The Elasticity of Housing Supply in Regional NSW

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Abstract
This paper presents estimates of the supply elasticity for houses in Local Government Areas (LGAs) of regional New South Wales (NSW) (i.e. outside of metropolitan Sydney). Our results suggest that over the period 1991-2012, the supply response for houses is relatively inelastic across all areas of regional NSW. The average supply elasticity for regional NSW is about 0.25 to 0.30; with the largest estimated elasticity only about 0.9. The finding of low supply elasticity across NSW is puzzling? Our prior expectation is that in rural or semi-rural regions – where land is not scarce – the marginal cost of supplying a new house would be low and this would imply a relatively elastic supply curve for houses. We do not see any evidence of this in our empirical results. A second (and related) feature of our results is the relative homogeneity of the estimates of supply elasticity for the 101 LGAs in regional NSW. It might be expected that there would be at least some LGAs with relatively elastic supply. In our view the lack of any LGAs with a high supply elasticity for houses, is suggestive of some State-wide constraint or restriction on the private sector's ability to produce new houses. In NSW the production of new houses is subject to a combination of State and Local government regulation.

JEL Classification: L24

Keywords: supply elasticity, housing supply, instrumental variables, ARDL bounds

1. **Introduction**

The large increase in the relative price of housing in Sydney over the past two decades is a well-documented observation (Hatzvi and Otto, 2008). What is less widely known is that the relative price of housing has also risen in most regional areas of NSW. In particular, in virtually all regional Local Government Areas (LGAs), there was a sharp increase in real median house prices beginning in about 2001-2002. In 2005 real house pieces in regional NSW were on average 66 percent higher than they were in 2001. This increase in real house prices was widespread across LGAs in NSW. Of the 101 LGAs in regional NSW, 95 experienced real house price increases between 2001 and 2005 of at least 30 percent. To give one example, in the LGA of Oberon, the median house price in real terms increased from $165,000 in 2001 to $274,000 in 2005; a percentage increase that exactly mirrors the regional average.

Large increases in property prices – relative to construction costs – would generally be expected to increase the profitability of building new houses and lead to a boom in private residential construction.[1] However one key finding of this paper is that the steep rise in house prices across regional NSW appears to have had a relatively small effect on the supply of new houses. We estimate the average supply elasticity for houses across all regional LGAs is only 0.32 (or 0.25 if occupied dwellings are used to measure the housing stock). While this estimate of the average supply elasticity for regional NSW is larger than for metropolitan Sydney, the size of the difference is surprisingly small.[2] Moreover, for all 101 LGAs in regional NSW, the estimated supply elasticity for houses is always less than unity, i.e. supply is inelastic. Given the relatively abundant stock of land in regional NSW – at least compared with many areas of Sydney – the lack of any LGAs with elastic supply curves for houses is unexpected. This finding is very different to the results for the United States where considerable variation is found in regional estimates of housing supply elasticity and there are a number of regions with highly elastic supply (Green, Malpezzi and Mayo, 2005 and Saiz, 2008).

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[1] In many OECD countries there is a close association between the profitability of house construction and private residential investment (Girouard and Blondal, 2001)

[2] Gitelman and Otto (2012) and Liu and Otto (2014) estimate the average supply elasticity for houses (includes detached, semi-detached, terraces and town-houses) in metropolitan Sydney is around 0.2.

This paper has the following structure. Section 2 presents an analysis of house prices and house stocks using LGA data aggregated into eleven larger regions. Using informal methods we show that despite a large common rise in real house prices across the regions between 2001 and 2005, there is little evidence of any corresponding sizeable increase in the supply of new houses. The data are suggestive of relatively inelastic housing supply in regional NSW. These findings are supported by formal econometric estimates of supply elasticity, reported in Section 3. Section 4 concludes with some conjectures for why housing supply is inelastic in regional NSW.

2. House Stocks and Prices in Regional NSW

This section provides an overview of the behaviour of house prices and the stock of houses in regional NSW since 1991 and uses the State-wide increase in house prices from 2002-2004 to informally estimate supply elasticity.

2.1 Data

Measurement of house prices in LGAs is proxied by median sales prices for non-strata dwellings (which are primarily detached houses in regional NSW). The data are sourced from the NSW Department of Housing's *Sales Reports*. For each LGA, the nominal median price is converted to a relative price by deflating with the consumer price index (CPI) for Sydney.[3]

The quantity or stock of houses is measured by the number of non-strata dwellings (both total and occupied dwellings are available) in an LGA. The data are constructed by combining Australian Bureau of Statistics (ABS) Census housing stock figures for the years 1991, 1996, 2001, 2006 and 2012, with figures on housing approvals for the financial years 1992 to 2012 (sourced from *Regional Statistics Profiles* for New South Wales, 1992-2003, and the Australian *National Regional Profile* for the remaining years, 2004-2012).

Real income in an LGA is measured by average real taxable income per taxpayer, based on data from the Australian Taxation Office's *Taxation Statistics.* Since no income data by LGA are currently available for the financial years 2010-11 and 2011-12, we simply assume that the growth rate of real income per taxpayer in these two years is equal to the growth rate for 2009-10.

[3] No CPI is available for regional NSW.

The other two economic variables used in the analysis are the resident population of an LGA (sourced from the ABS and the NSW Local Grants Commission) and the 10-year indexed government bond rate. All variables are measured on an annual basis.

2.2 Regional Data Analysis

Given the relatively large number of LGAs in regional NSW, it is useful to group them into larger regions for a preliminary data analysis. LGAs in NSW outside of metropolitan Sydney can be classified into 11 regions. The regions are Richmond-Tweed, Mid-North Coast, Hunter, Illawarra, South-Eastern (all of which include some LGAs with coastlines) and the entirely inland regions of Northern, North-Western, Central West, Murrumbidgee, Murray and Far West. Tables A1 and A2 in the Appendix can be used to match LGAs to regions.

Growth of Regional Variables

Table 1 reports the growth rate of housing stocks (occupied and total), real house prices, real income and population for each region over the period 1991-2011.[4] There is considerable variation in the growth rate of the number of houses across regions. The highest growth in the housing stock is found in the coastal regions and the average growth rate of house stocks in the coastal regions is about double that for the inland regions. Only one region has experienced an actual decline in its stock of houses – the Far West – but it should be noted that data for this region only includes a single LGA (Broken Hill).

All regions have experienced positive growth in real house prices over the 1991-2011 period. The highest growth has been in the South-Eastern region (113 percent) and the lowest in the North-Western region (42 percent). Across all of regional NSW, real house prices have grown at an average rate of about 3 percent per annum.

Aside from the Far West, growth in real income is relatively homogenous across regions.

Finally population growth has largely been concentrated in coastal regions, with an average rate of 23 percent over the period 1991-2011. Most of the inland regions have experienced declines in population over this period and population has declined by about 4 percent across all inland regions. A number of studies have emphasised the impact of leisure related activities and the sea-change phenomenon in driving population growth and housing development in coastal areas, (Paris, Jorgensen and Martin, 2009, Costello, 2009; Rowley and McKenzie, 2009).

[4] The year 2011 (rather than 2012) is selected because it is a census year and records actual rather than imputed values for house stocks.

Scatter-Plots

It is useful to examine some simple correlations between the variables in Table 1 using scatter-plots. Figure 1 shows the strong positive relationship between the growth of the housing stock and population across regions. In the longer term, a one percentage point increase in population growth is associated with (approximately) a one percentage point increase in housing stock growth.

Population growth has a much weaker correlation with the growth rate of real house prices; although the relationship is positive as might be expected, see Figure 2. In this case the long-run effect of a one percentage point increase in population growth is associated with a 0.8 percentage point increase in the growth rate of real house prices. Finally the growth rate of real income also has a positive association with real price growth, although the fit – measured by the R-squared – is close to zero, see Figure 3. Note that removal of the Far West data observation (an apparent outlier), produces a steeper regression line, but does not markedly improve its fit of the data.

2.3 "Exogenous" Demand Shocks and the (Non-) Response of House Supply

This section provides a more detailed analysis of the behaviour of real house prices and house stocks in the regions over the period 1991-2011. One important feature of regional house prices that is not evident from Table 1 is a large rise in real house prices in virtually every LGA, in regional NSW, during the period 2001 to 2005. In general there are only small variations in the timing of the increases across LGAs. With few exceptions, real house prices showed a virtually simultaneous increase in all LGAs outside of metropolitan Sydney.

Real House Prices

To illustrate the marked rise in the price of houses, Figure 4 shows real house prices in LGAs by region for two sub-periods 1991-2001 and 2005-2012. The observations for the years 2002 to 2004 are removed from the graphs, to emphasize the sharp increase in prices that occurred during these years. For ease of comparison between the two sub-samples, real house prices for each LGA are normalised by dividing each series by its (full) sample average. The first graph in Figure 4 shows data for eight of the ten LGAs that comprise the Central West region.[5]

[5] There are two LGAs (Lachlan and Weddin) in the Central West region where house prices do not clearly exhibit the same pattern as the other LGAs.

Figure 4 points to evidence of common and virtually simultaneous increases in house prices across regional LGAs during the period 2001-2005. In 2005 real house prices in regional NSW were on average 66 percent higher than they were in 2001. If we use a standard supply and demand model for housing to interpret this empirical observation, the rise in price must reflect some "common" increase in the demand curve and/or some "common" upward shift in the supply curve. While there is no obvious source of a common negative supply shock, there is a potential candidate for a common demand shock, which is the economy-wide decline in real interest rates that occurred during the mid to late 1990s. Hatzvi and Otto (2008) present evidence that it was a decline in the discount rate that caused the increase in housing prices in metropolitan Sydney over the period 1991-2006. It is possible that this factor was also responsible for the sharp rise in regional house prices.

