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DISCUSSION PAPER SERIES

IZA DP No. 12402

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ABSTRACT

Did the Post-1986 Decline in the Homeownership Rate Benefit the New Zealand Labour Market? A Spatial-Econometric Exploration

The proportion of New Zealand households living in owner-occupied dwellings has declined steadily since the early 1990s. The unemployment rate declined steadily as well, except for upward shifts due to the late 1990s Asian Financial Crisis and the Global Financial Crisis a decade later. Research initiated by Andrew Oswald in the 1990s posits that declining homeownership and declining unemployment are linked and that the causality runs from high homeownership leading to high unemployment. The international empirical evidence for this hypothesis is rather mixed. In this paper we revisit the issue with New Zealand census data for commuting-defined labour market areas from 1986 until 2013. Allowing for spatial spillovers in our data, we apply a general nesting spatial econometric model. We also consider the potentially different impacts of freehold and mortgaged homeownership. Generally, the evidence that a declining homeownership rate contributes to a lower unemployment is statistically fragile, but a greater prevalence of freehold ownership and mortgaged ownership below the mean across labour market areas do have small upward effects on a labour market area's unemployment rate.

JEL Classification: J61, J64, R23, R31

Keywords: Oswald hypothesis, unemployment, homeownership, labour market flexibility, spatial econometrics

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1. Introduction

As in many other developed countries, New Zealand has seen a substantial increase in the rate of homeownership during the 20th century. While in a perfectly competitive housing market the real cost of housing services would be identical for owners and renters, in reality the housing market is complex and subject to many forms of externalities and imperfections. Living in one's own home confers significant private and public benefits that have encouraged governments of many countries to adopt pro-ownership policies (e.g., Atterhög and Song, 2009), although there are also countries that encourage renting (e.g., Goodman and Mayer, 2018). Nonetheless, recent research shows that homeownership increases life satisfaction (Ren et al, 2018). Figure 1 shows that more than half of New Zealand households are owner-occupiers of their dwelling, with the lowest rate (of 50.5 percent) recorded in the 1936 census, heavily influenced by the Depression years. From 1935 onwards, pro-ownership policies of the First Labour Government kicked off a long-term upward trend in ownership rates. Subsequent governments continued to protect or implement ownership-friendly policies until about three quarters of dwellings were owner-occupied by the second half of the 1980s.

However, since the late 1980s a steady decline in homeownership rates commenced, with the 2013 rate at 64.8 percent, being similar to the rate of the early 1950s. The proportion of New Zealand households living in owner-occupied dwellings declined from a little less than 74 percent in 1986 and 1991, to 70.5 percent in 1996, 67.8 percent in 2001, 66.9 percent in 2006 and 64.8 percent by 2013. This is also shown in Figure 1.[1]

(FIGURE 1 ABOUT HERE)

Various causes have been posited for the post-1986 decline in New Zealand homeownership (see, e.g., Morrison, 2008; Eaqub and Eaqub, 2015). Firstly, changing demographics and social dynamics have resulting in more fluid family arrangements that have led to a greater demand for rental accommodation. Secondly, house prices have been rising faster than household incomes, reinforced by a speculative housing 'bubble' up to 2008 and re-occurring in recent years, particularly in the largest city, Auckland (which represents one third of the country's population of 4.8 million), driven by existing owner-occupiers and net inward migration but also by residential property investors and by increasing land prices that reflect the benefits of increasing agglomeration. The growth in house prices is a trend that is common to many advanced economies (e.g., Knoll et al, 2017). Rising house prices, together with increasing average personal debt due to much higher enrolments in tertiary education and the resulting student loans, lowered housing affordability of potential first home buyers. Moreover, the supply of homes that first home buyers can afford diminished. This situation was exacerbated by a lack of building of new dwellings at the cheaper end of the market. Finally, increasing levels of consumer debt and the removal of specific assistance for entry into homeownership also lowered households' ability to own.[2]

The downward trend in the homeownership rate is generally seen as an undesirable trend, for a variety of reasons (see, e.g., Equab and Equab, 2015, for New Zealand-specific arguments). However, renters are geographically more mobile than homeowners (e.g., Poot, 1984, in the New Zealand context). The decline in homeownership indeed coincided with an increase in residential mobility in New Zealand, particularly in

1. Homeownership rates are only observed in the NZ Census of Population and Dwellings. The rates have been linearly interpolated for the intercensal periods. It should also be noted that there have been changes in the census questions on homeownership that may affect the intercensal comparison.
2. A left-of-centre coalition government elected in October 2017 has implemented a range of policies to improve the supply, quality and affordability of housing.

Auckland where ownership rates have been declining faster than in other regions (e.g., Morton et al, 2014).[3] Greater residential mobility makes it easier for individuals and families to respond to labour market shocks. Given that homeowners incur much greater costs when changing residence than renters, it might therefore be expected that high rates of homeownership impact negatively on labour market flexibility and, consequently, may lead to a higher natural rate of unemployment. This potential link between homeownership rates and unemployment rates was first forcefully argued by Andrew Oswald in a series of working papers and a letter to the *Journal of Economic Perspectives* (Oswald, 1996; 1997; 1999). Following this argument, the decline in homeownership observed in New Zealand since the 1980s would have increased geographic mobility and labour market flexibility, contributing to the decline in the long-term rate of unemployment.

From 1984 onwards, New Zealand started on a path of radical economic liberalisation that led to a significant transformation of the economy. This liberalisation process triggered initially a dramatic increase in the unemployment rate, driven in large part by the destruction of employment in the previously heavily protected manufacturing sector.[4] As can be seen from Figure 2, the unemployment rate peaked at close to 12 percent by 1991, compared with an average rate of 4 percent a decade earlier.[5] In 1991 the government at that time extended the economic reforms to the labour market through the introduction of the Employment Contracts Act (ECA) which promoted individual contracts and weakened the scope of collective bargaining and the power of trade unions. Subsequently, unemployment declined markedly and reviews of the reforms such as Evans et al. (1996) attributed this in part to the success of the ECA in enhancing labour market flexibility.

(FIGURE 2 ABOUT HERE)

A formal assessment of the impact of labour market reform is actually easier said than done (Gorter and Poot, 1999). Besides the positive impacts highlighted by Evans et al. (1996), the reforms also led to growing inequality, lesser social cohesion and increasing vulnerability of certain regions and population groups. This triggered a political change of direction following the 1999 election of a Labour government that stepped back from the reforms of the 1980s and 1990s in favour of a more 'Third Way' approach to economic management. The trend in the unemployment rate remained actually downward during this time of reintroduction of somewhat greater regulation of the labour market, which coincided with buoyant economic conditions. By December quarter 2007, the unemployment rate was down to 3.3 percent. The consequences of the Global Financial Crisis (GFC) of 2008 triggered an increase to a peak above 7 percent by 2012, with the rate then trending downwards again subsequently.

