Regional Variation in Rental Costs for Larger Households

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Abstract

Housing costs comprise a major part of most household budgets. Larger households require greater space than do smaller households but do not necessarily have larger incomes. The cost of extra housing space (e.g. the cost of an extra bedroom) may vary across different locations, both absolutely (dollars per week) and proportionately (percentage of overall costs). If this is the case, differential regional costs of additional space may provide an incentive for different sized households to locate in particular areas where housing costs most appropriately fit their needs. Our analysis uses tenancy bond rental data to analyse the cost of renting an extra bedroom in different locations throughout New Zealand. It discusses the theory of what determines rents. We then examine the nature of regional rental costs, testing whether the documented patterns fit with theoretical predictions. Finally, we reflect on what the results may imply for social outcomes and housing policy in New Zealand. To give a flavour of the issues, consider the following. In 2003, the average weekly rental cost of a two bedroom dwelling in Auckland was $37 more than for a one bedroom dwelling. The cost of a third bedroom was an extra $50 and the cost of a fourth bedroom was an additional $90. Thus weekly rental cost for a four bedroom dwelling exceeded that of a one bedroom dwelling by $177. In Manawatu-Wanganui, the cost of a two bedroom dwelling was $38 more than for a one bedroom dwelling - almost identical to the margin in Auckland. But the cost of additional bedrooms was much lower than in Auckland: $29 for a third bedroom and $33 for a fourth bedroom. This raw data might suggest that it would be beneficial for larger households to locate in Manawatu-Wanganui and for smaller households to locate in Auckland. However, the interaction with other factors has to be taken into account before such a conclusion can be reached. At the minimum, the data suggests there is a material issue to be addressed relating to disparities in regional housing costs for different sized households.

JEL classification:
R21; R31; R51

Keywords:
House Rents; Deprivation; Regional Disparities

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1 Introduction

Housing costs represent a large proportion of total income for many households. In 2001, 33% of households spent at least a quarter of their income on housing; 15% of households spent more than two-fifths of their income on housing. Housing costs can therefore have a significant impact on living standards for many people, and may be particularly germane for lower income households that rent. One of the nine variables that comprise the deprivation index for New Zealand is "not living in own home" (Crampton et al, 2000). While covering a number of categories, the majority of people covered by this variable will be renters. An understanding of the determinants of rents across different localities is therefore vital for understanding the determinants of overall living standards, especially for more deprived households.

Large families have a greater need for housing services than do smaller families. A family with one child may receive quite satisfactory housing quality through their rental of a one or two bedroom house or apartment, but a five child household may need at least a four bedroom house to achieve the same housing quality. In understanding living standard outcomes of large households, we therefore need to understand the determinants of housing costs - in this case, rentals - for dwellings of different sizes.[1]

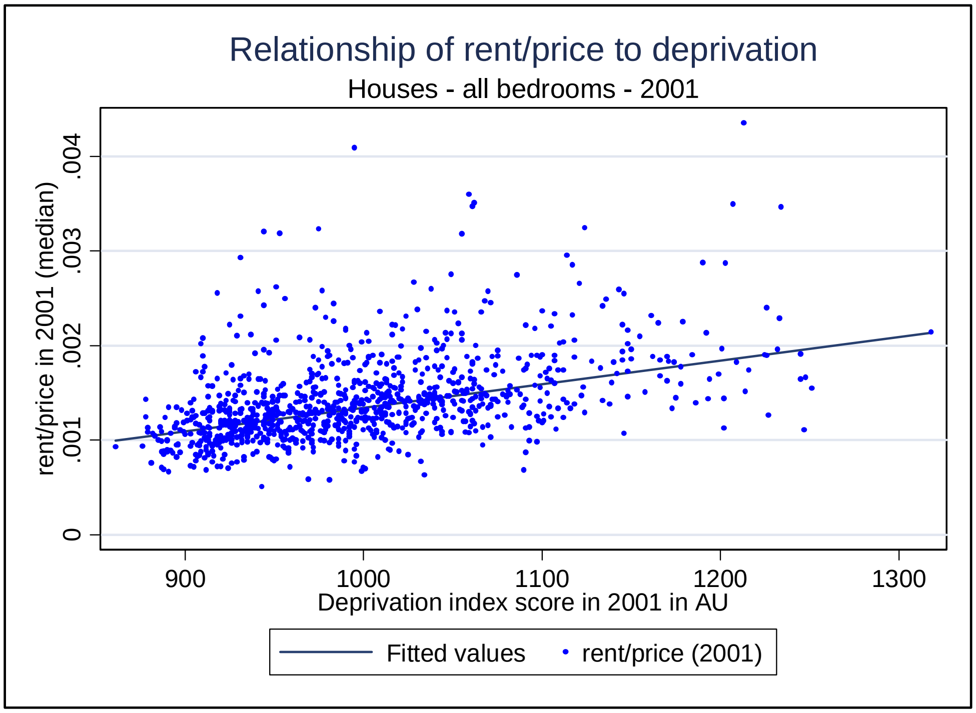
In this study, we examine the determinants of rents for houses and apartments of different sizes across locations in New Zealand. Initially, we analyse the relationship of rents to house prices aggregating together houses of all sizes and apartments of all sizes (but maintaining a segregation between houses

[1] Henceforth "dwellings" refers to the combined set of houses and apartments; "size" refers to number of bedrooms. The terms "apartment" and "flat" are used interchangeably.

and apartments). We then extend our analysis to determining the costs of extra bedrooms in houses across locations.

House prices can be taken as a summary statistic for the way purchasers value the location, amenity and housing characteristics in each locality (Can, 1992; Dubin, 1992; Grimes et al, 2003; Grimes and Aitken, 2004; Meen, 2001). It might therefore be reasonable to expect that rentals will be proportionate to house prices across locations. But this is not the case. Using 2001 data for New Zealand (discussed in greater detail in section 3), Figure 1 demonstrates that, on average, rents are high relative to house prices in locations that have high levels of deprivation (an increase in the deprivation scale indicates a more deprived area). Given that more deprived households have a greater likelihood of renting than do less deprived households (Crampton et al, 2000) these relationships imply that such households may be caught in a housing cost trap. One contribution of this paper is to analyse the reasons behind the existence of this trap.

Figure 1: Rent/Price Ratio (Houses) Related to Deprivation Index Score



Large households, in particular, may be faced with a housing cost trap if their rental costs are so high that they are prevented from saving sufficient to afford a deposit to purchase a home (DTZ Research, 2004). Evidence shows that the nature of this trap differs across locations. For instance, in 2003, the average weekly rental cost of a two bedroom dwelling in Auckland was $37 more than for a one bedroom dwelling. The cost of a third bedroom was an extra $50 and the cost of a fourth bedroom was an additional $90. Thus weekly rental cost for a four bedroom dwelling exceeded that of a one bedroom dwelling by $177. In Manawatu-Wanganui, the cost of a two bedroom dwelling was $38 more than for a one bedroom dwelling - almost identical to the margin in Auckland. But the cost of additional bedrooms was much lower than in Auckland: a marginal cost of $29 for a third bedroom and $33 for a fourth bedroom. It therefore appears easier for larger renting households to save for a deposit by living in a city such as Palmerston North than in Auckland.

These raw data suggest that it would be beneficial for larger households to rent in Manawatu-Wanganui and for smaller households to rent in Auckland. However, the interactions with income prospects and other factors have to be taken into account before such a conclusion can be reached. At the minimum, the data suggests there is a material issue to be addressed relating to disparities in regional housing costs for different sized households. The data also suggest that there are important issues to be addressed regarding support for renting versus buying, especially for more deprived households facing high rental costs relative to purchase costs (from the evidence in Figure 1).

We discuss some social policy implications of these issues in section 6 of the paper. Before doing so, we undertake an analysis of the determinants of the observed data. Section 2 outlines a theoretical model of the relationship between rents and house prices across different locations. This model provides a framework for the subsequent empirical analysis and for interpreting the implications of our findings. In particular, the framework demonstrates that simple housing policy solutions, drawn at face value from the data, could place low income families in some jeopardy if implemented. Section 3 briefly outlines the data used in the study. Section 4 examines the relationship between rents and prices for houses and apartments across locations. In this section, we aggregate each of houses and apartments across all sizes (but still differentiate between houses and apartments). Section 5 extends this analysis to determining the cost of additional bedrooms in houses across localities.

2 Theory

2.1 General Aspects

Following Capozza and Seguin (1996), we model the housing market as one in which standard asset pricing relationships hold. Thus the purchaser of a rental property should expect a total return equal to the cost of capital and the seller of the rental property should expect a price that reflects this same relationship. The cost of capital in turn reflects the risk free rate of interest (e.g. on government bonds) plus a risk premium applicable to rental housing. Since holdings of rental housing can be diversified across locations, in an efficient market there should be no risk premium applicable to a particular location; any such location-specific risk is diversifiable and so should have zero price. It is only undiversifiable risk that is priced in an efficient market.[2]

We denote the cost of capital for rental housing in period t as μ^t, the one-period rental on a j-bedroom house in location i (set at the start of period t) as R_{ij}^t, the price of a j-bedroom house in location i (at the start of period t) as P_{ij}^t and the one period expected rate of capital gain on a j-bedroom house in location i (at the start of period t) as K_{ij}^t. The expected total return on the property in period t is equal to the rental yield (R_{ij}^t / P_{ij}^t) plus the expected rate of capital gain. This total return should equal the cost of capital as in (1): (see next page).

[2] For example, see Brealey and Myers (2003). Recent work by CRESA (Saville-Smith and Fraser, 2004) indicates that a large proportion of the private rental stock in New Zealand is held by "hobbyist" landlords with only one or two rental properties each. They face undiversified location-specific risk and this risk may be reflected in a premium that they and/or their tenants bear. Our functional form accommodates the presence of such location-specific risk premia, although if premia exist they are indistinguishable from the expected capital gains component. We interpret this latter component purely as a capital gains component; if a location-specific risk premium is present, then this component should be thought of as a net capital gain where the location-specific risk premium is deducted from the expected capital gain.

$$(R_{ij}^t / P_{ij}^t) + K_{ij}^t = \mu^t \qquad \forall \text{ i, j, t} \qquad (1)$$

From (1) it is clear that the rental yield will only be constant across locations in any period if expected capital gains on the price of rental houses are equal across locations. This will not normally be the case. Where it is not the case, the rental yield will differ across locations.

For instance, consider a simple example of two locations in which, initially, the expected rental over time is constant. With constant cost of capital, the house price in each location will be constant over time, the expected rate of capital gain will therefore be zero and the rental yields will be equal. Now consider a situation in which one location has a temporary downturn in desirability - perhaps because of a major new construction project that will take 3 years to build, lowering rents that can be charged in the area for that period. The house price will fall on announcement of the new project (because of the reduction in present discounted value of rents that will be received) but will then rise over the three years back to the same level as prior to the announcement (and back to the same level as in the unaffected location). Expected capital gains will therefore be positive during the project's construction phase as the length of time of lower rents shortens. Since expected capital gains in this case are positive through this period, the rental yield will be lower than in the unaffected location.

In general, in an efficient market, any factors that are thought to impact on the future desirability of an area will be partly reflected in current prices and partly reflected in expected capital gains and rentals in such a way as to ensure that the relationship in (1) holds. The dynamics (i.e. the split between R_{ij}^t / P_{ij}^t

and K_{ij}^{t}) will depend on the dynamics of the factors affecting the current and future desirability of the location.

2.2 Application

Equation (1) can be rearranged to give the linear relationship which can be estimated (if appropriate data were available):

$$R_{ij}^{t} / P_{ij}^{t} = \mu^{t} - K_{ij}^{t} \quad (2)$$

In practice, with cross-section data, a constant term can be substituted for μ^{t} (obviating the need to specify the determinants of the risk premium) and variables influencing capital gains expectations can be substituted for K_{ij}^{t}. This raises the question of what determines expected capital gains. We address this issue by estimating the relationship between past capital gains and variables known at the start of the past period.

Let the set of variables hypothesised to have a potential effect on the desirability of an area (and hence on the split between capital gains and rental yield) be Z_{ij}^{t}. The elements of Z_{ij}^{t} are chosen from the literature on house price determination (e.g. see Meen, 2001) provided corresponding data is available at the required level of disaggregation. We then regress K_{ij}^{t-1} on each element of Z_{ij}^{t-1} and find the subset of variables that have a significant relationship with K_{ij}^{t-1}. We denote this subset of variables as Y_{ij}^{t-1} and use the current values of these variables (Y_{ij}^{t}) to proxy K_{ij}^{t}. This approach is a form of rational expectations based on the maintained hypothesis that the same variables which determined past relative capital gains across areas also determine currently expected relative capital gains; i.e. that the housing market operates in a stable fashion across areas over time. We do not impose the requirement that the capital gains coefficients remain stable over time since different macroeconomic effects may change their magnitudes.