If we are willing to treat the sharp rise in house prices during 2001-2005 as primarily reflecting an exogenous demand shock, this allows us to treat the increase in new houses during (and after) this period as reflecting a movement along a given housing supply curve. We can then examine how the growth in house stocks responded to the large price increase, associated with the demand shock.

House Stocks

Table 2 reports detailed data on the number and growth rate of non-strata dwellings in NSW regions. The data are reported for each census date. In 2011 there were about 1 million non-strata dwellings in regional NSW (of which about 0.86 million were occupied). The total stock of dwellings increased by 31 percent over the period 1991 to 2011, with the highest growth rates concentrated in the coastal regions; including Richmond-Tweed (56 percent), Mid North Coast (50 percent), South-Eastern (45 percent), Illawarra (39 percent) and Hunter (38 percent). More than half of the total growth in non-strata dwellings is accounted for by growth in the Hunter, Illawarra and Mid-North Coast regions. Of the inland regions, Murray and Central West have seen the highest growth in dwellings. The Far West region has seen a fall in the number of non-strata dwellings of 1.9 percent over the period 1991-2011.

Figure 6 plots the inter-censual growth rates of house stocks by region. It is evident that – in contrast to real house prices – there is little evidence of a common increase in the growth rate of the house stocks in regional NSW in the period 2001-2005. Comparing Figures 4 and 5 would suggest that the supply response of houses in regional NSW is relatively inelastic.

An informal estimate of the supply elasticity for each region can be calculated as the ratio of the percentage change in house stocks to the percentage change in real house prices. We consider two such estimates. One compares the growth rates of houses and prices for the period 2001 to 2005, while a second is based the ratio of the growth rate of the housing stock from 2002 to 2006 to the growth rate of real house prices from 2001 to 2005. The one year lag is to allow for possible delays or adjustment costs in the production of new houses.

Results are presented in Figure 6. Aside from the Far West region – where the elasticity estimates are negative – supply elasticities all lie in the range 0.05 to (about) 0.12. These figures suggest that regional NSW displayed a very inelastic supply response to the large rise in house prices in 2001-2005.

3. Housing Supply Elasticity Estimates

In this section we report formal estimates of supply elasticity for each of the 101 LGAs in regional NSW. These estimates are obtained using annual time-series observations from 1991-2012. We use two approaches to estimation. The first approach is based on a standard supply and demand framework for house stocks and prices and seeks to account for potential endogeneity by use of instrumental variables. The second approach makes use the ADRL (autoregressive distributed lag) bounds procedure (Pesaran, Shin and Smith, 2001). This procedure has the attractive feature of being robust to the some common types of non-stationarity that might be present in our time-series data.

Housing Supply Curve

Given the time-series data that is currently available at the LGA-level, we are restricted to the following parsimonious form for the supply curve for houses;

$$lnH_t^i = \alpha^i + \beta^i lnP_t^i + u_t^i \tag{1}$$

where i denotes an LGA, *lnH* is the logarithm of the stock of houses, *lnP* is the log of real house prices and *u* is an error-term, that is assumed to be stationary, but not necessarily iid. In this model β^i is the supply elasticity for the i'th LGA. Equation (1) is a static model and we assume that all dynamic adjustments in the housing market are completed within a year. In effect we view β^i as a long-run supply elasticity.

Consistent estimation of (1) is complicated by the fact that lnP_t^i is likely to be correlated with the error term u_t^i. We address this problem by using instrumental variables, where the instruments are variables that are likely to affect the demand curve for housing, but can be excluded from the supply curve. Given the available data, our general reduced-form model for real house prices is;

$$lnP_t^i = \pi_0^i + \pi_y^i lnY_t^i + \pi_N^i lnN_t^i + \pi_R^i R_t + e_t^i \quad (2)$$

where *lnY* is a measure of real income, *lnN* is population and *R* is a measure of the economy-wide real interest rate.[6] The error term *e* is assumed to be stationary, but not necessarily iid.

Supply Elasticity Estimates

Equation (1) is estimated using generalised instrumental variables, with serial correlation and heteroskedasticity-robust standard errors (Newey and West, 1987)[7]. Supply elasticity estimates are obtained for all 101 LGAs using total houses. The following results are based on using only *lnY* and *R* as instruments.

As a test for instrument quality we compute the F-statistics for the joint significance of the coefficients in equation (2). The F-statistics are show in Figure 7 and are typically quite large. Results in Stock and Yogo (2002) imply that the null hypothesis of weak instruments can be rejected at the 5 percent level of significance for F-statistics greater than 13.9. We can reject weak instruments for 90 percent LGAs.

Figure 8 presents supply elasticity estimates for total houses. The estimates imply that for the period 1991-2012 the supply response for houses is inelastic in all regional LGAs. The largest estimated elasticity is 0.90 and the average across all LGAs is 0.32, so that on average a 10 percent increase in real house prices in regional NSW will increase the long-run stock of houses by 3.2 percent. The five LGAs with the largest supply elasticity are Murray (0.90), Hastings (0.85), Great Lakes (0.79), Port Stephens (0.67) and Bathurst (0.64). The LGAs with the most inelastic supply are Bourke (-0.11), Lachlan (-0.05), Gilgandra (-0.03) and Lockhart (-0.01). Although instrument quality is very low in these latter cases.

ARDL Estimates

In this section we use the ARDL bounds procedure to estimate the long run supply elasticity (Pesaran, Shin and Smith, 2001). We initially test for the existence of a levels relationship between *lnH* and *lnP*. The ARDL approach can be used to test for the presence of a relationship in levels regardless of whether the variables in (1) are trend or first-

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[6] In some sets of estimates a dummy variable D_{0204} (taking the value 1 for the years 2002-2004 and zero elsewhere) is included in both equations (1) and (2). Also some sets of estimates do not use population as an instrument.

[7] In the Newey-West estimator two auto-covariances are estimated.

difference stationary. Conditional on the existence of a levels relationship, we can obtain an estimate of the long-run elasticity, which under certain conditions may provide a valid estimate of the supply elasticity. One advantage of the ARDL procedure is that it is not necessary to pre-test for order of integration of series.

One issue that does arise with using the ARDL procedure is the need to assume that one of the variables in the supply curve can be treated as being weakly exogenous. In using IV to estimate (1) we have treated lnH_t^i and lnP_t^i as being simultaneously determined. However for the ARDL analysis we assume it is valid to condition on either lnH_t^i or lnP_t^i, and since it is not evident which is the more reasonable assumption, we estimate both possible conditional error correction models. Since there is only a relatively small sample of observations for each LGA, we use the following parsimonious specifications for the ARDL models:

$$\Delta lnH_t^i = \delta_{H0}^i + \delta_{HP}^i lnP_{t-1}^i + \delta_{HH}^i lnH_{t-1}^i + \omega_{HP}^i ln\Delta P_t^i + \theta_H^i D_{0204} + \varepsilon_H^i \qquad (3a)$$

$$\Delta lnP_t^i = \delta_{P0}^i + \delta_{PP}^i lnP_{t-1}^i + \delta_{PH}^i lnH_{t-1}^i + \omega_{PP}^i ln\Delta H_t^i + \theta_P^i D_{0204} + \varepsilon_P^i \qquad (3b)$$

Given the sharp increase in residential property prices around 2002 – which is not well explained by the standard ARDL regressors – we augment these specifications with a dummy variable D_{0204}, that takes the value 1 for the years 2002, 2003 and 2004 and zero elsewhere.

We can test for the presence of a relationship in (log) levels by testing the null hypothesis $H_0\colon \delta_{HP}^i = \delta_{HH}^i = 0$ in equation (3a), or $H_0\colon \delta_{PP}^i = \delta_{PH}^i = 0$ in (3b), using an F-statistic. Since we do not know the order of integration of the two variables, this hypothesis test takes the form of a bounds test. The asymptotic critical values for the ADRL bounds F-test are [4.94, 5.73] at the 5% level of significance, see Pesaran, Shin and Smith, (2001, Table CI(iii)). If the F-statistic is less than 4.94 or greater than 5.73 we can make a decision about the null hypothesis, without knowing if the series are I(1) or I(0). Provided we can reject the null hypothesis of no-levels relationship using either (3a) or (3b), an estimate of the long-run supply elasticity β_i in (1) can be computed using the relevant ratio $\frac{\delta_{HP}^i}{\delta_{HH}^i}$ or $\frac{\delta_{PP}^i}{\delta_{PH}^i}$. These ratios provide an alternative set of estimates of the supply elasticity to the IV estimator.

The results of the ARDL procedure are reported in the Appendix in Table A2. Since the largest F-statistics typically arise from specification (3a), we report the results for that specification. For about 60 percent of the LGAs we can reject the null hypothesis of no levels relationship between lnH_t^i or lnP_t^i (at the 10 percent significance level).

At present we view the ARDL results as robustness check on the IV estimates. For our analysis the primary question is whether – when the bounds test points to evidence of a levels relationship – the ARDL model yields an estimated elasticity that is similar in magnitude to the IV estimate. Figure 9 presents a scatter-plot of the IV estimate and an ARDL estimate for those LGAs where the hypothesis of no-levels relationship is rejected (or where the bounds test is inconclusive). It is apparent that there is a reasonably strong positive correlation between the supply elasticity estimates obtained from the two estimators. On balance the ARDL estimates are broadly consistent with those obtained from the IV estimator; and this suggests the IV estimates are robust to possible stochastic non-stationarity in the data.

