric Research as the most concise way to measure the agriculture productivity of particular land areas. The variables should also be good measures of the amenity value of local climate. Temperature is measured 1.3 m above the ground, a day is counted as a day of soil moisture deficit when the soil moisture, calculated using a water balance of incoming rainfall minus outgoing evaporation, is less than or equal to 75 mm, and the frost-free period runs from the last frost of the year until the first frost in the following year, where an air frost-free day is one on which the minimum air temperature measured 1.3 m above the ground did not fall below 0°C.

[18] This database records official place names in New Zealand, and contains more than 40,000 entries. The dataset is publicly available via the internet and contains only names that are in current use on topographic maps.

[19] The MLIB records Māori land boundaries and ownership details as defined by Te Ture Whenua Maori Act 1993/Maori Land Act 1993. The land governed by this act can be categorised as Māori freehold land, Māori customary land, or general land owned by Māori. The MLIB database was last updated in 2000.

[20] These assessments are intuitive interpretations by experts and not only rate each parcel based on an evaluation of the five factors, but take into account climate, past land use effects, and potential for erosion.

drainage characteristics, induration (hardness), and particle size.[21] These variables are all categorical and we calculate the percentage of land in each category in each MB by overlaying these layers with the MB boundaries. We also calculate the average slope of all land areas in each MB using an overlay approach. The soil and slope variables are correlated with LUC class, which is derived from soil type, slope, and climate information.

Table 3 presents summary statistics for all variables used in our analysis. The first column displays the means of all variables for the 1,572 rural MBs that have QVNZ data for the 2001–2003 cycle but are missing valuation data for the 1989–1991 cycle. The second column displays the means for the 8,437 MBs with valuation data for both cycles, which make up the sample for the remainder of our analysis. The excluded MBs have, on average, slightly more valuable land, land that is more likely to be used for horticulture, lifestyle, and commercial forestry uses, land that is less likely to be used for intensive pastoral uses, and slightly different productive and amenity characteristics. Overall, there is no clear pattern to the differences between the excluded MBs and the analysis sample, making it difficult to know whether we should be concerned about the representativeness of our main results.

4 Results

4.1 Changes in Land Values and Land Use

In this section we describe how land values and land use have changed in our subset of rural MBs that have valuation data for both the 1989–1991 and 2001–2003 valuation cycles. All comparisons are between these two end points in our data. Table 4 summarises changes in land use within MBs. The first three columns list the number of MBs in each period that have

[21] Acid soluble soil phosphorous relates to the soil's natural long-term fertility level, but does not indicate its potential response to fertiliser. Soil age recognises the distinction between recent soils and older soils, with young soils forming on recent flood, volcanic, or dune deposits having less fertility than older soils. Soil exchangeable calcium relates to soil acidity and nutrient levels, with low calcium soils normally having less versatility and requiring more chemical inputs for agriculture. Induration (hardness) describes the ability for deep soils to form, with deeper soils generally being more productive than the shallow soils that occur on hard rock types. Soil particle size categories range from silt and clay (most productive) to boulders and bedrock (least productive).

a particular type of land use. For example, the results in the row labelled 'urban' show that 5,572 out of 8,437 rural MBs had some urban land in both valuation cycles, 94 MBs had urban land in 1989–1991 but not in 2001–2003, 574 had urban land in 2001–2003 but not previously, and the remaining 2,197 MBs had no urban land in either cycle. The next four columns compare the average log value of each type of land in each valuation cycle broken down by whether the MB starts, stops, or continues in that land use across cycles. For example, the results in the row labelled 'urban' show that the average log value of urban land in the 94 MBs that stopped having urban land was 9.43 in 1989–1991 while the average log value of urban land in the 5,572 MBs that continued to have urban land was 10.30 in 1989–1991.

The results in this table highlight both how land use has been changing and whether MBs that are changing uses are increasingly developing marginal land. There has been a large increase in the number of MBs with lifestyle, deer/horse, dairy, pig/chicken, urban, and commercial forestry land uses. The new land devoted to these uses is, on average, of less value than the land in MBs already in these uses, for all uses but pig/chicken and commercial forestry. In particular, increasingly marginal lands appear to be used for urban, lifestyle, and dairy uses with new land approximately 20–30% less valuable. On the other hand, new land devoted to pig/chicken and commercial forestry uses is worth approximately 25–30% more than the average land in MBs already in these uses. This may indicate that technological innovations have allowed new land areas to be used more profitably for these uses.

The remaining land uses (horticulture, arable, and intensive and extensive pastoral) have seen balanced churning with an equal number of new MBs starting to have these types of land use as old MBs no longer having them. These land uses can be broken down into two groups. In the first group, MBs that stopped having intensive and extensive pastoral land use had pastoral lands worth more than the average pastoral land in continuously farmed MBs, but MBs that started having pastoral land use also have pastoral lands worth more than the average pastoral land in continuously farmed MBs. This suggests there was some change in the type of land that made good quality pasture land over the period. In the second group, MBs that stopped having horticulture and arable land uses had slightly lower value land in these uses than the continuing MBs, and MBs that started having these land uses had approximatley 15% lower value land in these uses than the continuing MBs.

Table 5 summarises changes in land values and changes in overall land use intensity. The first two columns display, for each land type, the average log value in each cycle for all rural MBs that have that land use in both cycles. The third column displays the percent change in the value of land in this fixed set of MBs and the fourth the number of MBs used in this analysis. The fifth and six columns display the overall percentage of rural land devoted to each land use, and the seventh column the percent change in each land use.

The real value of land in all uses has increased substantially over the years being examined. The land uses that were initially the least valued (commercial forestry, intensive and extensive pastoral, and arable) increased the most (240–300%), but even the highest valued land uses (urban, horticulture, pig/chicken, and lifestyle) increased by 125–165%. Land use also changed considerably during this period, but was essentially uncorrelated with changes in land values.[22] There was a large increase in the percentage of rural land used for deer/horse, pig/chicken, and commercial forestry uses, a smaller increase in land used for lifestyle and dairy uses, and a moderate decline in land used for intensive and extensive pastoral, arable, horticulture, and urban uses. We find no evidence of a shift to higher value land uses.[23]

[22] More formally, the correlation coefficient between changes in land use and changes in land values is 0.02.
[23] The correlation coefficient between average land values in 1989–2001 and the percent change in land use is -0.12, indicating that there was, in fact, a weak shift towards lower value land uses.

Table 6 decomposes the overall change in tradable land value between 1989–1991 and 2001–2003 into two components: changes in the value of land in different uses and changes in land use holding values constant in each use. We beginning by first decomposing total tradable land value in each three-year cycle into the contributions from each land use. Columns 1 and 2 display the average log real value for each land use in 1989–1991 and 2001–2003 multiplied by the percentage of land in that use in each cycle. This is an approximate decomposition because, as noted above, not every land use exists in each MB, so the total of each of these components (7.88 in 1989–1991 and 9.00 in 2001–2003) is less than the actual average log value of tradable land (7.96 in 1989–1991 and 9.16 in 2001–2003). Columns 3 and 4 display the share of the approximate overall log value of tradable land contributed by each land use in each cycle, and column 5 displays the percent change in these contributions.

These results show that in 1989–1991 intensive pastoral uses contributed 31% of the total value of rural land, dairy contributed 20%, lifestyle 19%, urban 10%, extensive pastoral 8.4%, horticulture 5.2%, arable 2.8%, commercial forestry 2.3%, deer/horse 1.0%, and pig/chicken 0.2%. Between 1989–1991 and 2001–2003 the contribution of deer/horse, commercial forestry, and pig/chicken uses to overall land values increased substantially, the contribution of lifestyle and dairy uses increased moderately, the contribution of extensive pastoral, arable, and intensive pastoral uses decreased moderately, and the contribution of urban and horticulture uses decreased substantially. Even with these changes, the ranking of the relative importance of each land use to overall land values remained the same besides commercial forestry surpassing arable land use in importance.

Finally, column 6 displays the overall log value of tradable land contributed by each land use in 1989–1991 using the average log real value of each land use in 2001–2003 to value the percentage of land in each use in 1989–1991. These results compared with those in column 2 isolate the contribution of changing land use to the overall change in tradable value. Similarly, column 7 displays the results of valuing each land use in 2001–2003 using 1989–1991 values, and these results compared with those in column 1 also isolate the contribution of changing land use to the overall change in tradable value using a different set of reference values. Overall, these results show that only 2% of the approximately 235% increase in overall land values seen in this period is explained by changes in land use; almost the entire increase is explained by the increasing value of all land uses holding actual land use constant.