Equation (2) imposes a unit elasticity on the relationship between rents and prices, as indicated by theory. This relationship can be tested explicitly by rearranging (2), incorporating the capital gains elements discussed above, and estimating the non-linear relationship:

$$\ln R_{ij}^{t} = \alpha_1 \ln P_{ij}^{t} + \ln(\beta_0 + \boldsymbol{\beta} Y_{ij}^{t}) \qquad (3)$$

The unit price elasticity can be examined by testing whether the restriction $\alpha_1 = 1$ can be rejected. The term $\boldsymbol{\beta} Y_{ij}^{t}$ proxies expected capital gains, other than the constant term in that relationship which is incorporated into β_0; $\boldsymbol{\beta}$ is a vector of coefficients corresponding to the elements of Y_{ij}^{t}. The β_0 term includes the effect of the cost of capital.

As discussed in section 3, we have data for each of the i and j aspects of R_{ij}^{t} in 2001; i.e. we have data for median rents for each of 1 to 5 bedroom houses across area units (AUs). We have data on a range of variables hypothesised to be included in Z_{ij}^{t} for each of 2001, 1996 and 1991 at the AU level and have data for median house prices in each AU for each of 2001, 1996 and 1991. However we do not have the data for house prices disaggregated by the number of bedrooms. For our analysis in section 5, we therefore have to proxy P_{ij}^{t} based on data for P_{i}^{t} where P_{i}^{t} denotes the median price for all-sized houses in area i at time t. To do so, we adopt a structure that relates the (unobserved) price of a j-bedroom house to the average sized house in an area based on dummies for the number of rented bedrooms, as in (4):

$$\ln P_{ij}^{t} = \sum_{j=1}^{5} \delta_j D_j + \sum_{j=1}^{5} \varepsilon_j D_j \ln P_i^{t} \qquad (4)$$

where D_j (j = 1, …, 5) are dummy variables =1 where a rented house has j bedrooms and =0 otherwise; $\delta_1, \ldots, \delta_5$ are corresponding intercept coefficients and $\varepsilon_1, \ldots, \varepsilon_5$ are corresponding slope coefficients. In section 5, we enter (4) in place of $\alpha_1 \ln P_{ij}^{t}$ within equation (3) to give equation (5):

$$\ln R_{ij}^{t} = \sum_{j=1}^{5} \delta_j D_j + \sum_{j=1}^{5} \varepsilon_j D_j \ln P_i^{t} + \ln(\beta_0 + \boldsymbol{\beta} Y_{ij}^{t}) \qquad (5)$$

The structure in (5) makes the δ_j and ε_j coefficients invariant to local conditions. However the variables in Y_{ij}^{t} that interact with the housing market in determining capital gains may also play a role in determining the price of a bedroom across locations. To test whether this is the case, we add further non-linearity to (5) by allowing each coefficient also to be a function of the elements of Y_{ij}^{t}. Thus for each j, we allow:

$$\delta_j = \boldsymbol{\delta_j} Y_{ij}^{t} \qquad (6a)$$

$$\varepsilon_j = \boldsymbol{\varepsilon_j} Y_{ij}^{t} \qquad (6b)$$

where Y_{ij}^{t} includes a constant term and where $\boldsymbol{\delta_j}$ and $\boldsymbol{\varepsilon_j}$ indicate the corresponding coefficient vectors. We test whether we can restrict all elements of $\boldsymbol{\delta_j}$ and $\boldsymbol{\varepsilon_j}$ (other than those corresponding to the constant term) to zero. If we cannot do so, the implication is that factors within Y_{ij}^{t} affect rents paid for additional bedrooms across locations, even after allowance is made for the general price of housing and expected capital gains across locations.

3 Data

3.1 Datasets

We use three main datasets in our analysis, all at area unit (AU) level. Area units correspond approximately to suburbs in major cities. The house price dataset from Quotable Value New Zealand (QVNZ) provides the median sales prices for residential property at AU level. QVNZ is a state-owned entity that collects data on all property sales and which values properties for local authority property tax purposes. We have measures, from this source, of the QVNZ valuation of houses that are sold, and the median sales price. For our work we use data from 1991, 1996 and 2001. The second dataset is the tenancy bond data at AU level from 2001 obtained from the Ministry of Housing. It contains information on the median weekly rent for houses and apartments depending on the number of bedrooms. The third major dataset comprises variables from the censuses of 1991, 1996 and 2001, as well as the deprivation index based on the censuses prepared by the Wellington School of Medicine.

After preparing the datasets (described below) we cover 1215 area units for 2001; 3,206,919 people live in these areas comprising 85.8 % of the New Zealand population. The median sales price is $159,707.60 for houses and $143,659.40 for flats respectively. The average rented dwelling has 2.66 bedrooms.

3.2 QVNZ data

QVNZ provides data for residential dwellings covering a number of categories. In order to gain sales price data for the dwelling types "House" and "Flat" we group categories based on the question: "Is it possible to buy a single flat in the house or does one have to buy the whole house?" (Our house sales price is the weighted average (by number of sales) of the sales prices in the QVNZ categories[3] RC, RD and RH; our flats sales price uses categories RF and RR.)

We use the median sales price in an area unit since it reflects prices that have been set by the market. Some of the sales price data is clearly spurious. For example one might find a sales price of just $2,660, but a capital value of $65,000 or vice versa. This can be the result of selling and buying within a family. For identifying this spurious data it is possible to compare the median sales price with the median capital value in an area unit. The capital value is an estimate of the value of the property calculated by QVNZ. One would expect the sales price to be close to the capital value. Therefore the ratio of the sales price to the capital value should be reasonably close to one. (We do not use the capital value for our analysis because it is an estimated value and does not necessarily reflect actual market conditions.) Figure 2 shows the distribution of this ratio for New Zealand. The majority of the data fulfils the requirement of being close to one; the spurious data form the tails of the graph.

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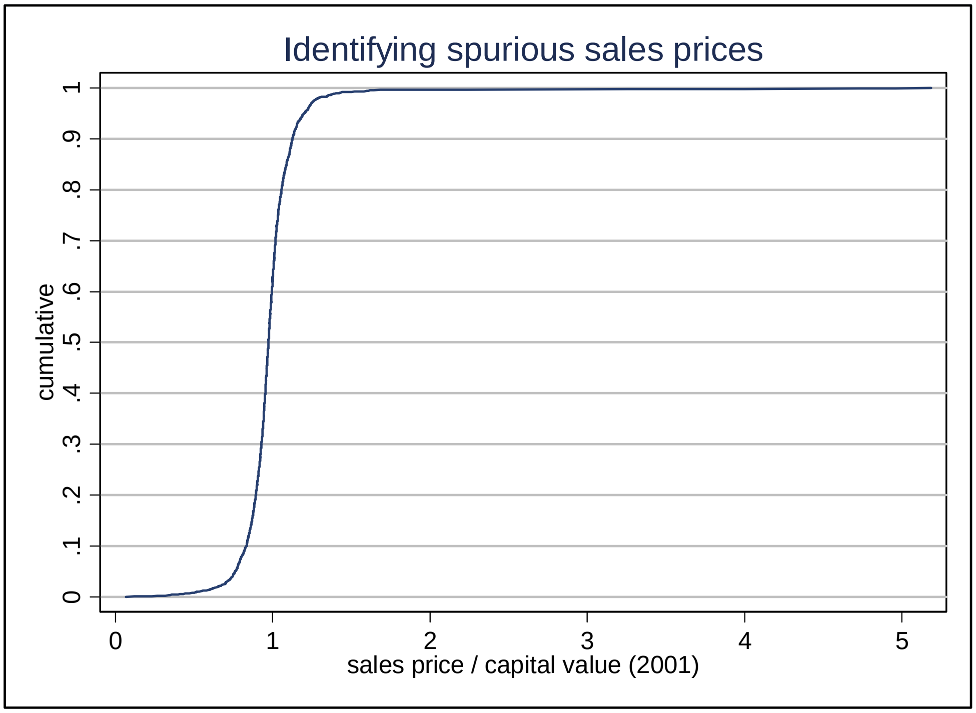
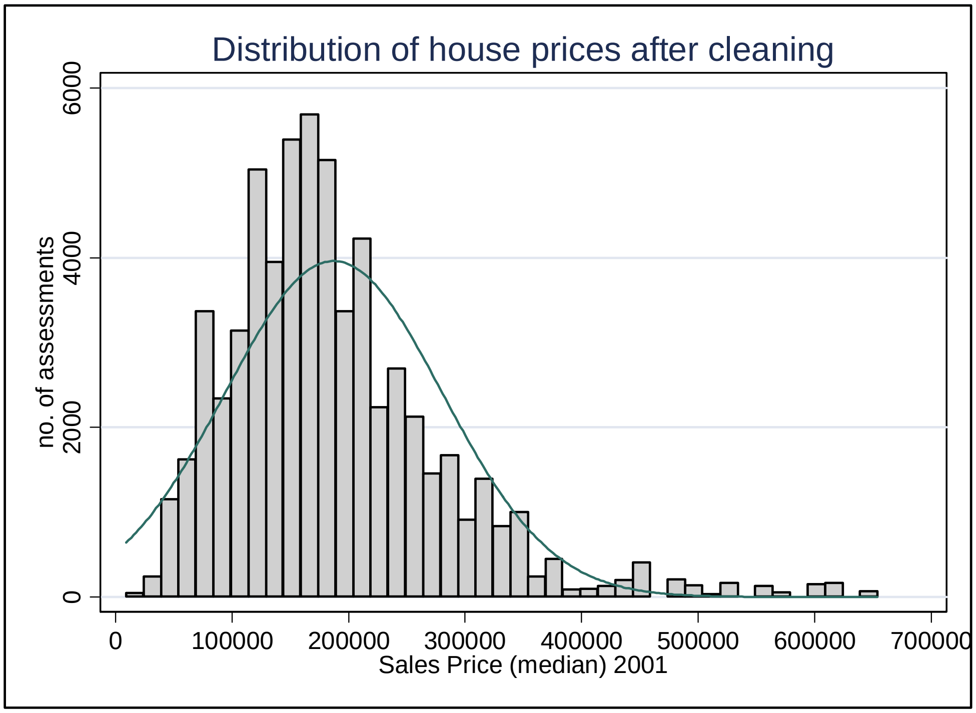
[3] RD: Dwelling houses of fully detached or semi-detached style on their own clearly defined piece of land.
RH: Home and income. The dwelling is the predominant use and there is an additional unit of use attached to, or associated with, the dwelling house which can be used to produce income.
RC: Converted dwelling houses which are now used as rental flats.
RR: Rental flats which have been purpose built.
RF: Ownership units which may be single storey or multi-storey and which do not have the appearance of dwelling houses.

Figure 2: Identifying spurious sale prices



In order to generate a sound dataset, the bottom and top 10 % of the ratios in each category (RC, RD, RH, RF and RR) are identified and any dwelling type that contains at least one spurious observation on any category is dropped. After this cleaning of the data, the sales price: capital value ratio varies between 0.805 and 1.147. Figure 3 shows the distribution of sales prices for the remaining area units after cleaning.

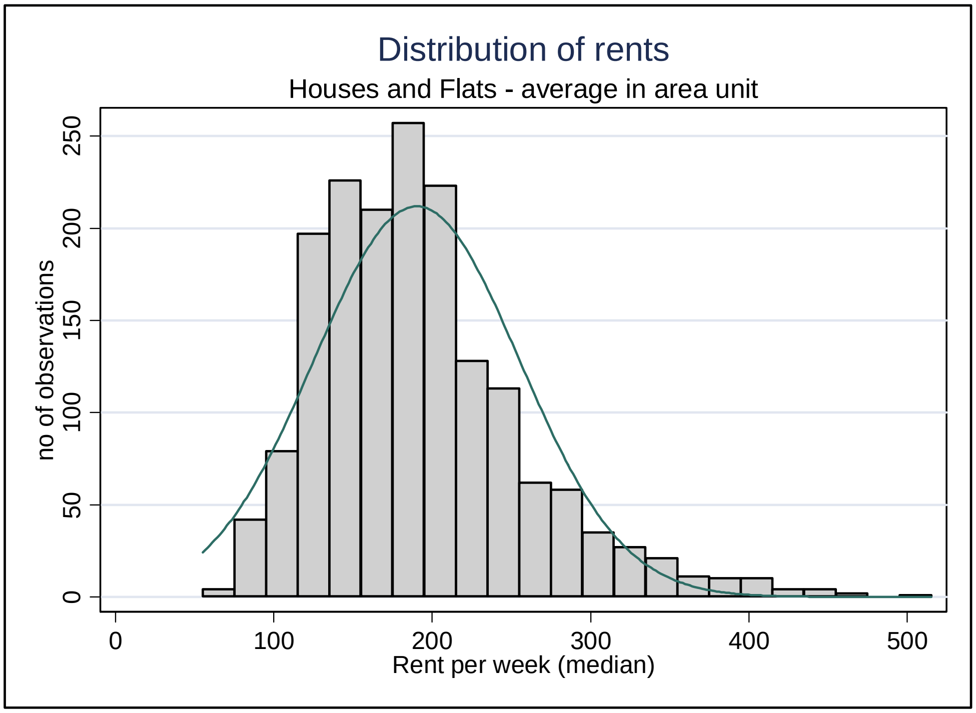
Figure 3: Distribution of House Prices for New Zealand, 2001



3.3 Tenancy bond data

An examination of the tenancy bond dataset indicates that it does not contain obviously spurious observations. However we drop observations where the owner may set rents that do not necessarily reflect market conditions. Hence observations where Housing NZ or the Local Authority is the landlord are dropped and only private landlords remain in the dataset. Furthermore, single rooms are deleted from the dataset. Figure 4 shows the distribution of rents for the remaining data.