Supply Elasticity and House Price Growth

We can examine if the growth rate of house prices across LGAs is positively correlated with our estimates of supply elasticity. It might be expected that LGAs with relatively lower supply elasticity will experience faster capital gains, particularly in response to shocks that are common across all regions. Figure 10 shows the relationship between the average annual growth rate of real house prices, from 1991 to 2011 and the estimated supply elasticity for all regional LGAs. When data for all LGAs is pooled, there seems to be little correlation between estimated supply elasticity and growth in capital gains. However if the LGAs are classified into their coastal and inland regional groupings (see Figures 11 and 12 respectively), there is some evidence from LGAs in the coastal region that larger supply elasticities are associated with smaller average capital gains.

4. Why is Regional Housing Supply so Inelastic?

We view our findings of low housing supply elasticity across most of regional NSW as puzzling. We expected that in rural or semi-rural locations – where land is not particularly scarce – the marginal cost of supplying a new house would be relatively low and this would imply a relatively elastic supply curve for houses. There is little evidence of this in the empirical results.

A second (and related) feature of the results is the relative homogeneity of the estimates of supply elasticity across the 101 LGAs in regional NSW. It might be expected that there would be some LGAs with relatively elastic supply. The lack of any LGAs with high supply elasticity for houses, is suggestive of some NSW-wide constraint or restriction of the private sector's ability to produce new houses.

The construction of new house in NSW is regulated by both State and Local governments. In general the State government is responsible for planning legislation and regional development strategies, while Local Councils are responsible for developing and implementing a local environmental plan. Permission to build new houses is controlled through zoning regulations. Zoning defines the legally permitted and prohibited uses of land, determining if a piece of land can be used for commercial, industrial, residential, agricultural purposes (or for none of these). Our estimates of supply elasticity for LGAs in regional NSW raise the question as to how much autonomy Local Councils have in the provision of permits to build. If Councils did have a large degree of autonomy with regard to zoning decisions, we might except to see large cross-section variation in zoning and planning restrictions and hence in the supply elasticity across LGAs. Since this is not the case it suggests the presence of effective NSW-wide controls on land-use planning and zoning regulations determined at the State government level.

In future work we plan investigate the process by which State and Local governments determine the amount of land that is zoned for residential housing.

Table 1: Percentage Growth of Main Variables, 1991-2011

	Percentage Growth				
	House Stock				
Region	**Occupied**	**Total**	**Real Price**	**Real Income**	**Population**
Central West	22.7	25.8	49.7	45.4	3.0
Far West	-12.7	-1.9	78.5	19.5	-21.4
Hunter	35.6	38.0	99.6	43.1	21.6
Illawarra	38.2	39.2	95.4	38.4	29.0
Mid-North Coast	45.9	50.0	74.0	43.2	22.9
Murrumbidgee	18.1	23.0	95.4	47.1	-3.8
Murray	24.4	29.5	53.7	48.1	7.3
North-Western	10.5	17.4	41.7	43.3	-10.1
Northern	14.1	19.4	77.4	39.2	-0.9
Richmond-Tweed	51.6	56.5	107.5	44.3	24.5
South-Eastern	42.4	45.2	113.1	48.8	18.8
Averages					
Coastal	40.6	43.3	101.9	43.6	23.4
Inland	17.0	22.2	71.0	40.4	-4.3
Regional	32.8	31.0	85.1	41.9	8.3

Notes: Coastal includes regions in which at least one LGA has a coastline (Richmond-Tweed, Mid-Coast, Hunter, Illawarra and South-Eastern.