4.2 Regression Analysis of Changing Land Values

In this section, we report results from estimating hedonic regression models that allow us to investigate the impact of land attributes on land values. A similar approach is taken by Bastian et al (2002), Plantinga et al (2002), and Plantinga and Miller (2001). As discussed in these papers, hedonic regression models are based on the premise that goods traded in the market are made up of different bundles of attributes and the relationship between these characteristics and market values reflect the underlying demand for these characteristics in the market. Hedonic regressions are reduced form models indicating the attributes relevant to both buyers and sellers of a particular good (i.e. rural land) and it is not possible to isolate the pathways through which a particular attribute affects market values.

The hedonic regression models estimated in this paper take the form:

$$LV_{ma} = \alpha + \beta X_{ma} + \delta Z_{ma} + e_a + e_{ma} \quad (1)$$

where m indexes MBs; a indexes area units; LV_{ma} is the average overall tradable log real land value per hectare in each MB in either 1989–1991 or 2001–2003 or the change in log value between 1989–1991 and 2001–2003; X_{ma} is a vector of variables that measure the productive characteristics of the land, the local climate, and various local amenities; and Z_{ma} is a vector of variables that measure land use in either 1989–1991 or 2001–2003 or the change in land use between 1989–1991 and 2001–2003.[24] The error term consists of two components: the first, e_a, is an area unit random effect that captures spatial correlation in land values by assuming that all MBs in each area unit have their own error component drawn from a mean-zero, variance σ_a^2 distribution that is uncorrelated with the explanatory variables; and the second, e_{ma} is a standard iid error term.[25]

Economic theory does not provide any direction concerning the functional form of variables included in hedonic regression models. Land values are calculated in logs because of the skewness in the distribution of land values across MBs, so all coefficients on the explanatory variables are interpreted as semi-elasticities (or elasticities in some cases). The functional form of all explanatory variables was decided on by evaluating the overall goodness-of-fit of a series of models in which groups of like variables were controlled for increasingly non-parametrically (i.e. first linearly, then in logs, quadratics, and finally in quantiles). The best trade-off between model fit and the conciseness of the explanatory variables was found in models where climate variables and slope were entered in quantiles (non-linearities are likely important for these variables because they measure both agricultural productivity and the liveability of locations), amenity variables and population density in logs, DoC and Māori land ownership by including indicator variables for some (<25%) and a lot of (>=25%) ownership, cadastral location linearly, and all other variables as the percentage of land in a particular category with one reference category excluded.

[24] The following variables are included in the X_{ma} vector: the 5 variables measuring climate, the 10 measuring distance to nearest amenities, and the 8 measuring land use capability, soil characteristics, and slope all defined in section 3.4, and whether the MB is on the coast, the percentage of land owned by DoC, the percentage of land owned by Māori, the percentage of land classified as a town in the NZLRI, whether the MB has any irrigated arable land according to QVNZ data, the cadastral location of the MB centroid, the population density in either 1991 or 2001, the change in population density between 1991 and 2001 in certain specifications, and indicator variables for the actual year in the three-year cycle in which the valuation occurred.

[25] Area units are the next level of aggregation above MBs in SNZ's classification scheme. There are 825 area units represented in our rural sample containing 1–79 MBs with an average of 10 and median of 5 MBs in each area unit. This type of random effects model is estimate using generalised least squares.

Table 7 presents eight specifications of the model described in equation (1). The first specification examines the relationship between overall land values in 1989–1991 and MB attributes excluding the Z_{ma} variables that control for actual land use in this cycle. This regression model explains 67% of the overall variation in land values across MBs in New Zealand in 1989–1991. Also displayed in the table is the partial r-squared attributed to each group of explanatory variables.[26] Population density and the distance to amenities variables are by far the most important determinants of overall land values. The most important amenities are airports, beaches, ports, schools, and ski areas, with land values declining by 1.7–2.1% for each 10% increase in distance from the nearest one of these. The only other amenity that affects land values is being near a large town with a 10% increase in distance from the nearest large town reducing land values by 0.8%. Population density is strongly positively related to land values with a 10% increase in population per hectare increasing values by 13%.

Of the remaining groups of variables, climate, LUCs, and soil characteristics are also important, but none has a partial r-squared greater than 0.02. Among the climate variables, sunshine hours are strongly positively related to land values with the one-fifth of MBs with the most sunshine hours having 57% higher land values than the one-fifth of MBs with the least sunshine hours, and rainfall is strongly negatively related to land values with the MBs with the most rainfall having 48% lower land values than those with the least. Very short frost-free periods, few days with soil moisture deficit, and low air temperatures are associated with lower land values, and a long frost-free period with high land values. There is a strong gradient in the relationship between LUC class and land values, with class 3 land worth 23%

[26] This is the squared partial correlation between each group of variables and log land values and is calculated as the decrease in r-squared that occurs if you remove that group of variables from the full regression model normalised by the overall explanatory power of all the remaining variables. The summation of all partial r-squareds does not equal the total r-squared for the model because of the additional explanatory power derived from the correlation between different groups of variables.

less than classes 1 and 2 land, class 4 land worth 37% less, class 5 land worth 51% less, class 6 land worth 66% less, class 7 land worth 117% less, and class 8 land worth 163% less.[27] Among soil characteristics and slope, MBs with steeper slopes, high levels of exchangeable calcium soil, and weakly indurated soil have lower land values, while those with moderate and high acid soluble phosphorous soil and older soil have higher land values.

The second specification in Table 7 examines the relationship between overall land values in 2001–2003 and MB attributes, but is otherwise identical to the first specification. This model explains 66% of the overall variation in land values and the same groups of variables are important in explaining this variation as in 1989–1991. The signs and magnitudes of most coefficients are similar in these two models. The general stability of the results suggests that the underlying processes that drive land values have not changed over the period examined. Importantly, this indicates that a model that attempts to explain changes in land values over time in different MBs will be able to identify particular characteristics that are correlated with long-run changes in land values.

The third specification adds the Z_{ma} variables that control for land use in 2001–2003 to the model estimated in the second specification. Controlling for land use increases the explanatory power of the model by only 1%; land use has a partial r-squared of 0.037, but its inclusion in the model reduces the explanatory power of most other groups of variables, indicating that one pathway through which these variables affect land values is through their direct impact on land use. Interestingly, while controlling for land use reduces the overall explanatory power of the other variables, it has almost no impact on the signs and magnitudes of most coefficients. The coefficients on the land use variables themselves are discussed in the next section of the paper.

[27] The reported percentage differences are the coefficients on each indicator variable multiplied by 100. This is an approximate percent change with the actual percentage change calculated as [exp(coefficient) – 1].

The fourth specification in Table 7 examines the relationship between changes in overall land values between 1989–1991 and 2001–2003 and fixed MB attributes. MB attributes explain only 10% of the variation in the change in land values observed in the data. Population density is the most important explanatory variable. Contrasting with the cross-sectional results, MBs with greater population density in 1991 had smaller increases in land values; a MB with 10% greater population density had a 2.7% smaller increase than an otherwise identical MB. None of the other groups of variables has much explanatory power. Some of the more interesting results are that areas with more sunshine hours, closer to airports, beaches, ports, train stations, and ski areas, on the coast, with LUC class 8 land, and with steeper slopes had a greater increase in land value than otherwise identical MBs, while areas with warmer temperatures, closer to large towns and schools, with lots of Māori-owned land, with flatter slopes, and with more town land had a smaller increase in land value.

The fifth specification adds control variables for land use in 1989–1991 to the model estimated in the fourth specification. Initial land use is an important explanatory variable for understanding changes in land values. However, controlling for initial land use has little impact on the explanatory power of the other groups of variables or on the signs and magnitudes of most coefficients. The sixth specification adds further control variables for changes in land use between 1989–1991 and 2001–2003 as well as changes in population density. It is quite likely that these variables are endogenous in the sense that land use and population movements are likely to change in response to changing land values. Changes in land use are found to be an important explanatory variable for understanding changes in land values. However, the inclusion of these variables has almost no impact on the signs and magnitudes of most coefficients, suggesting that endogeneity bias may not be an important concern. Interestingly, only large increases in population density are related to changes in land values, with the one-fifth of MBs with the largest increase in population density having a

6–10% greater increase in land values than other MBs. Again, the coefficients on the land use variables themselves are discussed in the next section of the paper.