Figure 4: Distribution of Rents for New Zealand, 2001



4 Relationship Between Rents & Prices

This section examines the relationship between rents and prices for each of houses and flats at aggregate level (i.e. aggregating all sized houses together and aggregating all sized flats together). According to the theory in section 2, rents are determined by prices and by expected capital gains. Higher expected capital gains should result in a lower rent/price ratio. In order to illustrate the validity of this model we initially conduct a simple two-step test.

At first the rent/price-ratio for 2001 is correlated across AUs with socio-economic variables hypothesised to influence the desirability of an area and hence influence capital gains. In particular, we examine the relationship between this ratio and each of income, deprivation, employment and two separate education variables.[4] Appendix A contains scatter plots together with linear predicted values for each of these relationships, and Table 1 summarises the findings. For example, a negative slope coefficient on median income (2001) means that in "richer" areas the rent/price-ratio tends to be lower.

Table 1: Significant relationships between socio-economic factors & the rent/price-ratio

	House	**Flat**
Median income (2001)	Negative	Negative
Deprivation index score (2001)	Positive	Positive
Proportion of people employed (2001)	Negative	Negative
Proportion of people with no education (2001)	Positive	Positive
Proportion of people with university degree (2001)	Negative	Negative
All results are significant at 1% level.		

The second step is to compare the same set of variables with the actual capital gains that occurred from 1996 to 2001. This allows us to test our model's prediction that factors that have negative impacts on capital gains should lead to a higher rent/price-ratio. For example, if capital gains from 1996 to 2001 were positively linked to median income in 1996 our model predicts a negative relationship of the rent/price-ratio and median income in 2001. Table 2 summarises the impacts of each of the socio-economic factors on capital gains from 1996 to 2001. Appendix B contains the corresponding scatter plots with the linear predicted values. For each of the socio-economic factors the predicted relationships hold (except for one case where the sign is as predicted but the result is not significant).

[4] We use the ratio of the population with no educational qualifications and the ratio with university qualifications. Other educational levels have also been tested but are not significant.

Table 2: Impact of socio-economic factors on capital gains (2001/1996)

	House	Flat	Inverse relationship with rent/price?
Median income (1996)	Positive	Positive	✓
Deprivation index score (1996)	(negative but not significant)	Negative	(✓)
Proportion of people employed (1996)	Positive	Positive	✓
Proportion of people with no education (1996)	Negative	Negative	✓
Proportion of people with university degree (1996)	Positive	Positive	✓
All stated results are significant at 1% level.			

In order to quantify the relationships of rents, prices and other socio-economic variables, we estimate equation (3) across AUs for each of houses and apartments in the form:

$$\ln rent = \alpha_1 \ln price + \ln(\beta_0 + \beta_1 income + \beta_2 deprivation + \beta_3 employment + \beta_4 noedu + \beta_5 uniedu) \quad (7)$$

where *rent* and *price* are as described in section 3 (using median tenancy bond and QVNZ data respectively); *income* is the median income in the AU; *deprivation* is the AU's deprivation index score; *employment* is the proportion of people aged over 15 in employment; *noedu* is the proportion of people with no educational qualification; and *uniedu* is the proportion of people with a university qualification.

Column 1 of Table 3 presents the resulting non-linear least squares estimates for houses. The deprivation variable includes some aspects of income, employment and education and these may be priced into capital gains in a fashion that differs from the price implied by their weighting within the deprivation scale. This could complicate the interpretation of the coefficients estimated when all five capital gains proxies are included. To test the robustness of our estimates to this possibility, column 2 presents the results with deprivation omitted, while column 3 presents the results with deprivation included but with the remaining four capital gains proxies excluded.

The results indicate that house prices are a major determinant of rents, albeit with a coefficient of around one half rather than unity (we discuss possible reasons for this further below). The socio-economic variables hypothesised to influence capital gains are also important. Higher deprivation increases rents for a given house price as indicated previously by the graphs. In addition, each of income, employment and the two education variables impact significantly on rents in at least one of the specifications.

Table 3: Results of estimating (7): Houses (Non-Linear)*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) IV	(6) IV
α_1 Price	0.4345 (29.43)*	0.4237 (26.50)*	0.5524 (48.29)*	0.5495 (34.27)*	0.5144 (29.05)*	0.6291 (48.72)*
β_0 Const	-0.4710 (2.80)*	1.4646 (4.59)*	0.1274 (3.74)*	-0.3185 (4.98)*	0.4237 (4.07)*	0.0400 (2.73)*
β_1 Income	0.0160 (3.55)*	0.0175 (3.21)*		0.0042 (3.16)*	0.0056 (2.64)*	
β_2 Deprivation	0.0014 (5.30)*		0.0001 (6.60)*	0.0005 (5.29)*		0.0001 (7.28)*
β_3 Employment	-0.1048 (0.82)	-0.9331 (3.63)*		0.0993 (3.64)*	-0.1639 $(2.51)^{+}$	
β_4 No edu	-0.5712 (2.65)*	-0.1396 (0.71)		-0.0981 $(2.15)^{+}$	0.0656 (1.28)	
β_5 University edu	0.4843 (2.78)*	0.6141 (2.83)*		0.1313 (2.61)*	0.2754 (3.01)*	
Adj.R^2	0.8156	0.7845	0.7689	0.8244	0.7789	0.7810
s.e.	0.1332	0.1441	0.1490	0.1299	0.1459	0.1450
N	798	798	798	798	798	798

* β_1 coefficients are multiplied by 1,000; t-values in parentheses; *significant at 1% level; $^{+}$significant at 5% level.

Table 4: Results of estimating (7): Apartments (Non-Linear)*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) IV	(6) IV
α_1 Price	0.2946 (9.15)*	0.3101 (9.35)*	0.4622 (18.40)*	0.3244 (9.16)*	0.3312 (9.14)*	0.4730 (15.26)*
β_0 Const	0.4510 (0.37)	5.0152 $(2.31)^+$	0.7378 (2.67)*	0.2242 (0.24)	3.2732 $(2.03)^+$	0.8360 $(2.37)^+$
β_1 Income	0.0969 (1.95)	0.0673 (1.79)		0.1075 (1.98)	0.0872 (1.88)	
β_2 Deprivation	0.0051 $(2.31)^+$		-0.00007 (0.60)	0.0032 $(2.11)^+$		-0.0002 (1.54)
β_3 Employment	0.2794 (0.28)	-1.2208 (1.11)		-0.4286 (0.50)	-1.1778 (1.17)	
β_4 No edu	-8.4783 $(2.15)^+$	-4.8516 (1.93)		-3.8053 (1.83)	-2.1141 (1.51)	
β_5 University edu	-5.9408 $(2.14)^+$	-3.7324 (1.93)		-3.1331 (1.69)	-1.8067 (1.32)	
Adj.R^2	0.5881	0.5578	0.5077	0.5325	0.5103	0.4356
s.e.	0.1716	0.1775	0.1874	0.1831	0.1871	0.2006
N	415	415	415	415	415	415

* β_1 coefficients are multiplied by 1,000; t-values in parentheses; *significant at 1% level; $^+$significant at 5% level.

Table 4 presents corresponding results for apartments. The results explain much less of the variation in rents and are not as robust as for houses. This is likely to reflect the fewer observations available for apartments and the possibility that apartments are more differentiated than are houses. However, some similarities with the house results are apparent, particularly the "low", but significant, coefficient on the price variable.

In each case, there is the potential for endogeneity of the regressors to cause inconsistent estimates. Our theory suggests that rents, prices and capital gains expectations are formed simultaneously. Further, each of the socio-economic variables could be affected by the level of rents (e.g. the proportion of the population in an area with no formal education might be partially determined, through migration and location choices, by rents charged in that area). To test the sensitivity of our results to potential simultaneity bias, we re-estimate each of the three equations for houses and for apartments using instrumental variables (IV). We replace each of the six regressors with their 1996 values and present the estimation results as columns 4 - 6 in the two tables.

The results do not vary substantially for each of the formulations, especially with respect to the impacts of prices, incomes and deprivation. One remaining quandary is the relatively low coefficient on prices indicating an elasticity of rents to prices of around one half instead of unity. The non-linear functional form is driven by the theory in section 2, but it is possible that the non-linearity is disguising the "true" elasticity of rents to prices. We test this possibility by replacing equation (7) with a linear functional form:

$$\begin{aligned}\ln rent = \alpha_1 \ln price + \beta_0 + \beta_1 \ln income + \beta_2 \ln deprivation + \beta_3 \ln employment \\ + \beta_4 noedu + \beta_5 uniedu\end{aligned} \qquad (8)$$

The results for houses and apartments are presented in Tables 5 and 6. The results are little changed. The coefficient on the price term remains around one half rather than unity. We surmise that this result may be due to a composition effect. Our price series represents the median sale price of all houses sold in an

AU in a particular year. This includes rented and owner-occupied dwellings. In a low price area, it is likely that the rental stock and owner-occupied stock are of similar quality; hence the observed aggregate price is an adequate proxy for the price of rental dwellings. By contrast, it is quite conceivable in high price areas that relatively low quality houses within the area will tend to be rented. If this is the case, the relationship of rentals prices to aggregate prices will be upward sloping but with a coefficient of less than one. This relationship will then be reflected in our estimates and, if the theoretical relationship outlined in section 2 holds, the elasticity of rents to prices would reflect this composition effect. Without additional data, we cannot determine whether the estimated coefficient(s) represent this effect or some other factor.[5]

[5] Future work, using panel data, could identify if composition is having an effect on the estimates, provided composition effects are stable over time.

Table 5: Results of estimating (8): Houses (Linear)*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) IV	(6) IV
α_1 Price	0.4311 (28.75)*	0.4291 (26.26)*	0.5528 (48.31)*	0.5486 (34.61)*	0.5217 (29.40)*	0.6300 (48.88)*
β_0 Const	-12.310 (13.00)*	-2.0285 (4.28)*	-5.0344 (7.84)*	-15.7505 (15.88)*	-2.4866 (5.42)*	-6.8125 (9.87)*
β_1 Income	0.2684 (5.86)*	0.2021 (4.07)*		0.2251 (5.15)*	0.1484 (3.03)*	
β_2 Deprivation	1.4384 (12.23)*		0.5402 (6.57)*	1.8252 (14.67)*		0.6786 (7.82)*
β_3 Employment	-0.0266 (0.40)	-0.3671 (5.64)*		0.1912 (3.45)*	-0.1653 (2.94)*	
β_4 No edu	-0.6460 (4.53)*	-0.1387 (0.93)		-0.3743 (3.30)*	0.1490 (1.23)	
β_5 University edu	0.4044 (2.99)*	0.5368 (3.65)*		0.4618 (3.24)*	0.6679 (4.18)*	
Adj.R^2	0.8149	0.7802	0.7689	0.8245	0.7771	0.7813
s.e.	0.1335	0.1455	0.1492	0.1300	0.1465	0.1451
N	798	798	798	798	798	798

* t-values in parentheses; *significant at 1% level; +significant at 5% level.

.