Aside from our exploratory work in Cochrane and Poot (2007), on which this paper builds, there has not been any formal assessment in New Zealand of a possible link between unemployment and homeownership,

3. See e.g. http://www.statschat.org.nz/2016/02/24/home-ownership-comparisons/ on the relatively faster declining homeownership rates in Auckland. Morton et al. (2014) reports the growing mobility of young families there.
4. Prior to the restructuring period many manufacturing products received effective rates of protection in excess of 100 per cent. In addition, subsidization of manufacturing exports was also common. Following 1984, tariffs were removed so that the effective assistance rate for manufacturing fell from 30 to around 7 per cent in 1996. Contemporaneously with the substantive removal of tariff protection, import licensing was removed from all but a few products (Chatterjee, 1996, p. 29).
5. It should be noted than even the 2-3 percent unemployment prevailing at the start of the 1980s was a marked departure from the unemployment rates that had been experienced in the period of the so-called long boom (Marglin & Schor, 1990) where New Zealand's unemployment rate is estimated to have remained below 1 percent until the final quarter of 1967 (Chappell, 1994).

despite Oswald's hypothesis having generated empirical studies in a number of other countries. Skilling (2004, p.19) refers to this hypothesis in a paper that advocates more widespread asset ownership among the New Zealand population, including of dwellings, but then downplays the possibility of homeownership having what he calls a "dark side" (in terms of generating unemployment) by referring to US evidence by Glaeser and Shapiro (2002) and Australian evidence by Flatau et al. (2002) that does not appear consistent with the Oswald hypothesis. Indirectly, some NZ econometric modelling by Maré and Timmins (2004) also contradicts the Oswald claim. Maré and Timmins estimate the responsiveness of the number of internal migrants to relative employment conditions in origin and destination regions and then interact this effect with homeownership rates. They find that responsiveness to relative employment performance is greater when more homes are owner-occupied, which is the opposite of what the Oswald hypothesis would suggest. However, their model analyses the spatial variation in mobility rates rather than unemployment rates per se.

The purpose of this paper is to investigate the Oswald hypothesis directly using a 1986-2013 panel of observations on New Zealand Labour Market Areas (LMAs). Spatial econometric models have been used previously in a cross-sectional setting to test the Oswald hypothesis (see Sari, 2015), but as far as we know the present paper provides the first estimates of the relationship in a panel data setting with spatial spillovers. The use of panel data techniques ameliorates problems, such as missing variable bias, that typically plague purely cross-sectional analyses. Moreover, the use of spatial econometric panel techniques addresses the often-overlooked problem of spatial spillovers explicitly.

The paper is structured as follows: the next section provides a more detailed account of the hypothesis and briefly considers the international literature generated by the hypothesis and its relevance in the New Zealand context. Section 3 outlines the data used in the modelling. Section 4 reviews the various estimation techniques while section 5 reports the results of the estimations. The final section provides conclusions and offers some ideas regarding further directions to be followed in this area of research.

2. The Oswald Hypothesis

Oswald (1996, 1997, 1999) argued that a significant proportion of the increase in the unemployment rates of most OECD countries between the 1960s and the 1990s was due to a "a secular change that has happened in all but a few Western housing markets -- the rise of home ownership and the decline in private renting" (1996, p. 2). Using largely OLS estimates for a number of data sets for varying time periods and collections of nations and sub regions,[6] he obtained a parameter estimate of approximately 0.2 on the homeownership variable in his regressions leading him to the conclusion that a 1 percentage point increase in the rate of homeownership might lead on average to a 0.2 percentage point increase in the unemployment rate.

Oswald (1999, pp. 3-4) identified four causal mechanisms that might underpin this relationship. The first mechanism is what might be called the first order effects of homeownership. These stem from the fact that selling a home is not a costless exercise. Indeed, the cost of selling a home can be substantial, amounting to over one sixth of the value of the property being sold in some European nations (Global Property Guide, 2009). This

6. A panel model with regional and time fixed effects was used for the "State-level US Unemployment Regressions with Housing Owner-Occupation as an Independent Variable, 1986-1995" and the "Region-level UK Unemployment Regressions with Proportion of Housing Privately Rented as an Independent Variable, 1973-1994", Tables 4 and 5 respectively in Oswald (1996, pp. 27-28).

expense is compounded if another property is purchased, as in most nations costs are incurred when buying and when selling properties. Such large transaction costs associated with the purchase and sale of properties pose an impediment to the mobility of homeowners. Consequently, homeowners are less able to respond to adverse employment shocks by means of relocation. Moreover, matching between employers and workers is adversely affected in an economy with low levels of spatial mobility. The result is that many workers end up doing jobs for which they are not particularly suited while local employers must select employees from a limited, and perhaps inadequate, pool of talent. These inefficiencies raise the cost of production and lower real wages in comparison to more mobile societies. For example, Yang (2019) finds US evidence that homeownership lowers post-unemployment wages.

Secondly, the labour market areas that have high levels of homes occupied by their owners have, by definition, a relatively small stock of rental properties. Hence high levels of owner occupation block entry to such areas by those who are capital constrained. Many young and unemployed workers are therefore unable to enter such areas of high homeownership, even if jobs would be available there, due to a combination of a thin rental market and a finance constraint(additionally, the labour market may be thin in these areas too, see Borg and Brandén, 2018). Thirdly, homeowners often oppose the development of nearby land for commercial or industrial purposes. This discourages the expansion of existing enterprises and deters new entrepreneurs from setting up enterprises within a labour market area with high rates of homeownership, resulting in lower levels of employment creation. Finally, and related to the previous point, homeowners may commute much more than renters and over longer distances; partially offsetting their lower propensity to move residence. Oswald contends that this may raise the cost of commuting, including due to traffic congestion and the concomitant increase in travel time. The greater cost of travel to and from work raises a person's reservation wage. It is well known that such an increase in reservation wages has the effect of making work at current wages less attractive compared to inactivity, thereby increasing unemployment.

In terms of the causal strength assigned to these mechanisms, most stress has been placed in the literature upon the first of these: the relative immobility of homeowners. That homeowners are relatively immobile when compared to renters is certainly plausible in the New Zealand context. The median years at the usual residence data obtainable from the census indicates that owner occupiers have been resident at their current address around three times longer than those resident in dwellings which they do not own (Statistics New Zealand, 2007).

Blanchflower and Oswald (2013) have revisited the mechanisms driving the postulated relationship between high homeownership and unemployment, emphasising that they do not hold the view that that homeowners themselves are disproportionately unemployed but rather that a combination of the lower levels of labour mobility and greater commuting times of homeowners, along with a reduction in the number of new businesses in areas of high homeownership, increases unemployment. With respect to the US they find that this effect operates in the long run and is large. In fact, they argue that the elasticity is greater than one. A doubling of the homeownership rate is expected to lead, according to Blanchflower and Oswald, to a more than doubling of the unemployment rate in the long run.

The international literature generated by the debate ensuing from Oswald's conjecture has been extensive and has been reviewed by Munch et al. (2006) and Rouwendal and Nijkamp (2010). Hence the review here will be brief and primarily focused on the seemingly contradictory evidence, particularly between micro and macro studies. There is general agreement that geographic mobility involves costs and benefits and that, as costs increase for given benefits, mobility will therefore decrease. There is also general agreement that there are significant transaction costs in the sale and purchase of a dwelling and owners may therefore be less inclined to look for employment opportunities outside the commuting range, as compared with renters. In addition, increasing duration of residence yields a non-pecuniary benefit in the form of attachment to the dwelling and its location that tends to be greater for owners than renters as the former have a greater opportunity to modify the dwelling attributes (in terms of alterations, landscaping etc.) to suit individual tastes. These modifications are a type of location-fixed capital that is lost with a move.

Besides the plausible arguments why homeowners have lower migration rates (and are more likely to commute over longer distances) there is also plenty of empirical evidence that confirms that intra-regional residential mobility and inter-regional migration rates among homeowners are lower, all else being equal. For New Zealand, see e.g. Statistics New Zealand (2007) and Stillman and Maré (2008). The question is whether it is possible to identify an unbiased causal effect of homeownership rates, via the mobility and job search effects, on the natural rate of unemployment.