The seventh specification in Table 7 examines the relationship between changes in land use between 1989–1991 and 2001–2003 and fixed MB attributes. Land use is measured by valuing each land use in a particular MB at the 1989–1991 average log value for that use in both 1989–1991 and 2001–2003 and summing all land uses for the MB (as in column 7 of Table 6). Thus, changes over time in this measure solely reflect changes in land use (i.e. an increase indicates a MB has shifted to higher value land use and vice versa). MB characteristics explain only 2% in the variation in changes in land use, with few significant variables. MBs with high levels of sunshine and greater population density are least likely to change to higher value land uses, while those with DoC- and Māori-owned land are most likely to change to higher value land uses. However, these results may just reflect the initial land use in a particular area, since it is difficult for a MB with mainly high value land in 1989–1991 to change to higher value uses.

To control for this possibility, the final specification adds additional control variables for land use in 1989–1991 to the model estimated in the seventh specification. Unsurprisingly, initial land use explains a large amount (27%) of the variation in changes in land use. No longer do we find any relationship between sunshine or land ownership and changes in land use, and we now find that population density is positively related to changes to higher value land uses. This confirms that the findings in the seventh specification arise because MBs with high levels of sunshine and greater population densities initially have mainly high value land uses, making it difficult for land use values to increase in these MBs (and vice versa for those with DoC- and Māori-owned land). Now, the variables measuring distance to amenities and population density also explain a significant amount of the variation in changes in land use. MBs closer to airports, beaches, ports, schools, and ski areas are more likely to change to higher value land uses than other MBs. MBs increasing the most in population density are also more likely to change to higher value uses.

4.3 Relationship between Land Use and Changing Land Values

Table 8 summarises the regression coefficients that measure the relationship between land values and land use. These coefficients are mostly estimated in the models discussed above and presented in table 7, although some are from slightly different specifications. The first column in this table displays the coefficients on land use from a regression of overall land values in 1989–1991 on MB attributes and variables that control for land use in 1989–1991. The second column presents the same coefficient for 2001–2003 (i.e. these match the third specification in table 7). The coefficients on each land use are interpreted relative to the omitted category of intensive pastoral use, which is the most common land use. In general, the coefficients are as expected, areas with more land in higher value uses have higher overall land values. Interestingly, MBs with more pig/chicken and deer/horse uses, two higher value uses, do not have higher overall land values, suggesting these often occur in tandem with lower value uses. Dairy land use stands out in both cycles as being strongly predictive of overall high value land use in an area. This is also found for lifestyle land use in 1989–1991.

The third column displays the coefficients on land use from a regression of the change in land values between 1989–1991 and 2001–2003 and controls for land use in 1989–1991. No other control variables are included in the model besides the valuation year indicator variables. Initial land use explains 5% of the variation in the change in land values. MBs with more urban, horticulture, pig/chicken, lifestyle, and diary land uses have smaller increases in land values than those with deer/horse, arable, intensive pastoral, and extensive pastoral land uses. MBs with more commercial forestry have by far the largest increases in land values. The fourth column displays the same coefficients after adding controls for MB attributes to the model (i.e. these match the fifth specification in table 7). All the previous findings remain, except now MBs with more urban land uses have higher than average growth in land values than other MBs.

The fifth column displays the same coefficients when we add further control variables for changes in land use between 1989–1991 and 2001–2003, as well as changes in population density (i.e. these match the sixth specification in table 7). Again, this has little impact on the previous findings, except that dairy land is no longer associated with a smaller increase in land values than the reference land use. This column also displays the coefficients on the change in land use variables. Of the variables that are strongly significant, MBs with increasing land use in pig/chicken, lifestyle, and extensive pastoral uses have much slower growth in land values than other MBs, while MBs with increasing land use in dairy have much stronger growth in land values.

The sixth and seventh columns display the coefficients on initial land use from regressions of changes in land use between 1989–1991 and 2001–2003 on MB attributes (in the seventh column) and controls for land use in 1989–1991 (in both columns). The results in the seventh column match the eighth specification in table 7. These coefficients reflect an essentially mechanical mean-reversion process, because only MBs with low value land use in 1989–1991 can have large increases in the value of land use when different land uses are measured over time in constant values. This relationship explains 15% of the variation in changes in land use when MB attributes are not included in the model and 26% when MB attributes are included.

5 Conclusions

This paper examines how the value of the rural land in New Zealand has changed between 1989 and 2003. We highlight the importance of both changes in land use and changes in the value of land in different uses in this adjustment process. We examine the relationship between productive characteristics of the land, the local climate, various local amenities, and these changes in land values and land use to better understand what changes have been driving the increase value of rural land seen across much of New Zealand during this period.

We find that the real value of rural land in all uses increased substantially over the years examined, with land uses that were initially the least valued (commercial forestry, intensive and extensive pastoral, and arable) increasing the most (240–300%), but with even the highest valued uses (urban, horticulture, pig/chicken, and lifestyle) increasing by 125–165%. Land use in rural areas also changed considerably during this period, with large increases in the percentage of land used for deer/horse, pig/chicken, and commercial forestry uses, smaller increases in land used for lifestyle and dairy uses, and a moderate decline in land used for intensive and extensive pastoral, arable, horticulture, and urban uses. Perhaps surprisingly, these changes in land use were essentially uncorrelated with changes in land values. For example, a decomposition shows that only 2% of the approximately 235% increase in overall land values is explained by changes in land use.

Our regression results indicate that rural land values increased the most in less populated areas with good climates and local amenities. Initial land use also plays an important role in explaining the variation in changes in rural land values with greater increases in land values found in areas with more land initially devoted to urban uses and commercial forestry, and less land initially devoted to horticulture and lifestyle uses. On the other hand, land use changed to increasingly higher values uses in areas with higher population densities, good amenities, and increasing population densities. Overall, the characteristics of local areas explain 15% of the change in rural land values and 8% of the change in rural land use during the period under investigation.

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Figure 1: Changing Value of Different Types of Land between 1990 and 2002 (1999 Dollars)