Figure 1: Growth in Total House Stocks and Population, 1991-2011

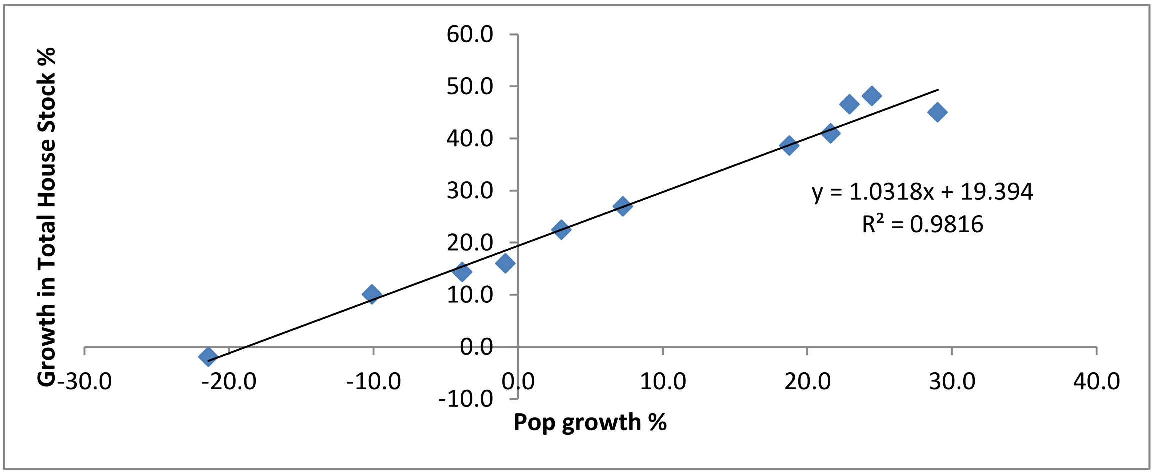


Figure 2: Growth in Real House Prices and Population, 1991-2011

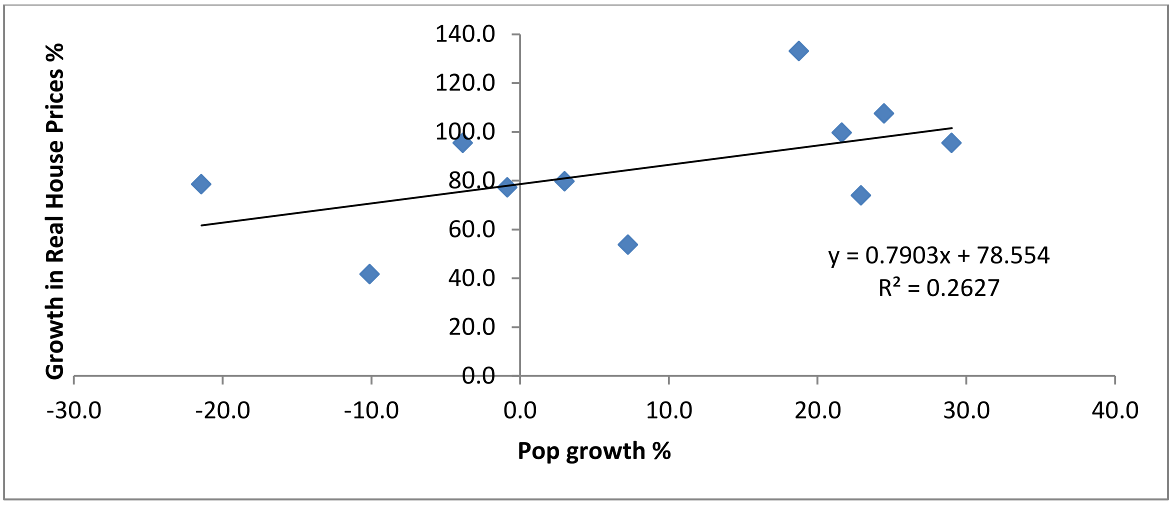


Figure 3: Growth in Real House Prices and Real Income, 1991-2011

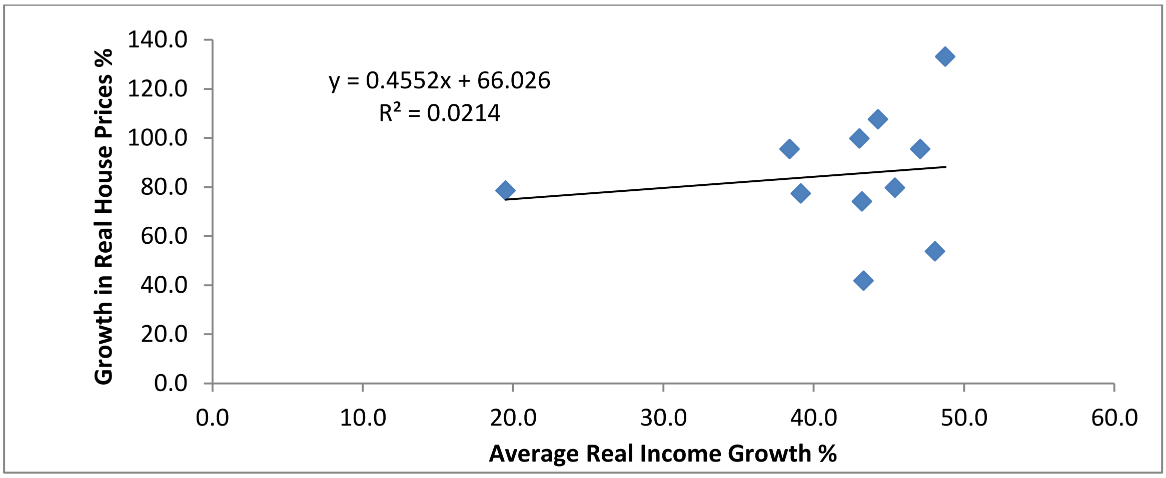
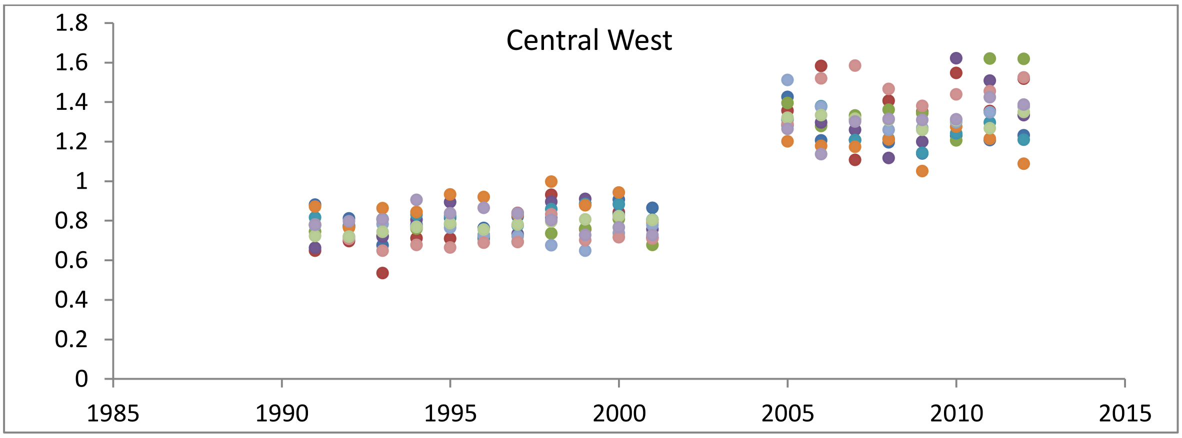
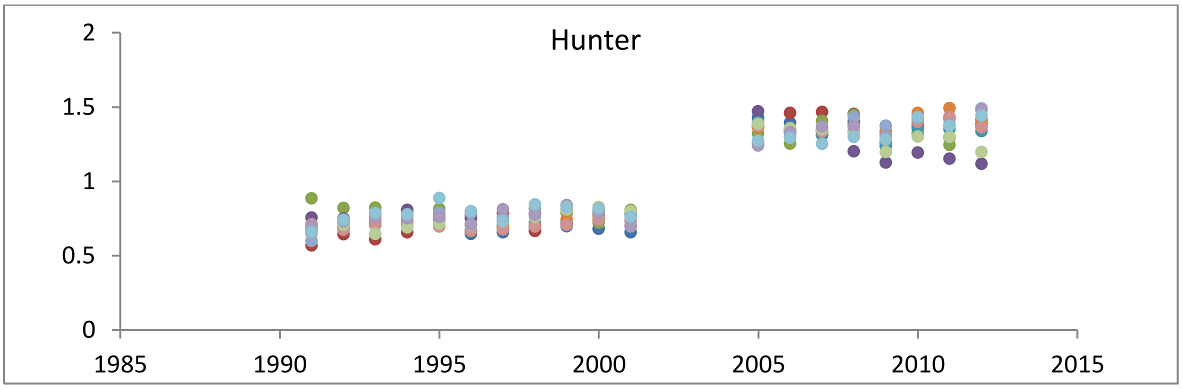
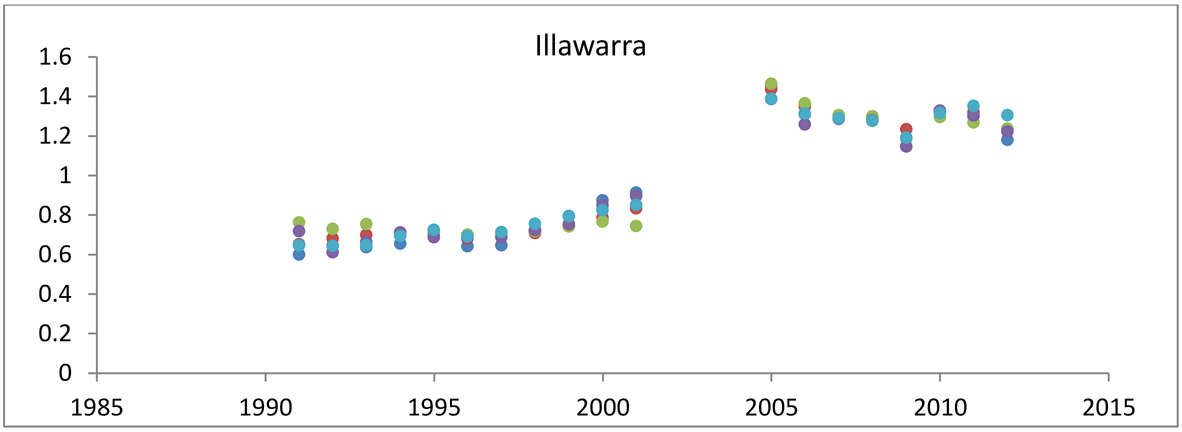
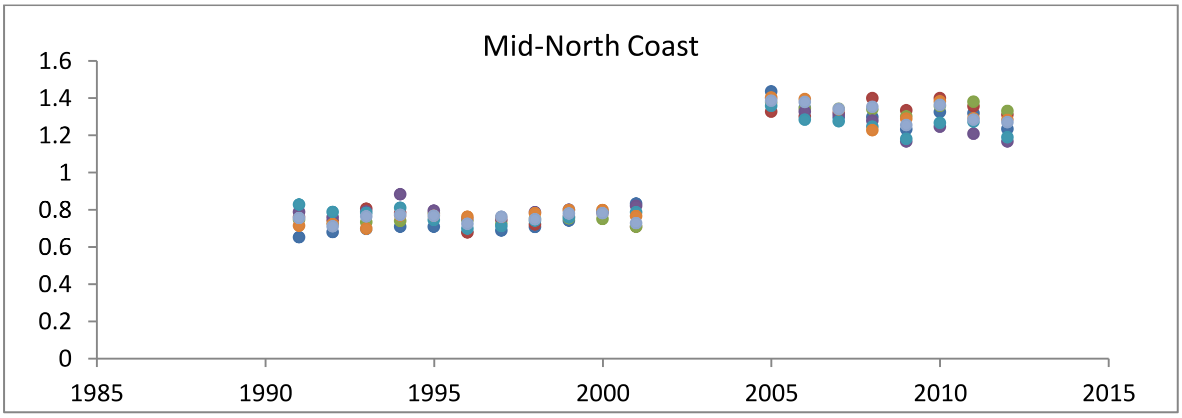


Figure 4: Normalised Real House Prices for Regional LGAs









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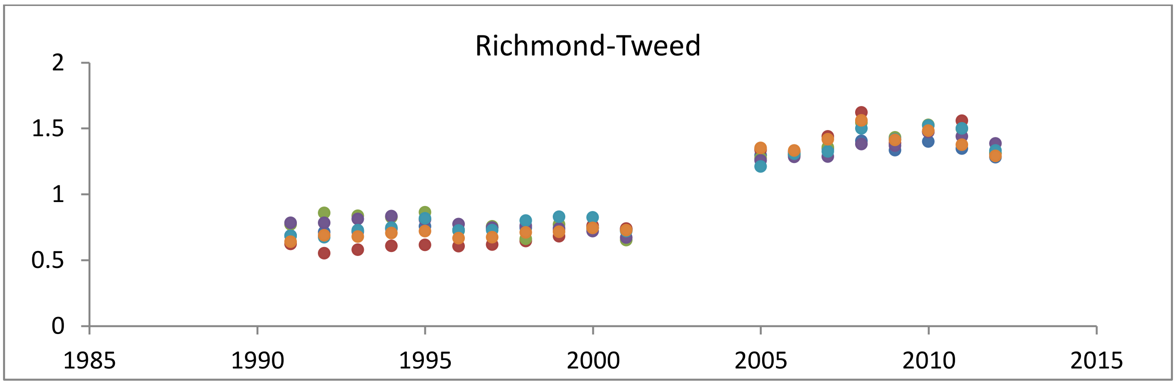
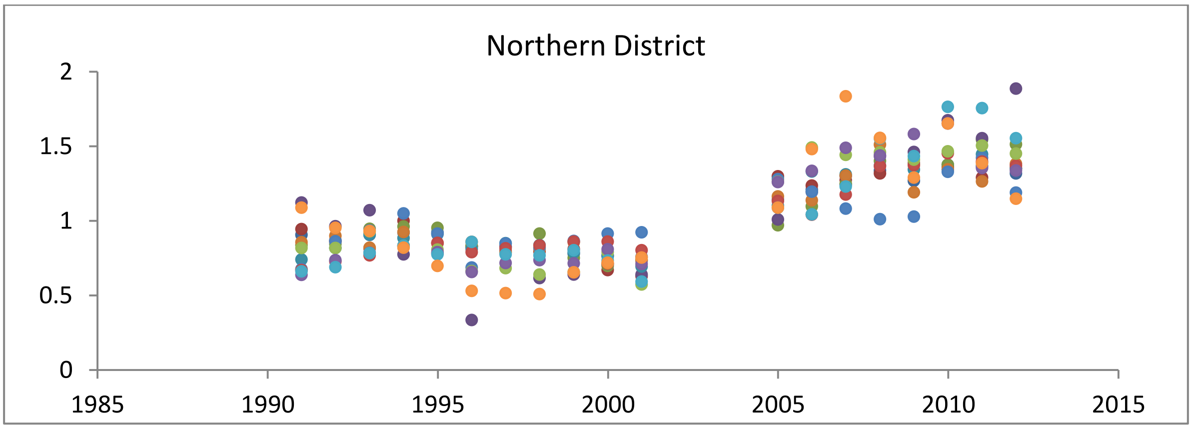
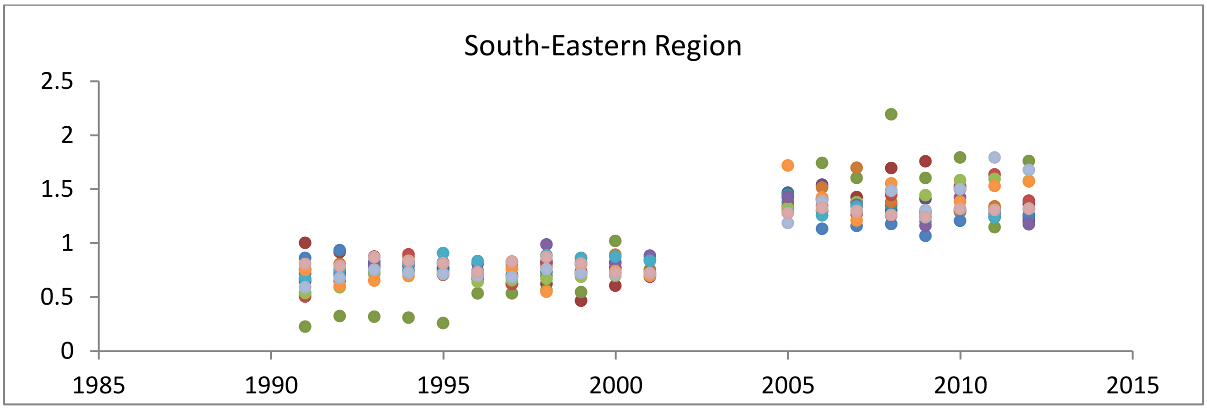