The macro-level studies initially supported the Oswald hypothesis (see, e.g., Pehkonen, 1999; Partridge and Rickman, 1997; and Nickell and Layard, 1999), but some subsequent studies are less conclusive (e.g., Flatau et al. 2002; 2003) or even reject the hypothesis (e.g., Green and Hendershott, 2001). More recently, Munch et al. (2008) have raised the possibility that, due to the transactions costs associated with moving, owners will have higher reservation wages for more distant work than for local employment. This implies, in opposition to Oswald, that ownership maybe accompanied by higher employment but at lower wages – a view supported by Brunet and Havet (2009, as cited in Isebaert et al., 2015). However, Isebaert et al. (2015), using a panel of 42 Belgian regions (arrondissements) from 1970-2005 and IV 3SLS to control for potential endogeneity in homeownership, find evidence in favour of the Oswald hypothesis. Similarly, Bouyon (2015) finds with European cross-country panel data that homeownership rates have had a positive impact on country unemployment rates. Laamanen (2017) uses a natural experiment, the deregulation of the Finnish rental housing market, as the means to identify a positive causal effect of homeownership on unemployment.

In recent years, some authors have investigated whether the effect of homeownership on unemploymen t rates is sensitive to the extent to which ownership is leveraged through large mortgages. In this context it is expected that owners with large mortgage debt may have lower reservation wages as defaulting on mortgage payments could have undesirable and costly consequences. Additionally, Demyanyk et al. (2017) found that even negative home equity is not a significant barrier to job-related mobility. In contrast, those who own their property outright may have higher reservation wages in job search. Baert et al. (2014) find some evidence in favour of these expectations, using Belgian microdata. They conclude that homeowners with a mortgage exit unemployment first, while outright owners stay unemployed the longest. On the other hand, Kantor et al. (2015) do not find evidence in Dutch data on individual unemployment spells that a bigger mortgage is associated with higher exit rates from unemployment. However, they make the important point that risk aversion may impact on a worker's assessment of mortgage debt and job search behaviour. We will return to this issue of the role of mortgage debt among homeowners in our analysis of New Zealand census data.

3. Data

The data for our analysis were obtained from the quinquennial New Zealand Census of Population and Dwellings 1986 to 2013. We construct Labour Market Areas (LMAs) by appropriately aggregating small spatial units called census area units.[7] The boundaries for the LMAs were derived by Newell and Papps (2001) from "travel to work data" from the 1991 and 1996 census. Based on ONS & Coombes (1998), Newell and Papps set the boundaries of commuting areas such that cross-boundary commuting is rare relative to within-boundary commuting. The resulting geographic areas reflect the extent of a self-contained local labour market better than administrative boundaries. This research yielded 140 LMAs for 1991 and 106 for 1996. However, many of these areas were of little economic significance, leading to the adoption of a 58 area LMA geography that supresses smaller and largely rural LMAs. The boundaries and names of these LMAs are shown in Figure 3. An assessment of the boundaries against subsequent commuting data suggests that the boundaries remain appropriate for the timespan of our analysis.

(FIGURE 3 ABOUT HERE)

The dependent variable in our model of the relationship between unemployment and homeownership is the LMA unemployment rate. Oswald's earlier work suggests that the coefficient of the homeownership variable in a regression of the percentage unemployment rate on the percentage of dwellings that are owner-occupied, and various other determinants of unemployment, will be positive and likely to be around 0.2.

As noted in the previous section, Baert et al (2014) and Kantor et al. (2015) argue that homeowners are not a homogenous group with respect to their labour market behaviour. Generally, we would expect that those who own their homes with a mortgage will have greater search intensity, particularly if the mortgage is large, as the mortgagee must usually have employment to be able to pay the mortgage. Consequently, heavily indebted mortagees will have shorter periods of unemployment. Outright owners do not face such a financial constraint as neither a mortgage nor rent has to be paid. Hence, we test the effect of differing modes of homeownership by differentiating between percentages of those who own homes with and without mortgages, the variables used referred to as *mortgaged* and *freehold* respectively.[8] Our expectation is that areas with high levels of mortgagee ownership will have lower levels of unemployment, ceteris paribus, than those where outright ownership is prevalent. To minimise the impact of potential reverse causality, in which sustained unemployment may lead to lower homeownership, we lag all explanatory variables in the regression by five years for unemployment rates measured in the 1996, 2001 and 2006 census and seven years for the 2013 census.

In addition to the ownership variables, we control for several key variables that have been suggested in the literature as potentially impacting on local unemployment rates.[9] Firstly, the demographic structure of the

7. New Zealand is divided into 2,020 area units. In urban areas these generally coincide with suburbs that contain a population of 3,000 to 5,000. In rural areas, area units cover larger areas but have much smaller populations.

[8] Some housing stock may be vacant. However, housing tenure (ownership or renting) is in our data only defined for all private dwellings that were occupied on census night. Hence the vacancy rate is by definition zero. It is in theory possible for renters to own a home that they did not occupy on census night (e.g. because it is an unoccupied vacation home or a home rented out to someone else) but the ownership rate in this paper is based on the tenure of the dwelling the person lives in during the night of the census. This is arguably the best measure of housing tenure in terms of a potential relationship with labour mobility.

[9] The range of variables that can be considered for our modelling is limited by the information included in the census and the extent to which this information is collected consistently across censuses. Except for the ownership variables, other variables included in this paper have been selected based on their robustness in our previous work (Cochrane and Poot, 2007). Additionally we also considered household type (% single person households); ethnicity and the net migration rate. The latter variable is problematic due to its endogeneity and the use of the others did not improve the fit. These alternative results are available upon request from the

population has significant and well documented effects on labour market dynamics (see Kuhn and Ochsen, 2009 for example), with younger populations tending to have both higher participation, job turnover and unemployment rates than older populations. Here we control for the effect of demographic structure through the introduction of a variable for the percentage of the LMA population aged 40 years and over in the previous census period, referred to as *older*. This variable is expected to have a negative coefficient as one would expect lower levels of unemployment in areas with larger older populations.

Besides the age composition effect, the skill composition of the work force is clearly likely to matter as well. Employment of unskilled or manual labour has declined throughout the period considered in this paper in every LMA. In part this has been due to the fall in the employment share of industries heavily dependent upon such labour, particularly manufacturing, as a result of the withdrawal of protective trade barriers during the period of economic restructuring, and in part to underlying changes in the nature of skills demanded in the contemporary economy (Hyslop and Maré, 2009). Additionally, since there is considerably co-movement in New Zealand's regional business cycles (Hall and McDermott, 2007), spatial variation in unemployment is likely to be due to structural factors, not demand deficiency. To capture the impact of the structural change in demand for unskilled or manual labour, the variable *manual* (the percentage of employment in manual occupations at the time of the preceding census) is included in the model. In regressions that do not control for the secular trend in shedding unskilled and manual workers, we would expect this variable to have a positive coefficient. However, once the trend has been removed, *manual* will impact negatively on the unemployment rate since those LMAs that maintain the largest relative rates of manual employment are the best able to absorb unskilled and manual workers made redundant during the years of economic restructuring.

Lastly, the extent to which an LMA can employ the local work force is in part explained by the presence of industries in the LMA that have been growing above or below average nationwide.[10] Hence the level of employment, and by implication the level of unemployment, is to a large extent the product of the industry mix of the LMA. This effect is captured by the inclusion of the variable *bartik* which is the Bartik index (Bartik, 1991) which measures the predicted percentage employment growth over the pre-census intercensal period in which it is assumed that each industry in the region grew at the national growth rate of that industry. Given that *bartik* measures the extent to which an LMA faces favourable change in its industry mix, its effect on the unemployment rate is expected to be negative.