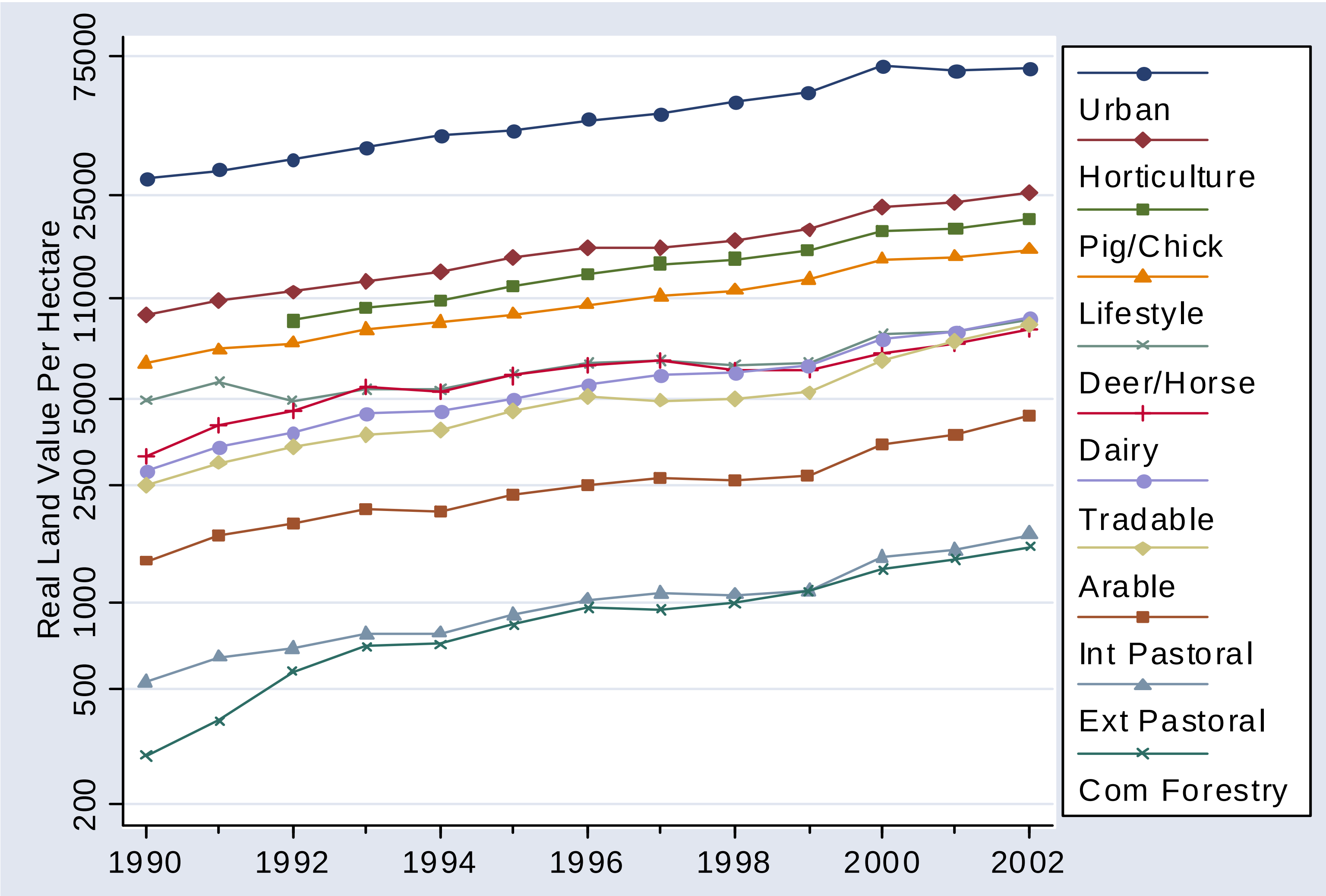

Figure 2: Spatial Variation in Land Values in the 2001-2003 Valuation Cycle (Darker Red = Higher Value)

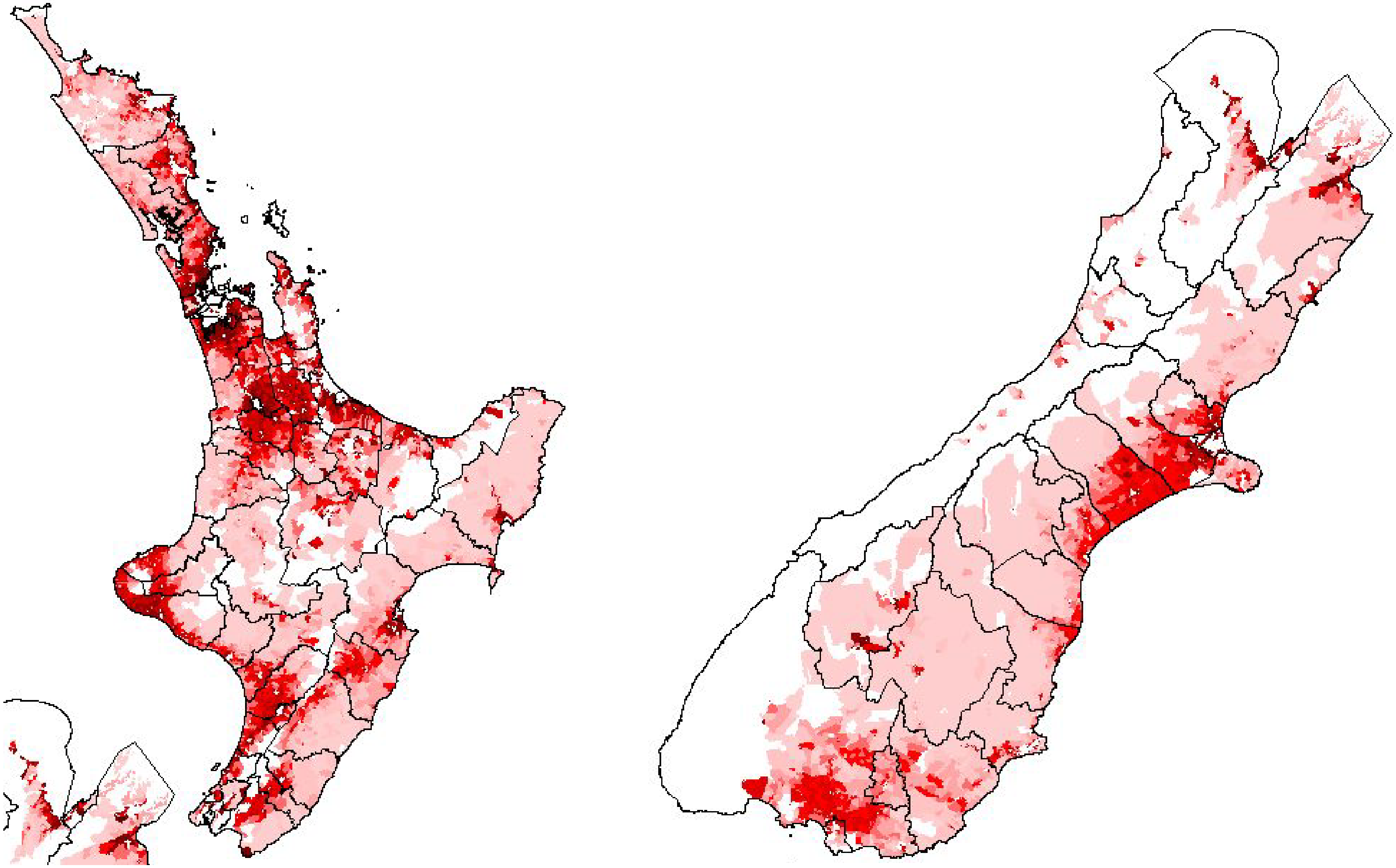

Table 1: Defining Land Use Groups

Aggregated Land Use	QVNZ Property Land Types
Non-Tradable/Non-Land	Other, Mining, Specialised Aquaculture, Forestry Indigenous/Protected
Urban	Commercial Built On, Industrial Built On, Commercial/Industrial Vacant, Residential Built On, Residential Vacant
Horticulture	Horticulture
Pig/Chicken	Specialised Poultry, Specialised Pigs, Specialised Other
Lifestyle	Lifestyle Improved, Lifestyle Vacant
Dairy	Dairying Factory, Dairying Town Supply
Deer/Horse	Specialised Deer, Specialised Horse
Arable	Arable Irrigated, Arable Non-Irrigated
Intensive Pastoral	Pastoral Fattening/Stud
Extensive Pastoral	Pastoral Grazing, Pastoral Run
Commercial Forestry	Forestry Exotic, Forestry Vacant

Note: Land types are aggregated together if they encompass land use that is similar both ecologically and in value.

Table 2: Defining Rural Land Areas

	Number of Meshblocks	2001 Population	1991 Population	Total Area (Sq KMs)
All Meshblocks (MBs)	38,366	3,734,106	3,370,116	405,812
Outside TLA (SNZ)	294	0%	0%	33%
Water MBs (SNZ)	225	0%	0%	2%
Off-Shore Islands (SNZ)	93	0%	0%	1%
Water MBs (NZLRI)	5	0%	0%	0%
Majority DoC (DoC Area > 50%)	763	1%	1%	18%
Urban Area (NZLRI: Town > 5%)	23,890	72%	74%	1%
Urban Area (QVNZ: 2001-2003 Cycle)	2,637	8%	6%	0%
No Valuation Data (QVNZ)	388	0%	0%	1%
No Tradable Land (QVNZ)	60	0%	0%	1%
Missing Valuation Data in 89-91 (QVNZ)	1,574	3%	3%	5%
Overall Rural Sample	10,011	19%	19%	44%
Balanced Panel Sample	8,437	16%	15%	38%

Note: Meshblocks are defined by Statistics New Zealand. Population figures are from the Census and land area is from Statistics New Zealand cadastral database.