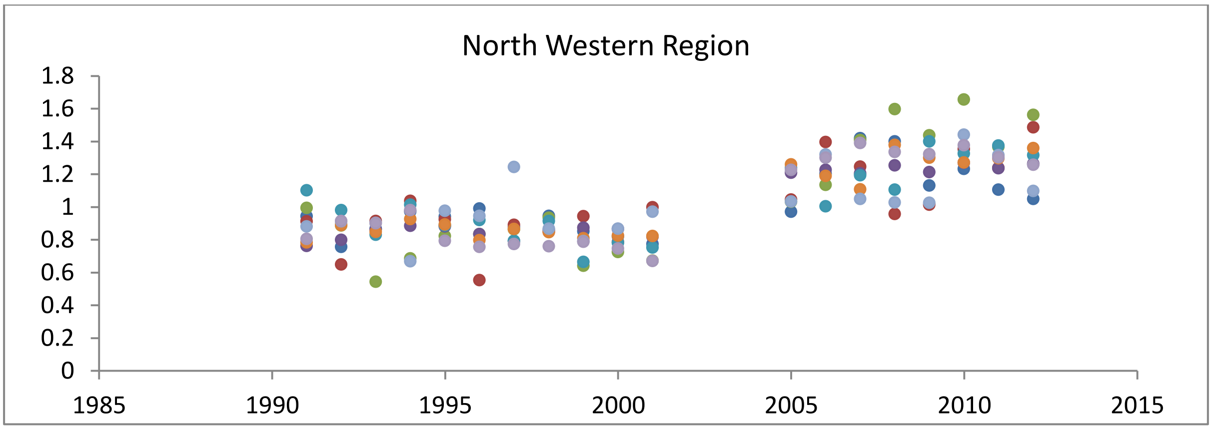
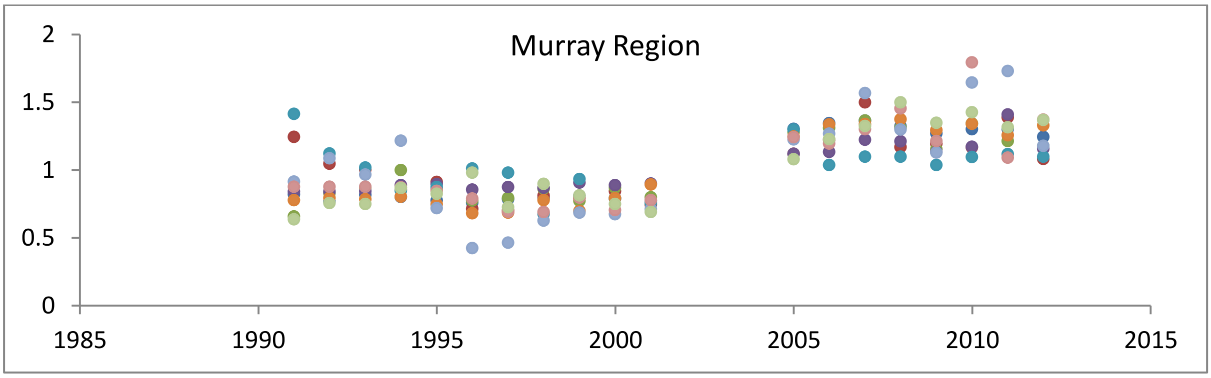


Figure 4: Continued



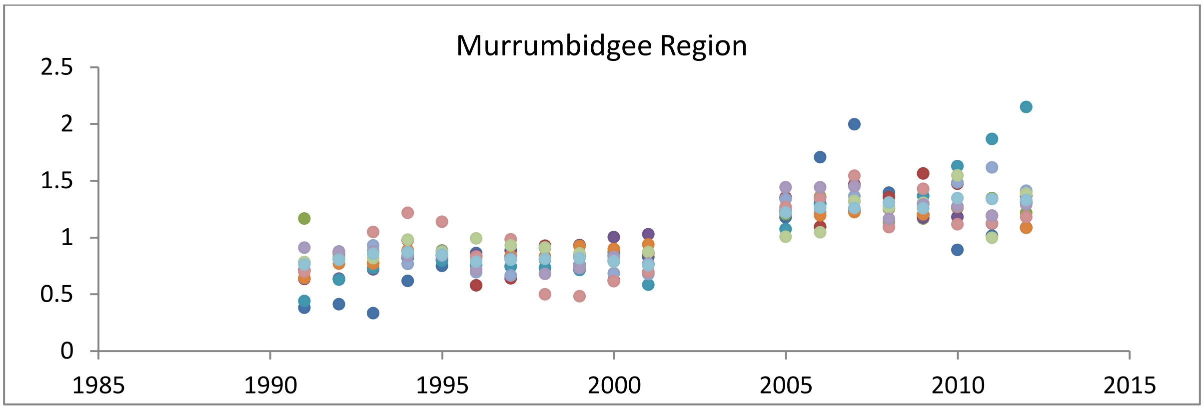


Table 2: Total Stock and Growth Rate of Houses by Region 1991-2011

Region	1991	1996	2001	2006	2011
Central West	65,064	69,261	73,029	77,400	81,872
	na	(0.064)	(0.054)	(0.059)	(0.057)
Far West	9,143	8,889	9,107	8,902	8,965
	na	(-0.02)	(0.024)	(-0.02)	(0.007)
Hunter	176,934	196,423	214,907	229,997	244,212
	na	(0.110)	(0.094)	(0.070)	(0.061)
Illawarra	117,824	130,886	143,023	154,394	163,960
	na	(0.110)	(0.092)	(0.079)	(0.061)
Mid-North Coast	80,536	91,954	102,313	112,150	121,018
	na	(0.141)	(0.112)	(0.096)	(0.079)
Murrumbidgee	42,827	45,182	48,120	49,950	52,852
	na	(0.054)	(0.065)	(0.038)	(0.058)
Murray	33,215	34,661	37,474	40,182	43,005
	na	(0.043)	(0.081)	(0.072)	(0.070)
North-Western	32,050	33,613	35,873	37,035	37,639
	na	(0.048)	(0.067)	(0.032)	(0.016)
Northern	58,047	60,744	63,485	65,940	69,288
	na	(0.046)	(0.045)	(0.038)	(0.050)
Richmond-Tweed	57,187	69,983	76,447	82,359	89,476
	na	(0.188)	(0.124)	(0.077)	(0.086)
South-Eastern	66,844	74,462	82,384	91,086	97,064
	na	(0.113)	(0.106)	(0.105)	(0.065)
Coastal	499,325	561,708	619,074	669,986	715,730
	na	(0.124)	(0.102)	(0.082)	(0.068)
Inland	240,350	252,350	267,088	279,409	293,621
	na	(0.049)	(0.058)	(0.046)	(0.050)
Regional	739,671	814,058	886,162	949,395	1,009,351
	na	(0.100)	(0.088)	(0.071)	(0.063)

Notes: Coastal includes regions in which at least one LGA has a coastline (Richmond-Tweed, Mid-Coast, Hunter, Illawarra and South-Eastern.