The econometric approach, to be elaborated in the next section, uses spatial weights. These reflect the spatial relations between LMAs and constitute a row-standardised queen's contiguity matrix (Getis & Aldstadt, 2004; Griffith, 1996). Given the many different ways in which one can construct a spatial weights matrix, this approach has attracted the criticism that spatial regression models tend to be unduly sensitive to the choice of the weights matrix (Arbia & Fingleton, 2008). LeSage and Pace (2014) found, however, on the basis of various simulations that the choice of weights matrix was not as crucial as widely believed and that past evidence of this was largely due to misspecification and the incorrect interpretation of coefficients in spatial models (LeSage and

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authors. See also Cochrane and Poot (2007) for including these variables in non-spatial estimation. By adopting panel estimation with fixed area and period effect, we reduce the potential impact of omitted variable bias.

10. In Cochrane and Poot (2007) we also considered additional determinants of unemployment rates, such as ethnic composition and household composition. Specification searches showed that the addition of these variables in the present context did not improve on the estimations. These results are available from the authors upon request.

Pace, 2009). Consequently, the decision to use the row standardised queen's contiguity matrix here is based on the desire to use a simple and straightforward specification with well understood properties.

Descriptive statistics are reported in Table 1. The total number of observations is 290, with data for 58 LMAs pooled across five periods (1986-91, 1991-96, 1996-01, 2001-06 and 2006-2013).[11] The LMA unemployment rates average about 7.2 percent, with a range from 1.8 to 21 percent. The average rate of homeownership is about 73 percent, roughly equally split between those who own their dwelling outright and those who are mortgagees. Freehold occupancy varies between an LMA in which one quarter of households own dwellings outright and an LMA where one half of dwellings are owned freehold. Employment in unskilled and manual occupations in LMAs is about 30 percent on average. The proportion of those aged more than 40 varies across LMAs from 27 percent to 62 percent. The industry-mix effect in LMA intercensal employment growth (*bartik*) is about 4.6 percent of average. Finally, it should be noted that the descriptive statistics for LMAs presented in Table 1 are not weighted by population. Hence, the mean value of a variable represents the average LMA, not the average individual.

(TABLE 1 ABOUT HERE)

4. Methodology

This section briefly discusses the approach taken for the estimation of the impact of homeownership on unemployment rates. The estimation was conducted using a range of spatial panel models, following the general to specific model selection process suggested by Hendry (see Florax et al., 2003) and the general nested spatial model proposed by Vega and Elhorst (2015). These models include the Spatial Lag of X Model (SLX), and the Spatial Durbin Error Model (SDEM) (Elhorst, 2014; LeSage, 2014; LeSage & Pace, 2009), along with pooled OLS and a non-spatial fixed effects panel for comparative purposes. As noted previously, to account for possible reverse causality, the explanatory variables have been lagged by five to eight years.

The use of spatial econometric techniques is motivated by the potential presence of spatial spillovers in the LMAs. Spatial spillovers occur when event(s) at one location influence or cause an effect at another location. These spillovers maybe local, with the impacts being limited to an area's immediate neighbours, or global, with changes in one area rippling out to effect all areas, whether they are neighbours of the original area or not, and reflecting back upon the initial area.[12] Hence global spillovers are characterised by the presence of endogenous interaction and feedback effects, but these are absent in the case of local spillovers (LeSage, 2014, pp. 13).

There are a variety of models that incorporate either or both local and global spatial spillovers **(**see Table 2**).** We follow Vega and Elhorst's (2015, p. 343) simple decision tree approach to select an appropriate model from these alternatives.

(TABLE 2 ABOUT HERE)

Vega and Elhorst start from the General Nested Spatial (GNS) model, which includes all possible interaction effects, and takes the following form:

11. The New Zealand Census is normally held every five years. However, a devastating earthquake in 2011 in the city of Christchurch, from where the census is administered, led to this census being delayed until 2013.
12. The classic illustration of this is the case of an increase in the sales tax on cigarettes in one area or state causing sales of cigarettes in neighbouring states with lower taxes to increase, as smokers cross state borders in search of cheaper cigarettes (LeSage, 2014, p.13).

$$Y = \rho WY + \alpha\iota_N + X\beta + WX\theta + u;\ u = \lambda Wu + \varepsilon \tag{1}$$

where Y is a $N \times 1$ vector consisting of one observation of the dependent variable for each spatial unit, ι_N is a unit vector associated with the constant term α, X is a $N \times K$ matrix of explanatory variables and $\beta$is the associated $K \times 1$ parameter vector (Vega and Elhorst,2015, pp. 343). The spatial weights matrix W is a positive $N \times N$ matrix which describes the structure of dependence between spatial units. WY are the endogenous interaction effects among the dependent variables while WX is the exogenous interaction effects among the independent variables. Wu represents the interaction effects among the disturbance terms of the different observations. The strength of dependence between spatial units is measured by the spatial diffusion parameters ρ and λ. Similarly, θ is a $K \times 1$ vector of response coefficients that measure the average impact of variation in unemployment determinants in surrounding LMAs (Vega and Elhorst,2015, pp. 344).

As the GNS encompasses all possible interaction effects, models containing fewer interaction effects can simply be obtained by imposing restrictions on one or more parameters (see Table 2). For example, with $\rho = 0$, as can be empirically tested from estimating the GNS model, the GNS reduces to the spatial Durbin error model (SDEM):

$$Y = \alpha\iota_N + X\beta + WX\theta + u;\ u = \lambda Wu + \varepsilon \tag{2}$$

Additionally, if the estimation of the SDEM model finds λ to be statistically insignificant, i.e. indistinguishable from 0, the SDEM model itself reduces to the spatial lag of X model (SLX):

$$Y = \alpha\iota_N + X\beta + WX\theta + \varepsilon \tag{3}$$

Of course, when considering the estimation of a specification using panel data the choice has to be made between fixed and random effects. Elhorst (2014, pp. 53–57) discusses this at some length. While the random effects specification enjoys several advantages over the fixed effects approach, questions remain as to its appropriateness in a spatial panel context. Elhorst (2014, pp. 53–57) argues, following Beenstock and Felsenstein (2007), that while random effects should be the starting point, fixed effects are required when "the sample happens to be the population"(Beenstock and Felsenstein (2007, p. 178) cited in Elhorst (2014, p. 56)) as "each spatial unit represents itself and has not been sampled randomly (Elhorst, 2014, p. 56). As the spatial units (LMA) here are sampled exhaustively, i.e. they are fixed and constitute the whole population of New Zealand, the fixed effects approach is preferred, as advocated by Elhorts (2014) and adopted in the panel estimations in the next section.

5. Results

This section presents the main empirical findings of the paper, using a variety of spatial and non-spatial estimators including pooled OLS and non-spatial panel estimation with LMA and period fixed effects, followed by GNS, SLX and SDEM panel models with LMA and period fixed effects. Robust standard errors have been calculated throughout. As a base line we first use a simple pooled OLS estimator with time period dummies (see Table 3).