Table 3: Characteristics of Rural Land Areas

	No Valuation Data Available for 89-91	Balance Panel (Analysis Sample)
Overall Tradable Real Land Value Per Ha in 2001-2003	$9,852	$9,550
Urban Real Land Value Per Ha in 2001-2003	$98,213	$63,981
Horticulture Real Land Value Per Ha in 2001-2003	$26,403	$25,197
Pig/Chicken Real Land Value Per Ha in 2001-2003	$29,220	$20,198
Lifestyle Real Land Value Per Ha in 2001-2003	$16,434	$16,585
Dairy Real Land Value Per Ha in 2001-2003	$6,350	$9,803
Deer/Horse Real Land Value Per Ha in 2001-2003	$9,838	$9,664
Arable Real Land Value Per Ha in 2001-2003	$15,473	$9,199
Intensive Pastoral Real Land Value Per Ha in 2001-2003	$3,647	$4,627
Extensive Pastoral Real Land Value Per Ha in 2001-2003	$1,655	$1,742
Commercial Forestry Real Land Value Per Ha in 2001-2003	$1,301	$1,645
Percent Urban Land Area in 2001-2003	7.3%	7.0%
Percent Horticulture Land Area in 2001-2003	9.5%	3.6%
Percent Pig/Chicken Land Area in 2001-2003	0.4%	0.3%
Percent Lifestyle Land Area in 2001-2003	26%	20%
Percent Dairy Land Area in 2001-2003	19%	22%
Percent Deer/Horse Land Area in 2001-2003	1.0%	1.7%
Percent Arable Land Area in 2001-2003	0.5%	2.5%
Percent Intensive Pastoral Land Area in 2001-2003	15%	29%
Percent Extensive Pastoral Land Area in 2001-2003	12%	10%
Percent Commercial Forestry Land Area in 2001-2003	8.4%	3.9%
Median Length of Frost Free Period days)	282	257
Median Annual Bright Sunshine Hours	2069	1911
Median Annual Rainfall Total (mm)	1384	1226
Median Annual Days With Soil Moisture Deficit	49	50
Median Annual Air Temperature (celcius)	14	12
Distance to Nearest Airport (km)	30	42
Distance to Nearest Beach (km)	37	68
Distance to Nearest Lake (km)	21	27
Distance to Nearest Port (km)	98	91
Distance to Nearest Large Town (km)	16	13
Distance to Nearest Train Station (km)	135	158
Distance to Nearest School (km)	5.2	5.4
Distance to Nearest Ski Area (km)	303	223
Coastal Meshblock	21%	13%
Percent Department of Conservation Land	4.2%	3.1%
Percent Māori Owned Land	5.1%	3.4%
Percent Land Area in Land Use Capability Class 1	4.5%	4.9%
Percent Land Area in Land Use Capability Class 2	15%	21%
Percent Land Area in Land Use Capability Class 3	21%	24%
Percent Land Area in Land Use Capability Class 4	15%	15%
Percent Land Area in Land Use Capability Class 5	0.5%	1.7%
Percent Land Area in Land Use Capability Class 6	32%	24%
Percent Land Area in Land Use Capability Class 7	10.0%	8.7%
Percent Land Area in Land Use Capability Class 8	2.6%	1.2%
Average Slope (degrees)	5.9	4.7
Percent Land Area w/ Very Low Acid Soluble Phosphorous Soil	35%	21%
Percent Land Area w/ Low Acid Soluble Phosphorous Soil	32%	32%
Percent Land Area w/ Moderate Acid Soluble Phosphorous Soil	18%	25%
Percent Land Area w/ High+ Acid Soluble Phosphorous Soil	15%	22%
Percent Land Area w/ Younger Soil	15%	14%
Percent Land Area w/ Older Soil	85%	86%
Percent Land Area w/ Low Exchangeable Calcium Soil	46%	28%
Percent Land Area w/ Moderate Exchangeable Calcium Soil	48%	64%
Percent Land Area w/ High+ Exchangeable Calcium Soil	6.0%	7.2%

Percent Land Area w/ Very Poor Draining Soil	5.3%	4.1%
Percent Land Area w/ Poor Draining Soil	8.5%	12.2%
Percent Land Area w/ Imperfect Draining Soil	22%	19%
Percent Land Area w/ Moderate Draining Soil	11%	21%
Percent Land Area w/ Good Draining Soil	53%	44%
Percent Land Area w/ Non-Indurated Soil	15%	26%
Percent Land Area w/ Very Weakly Indurated Soil	28%	32%
Percent Land Area w/ Weakly Indurated Soil	22%	11%
Percent Land Area w/ Strongly+ Indurated Soil	35%	31%
Percent Land Area w/ Silt and Clay Soil	37%	53%
Percent Land Area w/ Sand Soil	25%	17%
Percent Land Area w/ Gravel Soil	14.1%	7.8%
Percent Land Area w/ Coarse to Very Coarse Gravel Soil	8.8%	8.6%
Percent Land Area w/ Boulders to Massive Soil	15%	14%
Has Irrigated Arable Land	0.9%	2.8%
Percent Land Area Town in NZLRI	0.1%	0.1%
Population Per Hectare in 1991	0.61	0.70
Change in Population Per Hectare between 1991 and 2001	0.16	0.11
Surveyed in 1989 for 1989-1991 Cycle		36%
Surveyed in 1990 for 1989-1991 Cycle		37%
Surveyed in 1991 for 1989-1991 Cycle		26%
Surveyed in 2001 for 2001-2003 Cycle	19%	44%
Surveyed in 2002 for 2001-2003 Cycle	39%	26%
Surveyed in 2003 for 2001-2003 Cycle	42%	29%
Number of Meshblocks	1,572	8,437

Note: Meshblocks are defined by Statistics New Zealand. All values are in 1999 real dollars. The summarised variables are from a number of sources and are defined in the body of the paper.

Table 4: Changes in Land Use between 1989-1991 and 2001-2003 Valuation Cycles

	Number of Meshblocks			Average Log Real Land Value Per Ha in 1989-1991		Average Log Real Land Value Per Ha in 2001-2003	
Land Type	Land Use in Only 1989-1991	Land Use in Both Cycles	Land Use in Only 2001-2003	Land Use in Only 1989-1991	Land Use in Both Cycles	Land Use in Only 2001-2003	Land Use in Both Cycles
Urban	94	5,572	574	9.43	10.30	10.77	11.10
Horticulture	230	1,255	338	9.16	9.20	10.00	10.17
Pig/Chicken	78	239	322	8.89	8.84	10.03	9.76
Lifestyle	44	6,228	1,045	8.86	8.81	9.54	9.75
Dairy	147	3,034	628	8.30	8.07	9.01	9.23
Deer/Horse	101	600	723	8.47	8.12	9.15	9.21
Arable	85	541	78	7.84	7.89	9.00	9.15
Intensive Pastoral	349	4,545	368	8.14	7.16	8.88	8.40
Extensive Pastoral	206	2,107	284	7.34	6.16	7.99	7.39
Commercial Forestry	176	929	532	5.36	5.89	7.60	7.30

Note: Meshblocks (MBs) are defined by Statistics New Zealand. All values are in 1999 real dollars. Land types are defined in the body of the paper. There are 8,437 rural MBs in the overall sample.

Table 5: Changes in Land Values and Land Use Intensity between 1989-1991 and 2001-2003 Valuation Cycles

	Average Log Real Land Value Per Ha			MBs w/ Land Use	Percent Total Land Area		
Land Type	1989-1991	2001-2003	Percent Change	in Both Cycles	1989-1991	2001-2003	Percent Change
Overall Tradable	7.96	9.16	233%	8,437			
Urban	10.30	11.10	123%	5,572	7.9%	7.0%	-12%
Horticulture	9.20	10.17	164%	1,255	4.4%	3.6%	-18%
Pig/chicken	8.84	9.76	152%	239	0.2%	0.3%	31%
Lifestyle	8.81	9.75	155%	6,228	17.2%	20.0%	16%
Dairy	8.07	9.23	217%	3,034	19.5%	21.6%	11%
Deer/Horse	8.12	9.21	196%	600	1.0%	1.7%	69%
Arable	7.89	9.15	252%	541	2.8%	2.5%	-10%
Intensive Pastoral	7.16	8.40	246%	4,545	33.2%	29.4%	-12%
Extensive Pastoral	6.16	7.39	241%	2,107	10.6%	10.0%	-6%
Commercial Forestry	5.89	7.30	309%	929	3.1%	3.9%	26%

Note: Meshblocks (MBs) are defined by Statistics New Zealand. All values are in 1999 real dollars. Land types are defined in the body of the paper. Average land values are calculated only for MBs with a particular type of land use in both 1989–1991 and 2001–2003.

Table 6: Decomposition of Overall Change in Land Values between 1989-1991 and 2001-2003 Valuation Cycles

	Average Log Real Land Value Per Ha * Percent Land Area in each Land Type		Share of Approx. Overall Tradable Log Real Value Per Ha			At 2001-2003 Log Real Value Per Ha	At 1989-1991 Log Real Value Per Ha
Land Type	1989-1991	2001-2003	1989-1991	2001-2003	Change	1989-1991	2001-2003
Overall Tradable (approx.)	7.88	9.00				8.98	7.90
Urban	0.82	0.78	10.4%	8.6%	-19.9%	0.88	0.72
Horticulture	0.41	0.37	5.2%	4.1%	-27.0%	0.45	0.33
Pig/Chicken	0.02	0.03	0.2%	0.3%	22.2%	0.02	0.03
Lifestyle	1.52	1.95	19.3%	21.6%	10.9%	1.67	1.76
Dairy	1.57	1.99	20.0%	22.1%	9.5%	1.79	1.75
Deer/Horse	0.08	0.15	1.0%	1.7%	39.7%	0.09	0.14
Arable	0.22	0.23	2.8%	2.5%	-9.0%	0.25	0.20
Intensive Pastoral	2.40	2.48	30.5%	27.5%	-10.7%	2.80	2.12
Extensive Pastoral	0.67	0.75	8.4%	8.3%	-1.9%	0.79	0.63
Commercial Forestry	0.18	0.29	2.3%	3.2%	29.1%	0.23	0.23

Note: All values are in 1999 real dollars. Land types are defined in the body of the paper. There are 8,437 rural meshblocks in the overall sample.