Figure 5: Growth Rate of House Stocks between Censuses

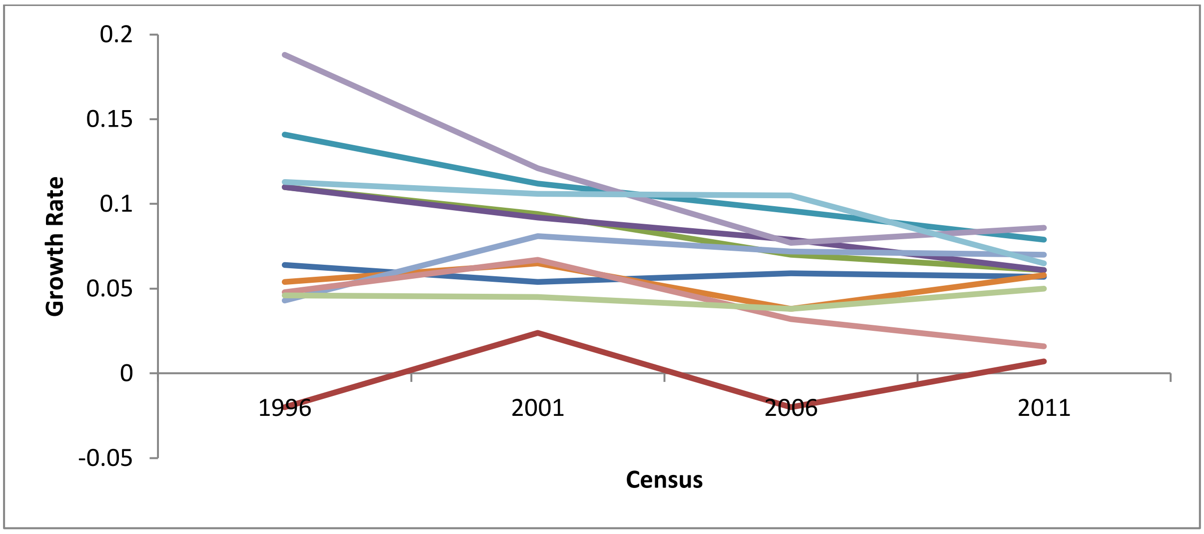


Figure 6: Informal Estimates of Supply Elasticity by Region

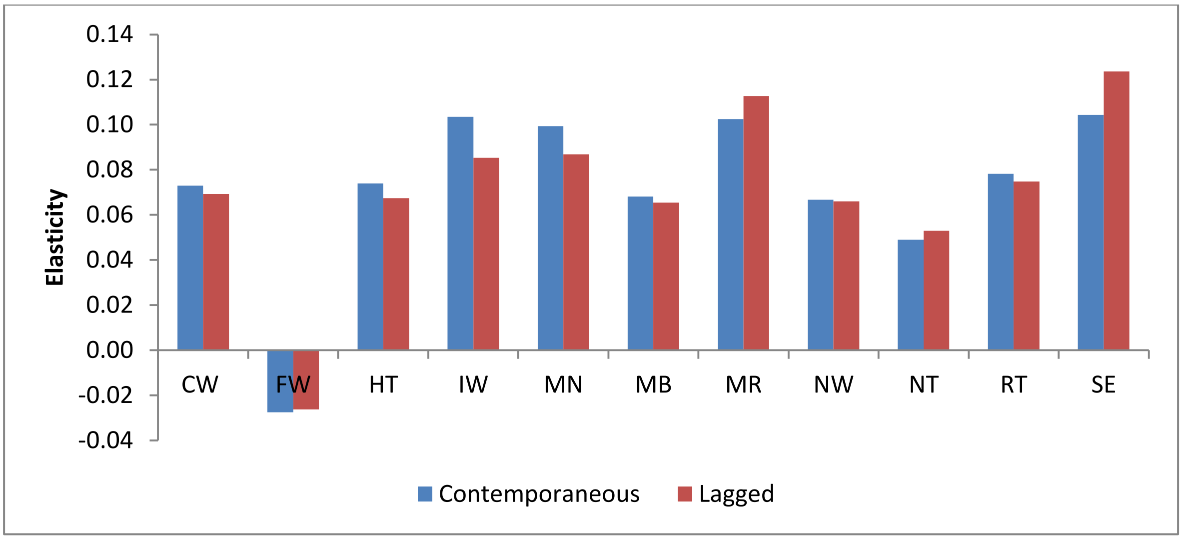


Figure 7: Instrument Quality – F-statistics

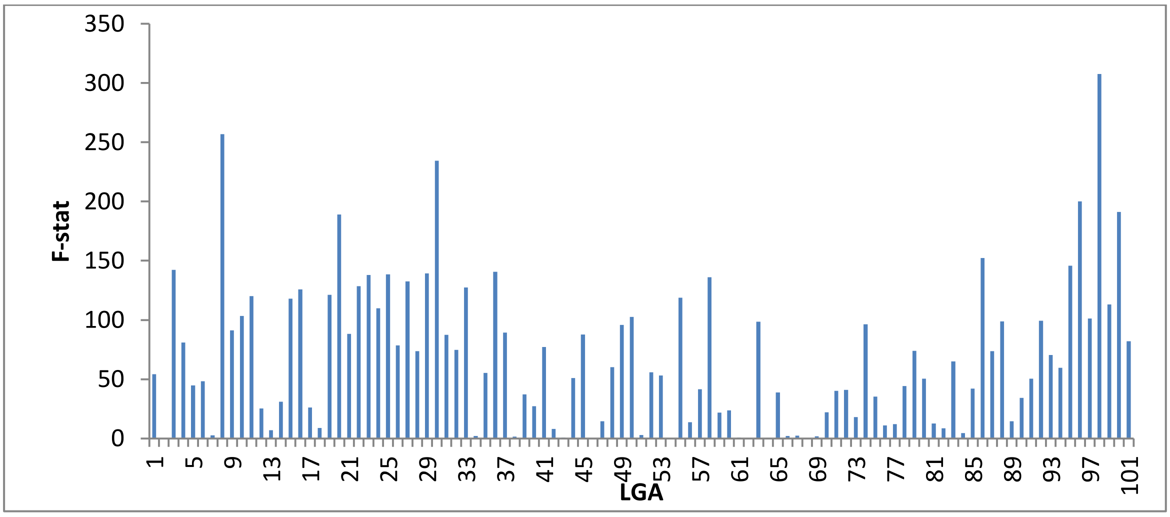


Figure 8: Estimates of Supply Elasticity

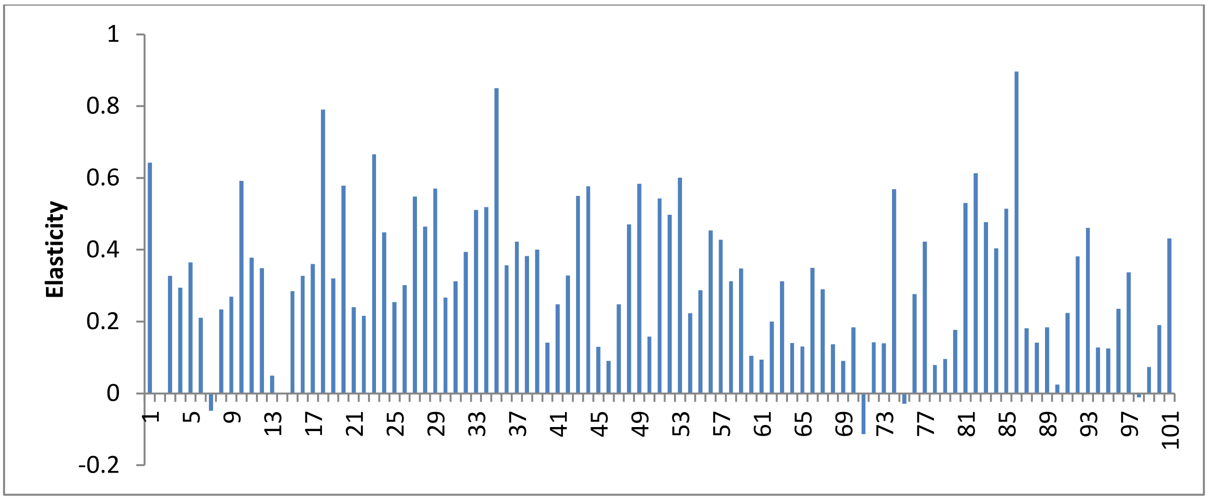


Figure 9: Correlation between IV and ARDL Estimates of Supply Elasticity

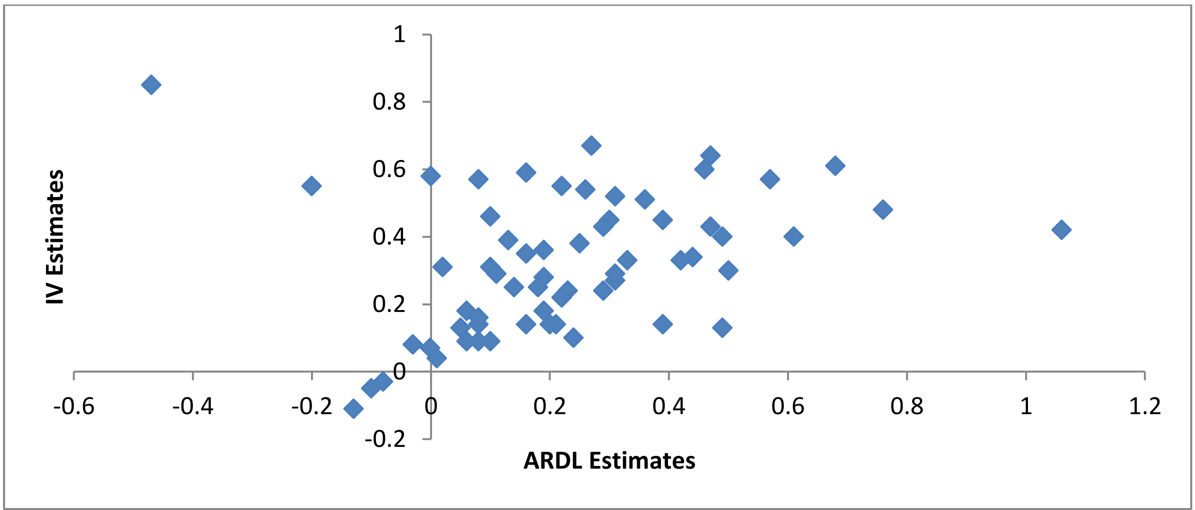


Figure 10: Supply Elasticity and Real Capital Gains: All LGAs

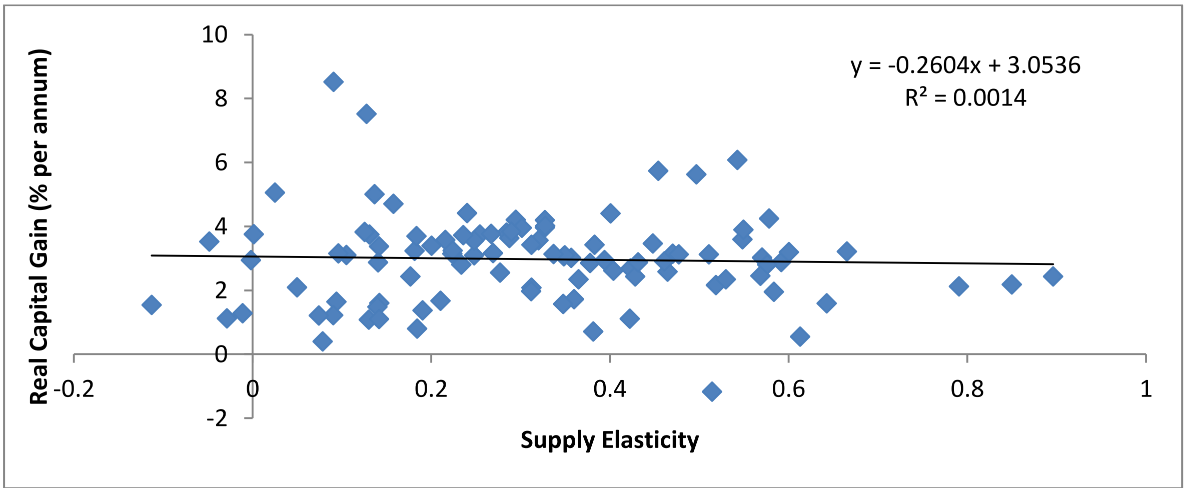


Figure 11: Supply Elasticity and Real Capital Gains: LGAs in Coastal Regions

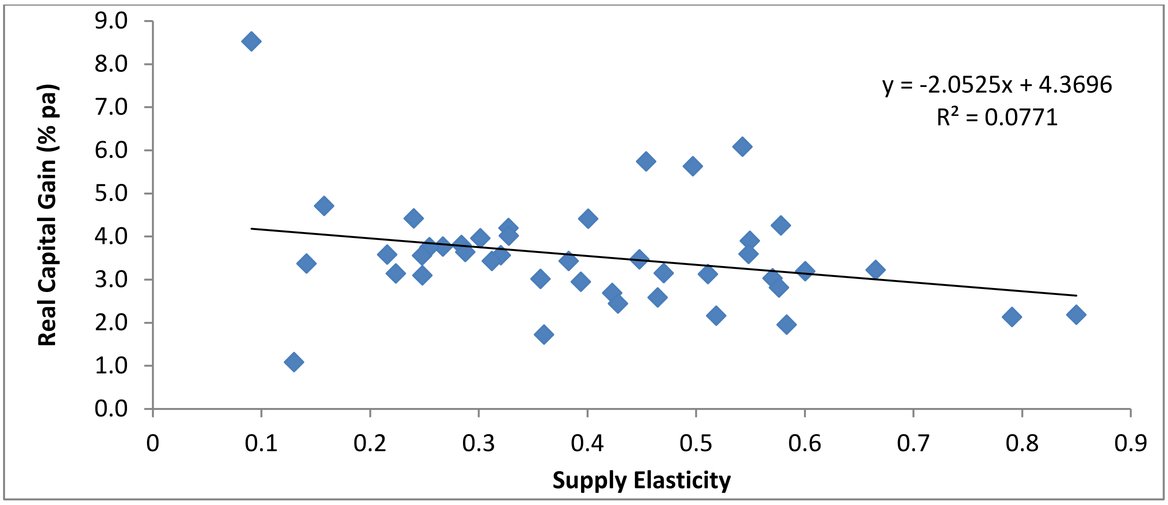
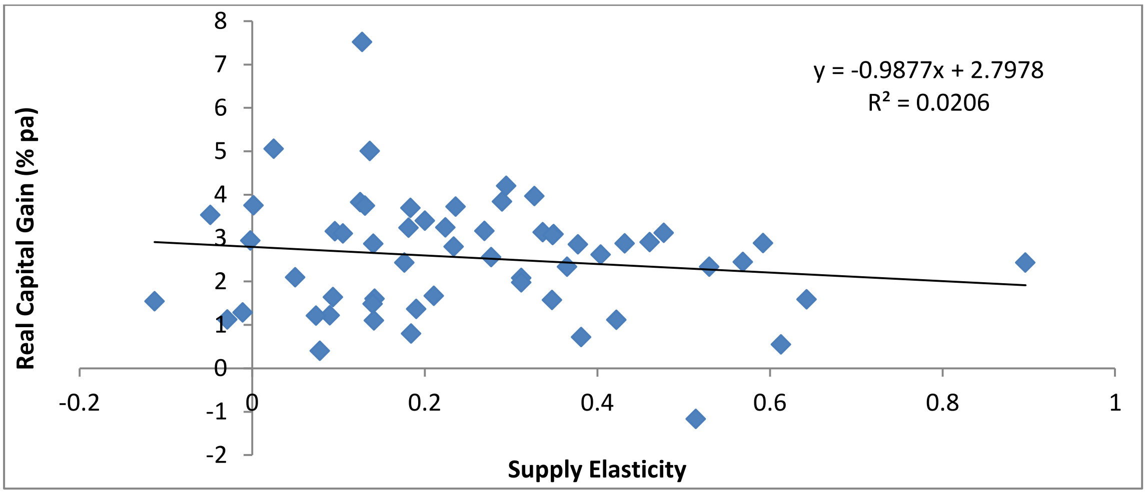


Figure 12: Supply Elasticity and Real Capital Gains: LGAs in Inland Regions



Appendix

Table A1: Instrumental Variables Estimates of Supply Elasticity by LGA

Region	LGA	Elasticity	Std Error	IQ
Central West	Bathurst Regional	0.64	0.082	65.3
Central West	Bland	0.00	0.005	0.8
Central West	Blayney	0.33	0.033	112.8
Central West	Cabonne	0.29	0.031	98.5
Central West	Cowra	0.36	0.043	80.4
Central West	Forbes	0.21	0.028	59.4
Central West	Lachlan	-0.05	0.019	5.3
Central West	Lithgow	0.23	0.013	324.6
Central West	Mid-Western Regional	0.27	0.025	116.6