(TABLE 3 ABOUT HERE)

Recall that all explanatory variables have been lagged by one intercensal period to minimise the potential bias associated with reverse causation. In the present context, we consider this to be an effective remedy given that we have removed long-term trends by means of year dummies and temporal autocorrelations are assumed absent over the five year to seven year span between observations (see Bellamare et al., 2017). However, given that we are using regional data we do test explicitly for spatial autocorrelation. We find that the coefficient on the owned with mortgage variable *mortgaged*, -0.139, is significant at the 5 percent level and in line with our expectation that higher proportions of mortgagee ownership will be associated with lower rates of unemployment. With respect to the coefficient on *freehold* ownership, the parameter estimate is positive, but around half (0.118) of that suggested by Oswald (0.2) and in fact not statistically significant. The control variables *manual*, *older* and *bartik* are all significant. However, the signs on *manual* and *bartik* are contrary our theoretical expectations.

The pooled OLS approach suffers from a number of shortcomings. Firstly, while the data here are of a panel nature, that is repeated observations on the same areas over time, this is not exploited by a pooled OLS estimator. As the model is unlikely to encompass all the determinants of unemployment across the LMAs, and some of these omitted variables are likely to be correlated with included variables, OLS may yield seriously biased parameter estimates. Additionally, the effect of a variable changing over time within a region may differ markedly from the effect of the same variable changing cross-sectionally relative to other LMAs. These shortcomings are relatively well known and covered in the econometrics literature (see for example Stock and Watson (2003, ch.8), Verbeek (2004, ch.10) or for a more advanced treatment Baltagi and Hani (2005)). An improvement upon the pooled OLS estimation procedure is a simple LMA and time period fixed effects (FE) model. The advantages of such models are well established, they are able to control for cross-sectional heterogeneity, are more informative than either pure time-series or cross-sectional models, present more variability and less collinearity, and can provide more efficient parameter estimates (Baltagi and Hani, 2005).

Table 4 provides the results from the non-spatial period and LMA fixed effects regression. The panel estimator shows a marked improvement in performance over the OLS model with the AIC falling from 1324 (OLS) to 775 (panel). Comparing to the earlier OLS estimator, we can see that the parameter of the *mortgaged* variable has changed sign and is now no longer significant. The *freehold* variable remains close to half the magnitude suggested by Oswald and is now significant at the 10 percent level. For the controls the demographic control (*older*) retains the expected sign but is only significant at the 10 percent level, while the proportion of manual workers (*manual*) is no longer significant. The expected employment growth variable (*bartik*) is now of the expected sign and significant.

(TABLE 4 ABOUT HERE)

However, turning to the spatial diagnostics at the bottom of Table 3, it is clear that evidence exists of spatial autocorrelation in the data. This is not taken into account in the pooled OLS model or in the non-spatial panel FE estimation. This suggest that the estimates of the coefficients of the explanatory variables in either model may not be reliable and that an explicitly spatial approach is warranted. Considering now such spatial models we follow Vega and Elhorst (2015) and start with the most general model, the GNS. The results are reported in Table 5. The large number of statistically insignificant coefficients suggests that this model is over-parameterized. However, two variables have robust effects: *freehold* and *bartik*. Of these two, only *bartik* has a spatial effect. With respect to the total effect, the spatial lag of *bartik* is positive and significant at the 10 percent level. Spatial spillovers are not always easy to interpret but suggest here, plausibly, that the unemployment rate is higher in

LMAs whose neighbours have high levels of expected employment growth. Because of our definition of areas in terms of LMAs, we know that the spillovers are unrelated to commuting behaviour. The alternative behavioural responses are then the migration of firms and/or migration of workers. A positive shock to w_bartik could lead to mobile production factors (skilled labour and capital) to move to surrounding regions. What is left behind is less mobile labour, such as unskilled (manual) and older workers. However, our model captures those latter two variables. Instead, the effect of w_bartik could be that job growth in the surrounding regions leads to less investment and job creation in the the region itself, thereby contributing to a higher unemployment rate. It is important to point out that bartik and w_bartik are not strongly spatially correlated. The standard measure of spatial autocorrelation, Moran's *I* is not statistically significant in four of the five waves of the LMA panel. Moran's *I* is only statistically significant over the period 1991-96 (with a value of 0.374).

The Oswald hypothesis is also confirmed in Table 5, with the total effect of freehold being positive and significant at the 10 percent level but the effect is, with a coefficient of 0.070, smaller than posited by Oswald. The indirect effects of all variables are insignificant, while in terms of direct effects only expected employment growth (*bartik*) is significant, and of the expected sign. Together, these results suggest that $\rho = 0$ while $\boldsymbol{\theta} \neq 0$ and $\lambda \neq 0$ (at the 10 percent level). We therefore consider the SDEM model next.

(TABLE 5 ABOUT HERE)

The results for the SDEM model are shown in Table 6. The results reconfirm the importance of industry mix in explaining the regional variation in unemployment rates. The *bartik* variable is significant at the 1 percent level, indicating that areas of high job growth have lower rates of unemployment. Additionally, the spatial lag of *bartik* and of *manual* employment are significant at the 10 percent level, as theoretically expected. The evidence for the Oswald effect is in this model very weak. Although the coefficient of freehold (0.086) remains close to the 0.1 of the earlier regressions, the robust standard error is slightly too large to suggest significance at the 10 percent level. However, as the estimation suggests that $\lambda = 0$, while $\boldsymbol{\theta} \neq 0$, we proceed with considering the SLX model.

(TABLE 6 ABOUT HERE)

The results from estimating the SLX model can be found in Table 7. Again, neither of the homeownership variables are significant at the 10 percent level, although the coefficient on the *freehold* variable is very close. Overall, the SLX results are similar to those obtained with SDEM: the *bartik* variable is significant at the 5 percent level and has the expected negative sign, while the spatial lags of the *manual* and *bartik* variables are significant at the 10 percent level. In terms of choosing between the SDEM and SLX models, there would seem to be little practical difference. However, we prefer the SDEM model on the basis of its slightly lower AIC and the strong general argument made in favour of the SDEM specification by LeSage (2014).

(TABLE 7 ABOUT HERE)

Finally, we carried out several robustness checks.[13] Firstly, we considered the potential interaction between the ownership variables and age structure (proxied by the *older* variable). Generally, older people are expected to have less mortgage debt than younger people, given that mortgages are paid off over a long time horizon. Those who still have significant mortgage debt at older ages may search more intensively for work in order to be able to service and pay off the mortgage, whereas younger persons may switch to renting instead.

[13] We thank an anonymous reviewer for suggesting to check for interaction effects and nonlinearity effects.

This would suggest a positive coefficient for a variable measuring the interaction between *mortgaged* and *older*. When we rerun our preferred SDEM model (Table 5) by adding the variables *mortgaged* and *freehold* interacted with *older*, we find indeed a statistically significant (at the 5 percent level) effect of *mortgaged* x *older* but with a very small coefficient of 0.007. Interestingly, the spatial lag of this variable is also statistically significant (with coefficient 0.017). However, none of the other homeownership-related variables and their spatial lags are significant in this specification.

Secondly, we also considered the potential interaction between the homeownership variables and the composition of the labour force in terms of skills and occupations, measured by *manual*. We find that this specification performs notably worse in terms statistical significance of the variables, goodness of fit and AIC. With this setup, none of the homeownership variables is statistically significant.

Another interesting question is the extent to which the effect of homeownership on unemployment is nonlinear. We test this by adding the square of *mortgaged* and the square of *freehold*, and their respective spatial lags, to the SDEM model reported in Table 5. The results are shown in Table 8. We see that the impact of *mortgaged* is now highly statistically significant in the form of a concave quadratic. The maximum of the quadratic occurs when *mortgaged* is 39 percent, which is in range of the data (between 28 percent and 48 percent, see Table 1) and slightly greater than the mean (36 percent, see Table 1). Thus, among LMAs where the prevalence of mortgaged ownership is relatively low, the relationship with the unemployment rate is positive, whereas at a high prevalence of mortgaged ownership the relationship with the unemployment rate turns negative. Further in-depth research will be required to uncover the reasons for this specific nonlinearity. Freehold ownership and the spatial lags of the ownership variables are not statistically significant. However, the bartik-related variables continue to have their important role in explaining spatial-temporal variation in unemployment rates.