Table 6: Results of estimating (8): Apartments (Linear)*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) IV	(6) IV
α_1 Price	0.2905 (9.00)*	0.3041 (9.12)*	0.4610 (18.23)*	0.3280 (9.09)*	0.3302 (8.95)*	0.4697 (15.01)*
β_0 Const	-10.2411 (5.97)*	-1.5993 (2.09)$^{+}$	0.4206 (0.34)	-10.7423 (5.57)*	-2.9959 (3.41)*	2.4496 (1.82)
β_1 Income	0.4455 (5.52)*	0.3380 (4.16)*		0.5365 (5.94)*	0.4437 (4.93)*	
β_2 Deprivation	1.1562 (5.58)*		-0.1166 (0.75)	1.0277 (4.48)*		-0.4221 (2.53)$^{+}$
β_3 Employment	-0.0697 (0.58)	-0.2295 (1.91)		-0.0987 (0.79)	-0.2221 (1.77)	
β_4 No edu	-1.7399 (6.62)*	-1.2381 (4.84)*		-1.0592 (4.39)*	-0.6714 (2.92)*	
β_5 University edu	-1.1039 (4.83)*	-0.8565 (3.69)*		-0.7548 (2.81)*	-0.4848 (1.81)	
Adj.R^2 s.e. N	0.5905 0.1709 415	0.5603 0.1771 415	0.5079 0.1874 415	0.5308 0.1830 415	0.5088 0.1872 415	0.4366 0.2005 415

* t-values in parentheses; *significant at 1% level; $^{+}$significant at 5% level.

A comparison of the results in Tables 3 and 4 with those in Tables 5 and 6 show that while the former are theoretically preferred (with the functional form being derived exactly from theory) the latter perform statistically just as well. Given this finding, in the following section we adopt the linear functional form in estimating the determinants of rents for additional bedrooms across areas. This is particularly useful given the added coefficient non-linearities that we wish to test in that work.

5 Rental Costs of Extra Bedrooms

Having examined the determinants of rents at the aggregate (all bedroom) level we turn now to estimating the cost of additional bedrooms across areas. For reasons of space, and given the relative lack of observations on apartments, we restrict our attention here to houses, although preliminary work shows apartments to follow similar pricing principles. We omit five bedroom houses owing to the small number of observations for that group.

We use equation (5) from section 2 as our basis. We express it in a slightly different, but equivalent, form by including a constant term plus three intercept dummies for 2, 3 and 4 bedroom houses; similarly, we include $\ln P_i$ plus three slope dummies representing interactions between the number of bedrooms and the price. Given the results in section 4 showing little difference between the linear and non-linear versions, we linearise the equation and estimate the form shown in (9):

$$\ln R_{ij} = \delta_0 + \sum_{j=2}^{4} \delta_j D_j + \varepsilon_0 \ln P_i + \sum_{j=2}^{4} \varepsilon_j D_j . \ln P_i + \sum_{k=1}^{5} \beta_k Y_{ki} \qquad (9)$$

where Y_1 is ln *income*

Y_2 is ln *deprivation*

Y_3 is ln *employment*

Y_4 is *noedu*

Y_5 is *uniedu*

Each of the variables is as defined in section 4. In keeping with section 4, we estimate the equations both with OLS on 2001 data and with IV using the 1996 data to instrument for each of the regressors. The results are shown in Table

7. The elasticity of one-bedroom rents with respect to prices (ε_0) increases with the IV estimates (to 0.65) which is more in keeping with theoretical priors. This result indicates likely endogeneity in the OLS estimates. However the rent to price elasticity falls for larger sized houses, and the intercept terms also change.

Table 7: Results of estimating (9)*

	(1) OLS	(2) IV
δ_0	-12.6833 (12.14)*	-16.9867 (13.81)*
δ_2	0.7439 (0.89)	2.1956 $(2.12)^+$
δ_3	0.2189 (0.26)	1.7240 (1.67)
δ_4	-0.3030 (0.36)	1.2038 (1.16)
ε_0	0.4007 (5.86)*	0.6489 (7.58)*
ε_2	-0.0332 (0.48)	-0.1580 (1.83)
ε_3	0.0239 (0.35)	-0.1046 (1.22)
ε_4	0.0805 (1.17)	-0.0480 (0.56)
β_1	0.3173 (9.80)*	0.2553 (8.07)*
β_2	1.4040 (17.27)*	1.7145 (19.63)*
β_3	-0.0025 (0.05)	0.1989 (4.79)*
β_4	-0.5580 (5.51)*	-0.2261 (2.67)*
β_5	0.2749 (3.01)*	0.4003 (4.01)*
Adj.R2 s.e. N	0.8313 0.1358 1,750	0.8317 0.1357 1,750

* t-values in parentheses; *significant at 1% level; $^+$significant at 5% level.

We test for equality of intercept and slope coefficients across bedrooms. The Wald test for $\delta_2 = \delta_3 = \delta_4 = 0$ rejects the restriction at the 1% level in both the OLS and IV specifications. This implies that the intercept term differs according to the number of bedrooms in the house. The Wald test for $\varepsilon_2 = \varepsilon_3 = \varepsilon_4 = 0$ rejects this restriction at the 1% level in both the OLS and IV specifications. Thus the slope coefficients on the price term also differ according to the number of bedrooms. Finally, the joint set of restrictions that $\delta_2 = \delta_3 = \delta_4 = \varepsilon_2 = \varepsilon_3 = \varepsilon_4 = 0$ is rejected at the 1% level in both the OLS and IV specifications.

The results therefore indicate that not only does the average rent of houses in an area increase with average sale prices in an area, but the rental price of additional bedrooms also varies according to the price of houses. To give an indication of how material each of the effects is, we calculate the estimated weekly rent for each sized house (where R1, R2, R3, R4 correspond to the estimated weekly rents for 1, 2, 3 and 4 bedroom houses respectively). The estimates use mean values for each variable in 2001 and 1996 and use the corresponding estimates from columns 1 and 2 of Table 7. The results are presented in the first row of Tables 8 and 9 using the OLS and IV estimates respectively. The last three columns of each table show the price of an additional room (e.g. R2-R1 is the rent for a 2-bedroom house less the rent for a 1-bedroom house). The estimated rents are very similar using the two sets of estimates.

Table 8: Effect of Variables on Rents ($ per week) - OLS (2001 data)*

	R1	R2	R3	R4	R2-R1	R3-R2	R4-R3
All @ means	*119.40*	*169.28*	*197.56*	*230.02*	*49.88*	*28.28*	*32.46*
Price: - 1SD	97.41	140.46	159.23	180.13	43.05	18.77	20.89
Income: - 1SD	110.60	156.80	183.00	213.07	46.21	26.20	30.07
Deprivation: - 1SD	132.03	187.19	218.47	254.36	55.16	31.27	35.89
All (ex.Price): -1 SD	114.13	161.81	188.84	219.87	47.68	27.03	31.02
All: -1SD	93.07	134.20	152.13	172.09	41.13	17.93	19.96
All: +1SD	153.38	213.82	256.90	307.85	60.44	43.08	50.95

All variable changes, other than the last row, are "for the worse"; i.e. a decrease in price, income, employment, university qualifications; and an increase in deprivation and no educational qualifications. Changes in the last row all "for the better".

Table 9: Effect of Variables on Rents ($ per week) - IV (1996 data)*

	R1	R2	R3	R4	R2-R1	R3-R2	R4-R3
All @ means	*120.91*	*169.30*	*197.99*	*229.12*	*48.40*	*28.69*	*31.13*
Price: - 1SD	89.70	135.08	154.14	173.79	45.38	19.06	19.65
Income: - 1SD	114.22	159.95	187.05	216.46	45.72	27.10	29.41
Deprivation: - 1SD	136.01	190.45	222.72	257.74	54.44	32.27	35.02
All (ex.Price): -1 SD	118.50	165.93	194.05	224.56	47.43	28.12	30.51
All: -1SD	87.92	132.39	151.07	170.33	44.47	18.68	19.26
All: +1SD	166.22	216.44	259.40	308.12	50.22	42.97	48.71

All variable changes, other than the last row, are "for the worse"; i.e. a decrease in price, income, employment, university qualifications; and an increase in deprivation and no educational qualifications. Changes in the last row all "for the better".

The second row of each table shows the rents for different sized houses where house prices are reduced one standard deviation below their mean in 2001 and 1996 respectively. In 2001, this means reducing the house price from the mean of $148,227 to $89,089, while in 1996, it means reducing the house price from $128,695 to $81,244. The one standard deviation reductions are of different sizes in the two years because of different distributions in the data, so the results are not directly comparable across the two data sets. They are nevertheless qualitatively similar; henceforth we discuss just the preferred IV (Table 9) results unless otherwise specified. Rents, as may be expected, are reduced across the board. More pertinent to the questions posed at the outset of this study is the sizeable difference in the cost of an extra bedroom, especially for larger houses. The cost of four bedrooms relative to two bedrooms falls from $59.82 to $38.71 per week (a fall of $10.65 per extra bedroom) whereas the cost of the second bedroom relative to the first falls by only $3.02. Thus rents for larger houses tend to be much cheaper in lower price areas relative to high price areas than is the case with smaller houses.

Rows 3 and 4 show the effects of a one standard deviation reduction in income, ceteris paribus, and a one standard deviation "worsening" in deprivation (i.e. an increase in deprivation). A fall in incomes is reflected in lower rents while greater deprivation leads to a rise in rents. The latter effect is particularly marked: a one standard deviation worsening in deprivation is associated with a 12.5% increase in rents across the board. This effect is theoretically associated with lower capital gains expectations in more deprived areas.

It would, however, be unusual to see deprivation or income change in isolation from other variables. Row 5 indicates the estimated rents for different sized houses if all variables other than house prices were to worsen by one standard deviation. In this case, the effects are more or less offsetting, and rents are 98% of their mean level (using 1996 data; 95.6% using 2001 data). If prices are also reduced by one standard deviation (row 6), the price effect dominates. The cost of a third and a fourth bedroom is each around $19 per week, compared with a cost of around $30 for each of the third and fourth bedroom when all variables are at their means.

To further emphasise this contrast in the cost of extra bedrooms as price and other variables change across areas, the last row increases all variables by one standard deviation. Comparing the last two rows shows a realistic divergence in rents for different sized houses between "rich" and "poor" suburbs. In rich suburbs, not only are rents much higher, but also the price of each additional bedroom stays in a range of $42 - $51 per week. By contrast, in poor suburbs, the price of a second bedroom is in the same range, but the price of third and fourth bedrooms falls to around $19 each.

The estimates presented above allow for socio-economic influences such as deprivation to impact on rents in an area, but that specification does not allow these influences to impact on the price of additional bedrooms across different areas. To examine whether socio-economic influences impact on the pricing of additional bedrooms, we interacted each of the income and deprivation terms with the intercept and price terms as in (6a) and (6b) of section 2. We then tested whether these interaction effects were significant with Wald tests. Each of the interactions of deprivation with intercept and slope terms was not significantly different from zero, and almost all income interactions were similarly insignificant. (The only significant effect for the latter occurred for 1-bedroom houses, but the effect was small.) We therefore do not report these results here.

6 Implications

Our results are noteworthy in a number of respects. First, the rental market appears to be efficient in the sense that areas with high expected capital gains have lower rental yields than areas with low expected capital gains. This finding is based on an assumption that capital gains expectations are formed in a forward-looking manner based on latest information, using influences seen to be important in determining past capital gains.

We show that high levels of deprivation are associated with low capital gains expectations; in other words, deprived areas are expected to remain in the doldrums, while areas of low deprivation are expected to outperform. Thus more deprived areas have higher rent to price ratios than do less deprived areas. While this may seem "unfair" for renters in more deprived areas, it is a natural consequence of landlords (and house sellers) seeking the same return across all areas when investing in (and selling) rental housing.

Overall, the influences on expectations are complex, reflecting income, employment and education outcomes specifically, as well as overall deprivation. Accounting for all these effects, the main determinant of rents in an area is house prices in that area.

Our second major finding is that the relative rents of different sized houses is crucially dependent on the level of house prices. Areas with low house prices tend to have more compressed relativities between rents of large and small houses than is the case with high house price areas (both in relative and absolute terms).

This latter finding is important when considering housing in a social policy context. After accounting for other influences, the effect of this compression will be to induce larger families to locate in lower priced areas and smaller families to locate in higher priced areas. On the assumption that children are more likely to live in larger than average households, the effect is to group households with children together in lower priced areas (over and above any life-cycle affordability effects). This grouping may have certain social capital benefits (e.g. through the grouping of households with shared interests) but it may also have negative social consequences. In particular, it may place added stress on resources required to service children and families in poorer (lower priced) areas. If provision of such services fails to meet the more intensive demand, negative consequences can emerge (e.g. through inadequate child-care, schooling, health services, parks, etc).

Further, there may be employment and other social and environmental consequences of this compression. Larger families may choose to locate in low priced areas, but the low prices may reflect lack of job prospects (e.g. in some rural or semi-rural locations). Rental costs of larger houses may therefore act to increase mis-match between jobs and potential workforce participants - especially those with families - across the country. Alternatively, people may locate to lower priced areas, but with long commute times to available work, placing greater pressure on transport links and energy use.