Central West	Oberon	0.59	0.058	120.1
Central West	Orange	0.38	0.027	134.1
Central West	Parkes	0.35	0.045	82.5
Central West	Weddin	0.04	0.061	0.2
Far West	Broken Hill	0.00	0.003	4.19
Hunter	Cessnock	0.28	0.025	87.7
Hunter	Dungog	0.33	0.026	185.1
Hunter	Gloucester	0.36	0.074	49.0
Hunter	Great Lakes	0.79	0.081	97.0
Hunter	Lake Macquarie	0.32	0.027	151.8
Hunter	Maitland	0.58	0.041	170.2
Hunter	Muswellbrook	0.24	0.020	132.9
Hunter	Newcastle	0.22	0.017	94.6
Hunter	Port Stephens	0.67	0.060	130.7
Hunter	Singleton	0.45	0.040	119.9
Hunter	Upper Hunter Shire	0.25	0.026	93.0
Illawarra	Kiama	0.30	0.028	124.1
Illawarra	Shellharbour	0.55	0.045	156.2
Illawarra	Shoalhaven	0.46	0.052	80.9
Illawarra	Wingecarribee	0.57	0.046	158.4
Illawarra	Wollongong	0.27	0.016	238.8
Mid North Coast	Bellingen	0.31	0.033	121.4
Mid North Coast	Clarence Valley	0.39	0.044	87.9
Mid North Coast	Coffs Harbour	0.51	0.042	147.6
Mid North Coast	Greater Taree	0.52	0.054	71.6
Mid North Coast	Hastings	0.85	0.104	66.5
Mid North Coast	Kempsey	0.36	0.028	159.2
Mid North Coast	Nambucca	0.42	0.047	78.4
Murrumbidgee	Carrathool	0.03	0.012	3.9
Murrumbidgee	Coolamon	0.22	0.032	64.0
Murrumbidgee	Cootamundra	0.38	0.083	25.9
Murrumbidgee	Griffith	0.46	0.073	82.8
Murrumbidgee	Gundagai	0.13	0.019	41.5
Murrumbidgee	Hay	0.13	0.065	7.7

Table A1: (Continued)