(TABLE 8 ABOUT HERE)

6. Conclusion

This paper provided regional-level evidence of a relationship between homeownership and unemployment in New Zealand. Given that New Zealand experienced a notable decline in the proportion of the population in owner-occupied dwellings at the same time as the rate of unemployment was on a downward trend, a study of whether a link between these two trends is either spurious or instead robust to well-specified econometric models is clearly of scientific interest as well as of policy significance. Various econometric models were estimated by means of pooled data on 58 Labour Market Areas observed at the times of the 1986, 1991, 1996, 2001, 2006 and 2013 population census and following the model selection strategy suggested by Vega and Elhorst (2015).

Overall, we found no evidence of global spatial spillovers. Local models such as the SLX and SDEM are statistically preferred. Three regional economic effects can be observed. Firstly, favourable industry composition in an LMA, as measured by the Bartik index, is associated with lower rates of unemployment. Secondly, a greater supply of unskilled and manual jobs in surrounding LMAs is also having a downward effect on the unemployment rate of an LMA. Thirdly, favourable industry composition (i.e., faster employment growth) in surrounding LMAs is accompanied by increased local rates of unemployment. As we noted in the previous section, the positive effect of the spatially-lagged Bartik index could be that job growth in the surrounding regions leads to less investment and job creation in the region itself, thereby contributing to a higher unemployment rate.

However, returning to the core issue addressed in this paper, we find that the relationship between homeownership and unemployment seldom or barely reaches significance and depends on the nature of homeownership (mortgaged or freehold) and the selected specification. In this respect, the paper adds to the existing literature by showing that the statistical evidence for effects of homeownership (as in Table 3 for example) may not be robust once spatial spillover effects are considered. Since these effects have often been ignored in the literature, evidence of the magnitude found by Oswald (0.2) is probably biased upward. Here we find some fragile evidence that for outright ownership there may be a small effect of ownership rates on unemployment rates, at a coefficient of at most 0.1. This effect vanishes when a nonlinear impact of mortgaged ownership is considered. In the latter case, the ownership rate is positively associated with the unemployment rate at relatively low rates of mortgaged ownership and negative associated with the unemployment rate at high rates of mortgaged ownership. Overall, however, it must be said that the data and analysis presented here offers little support for the Oswald hypothesis.

As always, differences between countries in institutional and other contextual factors imply that the New Zealand results may not necessarily transfer to other countries. There is clearly still scope for additional case studies that conduct a spatial-econometric investigation of panel data on regional labour markets. Additionally, this literature could benefit from a formal meta-analysis of the existing evidence (e.g., Stanley et al., 2013).Finally, further microeconometric work could also be done, for example to consider differences in actions taken between owners or renters when faced with quits or layoffs, or to consider differences between the two groups in terms of job-qualification mismatches. Clearly, investigation links between the labour and housing markets remains a fruitful area for further research.

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Table 1 Descriptive statistics

	Obs	Mean	Std.Dev.	Min	Max
unemployment	290	7.197	3.201	1.780	21.020
mortgaged	290	36.495	3.527	28.021	48.352
freehold	290	36.623	4.904	23.211	49.536
manual	290	29.953	3.739	16.719	38.013
older	290	44.055	6.620	27.127	62.117
bartik	290	4.586	8.646	-11.965	22.135

Table 2

Model[2]		Restriction on GNS
GNS	$Y = \rho WY + \alpha\iota_N + X\beta + WX\theta + u;\ u = \lambda Wu + \varepsilon$	
SAC	$Y = \rho WY + \alpha\iota_N + X\beta + u;\ u = \lambda Wu + \varepsilon$	$\theta = 0$
SDM	$Y = \rho WY + \alpha\iota_N + X\beta + WX\theta + \varepsilon$	$\lambda = 0$
SDEM	$Y = \alpha\iota_N + X\beta + WX\theta + u;\ u = \lambda Wu + \varepsilon$	$\rho = 0$
SAR	$Y = \rho WY + \alpha\iota_N + X\beta + \varepsilon$	$\theta = 0, \lambda = 0$
SLX	$Y = \alpha\iota_N + X\beta + WX\theta + \varepsilon$	$\rho = 0, \lambda = 0$
SEM	$Y = \alpha\iota_N + X\beta + u;\ u = \lambda Wu + \varepsilon$ (if $\theta = -\rho\beta, \lambda = \rho$)	$\rho = 0, \theta = 0$ or $\theta = -\rho\beta, \lambda = 0$
OLS	$Y = \alpha\iota_N + WX\theta + \varepsilon$	$\rho = 0, \theta = 0, \lambda = 0$

1 Symbols have the same meaning as in equation 1

2 GNS = General Nested Spatial model, SAC = Spatial Autoregressive Combined model, SDM = Spatial Durbin model, SDEM = Spatial Durbin Error model, Spatial Autoregressive model, SLX = Spatial Lag of X model, SEM = Spatial Error model, OLS = Ordinary Least Squares model

(Based on Vega and Elhorst's (2015, p. 343))

Table 3 Pooled OLS with Spatial Diagnostics

					Nobs	290
					F(9, 280)	31.51
					Prob > F	0
					R-squared	0.486
					Root MSE	2.331
					AIC	1323.562
	Coef.	**Robust.Std. Err.**	**t**	**P>t**	**[95% Conf.Interval]**	
mortgaged	-0.139	0.066	-2.100	0.037	-0.270	-0.008
freehold	0.118	0.085	1.390	0.165	-0.049	0.285
manual	0.267	0.045	5.990	0.000	0.179	0.354
older	-0.285	0.077	-3.690	0.000	-0.437	-0.133
bartik	0.457	0.071	6.410	0.000	0.316	0.597
1991 year dummy	13.062	1.675	7.800	0.000	9.765	16.359
1996 year dummy	0.067	0.822	0.080	0.935	-1.552	1.686
2001 year dummy	5.071	0.718	7.060	0.000	3.658	6.484
2013 year dummy	9.641	1.175	8.210	0.000	7.328	11.954
_cons	4.848	3.565	1.360	0.175	-2.170	11.866
Spatial Diagnostics						
Test	**Statistic**	**df**	**p-value**			
Spatial error:						
Moran's I	10.131	1	0.000			
Lagrange multiplier	88.255	1	0.000			
Robust Lagrange multiplier	0.01	1	0.919			
Spatial lag:						
Lagrange multiplier	100.546	1	0.000			
Robust Lagrange multiplier	12.301	1	0.000			

Table 4 **Non-spatial panel with LMA and time period fixed effects**

					Nobs	290
					Groups	58
R-sq:					Obs per group:	
within	0.8188				min	5
between	0.0176				avg	5
overall	0.3266				max	5
					F(9,57)	166.41
corr(u_i, Xb) = -0.0378					Prob > F	0.000
					AIC	775.009