While these effects may each be important, potential policy responses have to be considered with care. Policies to subsidise housing can be capitalised into the price (and/or the rent) with benefits accruing primarily to the existing owner, and not necessarily to the recipient of the subsidy. Policy responses that ensure services are up to scratch in areas with larger families help address the negative social impacts that may arise from the grouping together of such households, but will also tend to be reflected (through pricing of amenity values) in house prices. Policies to provide income relief to larger households have less of a distortionary effect on the housing market but have other complications, not least of which is fiscal cost and hence the overall burden of taxation.

Encouraging home ownership is often viewed as a policy with positive outcomes both socially and for more disadvantaged people that become house owners. However, our theoretical framework and empirical results indicate that care must be taken with such a policy initiative. Encouraging home ownership amongst renters in areas with high rents (relative to prices) may have the effect of inducing lower income families to make housing investments in areas with low prospective capital gains. This outcome could, in turn, perpetuate their relative disadvantage.

Given the complexities associated with housing policy, it is likely that some mixture of policy responses will be appropriate. Whatever the responses, it is important to ensure that negative social effects arising from concentration of large families in relatively cheap rental accommodation is minimised if long term disadvantage associated with housing conditions is to be avoided.

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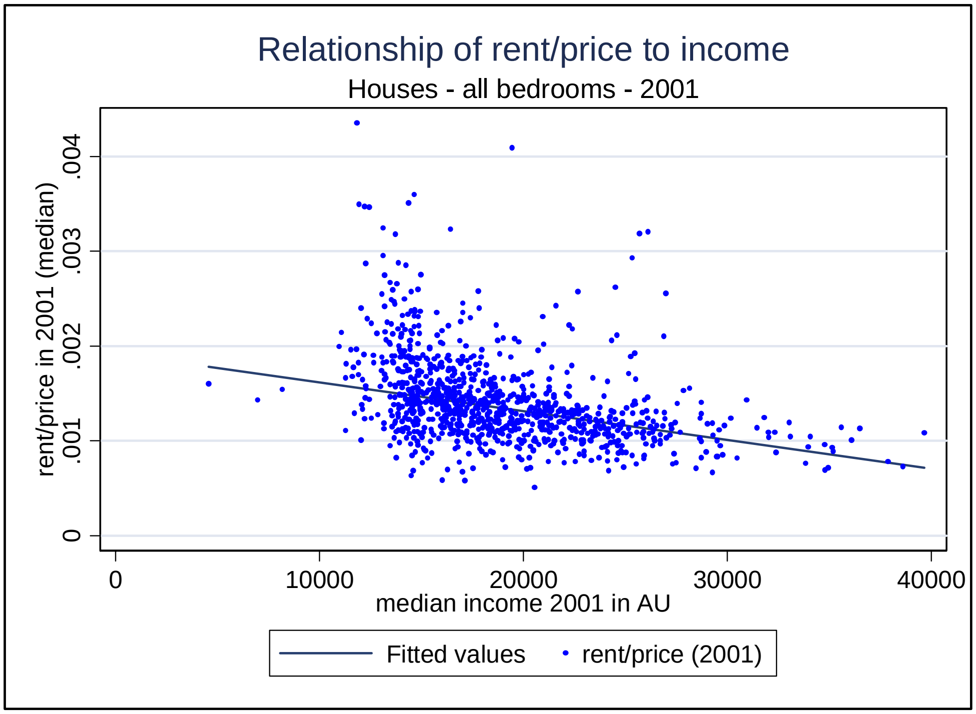
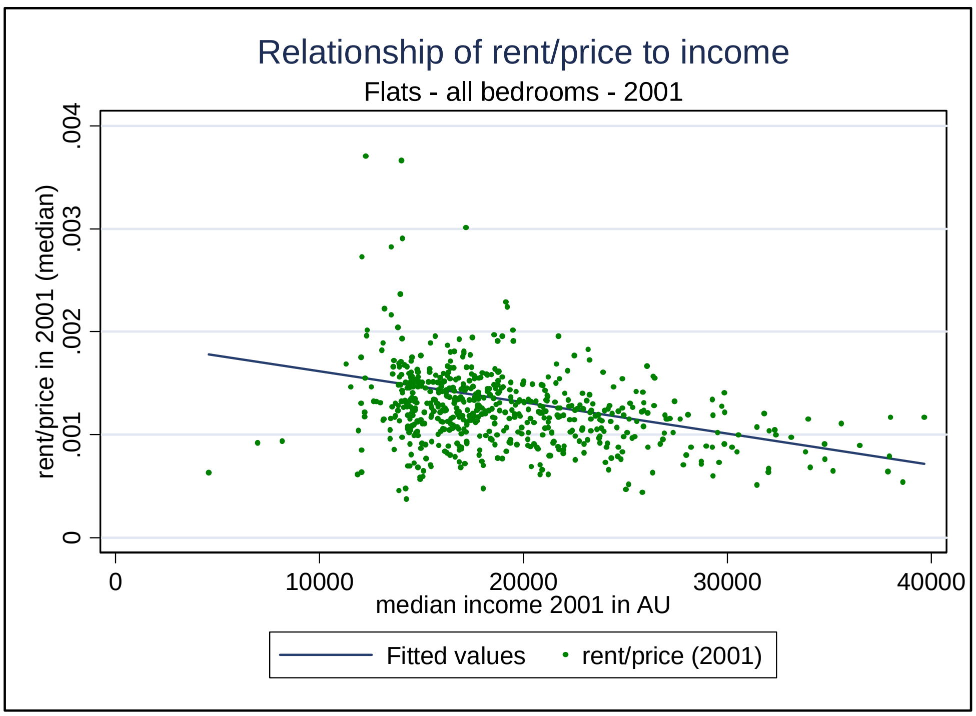
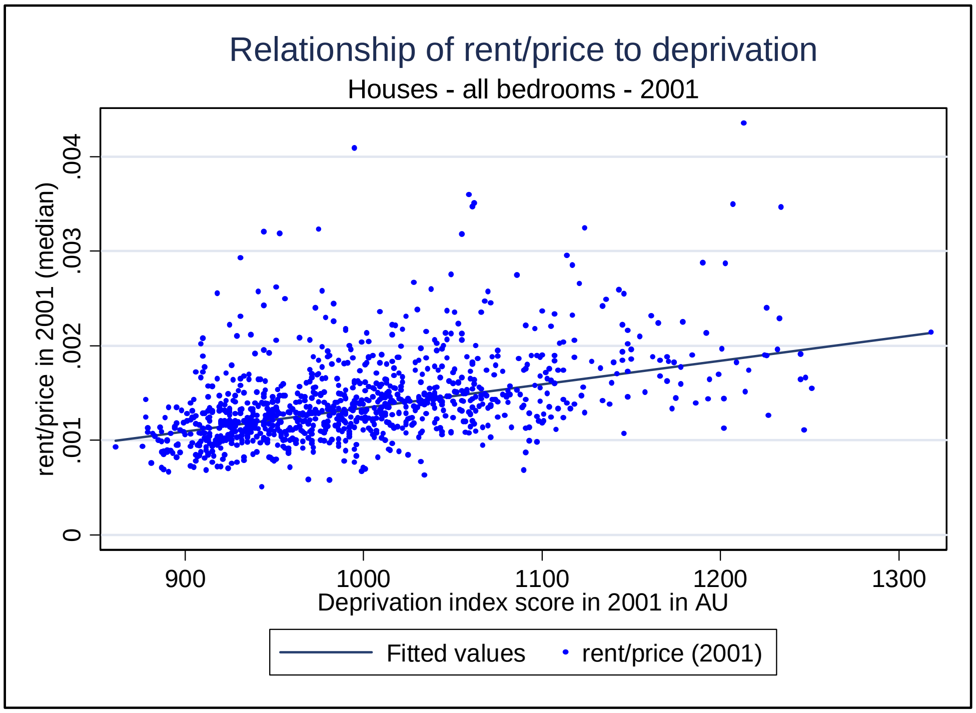
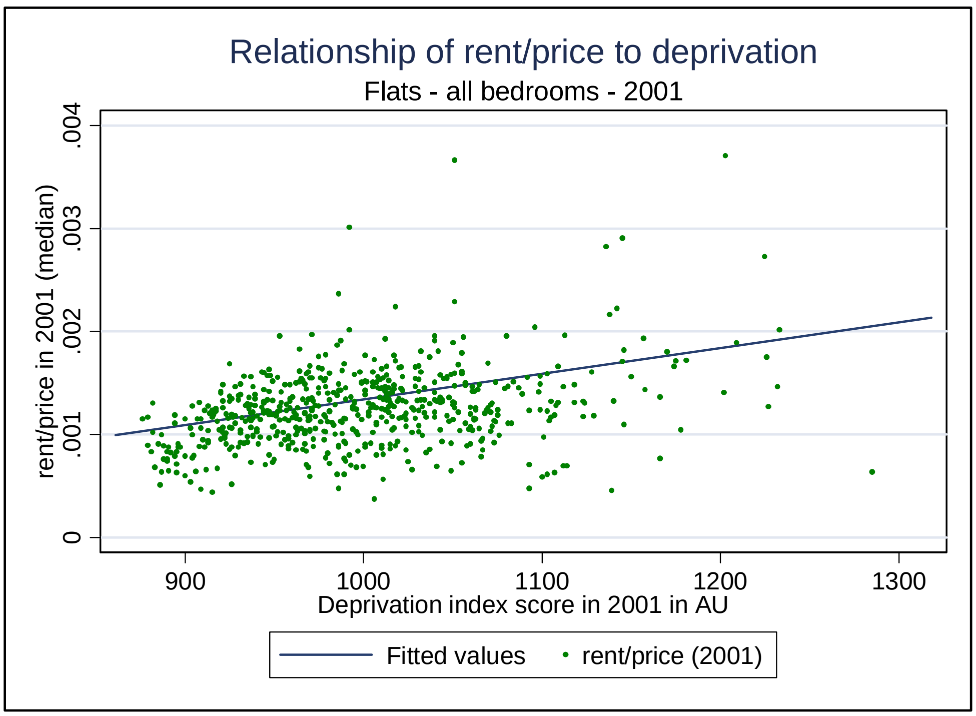
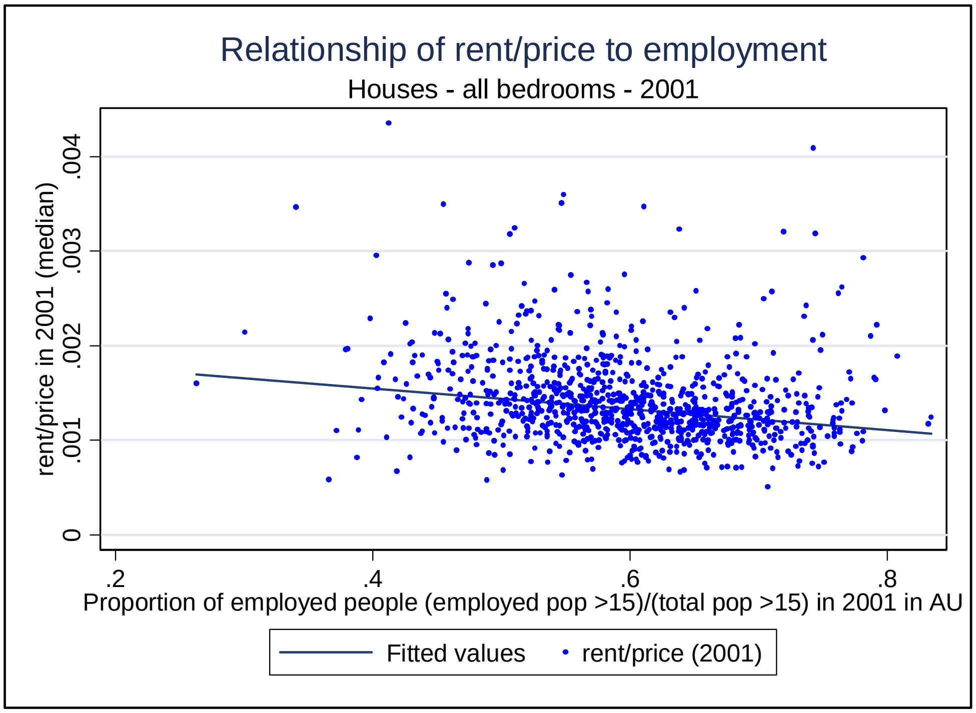
Appendix A: Rent/Price Relationships