Table 7: Predictors of Overall Tradable Log Real Land Value Per Hectare

	1989-1991	2001-2003	2001-2003	Change in Tradable Land Value between 1989-1991 and 2001-2003			Change in Land Use at Constant 1989-1991 Values	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total R-Squared	[0.665]	[0.657]	[0.670]	[0.097]	[0.122]	[0.153]	[0.021]	[0.281]
Partial R-Squared for Initial Land Use			[0.037]		[0.028]	[0.021]		[0.265]
Partial R-Squared for Climate	[0.015]	[0.019]	[0.021]	[0.006]	[0.008]	[0.011]	[0.003]	[0.002]
Partial R-Squared for Distance to Amenities	[0.158]	[0.171]	[0.135]	[0.010]	[0.008]	[0.008]	[0.001]	[0.022]
Partial R-Squared for Ownership and Coastal	[0.008]	[0.014]	[0.012]	[0.001]	[0.001]	[0.002]	[0.002]	[0.001]
Partial R-Squared for LUC Index	[0.020]	[0.017]	[0.010]	[0.003]	[0.004]	[0.003]	[0.001]	[0.001]
Partial R-Squared for Soil Characteristics	[0.022]	[0.026]	[0.015]	[0.010]	[0.008]	[0.009]	[0.004]	[0.011]
Partial R-Squared for Town and Irrigation	[0.002]	[0.000]	[0.000]	[0.001]	[0.001]	[0.001]	[0.001]	[0.000]
Partial R-Squared for Population Density	[0.285]	[0.271]	[0.150]	[0.046]	[0.052]	[0.046]	[0.005]	[0.039]
Partial R-Squared for Geographical Location	[0.008]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]
Partial R-Squared for Year Dummy Variables	[0.001]	[0.018]	[0.021]	[0.005]	[0.005]	[0.007]	[0.000]	[0.001]
Partial R-Squared for Δ Population Density						[0.007]		[0.010]
Partial R-Squared for Δ in Land Use						[0.031]		
1st Quantile Length of Frost Free Period	-0.124**	-0.100**	-0.094**	0.011	0.026	0.033	0.024	0.012
	(0.050)	(0.045)	(0.045)	(0.034)	(0.034)	(0.034)	(0.025)	(0.021)
2nd Quantile Length of Frost Free Period	-0.018	-0.038	-0.050	-0.024	-0.018	-0.017	-0.002	0.008
	(0.039)	(0.035)	(0.035)	(0.026)	(0.026)	(0.026)	(0.019)	(0.016)
4th Quantile Length of Frost Free Period	0.031	0.017	0.006	0.004	-0.003	0.003	0.009	0.033**
	(0.040)	(0.036)	(0.036)	(0.027)	(0.027)	(0.027)	(0.020)	(0.017)
5th Quantile Length of Frost Free Period	0.105**	0.084*	0.070	0.006	0.002	0.014	0.036	0.076***
	(0.053)	(0.048)	(0.048)	(0.037)	(0.036)	(0.036)	(0.026)	(0.023)
1st Quantile Annual Bright Sunshine Hours	-0.350***	-0.274***	-0.274***	0.089*	0.088*	0.070	0.058	0.031
	(0.075)	(0.067)	(0.066)	(0.053)	(0.052)	(0.051)	(0.037)	(0.032)
2nd Quantile Annual Bright Sunshine Hours	-0.131***	-0.108***	-0.103***	0.018	0.014	0.006	0.005	-0.008
	(0.044)	(0.040)	(0.039)	(0.030)	(0.030)	(0.030)	(0.022)	(0.018)
4th Quantile Annual Bright Sunshine Hours	0.108**	0.166***	0.174***	0.072**	0.065**	0.071**	-0.041*	-0.023
	(0.046)	(0.042)	(0.041)	(0.032)	(0.032)	(0.031)	(0.023)	(0.020)
5th Quantile Annual Bright Sunshine Hours	0.218***	0.341***	0.351***	0.141***	0.133***	0.146***	-0.068**	-0.034
	(0.067)	(0.060)	(0.059)	(0.047)	(0.047)	(0.046)	(0.034)	(0.028)
1st Quantile Annual Rainfall Total	0.206***	0.228***	0.202***	0.025	0.003	-0.002	0.021	0.028
	(0.068)	(0.061)	(0.061)	(0.047)	(0.046)	(0.046)	(0.034)	(0.029)
2nd Quantile Annual Rainfall Total	0.149***	0.131***	0.097**	-0.026	-0.032	-0.036	0.046**	0.049***
	(0.044)	(0.040)	(0.040)	(0.030)	(0.030)	(0.030)	(0.022)	(0.019)

4th Quantile Annual Rainfall Total	-0.077*	-0.076**	-0.066*	-0.003	-0.011	-0.012	0.021	0.008
	(0.040)	(0.037)	(0.036)	(0.028)	(0.027)	(0.027)	(0.020)	(0.017)
5th Quantile Annual Rainfall Total	-0.276***	-0.283***	-0.269***	-0.007	-0.030	-0.033	0.047	0.010
	(0.059)	(0.053)	(0.053)	(0.041)	(0.040)	(0.040)	(0.029)	(0.025)
1st Quantile Days w/ Soil Moisture Deficit	-0.146**	-0.155***	-0.150***	-0.007	-0.034	-0.029	-0.007	-0.011
	(0.059)	(0.054)	(0.053)	(0.041)	(0.041)	(0.040)	(0.030)	(0.025)
2nd Quantile Days w/ Soil Moisture Deficit	-0.003	-0.025	-0.019	-0.027	-0.043	-0.043	-0.029	-0.029
	(0.043)	(0.039)	(0.039)	(0.030)	(0.030)	(0.029)	(0.022)	(0.018)
4th Quantile Annual w/ Soil Moisture Deficit	-0.019	-0.009	0.002	0.018	0.016	0.022	0.029	0.007
	(0.045)	(0.041)	(0.040)	(0.031)	(0.031)	(0.031)	(0.022)	(0.019)
5th Quantile Annual w/ Soil Moisture Deficit	-0.019	0.047	0.048	0.087*	0.085*	0.092**	0.046	0.033
	(0.065)	(0.059)	(0.058)	(0.046)	(0.045)	(0.045)	(0.033)	(0.028)
1st Quantile Annual Air Temperature	-0.213***	-0.182***	-0.159**	-0.001	-0.020	0.010	0.073*	0.012
	(0.076)	(0.069)	(0.068)	(0.053)	(0.053)	(0.052)	(0.038)	(0.032)
2nd Quantile Annual Air Temperature	-0.054	-0.054	-0.049	-0.005	-0.018	-0.006	0.022	-0.005
	(0.048)	(0.044)	(0.043)	(0.033)	(0.033)	(0.033)	(0.024)	(0.020)
4th Quantile Annual Air Temperature	-0.043	-0.093*	-0.095**	-0.047	-0.033	-0.027	0.004	0.014
	(0.054)	(0.049)	(0.048)	(0.037)	(0.037)	(0.037)	(0.027)	(0.023)
5th Quantile Annual Air Temperature	0.066	-0.098	-0.092	-0.126**	-0.120**	-0.096*	0.036	0.061*
	(0.075)	(0.068)	(0.067)	(0.052)	(0.052)	(0.051)	(0.037)	(0.032)
Log Distance to Nearest Airport	-0.167***	-0.199***	-0.191***	-0.039**	-0.039**	-0.042**	-0.009	-0.027**
	(0.027)	(0.024)	(0.023)	(0.019)	(0.019)	(0.019)	(0.013)	(0.011)
Log Distance to Nearest Beach	-0.210***	-0.267***	-0.258***	-0.056***	-0.057***	-0.059***	-0.006	-0.036***
	(0.024)	(0.021)	(0.021)	(0.017)	(0.017)	(0.017)	(0.012)	(0.010)
Log Distance to Nearest Lake	0.006	0.034**	0.035**	0.034***	0.028**	0.024*	0.012	0.002
	(0.018)	(0.016)	(0.016)	(0.013)	(0.013)	(0.012)	(0.009)	(0.008)
Log Distance to Nearest Port	-0.195***	-0.221***	-0.206***	-0.058**	-0.072***	-0.068***	-0.015	-0.038**
	(0.036)	(0.031)	(0.030)	(0.027)	(0.027)	(0.026)	(0.018)	(0.015)
Log Distance to Nearest Large Town	-0.078***	-0.042**	-0.026	0.036***	0.033**	0.030**	0.005	-0.015*
	(0.019)	(0.017)	(0.017)	(0.013)	(0.013)	(0.013)	(0.010)	(0.008)
Log Distance to Nearest Train Station	-0.020	-0.068***	-0.070***	-0.051**	-0.050**	-0.052**	-0.006	-0.005
	(0.028)	(0.025)	(0.024)	(0.021)	(0.020)	(0.020)	(0.014)	(0.012)
Log Distance to Nearest School	-0.202***	-0.152***	-0.142***	0.035**	0.031**	0.022	0.012	-0.037***
	(0.020)	(0.019)	(0.019)	(0.014)	(0.014)	(0.014)	(0.010)	(0.009)
Log Distance to Nearest Ski Area	-0.194***	-0.320***	-0.322***	-0.138***	-0.145***	-0.145***	-0.022	-0.063***
	(0.054)	(0.047)	(0.046)	(0.039)	(0.039)	(0.038)	(0.027)	(0.022)
Coastal Meshblock	0.018	0.125***	0.130***	0.081***	0.081***	0.074***	-0.012	-0.022
	(0.038)	(0.035)	(0.035)	(0.026)	(0.026)	(0.026)	(0.019)	(0.016)