	Coef.	Robust.Std. Err.	t	P>t	[95% Conf.Interval]	
mortgaged	0.037	0.073	0.510	0.613	-0.109	0.184
freehold	0.107	0.058	1.840	0.071	-0.010	0.224
manual	-0.015	0.044	-0.350	0.729	-0.103	0.072
older	-0.121	0.066	-1.840	0.071	-0.252	0.011
bartik	-0.072	0.032	-2.280	0.027	-0.135	-0.009
1991 year dummy	2.739	0.998	2.740	0.008	0.740	4.737
1996 year dummy	2.036	0.517	3.940	0.000	1.000	3.072
2001 year dummy	1.210	0.434	2.790	0.007	0.342	2.079
2013 year dummy	1.707	0.592	2.880	0.006	0.520	2.893
_cons	6.470	3.900	1.660	0.103	-1.339	14.278
sigma_u	2.489					
sigma_e	1.018					
rho	.857	(fraction of variance due to u_i)				

Table 5 **General Nesting Spatial Model (GNS) with LMA and time period fixed effects**

R-sq:				Nobs		290
within	0.4477			Groups		58
between	0.0012					
overall	0.1809					
				Mean of fixed-effects		17.760
				Log-pseudolikelihood		-368.484
				AIC		762.967
Main	Coef.	Robust.Std. Err.	z	P>z	[95% Conf.Interval]	
mortgaged	0.052	0.078	0.660	0.507	-0.102	0.206
freehold	0.101	0.058	1.730	0.083	-0.013	0.215
manual	-0.025	0.049	-0.520	0.600	-0.121	0.070
older	-0.105	0.071	-1.480	0.138	-0.243	0.034
bartik	-0.119	0.039	-3.020	0.002	-0.196	-0.042
w_mortgaged	0.076	0.143	0.530	0.594	-0.204	0.357
w_freehold	0.187	0.163	1.150	0.251	-0.132	0.505
w_older	-0.332	0.217	-1.530	0.126	-0.756	0.093
w_manual	-0.102	0.067	-1.520	0.128	-0.234	0.030
w_bartik	0.161	0.085	1.890	0.058	-0.006	0.328
Spatial						
rho	-0.419	0.360	-1.160	0.245	-1.124	0.287
lambda	0.462	0.242	1.910	0.056	-0.012	0.936
Variance						
sigma2_e	0.839	0.169	4.950	0.000	0.507	1.171
LR_Direct						
mortgaged	0.065	0.100	0.650	0.517	-0.131	0.260
freehold	0.113	0.077	1.460	0.144	-0.039	0.265
manual	-0.026	0.058	-0.450	0.652	-0.140	0.087
older	-0.118	0.091	-1.300	0.195	-0.296	0.060
bartik	-0.129	0.044	-2.950	0.003	-0.214	-0.043
w_mortgaged	0.099	0.190	0.520	0.602	-0.273	0.471
w_freehold	0.222	0.229	0.970	0.333	-0.227	0.672
w_older	-0.390	0.303	-1.290	0.199	-0.984	0.205
w_manual	-0.102	0.072	-1.420	0.157	-0.242	0.039
w_bartik	0.184	0.118	1.550	0.121	-0.048	0.416
LR_Indirect						
mortgaged	-0.032	0.058	-0.550	0.585	-0.146	0.082
freehold	-0.043	0.058	-0.740	0.459	-0.157	0.071
manual	0.017	0.033	0.520	0.606	-0.048	0.083
older	0.048	0.063	0.750	0.451	-0.076	0.171
bartik	0.037	0.046	0.800	0.424	-0.053	0.126
w_mortgaged	-0.063	0.119	-0.530	0.593	-0.296	0.169
w_freehold	-0.103	0.155	-0.660	0.509	-0.407	0.202
w_older	0.163	0.218	0.740	0.457	-0.265	0.591
w_manual	0.029	0.042	0.700	0.486	-0.053	0.111
w_bartik	-0.072	0.091	-0.780	0.432	-0.250	0.107
LR_Total						
mortgaged	0.033	0.060	0.540	0.587	-0.086	0.151
freehold	0.070	0.042	1.670	0.094	-0.012	0.152
manual	-0.009	0.040	-0.220	0.824	-0.087	0.069
older	-0.070	0.052	-1.350	0.178	-0.172	0.032
bartik	-0.092	0.050	-1.840	0.065	-0.190	0.006
w_mortgaged	0.036	0.112	0.320	0.749	-0.183	0.255
w_freehold	0.120	0.117	1.020	0.306	-0.109	0.348
w_older	-0.227	0.142	-1.600	0.110	-0.505	0.051
w_manual	-0.073	0.057	-1.270	0.205	-0.185	0.040
w_bartik	0.112	0.056	2.020	0.044	0.003	0.221

*w_ indicates the spatial lag of the variable

Table 6 **Spatial Durbin Error Model (SDEM) with LMA and time period fixed effects**

R-sq:					Nobs	290
within	0.437				Groups	58
between	0.009					
overall	0.190					
				Mean of fixed-effects		14.8452
				Log-pseudolikelihood		-369.5385
					AIC	763.077

	Coef.	Robust.Std. Err.	z	P>z	[95% Conf.	Interval]
Main						
mortgaged	0.038	0.074	0.510	0.609	-0.107	0.183
freehold	0.086	0.053	1.610	0.107	-0.018	0.191
manual	-0.012	0.043	-0.290	0.774	-0.097	0.072
older	-0.077	0.058	-1.320	0.187	-0.192	0.037
bartik	-0.132	0.046	-2.850	0.004	-0.223	-0.041
w_mortgaged	0.017	0.105	0.170	0.868	-0.188	0.223
w_freehold	0.112	0.117	0.960	0.336	-0.117	0.341
w_older	-0.229	0.160	-1.440	0.151	-0.542	0.084
w_manual	-0.110	0.062	-1.780	0.076	-0.232	0.011
w_bartik	0.167	0.088	1.910	0.056	-0.004	0.339
Spatial						
lambda	0.119	0.083	1.430	0.152	-0.044	0.281
Variance						
sigma2_e	0.746	0.211	3.540	0.000	0.333	1.159

*w_ indicates the spatial lag of the variable

Table 7 **Spatial Lag of X (SLX) with LMA and time period fixed effects**

R-sq:					Nobs	290
within	0.8284				Groups	58
between	0.0099				F(14,57) =	110.74
overall	0.3542				Prob > F =	0
corr(u_i, Xb)	-0.0335				AIC	769.235

	Coef.	Robust.Std. Err.	t	P>t	[95% Conf.	Interval]
mortgaged	0.044	0.078	0.570	0.573	-0.111	0.199
freehold	0.093	0.056	1.660	0.101	-0.019	0.204
manual	-0.011	0.044	0.250	0.804	-0.099	0.077
older	-0.083	0.060	1.370	0.175	-0.204	0.038
bartik	-0.123	0.050	2.470	0.017	-0.223	-0.023
w_mortgaged	-0.005	0.105	0.050	0.964	-0.214	0.205
w_freehold	0.105	0.114	0.920	0.361	-0.124	0.334
w_older	-0.209	0.155	1.350	0.183	-0.521	0.102
w_manual	-0.115	0.065	1.790	0.079	-0.245	0.014
w_bartik	0.153	0.088	1.740	0.087	-0.023	0.329
_cons	13.512	4.599	2.940	0.005	4.303	22.721
sigma_u	2.439					
sigma_e	1.002					
Fraction of variance due to u_i			0.856			