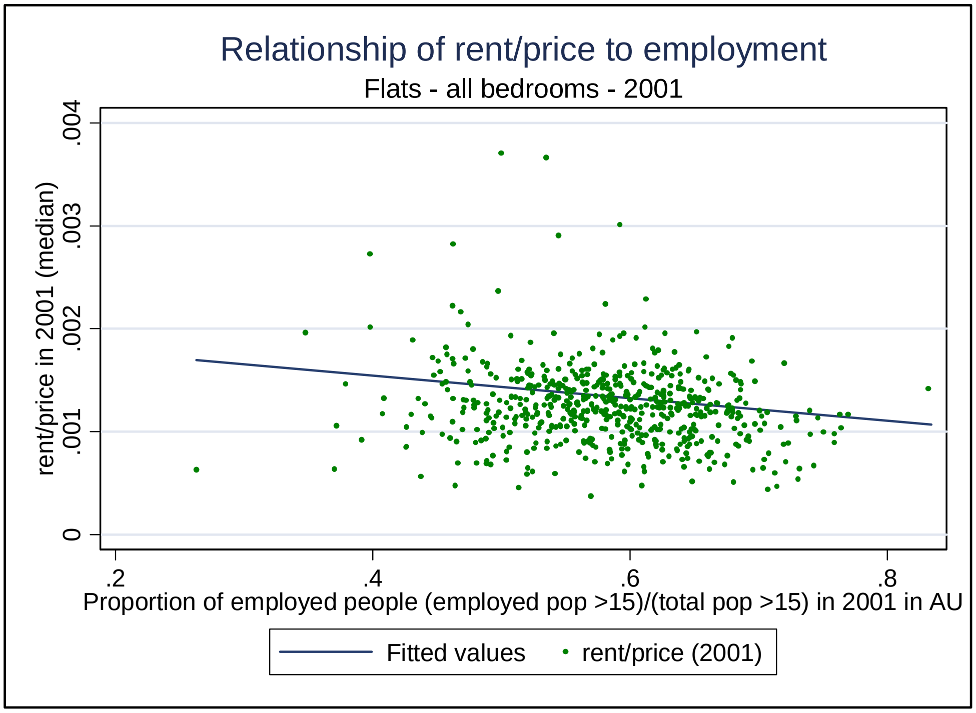


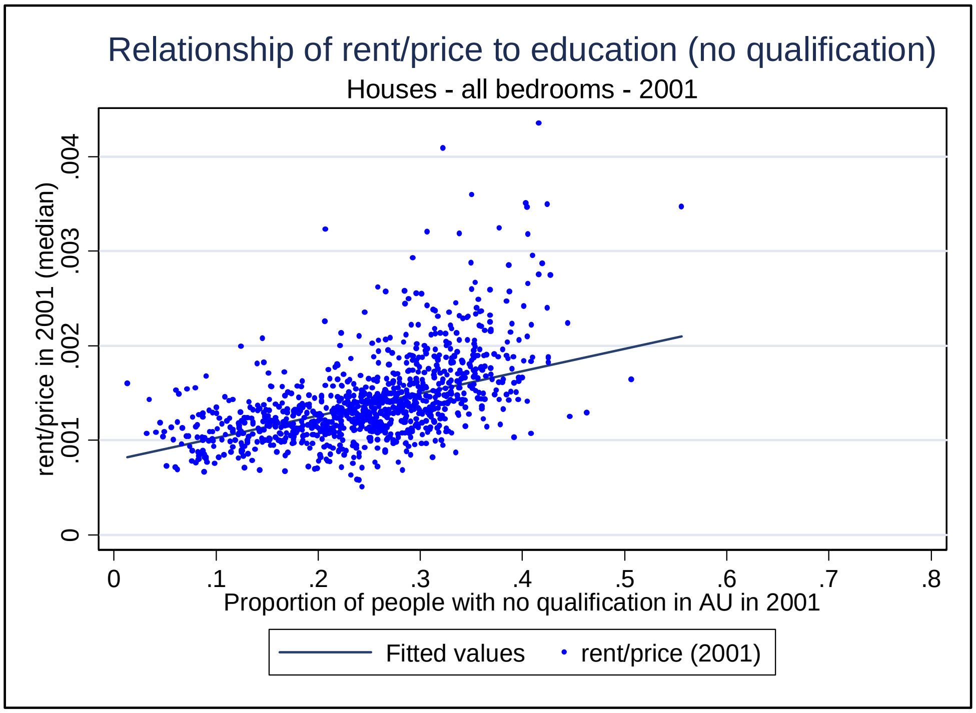


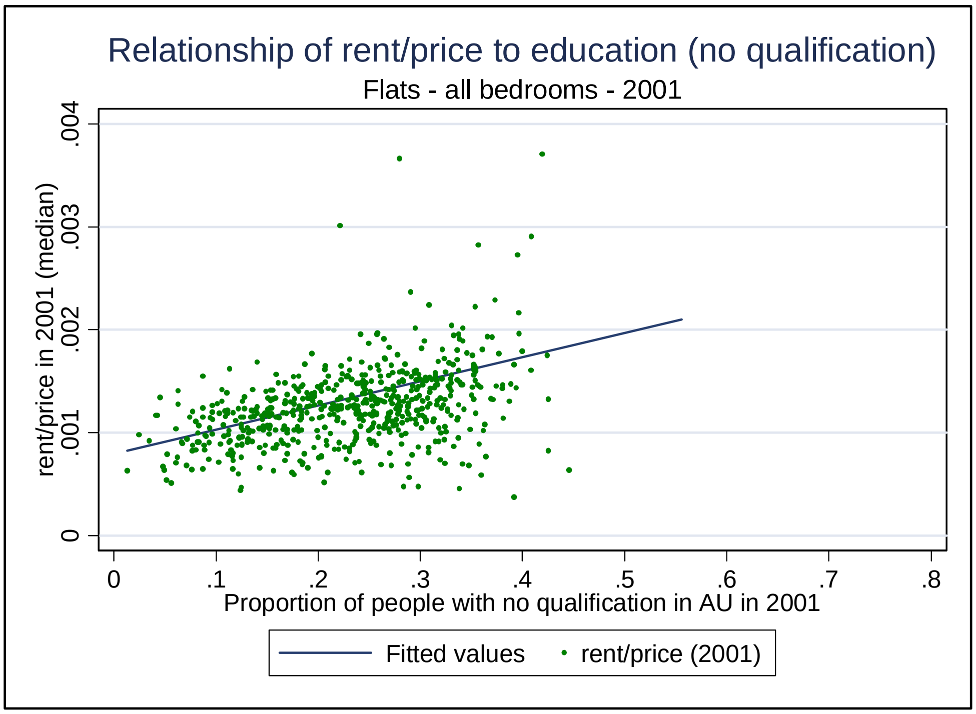

Relationship of rent/price to deprivation
Houses - all bedrooms - 2001
rent/price in 2001 (median)
0
.001
.002
.003
.004
900
1000
1100
1200
1300
Deprivation index score in 2001 in AU
Fitted values
rent/price (2001)

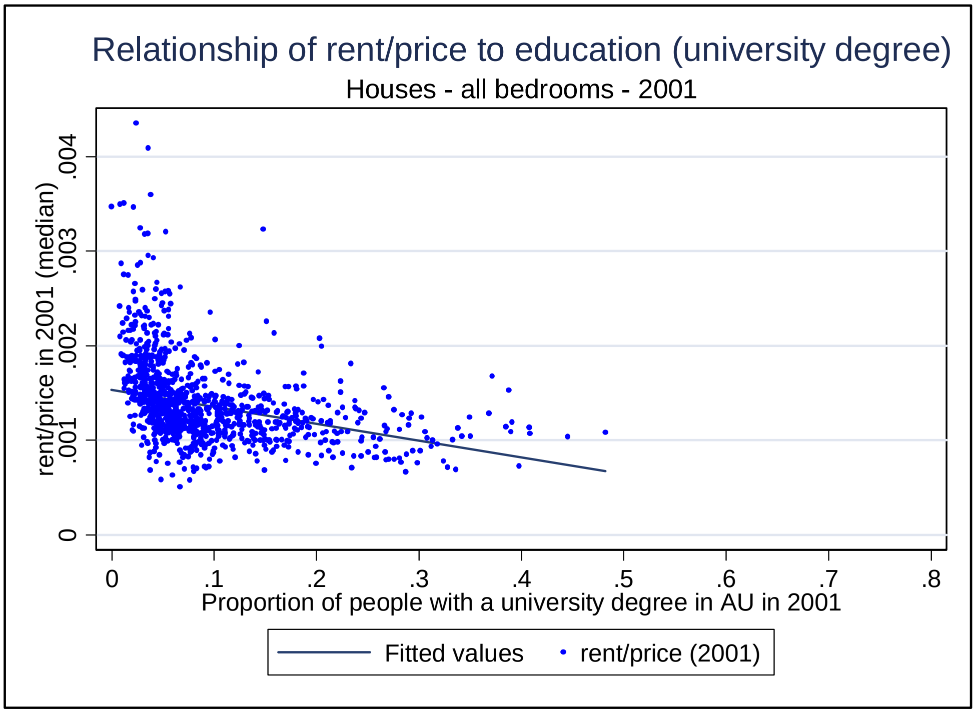

Relationship of rent/price to deprivation
Flats - all bedrooms - 2001
rent/price in 2001 (median)
0
.001
.002
.003
.004
900
1000
1100
1200
1300
Deprivation index score in 2001 in AU
Fitted values
rent/price (2001)

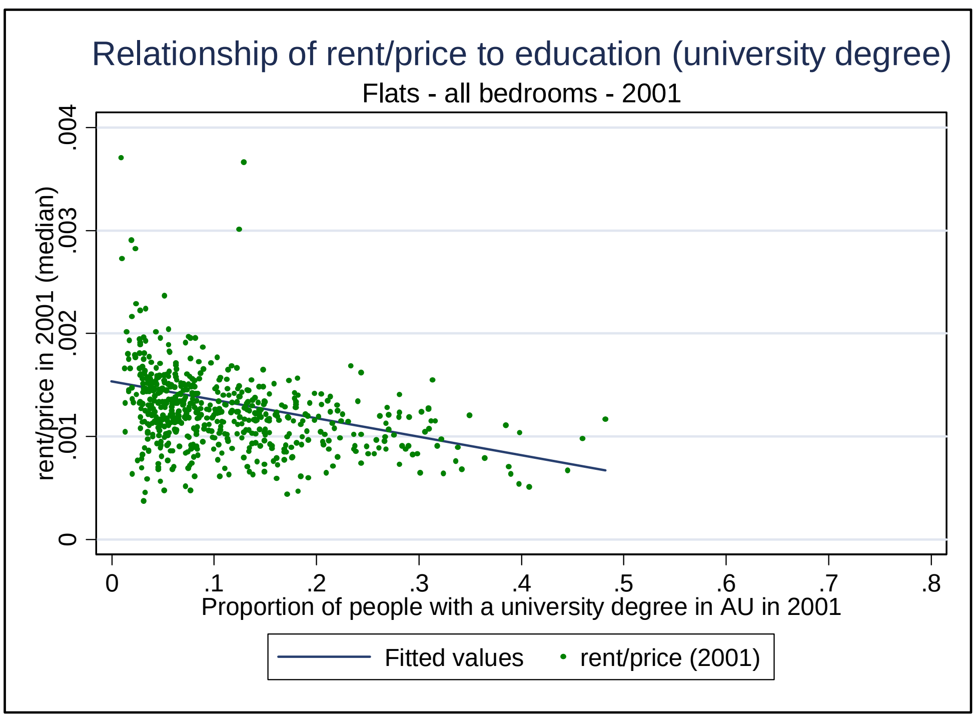

Relationship of rent/price to employment
Houses - all bedrooms - 2001
rent/price in 2001 (median)
0
.001
.002
.003
.004
.2
.4
.6
.8
Proportion of employed people (employed pop >15)/(total pop >15) in 2001 in AU
Fitted values
rent/price (2001)


Relationship of rent/price to employment
Flats - all bedrooms - 2001
rent/price in 2001 (median)
0
.001
.002
.003
.004
.2
.4
.6
.8
Proportion of employed people (employed pop >15)/(total pop >15) in 2001 in AU
Fitted values
rent/price (2001)