Has Some DoC Land (< 25%)	-0.046*	-0.026	-0.019	0.018	0.006	0.011	0.038***	0.010
	(0.024)	(0.022)	(0.022)	(0.016)	(0.016)	(0.016)	(0.012)	(0.010)
Has A Lot of DoC Land (>= 25%)	-0.061	0.005	0.026	0.062*	0.028	0.037	0.055**	0.007
	(0.055)	(0.050)	(0.050)	(0.037)	(0.037)	(0.037)	(0.027)	(0.023)
Has Some Māori Owned Land (< 25%)	-0.082***	-0.053*	-0.050*	0.019	0.004	-0.004	0.028*	-0.002
	(0.030)	(0.027)	(0.027)	(0.020)	(0.020)	(0.020)	(0.015)	(0.013)
Has A Lot of Māori Owned Land (>= 25%)	-0.291***	-0.345***	-0.321***	-0.092**	-0.118***	-0.127***	0.080***	0.001
	(0.056)	(0.051)	(0.051)	(0.038)	(0.038)	(0.038)	(0.028)	(0.024)
Percent Land Area in LUC Class 2	-0.060	-0.100	-0.080	-0.058	-0.083	-0.090	-0.009	-0.028
	(0.086)	(0.078)	(0.078)	(0.059)	(0.059)	(0.058)	(0.042)	(0.037)
Percent Land Area in LUC Class 3	-0.228***	-0.167**	-0.136*	0.052	0.016	0.005	0.029	-0.021
	(0.088)	(0.080)	(0.080)	(0.061)	(0.061)	(0.060)	(0.044)	(0.038)
Percent Land Area in LUC Class 4	-0.367***	-0.286***	-0.248***	0.059	0.002	-0.009	0.003	-0.048
	(0.097)	(0.088)	(0.089)	(0.067)	(0.068)	(0.067)	(0.048)	(0.042)
Percent Land Area in LUC Class 5	-0.508***	-0.659***	-0.594***	-0.146	-0.214*	-0.200*	-0.129	-0.186***
	(0.164)	(0.149)	(0.149)	(0.113)	(0.113)	(0.112)	(0.081)	(0.070)
Percent Land Area in LUC Class 6	-0.663***	-0.647***	-0.524***	0.006	-0.098	-0.080	-0.019	-0.116***
	(0.103)	(0.093)	(0.095)	(0.071)	(0.072)	(0.071)	(0.051)	(0.045)
Percent Land Area in LUC Class 7	-1.168***	-1.135***	-0.920***	0.040	-0.104	-0.069	-0.076	-0.174***
	(0.120)	(0.109)	(0.110)	(0.083)	(0.084)	(0.083)	(0.060)	(0.052)
Percent Land Area in LUC Class 8	-1.625***	-1.220***	-1.034***	0.448***	0.281*	0.303**	0.052	-0.030
	(0.225)	(0.205)	(0.204)	(0.155)	(0.154)	(0.152)	(0.112)	(0.096)
1st Quantile Average Slope	-0.036	-0.141***	-0.153***	-0.095***	-0.085***	-0.092***	-0.020	0.025
	(0.046)	(0.042)	(0.042)	(0.032)	(0.032)	(0.031)	(0.023)	(0.020)
2nd Quantile Average Slope	0.005	-0.051	-0.058*	-0.058**	-0.058**	-0.063***	-0.007	0.019
	(0.036)	(0.033)	(0.033)	(0.025)	(0.025)	(0.024)	(0.018)	(0.015)
4th Quantile Average Slope	-0.061	-0.054	-0.028	-0.011	-0.021	-0.002	-0.010	-0.043***
	(0.038)	(0.035)	(0.035)	(0.026)	(0.026)	(0.026)	(0.019)	(0.016)
5th Quantile Average Slope	-0.288***	-0.187***	-0.093*	0.082**	0.046	0.072**	-0.012	-0.097***
	(0.053)	(0.049)	(0.049)	(0.037)	(0.037)	(0.036)	(0.027)	(0.023)
Percent Land Area w/ Low ASP Soil	0.056	-0.025	-0.045	-0.077	-0.079	-0.083*	0.019	0.027
	(0.070)	(0.064)	(0.063)	(0.049)	(0.048)	(0.047)	(0.035)	(0.030)
Percent Land Area w/ Moderate ASP Soil	0.157**	0.007	-0.018	-0.129**	-0.110**	-0.113**	0.037	0.058*
	(0.077)	(0.070)	(0.069)	(0.053)	(0.053)	(0.052)	(0.038)	(0.033)
Percent Land Area w/ High+ ASP Soil	0.223**	0.130	0.090	-0.082	-0.069	-0.079	0.120***	0.132***
	(0.088)	(0.079)	(0.078)	(0.061)	(0.060)	(0.059)	(0.044)	(0.037)
Percent Land Area w/ Older Soil	0.120**	0.124**	0.122**	0.046	0.043	0.046	0.042	0.025
	(0.054)	(0.049)	(0.049)	(0.037)	(0.037)	(0.037)	(0.027)	(0.023)