Region	LGA	Elasticity	Std Error	IQ
Murrumbidgee	Junee	0.24	0.037	40.1
Murrumbidgee	Leeton	0.34	0.036	90.8
Murrumbidgee	Lockhart	-0.01	0.019	0.9
Murrumbidgee	Narrandera	0.07	0.024	7.8
Murrumbidgee	Temora	0.19	0.033	38.6
Murrumbidgee	Wagga Wagga	0.43	0.041	76.1
Murry	Albury	0.53	0.047	132.7
Murry	Berrigan	0.61	0.368	2.8
Murry	Corowa Shire	0.48	0.066	58.2
Murry	Deniliquin	0.40	0.052	66.2
Murry	Greater Hume Shire	0.51	0.381	3.6
Murry	Murray	0.90	0.078	129.8
Murry	Tumbarumba	0.18	0.052	20.4
Murry	Wakool	0.14	0.038	12.1
Murry	Wentworth	0.18	0.016	190.3
North Western	Bogan	0.18	0.042	20.8
North Western	Bourke	-0.11	0.029	16.5
North Western	Cobar	0.14	0.034	21.4
North Western	Coonamble	0.14	0.082	2.69
North Western	Dubbo	0.57	0.052	114.2
North Western	Gilgandra	-0.03	0.026	0.2
North Western	Narromine	0.28	0.047	35.4
North Western	Walgett	0.42	0.141	6.7
North Western	Warren	0.08	0.044	0.9
North Western	Warrumbungle Shire	0.10	0.026	13.0
North Western	Wellington	0.18	0.058	6.0
Northern	Armidale Dumaresq	0.31	0.063	24.5
Northern	Glen Innes Severn	0.35	0.048	47.5
Northern	Gunnedah	0.11	0.015	44.8
Northern	Guyra	0.09	0.035	13.0
Northern	Inverell	0.20	0.020	181.3
Northern	Liverpool Plains	0.31	0.055	29.6
Northern	Moree Plains	0.14	0.026	29.6
Northern	Narrabri	0.13	0.013	97.4
Northern	Tamworth Regional	0.35	0.053	63.2
Northern	Tenterfield	0.29	0.036	63.1
Northern	Uralla	0.14	0.021	34.8
Northern	Walcha	0.09	0.021	21.5
Richmond-Tweed	Ballina	0.38	0.046	70.5
Richmond-Tweed	Byron	0.40	0.041	99.1
Richmond-Tweed	Kyogle	0.14	0.023	47.6
Richmond-Tweed	Lismore	0.25	0.037	66.2
Richmond-Tweed	Richmond Valley	0.33	0.026	136.3

Table A1: (Continued)

Region	LGA	Elasticity	Std Error	IQ
Richmond-Tweed	Tweed	0.55	0.059	78.5
South-Eastern	Bega Valley	0.58	0.057	100.6
South-Eastern	Bombala	0.13	0.027	21.6
South-Eastern	Boorowa	0.09	0.009	182.7
South-Eastern	Cooma-Monaro	0.25	0.031	56.0
South-Eastern	Eurobodalla	0.47	0.042	143.8
South-Eastern	Goulburn Mulwaree	0.58	0.072	69.4
South-Eastern	Harden	0.16	0.025	40.1
South-Eastern	Palerang	0.54	0.043	179.6
South-Eastern	Queanbeyan	0.50	0.034	213.2
South-Eastern	Snowy River	0.60	0.048	152.6
South-Eastern	Tumut Shire	0.22	0.013	312.0
South-Eastern	Upper Lachlan Shire	0.29	0.029	109.2
South-Eastern	Yass Valley	0.45	0.042	122.9
South-Eastern	Young	0.43	0.041	80.7

Notes: Instruments are real per-capita income and the real interest rate. Standard errors are robust to serial correlation (lags=2) and heteroskedasticity (Newey and West, 1987). IQ is the F-statistic for the joint significance of the instruments (Stock and Yogo, 2002).

Table A2: ARDL Bounds Procedure by LGA

Region	LGA	F-stat	$\frac{\delta^i_{HP}}{\delta^i_{HH}}$	IV Estimate
Central West	Bathurst Regional	5.75	0.47	0.64
Central West	Bland	-	na	0.00
Central West	Blayney	17.80	0.33	0.33
Central West	Cabonne	-	na	0.29
Central West	Cowra	20.18	0.19	0.36
Central West	Forbes	-	na	0.21
Central West	Lachlan	8.10	-0.10	-0.05
Central West	Lithgow	-	na	0.23
Central West	Mid-Western Regional	-	na	0.27
Central West	Oberon	6.15	0.16	0.59
Central West	Orange	-	na	0.38
Central West	Parkes	22.66	0.16	0.35
Central West	Weddin	7.71	0.01	0.04
Far West	Broken Hill	-	na	0.00
Hunter	Cessnock	6.96	0.19	0.28
Hunter	Dungog	6.63	0.42	0.33
Hunter	Gloucester	-	na	0.36
Hunter	Great Lakes	-	na	0.79
Hunter	Lake Macquarie	-	na	0.32
Hunter	Maitland	-	na	0.58
Hunter	Muswellbrook	4.08	0.29	0.24
Hunter	Newcastle	-	na	0.22
Hunter	Port Stephens	12.88	0.27	0.67
Hunter	Singleton	36.93	0.30	0.45
Hunter	Upper Hunter Shire	21.93	0.18	0.25
Illawarra	Kiama	4.01	0.50	0.30
Illawarra	Shellharbour	58.96	-0.20	0.55
Illawarra	Shoalhaven	62.80	0.10	0.46
Illawarra	Wingecarribee	5.45	0.57	0.57
Illawarra	Wollongong	4.03	0.31	0.27
Mid North Coast	Bellingen	62.81	0.02	0.31
Mid North Coast	Clarence Valley	17.39	0.13	0.39
Mid North Coast	Coffs Harbour	-	na	0.51
Mid North Coast	Greater Taree	23.76	0.31	0.52
Mid North Coast	Hastings	71.55	-0.47	0.85
Mid North Coast	Kempsey	-	na	0.36
Mid North Coast	Nambucca	-	na	0.42
Murrumbidgee	Carrathool	-	na	0.03
Murrumbidgee	Coolamon	5.34	0.22	0.22
Murrumbidgee	Cootamundra	4.56	0.25	0.38
Murrumbidgee	Griffith	-	na	0.46
Murrumbidgee	Gundagai	7.34	0.05	0.13
Murrumbidgee	Hay	13.68	0.49	0.13

Table A1: (Continued)

Region	LGA	F-stat	$\frac{\delta_{HP}^{i}}{\delta_{HH}^{i}}$	IV Estimate
Murrumbidgee	Junee	7.74	0.23	0.24
Murrumbidgee	Leeton	5.04	0.44	0.34
Murrumbidgee	Lockhart	-	na	-0.01
Murrumbidgee	Narrandera	9.54	-.001	0.07
Murrumbidgee	Temora	-	na	0.19
Murrumbidgee	Wagga Wagga	4.10	0.29	0.43
Murry	Albury	-	na	0.53
Murry	Berrigan	4.93	0.68	0.61
Murry	Corowa Shire	8.78	0.76	0.48
Murry	Deniliquin	6.00	0.49	0.40
Murry	Greater Hume Shire	4.60	0.36	0.51
Murry	Murray	-	na	0.90
Murry	Tumbarumba	-	na	0.18
Murry	Wakool	6.09	0.21	0.14
Murry	Wentworth	10.81	0.19	0.18
North Western	Bogan	-	na	0.18
North Western	Bourke	11.57	-0.13	-0.11
North Western	Cobar	-	na	0.14
North Western	Coonamble	5.22	0.39	0.14
North Western	Dubbo	40.83	0.08	0.57
North Western	Gilgandra	4.11	-0.08	-0.03
North Western	Narromine	-	na	0.28
North Western	Walgett	5.09	1.06	0.42
North Western	Warren	9.53	-0.03	0.08
North Western	Warrumbungle Shire	6.28	0.24	0.10
North Western	Wellington	28.29	0.06	0.18
Northern	Armidale Dumaresq	44.00	0.10	0.31
Northern	Glen Innes Severn	-	na	0.35
Northern	Gunnedah	-	na	0.11
Northern	Guyra	39.03	0.08	0.09
Northern	Inverell	-	na	0.20
Northern	Liverpool Plains	-	na	0.31
Northern	Moree Plains	4.16	0.20	0.14
Northern	Narrabri	-	na	0.13
Northern	Tamworth Regional	-	na	0.35
Northern	Tenterfield	5.62	0.11	0.29
Northern	Uralla	12.96	0.08	0.14
Northern	Walcha	4.23	0.06	0.09
Richmond-Tweed	Ballina	-	na	0.38
Richmond-Tweed	Byron	4.14	0.61	0.40
Richmond-Tweed	Kyogle	11.49	0.16	0.14
Richmond-Tweed	Lismore	24.69	0.14	0.25
Richmond-Tweed	Richmond Valley	-	na	0.33

Table A1: (Continued)

Region	LGA	F-stat	$\frac{\delta^i_{HP}}{\delta^i_{HH}}$	IV Estimate
Richmond-Tweed	Tweed	7.50	0.22	0.55
South-Eastern	Bega Valley	23.72	0.00	0.58
South-Eastern	Bombala	-	na	0.13
South-Eastern	Boorowa	8.31	0.10	0.09
South-Eastern	Cooma-Monaro	-	na	0.25
South-Eastern	Eurobodalla	-	na	0.47
South-Eastern	Goulburn Mulwaree	-	na	0.58
South-Eastern	Harden	7.80	0.08	0.16
South-Eastern	Palerang	7.58	0.26	0.54
South-Eastern	Queanbeyan	-	na	0.50
South-Eastern	Snowy River	6.61	0.46	0.60
South-Eastern	Tumut Shire	10.32	0.22	0.22
South-Eastern	Upper Lachlan Shire	4.07	0.31	0.29
South-Eastern	Yass Valley	14.30	0.39	0.45
South-Eastern	Young	5.23	0.47	0.43

Notes: The ADRL results reported in this table are based on the model 3(a). The F-statistic is used to test for the absence of a levels relationship. Critical bounds for the F-test are [4.04, 4.78] for the 0.10 level of significance. The table reports F-statistics greater than 4 and the implied vale for the long-run supply elasticity.

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