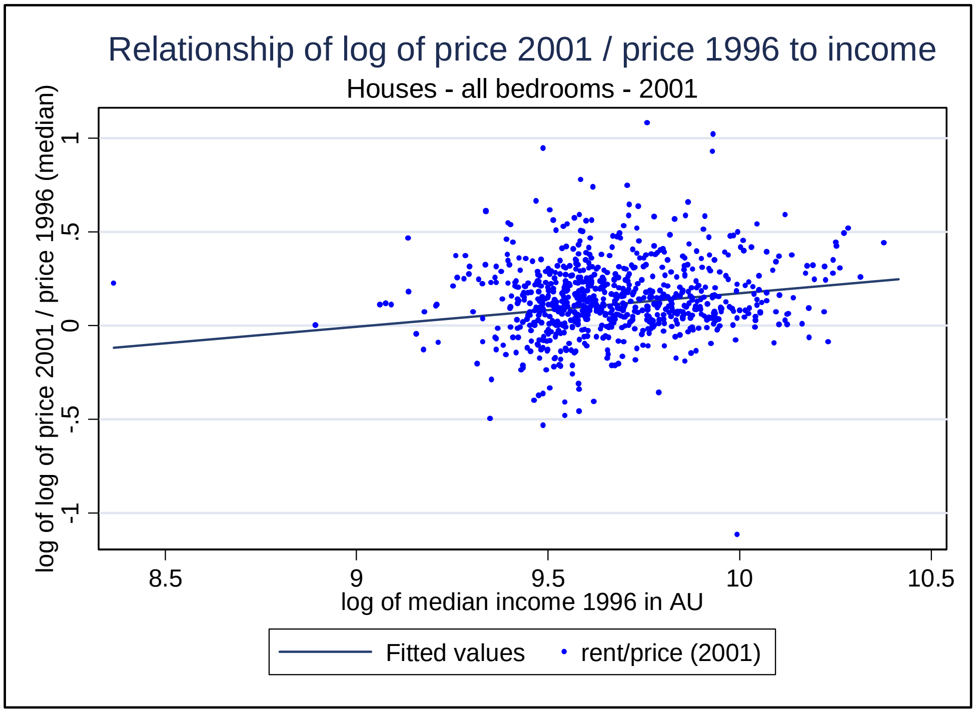

Relationship of rent/price to education (no qualification)
Houses - all bedrooms - 2001
rent/price in 2001 (median)
0
.001
.002
.003
.004
0
.1
.2
.3
.4
.5
.6
.7
.8
Proportion of people with no qualification in AU in 2001
Fitted values
rent/price (2001)

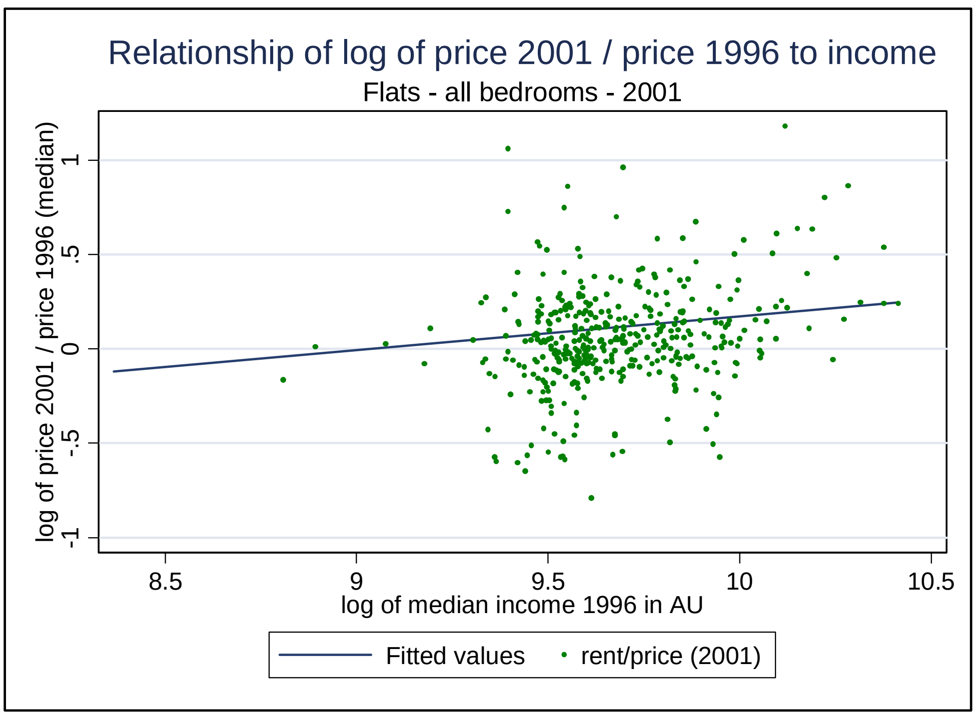

Relationship of rent/price to education (no qualification)
Flats - all bedrooms - 2001
rent/price in 2001 (median)
0
.001
.002
.003
.004
0
.1
.2
.3
.4
.5
.6
.7
.8
Proportion of people with no qualification in AU in 2001
Fitted values
rent/price (2001)

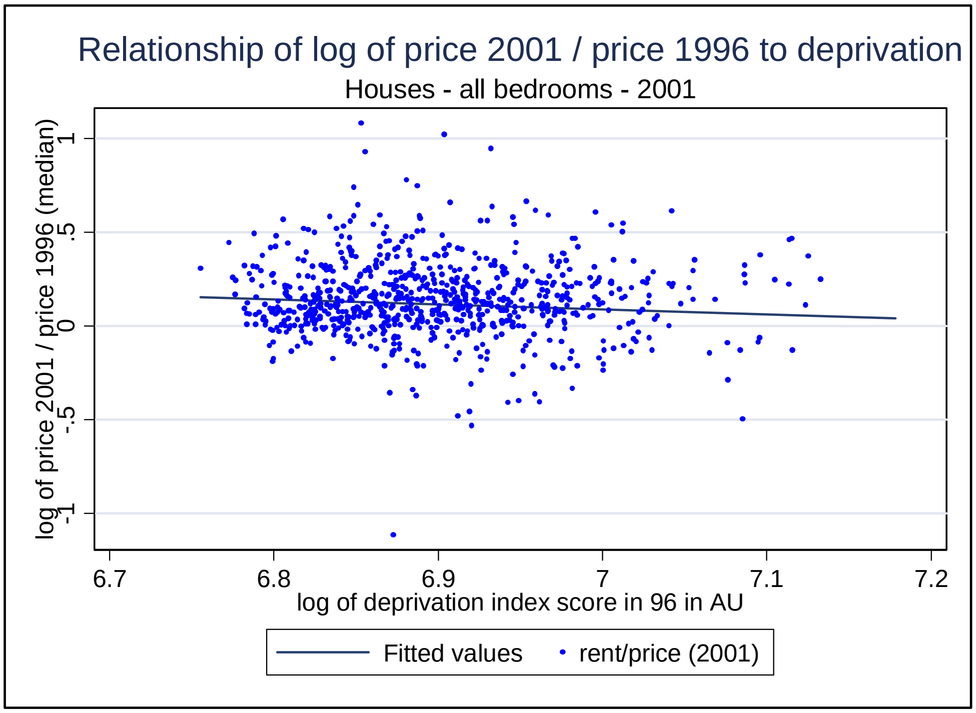

Relationship of rent/price to education (university degree)
Houses - all bedrooms - 2001
rent/price in 2001 (median)
0
.001
.002
.003
.004
0
.1
.2
.3
.4
.5
.6
.7
.8
Proportion of people with a university degree in AU in 2001
Fitted values
rent/price (2001)

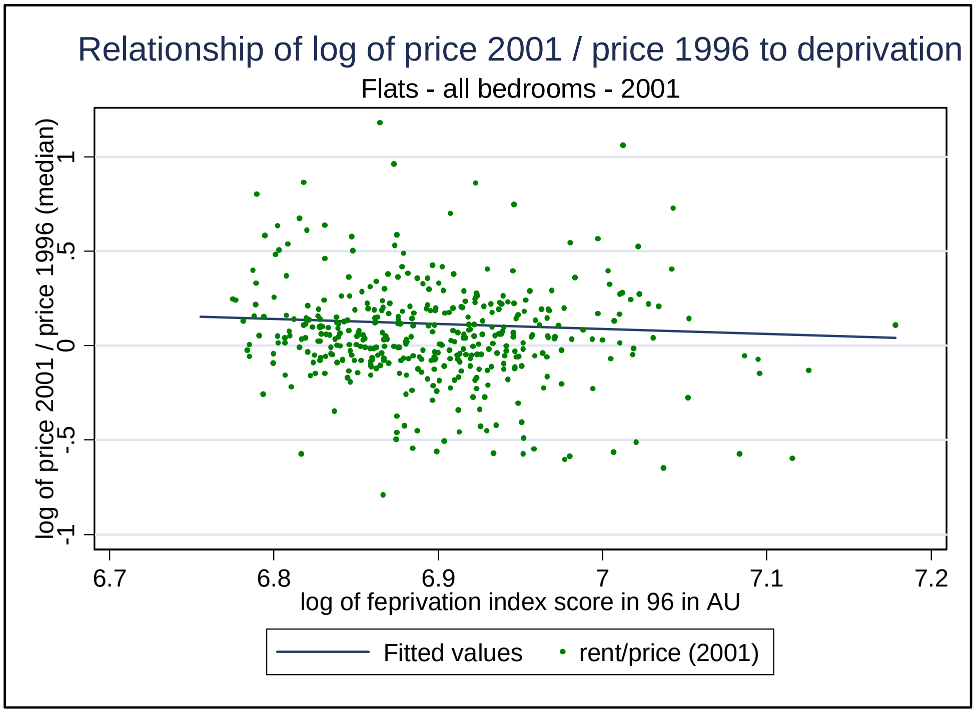

Relationship of rent/price to education (university degree)
Flats - all bedrooms - 2001
rent/price in 2001 (median)
0
.001
.002
.003
.004
0
.1
.2
.3
.4
.5
.6
.7
.8
Proportion of people with a university degree in AU in 2001
Fitted values
rent/price (2001)