*w_ indicates the spatial lag of the variable

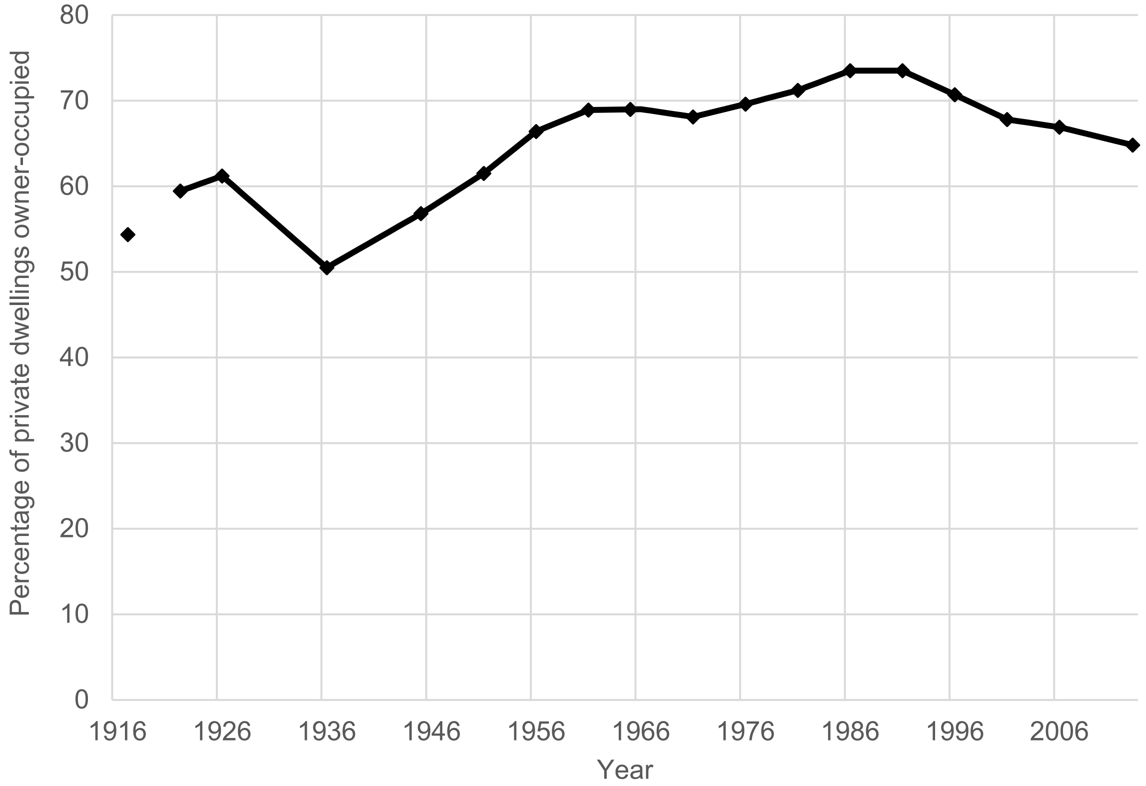
Table 8 **Spatial Durbin Error Model (SDEM) with nonlinear homeownership variables**

R-sq:			Nobs		290
within	0.511		Groups		58
between	0.0043				
overall	0.1755				
			Mean of fixed-effects		11.325
			Log-pseudolikelihood		-361.3438
			AIC		754.6875

	Coef.	Robust.Std. Err.	z	P>z	[95% Conf.Interval]	
Main						
mortgaged	1.113	0.384	2.900	0.004	0.361	1.865
freehold	-0.024	0.255	-0.090	0.925	-0.524	0.476
manual	-0.011	0.041	-0.280	0.782	-0.091	0.069
older	-0.060	0.060	-1.000	0.317	-0.177	0.057
bartik	-0.149	0.044	-3.400	0.001	-0.235	-0.063
mortsq	-0.014	0.005	-2.870	0.004	-0.024	-0.005
freesq	0.002	0.003	0.480	0.634	-0.005	0.008
w_mortgaged	-0.406	0.780	-0.520	0.603	-1.935	1.124
w_freehold	-0.449	0.565	-0.790	0.427	-1.558	0.659
w_older	-0.155	0.146	-1.060	0.290	-0.442	0.132
w_manual	-0.139	0.067	-2.080	0.038	-0.270	-0.008
w_bartik	0.168	0.083	2.020	0.044	0.005	0.332
w_mortsq	0.006	0.010	0.590	0.555	-0.014	0.026
w_freesq	0.007	0.007	1.020	0.307	-0.007	0.022
Spatial						
lambda	0.101	0.088	1.140	0.254	-0.072	0.274
Variance						
sigma2_e	0.706	0.205	3.440	0.001	0.304	1.108

Note: This model also includes LMA and time period fixed effects

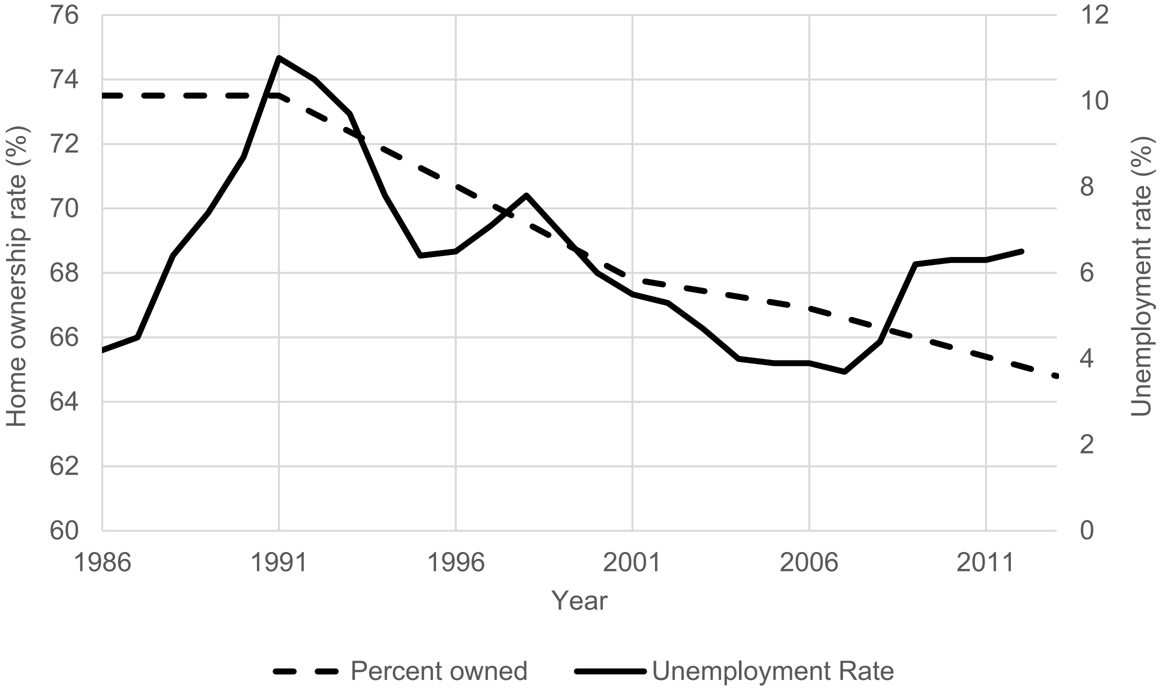
Figure 1. Percentage of private dwellings owner-occupied, 1916-2013



Source: Statistics New Zealand (2015) A *Century of Censuses*.

Notes: 1916 and 1921 exclude Māori. Cases of tenure not stated have been excluded. 2006 and 2013 include ownership by family trusts.

Figure 2. **New Zealand unemployment rate and homeownership rate 1986-2013**



Source: Statistics New Zealand

Notes: The homeownership rate has been linearly interpolated between censuses. The source of the unemployment rate is the quarterly Household Labour Force Survey.

Figure 3. New Zealand Labour Market Areas