Percent Land Area w/ Moderate EC Soil	-0.051	0.004	0.002	0.053	0.052	0.040	-0.053*	-0.036
	(0.065)	(0.058)	(0.058)	(0.045)	(0.045)	(0.044)	(0.032)	(0.027)
Percent Land Area w/ High+ EC Soil	-0.174*	-0.054	-0.077	0.103	0.104*	0.085	-0.097**	-0.046
	(0.092)	(0.083)	(0.082)	(0.064)	(0.063)	(0.062)	(0.046)	(0.039)
Percent Land Area w/ Poor Draining Soil	-0.060	-0.098	-0.088	0.002	0.002	0.006	-0.002	0.000
	(0.109)	(0.099)	(0.098)	(0.075)	(0.075)	(0.074)	(0.054)	(0.046)
Percent Land Area w/ Imperfect Draining Soil	0.036	0.004	0.008	-0.005	-0.013	0.005	-0.038	-0.012
	(0.110)	(0.099)	(0.098)	(0.076)	(0.075)	(0.074)	(0.054)	(0.047)
Percent Land Area w/ Moderate Draining Soil	0.012	0.048	0.058	0.101	0.097	0.113	-0.012	0.005
	(0.108)	(0.098)	(0.097)	(0.075)	(0.074)	(0.073)	(0.054)	(0.046)
Percent Land Area w/ Good Draining Soil	0.022	0.045	0.043	0.081	0.082	0.094	-0.059	-0.005
	(0.109)	(0.099)	(0.098)	(0.075)	(0.075)	(0.074)	(0.054)	(0.046)
Percent Land Area w/ V. Weakly Indurat Soil	-0.002	0.075	0.101*	0.092**	0.068	0.070	0.003	-0.042
	(0.065)	(0.059)	(0.058)	(0.045)	(0.045)	(0.045)	(0.033)	(0.028)
Percent Land Area w/ Weakly Indurated Soil	-0.306***	-0.251***	-0.195**	0.075	0.059	0.062	-0.050	-0.088**
	(0.090)	(0.082)	(0.081)	(0.063)	(0.062)	(0.061)	(0.045)	(0.038)
Percent Land Area w/ Strongly+ Indurat Soil	-0.129	-0.109	-0.102	0.062	0.040	0.028	0.001	-0.029
	(0.082)	(0.074)	(0.073)	(0.057)	(0.056)	(0.056)	(0.041)	(0.035)
Percent Land Area w/ Sand Soil	0.086	0.123**	0.139**	0.016	0.020	0.024	-0.020	-0.026
	(0.065)	(0.059)	(0.059)	(0.045)	(0.045)	(0.044)	(0.033)	(0.028)
Percent Land Area w/ Gravel Soil	0.055	0.122	0.168**	0.034	0.013	0.017	-0.052	-0.104***
	(0.092)	(0.083)	(0.082)	(0.064)	(0.064)	(0.063)	(0.046)	(0.039)
Percent Land Area w/ Coarse+ Gravel Soil	-0.151	-0.310***	-0.231**	-0.220***	-0.209***	-0.179**	-0.163***	-0.149***
	(0.114)	(0.103)	(0.103)	(0.079)	(0.079)	(0.078)	(0.057)	(0.049)
Percent Land Area w/ Boulders+ Soil	-0.052	-0.086	-0.013	-0.085	-0.084	-0.050	-0.018	-0.052
	(0.089)	(0.081)	(0.080)	(0.062)	(0.061)	(0.060)	(0.044)	(0.038)
Percent Land Area Town in NZLRI	8.947***	5.237***	4.628***	-3.497***	-4.165***	-4.447***	-1.428	1.028
	(1.961)	(1.778)	(1.759)	(1.357)	(1.346)	(1.327)	(0.974)	(0.834)
Has Irrigated Arable Land	0.106	0.206***	0.146*	-0.001	0.005	-0.009	0.001	0.024
	(0.086)	(0.069)	(0.078)	(0.059)	(0.063)	(0.062)	(0.043)	(0.040)
Coordinate on Line Lying SW to NE	0.048***	0.044***	0.044***	0.002	0.003	0.002	0.016*	0.008
	(0.017)	(0.015)	(0.015)	(0.013)	(0.013)	(0.012)	(0.009)	(0.007)
Coordinate on Line Lying NW to SE	0.116***	0.144***	0.126***	0.035	0.045	0.032	0.004	0.016
	(0.037)	(0.032)	(0.031)	(0.029)	(0.028)	(0.028)	(0.019)	(0.015)
Log Population Per Hectare in 1991 (2001)	1.270***	1.105***	1.045***	-0.274***	-0.334***	-0.329***	-0.062***	0.184***
	(0.027)	(0.023)	(0.028)	(0.019)	(0.021)	(0.022)	(0.013)	(0.013)
1st Quantile Δ In Pop. Per Ha 1991/2001						-0.042		0.032*
						(0.028)		(0.018)

2nd Quantile Δ In Pop. Per Ha 1991/2001	-0.038	0.004
	(0.023)	(0.015)
4th Quantile Δ In Pop. Per Ha 1991/2001	-0.003	0.038**
	(0.026)	(0.017)
5th Quantile Δ In Pop. Per Ha 1991/2001	0.062**	0.108***
	(0.031)	(0.019)

Note: Coefficients followed by a * are significantly different from zero at the 10% level, ** at the 5% level and *** stars at 1% level. Standard errors are in parentheses. All regressions control for the actual valuation year for each meshblock (MB) and include an area unit random effect to allow for spatial correlation in values. Specifications (3), (5), (6), and (8) include additional controls for the percentage of land in each land type in that year (or the beginning of the sample period for the change regression) and specification (6) also includes controls for the change in the percentage of land in each land type between the sample years. Included in each regressions are 8,436 rural MBs without missing covariates from 825 area units.

Table 8: Relationship between Land Use and Overall Tradable Log Real Land Value Per Hectare

	Overall Tradable Land Value		Change in Tradable Land Value			Change at 1989-1991 Values	
	1989-1991	2001-2003	no controls	controls	plus Δ land use	no controls	controls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Total R-Squared	[0.681]	[0.670]	[0.054]	[0.126]	[0.153]	[0.150]	[0.281]
Partial R-Squared for Initial Land Use	[0.047]	[0.037]	[0.048]	[0.027]	[0.021]	[0.149]	[0.265]
Total Partial R-Squared for Control Variables	[0.357]	[0.364]	[0.006]	[0.083]	[0.087]	[0.000]	[0.076]
Partial R-Squared for Δ Population Density				[0.005]	[0.007]		[0.010]
Partial R-Squared for Δ in Land Use					[0.031]		
Percent Urban Land Area in Initial Year	0.155**	0.447***	-0.174***	0.218***	0.316***	-1.052***	-1.396***
	(0.071)	(0.082)	(0.043)	(0.049)	(0.062)	(0.027)	(0.030)
Percent Horticulture Land Area in Initial Year	0.401***	0.295***	-0.242***	-0.189***	-0.207***	-0.507***	-0.713***
	(0.092)	(0.103)	(0.061)	(0.064)	(0.079)	(0.039)	(0.040)
Percent Pig/Chicken Land Area in Initial Year	-0.261	-0.207	-0.241	-0.137	-0.457	-0.311*	-0.496***
	(0.394)	(0.380)	(0.275)	(0.270)	(0.321)	(0.177)	(0.170)
Percent Lifestyle Land Area in Initial Year	0.259***	0.047	-0.166***	-0.088**	-0.175***	-0.328***	-0.483***
	(0.051)	(0.050)	(0.034)	(0.036)	(0.039)	(0.022)	(0.022)
Percent Dairy Land Area in Initial Year	0.268***	0.242***	-0.173***	-0.138***	0.009	-0.192***	-0.307***
	(0.052)	(0.049)	(0.033)	(0.035)	(0.039)	(0.021)	(0.022)
Percent Deer/Horse Land Area in Initial Year	0.153	0.045	-0.042	-0.079	-0.135	-0.116	-0.230***
	(0.167)	(0.135)	(0.116)	(0.114)	(0.122)	(0.075)	(0.072)
Percent Arable Land Area in Initial Year	0.340***	0.209*	-0.075	-0.032	0.045	-0.108**	-0.255***
	(0.109)	(0.113)	(0.066)	(0.074)	(0.080)	(0.043)	(0.047)
Percent Extensive Pastoral Land Area in Initial Year	-0.498***	-0.548***	0.062*	0.088**	0.042	0.066***	0.267***
	(0.056)	(0.056)	(0.035)	(0.038)	(0.042)	(0.022)	(0.024)
Percent Commercial Forestry Land Area in Initial Year	-0.613***	-0.342***	0.604***	0.600***	0.569***	0.362***	0.547***
	(0.085)	(0.074)	(0.056)	(0.058)	(0.063)	(0.036)	(0.037)
Change in Percent Urban Land Area Between Cycles					0.129*		
					(0.078)		
Change in Percent Horticulture Land Area Between Cycles					-0.163		
					(0.114)		
Change in Percent Pig/Chicken Land Area Between Cycles					-0.672**		
					(0.312)		
Change in Percent Lifestyle Land Area Between Cycles					-0.308***		
					(0.055)		
Change in Percent Dairy Land Area Between Cycles					0.525***		
					(0.053)		

Change in Percent Deer/Horse Land Area Between Cycles		-0.116
		(0.119)
Change in Percent Arable Land Area Between Cycles		0.201
		(0.139)
Change in Percent Ext. Pastoral Land Area Between Cycles		-0.212***
		(0.067)
Change in Percent Com. Forest Land Area Between Cycles		-0.122*

Note: Coefficients followed by a * are significantly different from zero at the 10% level, ** at the 5% level and *** at 1% level. Standard errors are in parentheses. All regressions control for the actual valuation year for each meshblock (MB) and include an area unit random effect to allow for spatial correlation in values. All specifications except (3) and (6) include all covariates include in Table 6. Included in each regressions are 8,436 rural MBs without missing covariates from 825 area units.

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