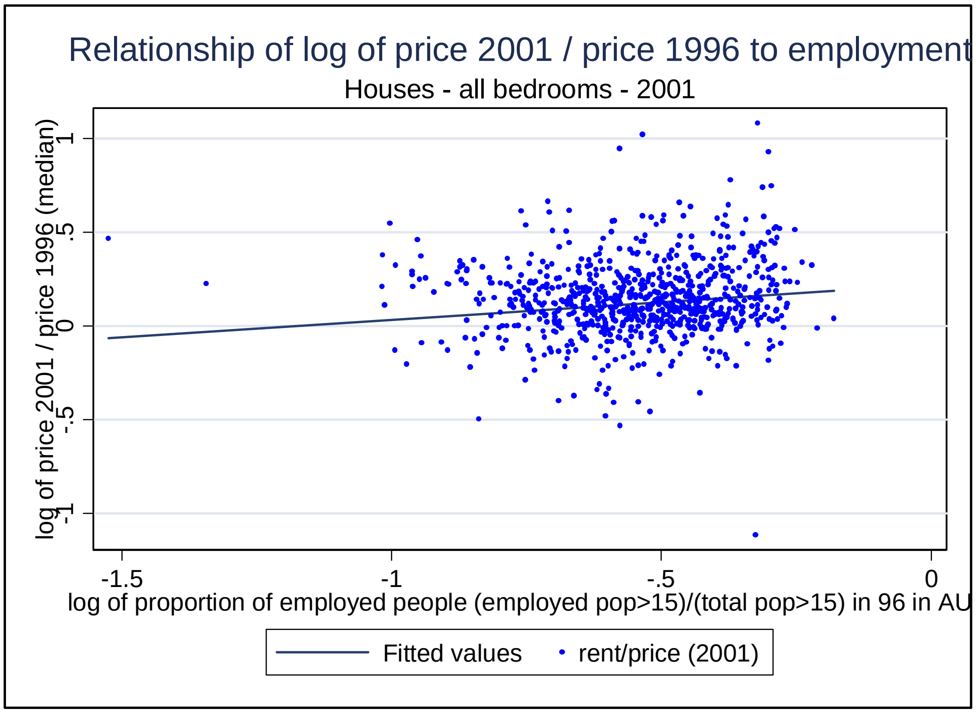
Appendix B: Capital Gains Relationships

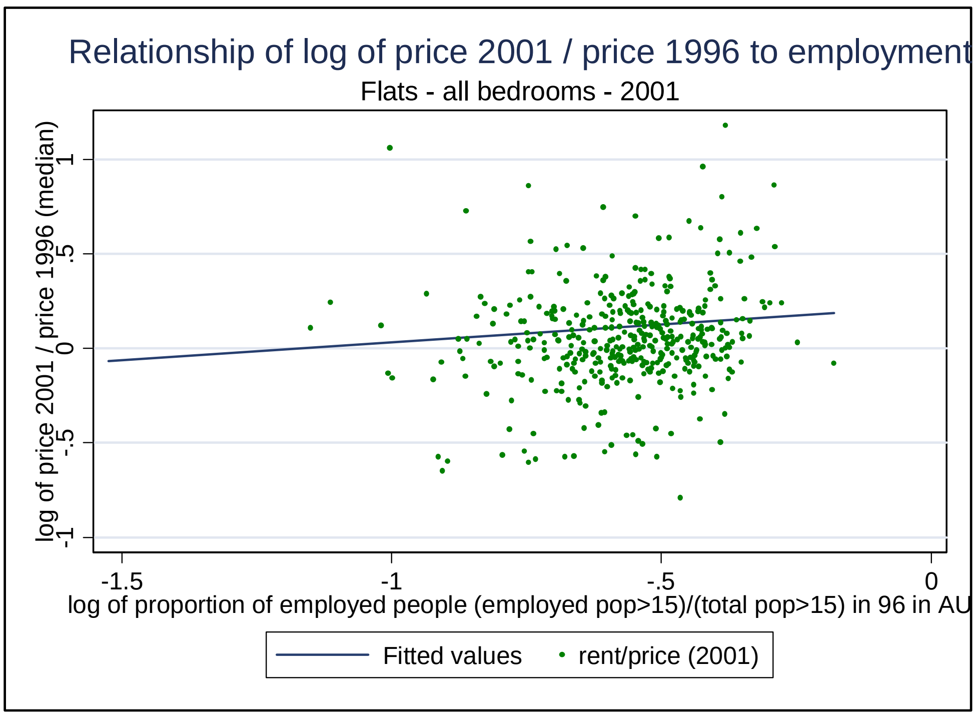


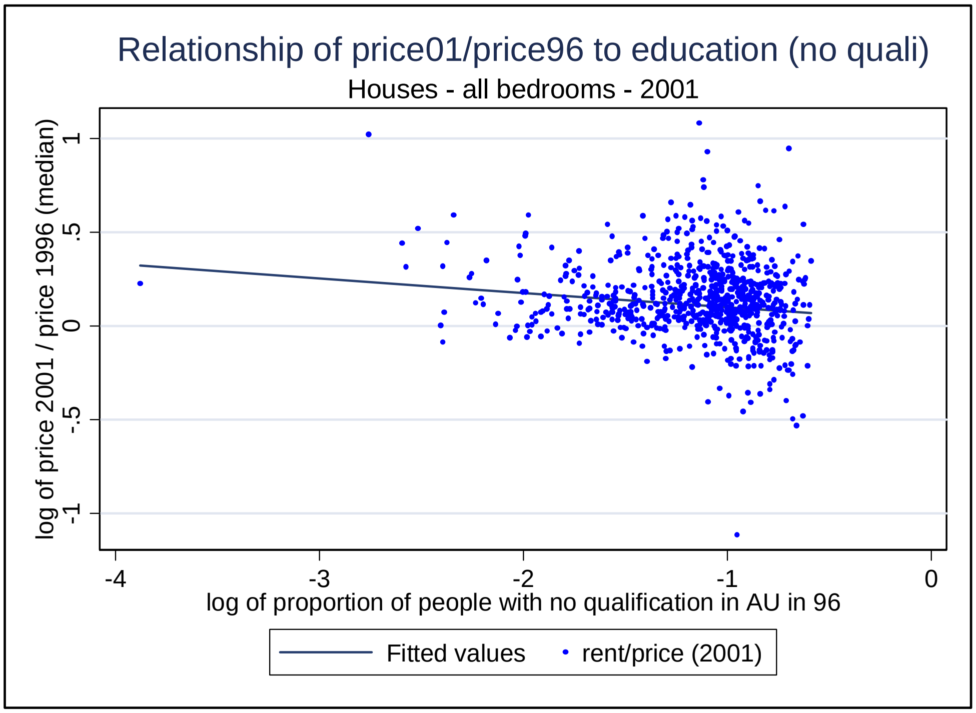


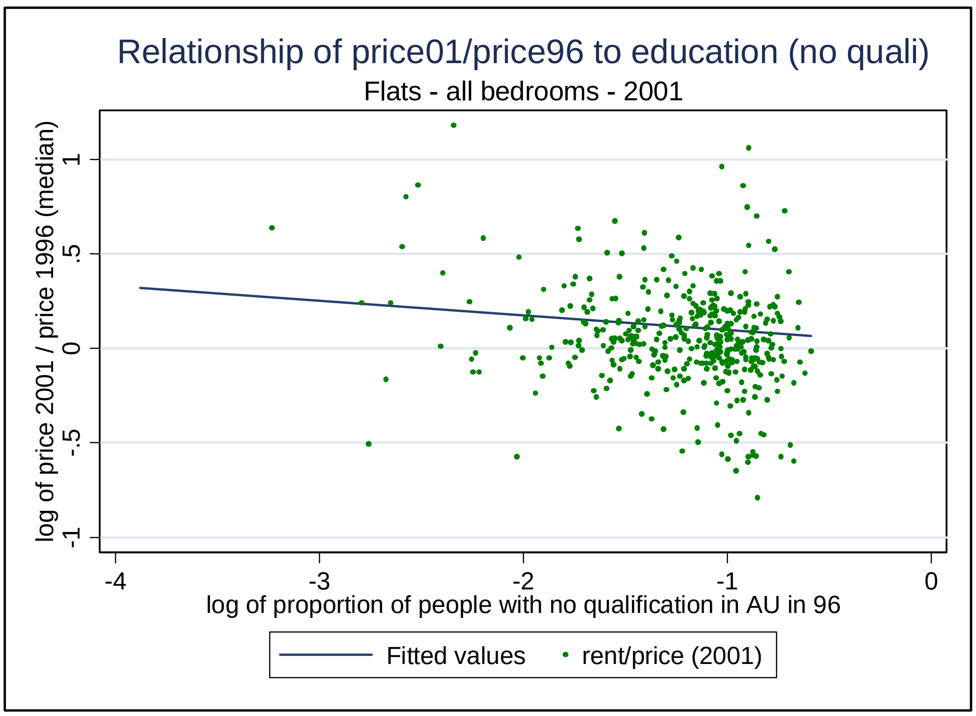

Relationship of log of price 2001 / price 1996 to deprivation
Houses - all bedrooms - 2001
log of price 2001 / price 1996 (median)
-1
-.5
0
.5
1
6.7
6.8
6.9
7
7.1
7.2
log of deprivation index score in 96 in AU
Fitted values
rent/price (2001)

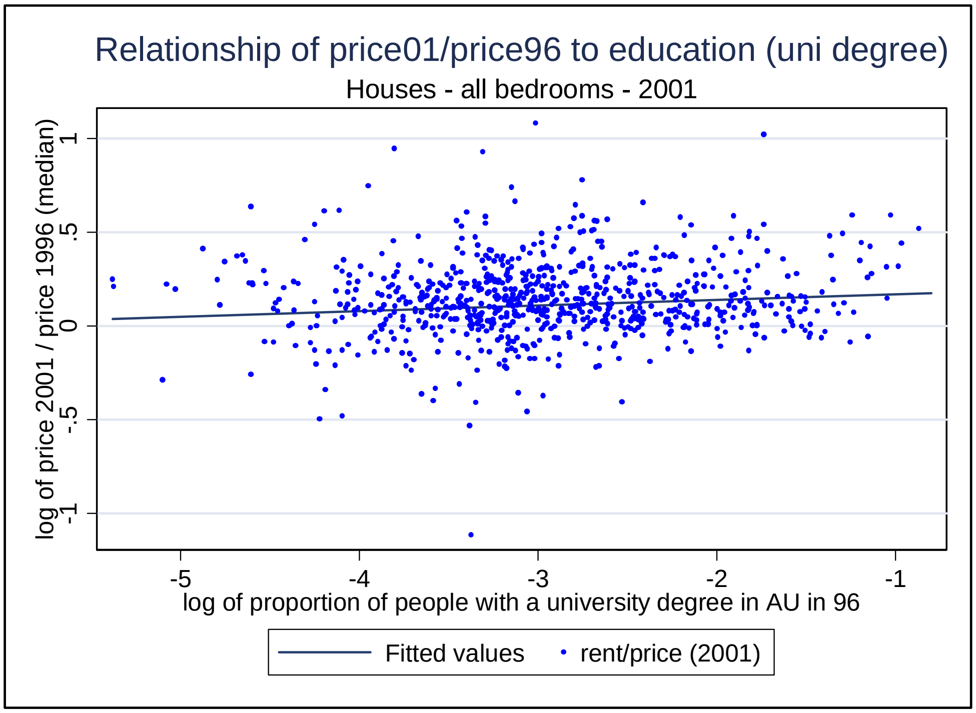

Relationship of log of price 2001 / price 1996 to deprivation
Flats - all bedrooms - 2001
log of price 2001 / price 1996 (median)
-1
-.5
0
.5
1
6.7
6.8
6.9
7
7.1
7.2
log of feprivation index score in 96 in AU
Fitted values
rent/price (2001)


Relationship of log of price 2001 / price 1996 to employment
Houses - all bedrooms - 2001
log of price 2001 / price 1996 (median)
-1
-.5
0
.5
1
-1.5
-1
-.5
0
log of proportion of employed people (employed pop>15)/(total pop>15) in 96 in AU
Fitted values
rent/price (2001)

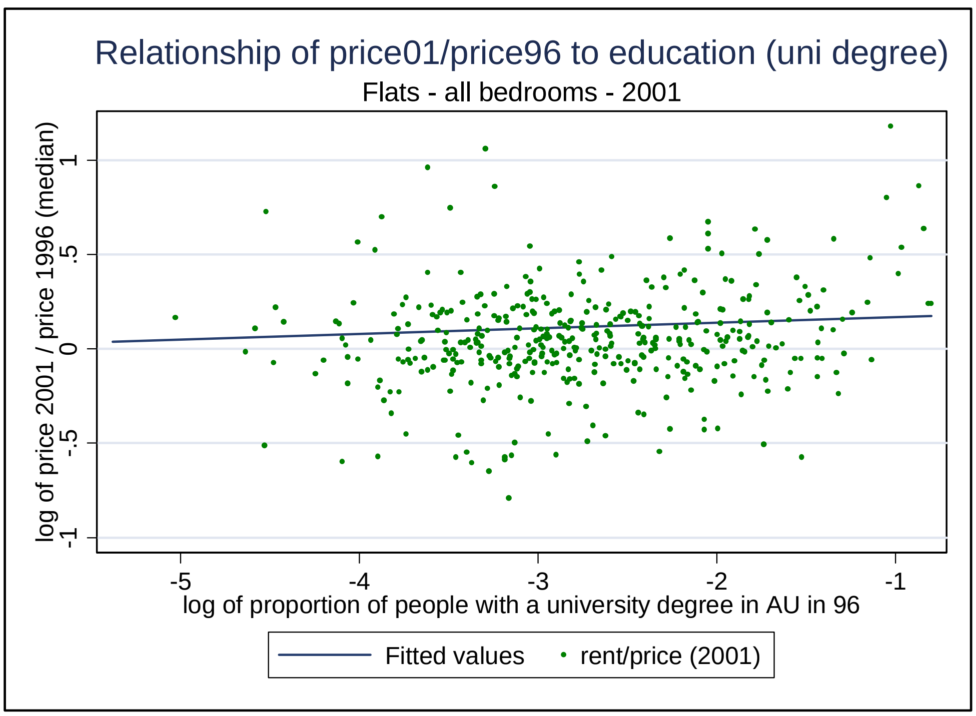

Relationship of log of price 2001 / price 1996 to employment
Flats - all bedrooms - 2001
log of price 2001 / price 1996 (median)
-1
-.5
0
.5
1
-1.5
-1
-.5
0
log of proportion of employed people (employed pop>15)/(total pop>15) in 96 in AU
Fitted values
rent/price (2001)


Relationship of price01/price96 to education (no quali)
Houses - all bedrooms - 2001
log of price 2001 / price 1996 (median)
1
.5
0
-.5
-1
-4
-3
-2
-1
0
log of proportion of people with no qualification in AU in 96
Fitted values
rent/price (2001)


Relationship of price01/price96 to education (no quali)
Flats - all bedrooms - 2001
log of price 2001 / price 1996 (median)
1
.5
0
-.5
-1
-4
-3
-2
-1
0
log of proportion of people with no qualification in AU in 96
Fitted values
rent/price (2001)



Relationship of price01/price96 to education (uni degree)
Houses - all bedrooms - 2001
log of price 2001 / price 1996 (median)
-1
-.5
0
.5
1
-5
-4
-3
-2
-1
log of proportion of people with a university degree in AU in 96
Fitted values
rent/price (2001)



Relationship of price01/price96 to education (uni degree)
Flats - all bedrooms - 2001
log of price 2001 / price 1996 (median)
-1
-.5
0
.5
1
-5
-4
-3
-2
-1
log of proportion of people with a university degree in AU in 96
Fitted values
rent/price (2001)

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