Urban Consolidation and House Prices

A case study of Melbourne 1990-2004

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A. Introduction

Urban consolidation is a major policy plank in the management of Australian metropolitan development. At its heart are a set of actions designed to reduce the land used by housing in the urban development process. These actions are focused on the development of the fringe as well as the re-development and use of land within the currently built fabric of inner and middle suburbs. On the fringe, implementation involves regulations on the size of lots, targets for housing density and since 2004 has included an urban growth boundary that constrains development within a specified area. In established areas implementation involves rights to build multiple dwellings on land previously occupied by a single house through to policy action that facilitates higher than previous density of housing in selected new projects.

Across that breadth of action a common thread is that urban consolidation is a lever that influences land and housing supply. At one level action like an urban growth boundary can be seen to be a limit on land supply as it prohibits the spread of the metropolitan area beyond a predetermined point. Superficially one might expect that in the vicinity of the urban growth boundary prices might raise more than expected as the supply restraint is felt, while in established areas the increase in supply could open up the market and lower prices. The impact of the supply constraint of urban consolidation policy has attracted considerable attention in the US (for example Pendall, R., Martin, J. and Fulton, W. 2002). Results of this analysis are mixed, with price gains recorded in some metropolitan areas, but not in others. It seems that the effect of supply restrictions are moderated by other circumstances that are in play in each local market. These circumstances influence housing prices at both macro and micro levels. At the macro level, changes in land supply works together with broad economic and demographic forces, such as international, national and local economic growth; income changes; fluctuations in the costs of labour, capital and construction materials; inter-state and international migration to determine the housing price. At the micro level, changes in land supply are location specific; these changes work together with neighbourhood conditions (e.g., socioeconomic status of the residents) and structural characteristics of the property (e.g., type and age of houses) in shaping housing prices. In essence this project explores the effectiveness of a narrow and focussed land market intervention in the context of a complex set of other influences.

B. Some Impacts of Urban Consolidation in Melbourne

One way to identify the impact of urban consolidation policy is to compare the construction of separate houses and the number of apartments, multi-unit dwellings and flats, creating a composite that can be labelled "multi unit housing". Like most Australian cities Melbourne home owners have long been characterized by their high degree of suburbanization and their love of the detached house. As seen in Figure 1 the construction of separate houses has outnumbered multi-unit dwellings such as flats, apartments, terrace houses and townhouses by three to one. However, the share that medium density dwellings have of total construction has increased steadily.

There is a distinct spatial expression of this activity, which has favoured inner areas, and the south and east more than the north and west, as Buxton and Tiema (2004) have shown. Their insight is reinforced by the data displayed in Table 1.

Data in Table 1 identifies all municipalities that have recorded a higher-than-metropolitan average share of housing in the category high density; their share has been converted into a concentration index by comparison with the share in the metropolitan area. In effect then, the City of Melbourne's share of higher density housing is four times that which has been experienced in the metropolitan area overall.

Figure 1. Numbers of Dwellings by Type of Building Melbourne 1991-2006

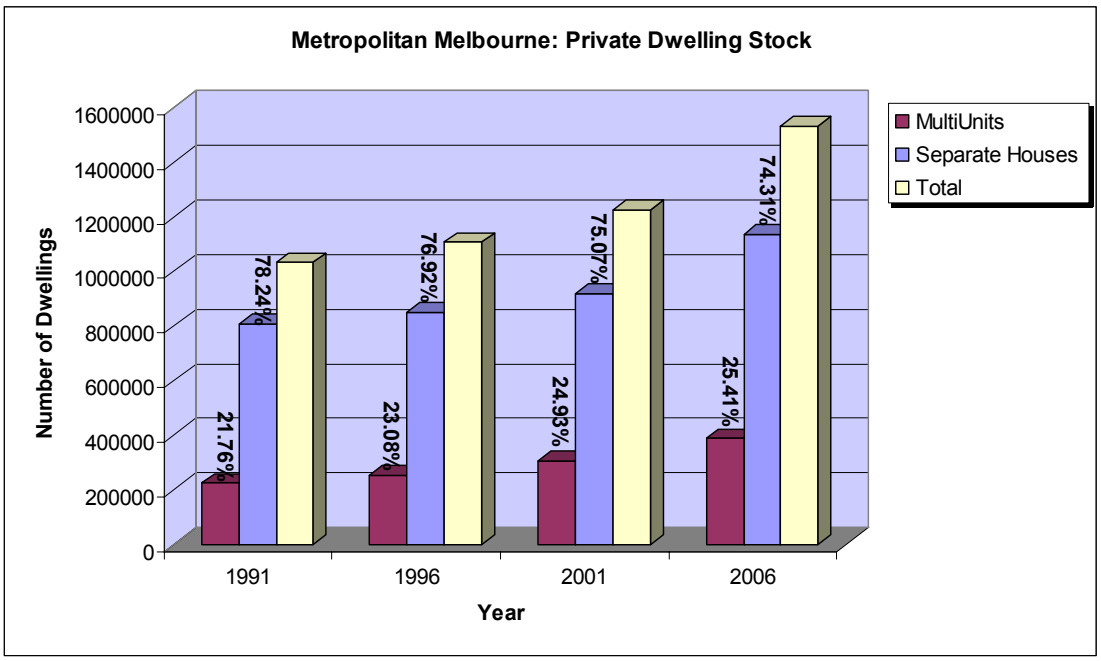


Table 1. Index of Concentration of High Density Housing in Municipalities 1991-2001

1991		**1996**		**2001**	
Melbourne	4.01	Melbourne	3.96	Melbourne	3.71
Port Phillip	3.68	Port Phillip	3.50	Port Phillip	3.71
Yarra	3.32	Yarra	3.29	Yarra	3.32
Stonnington	2.62	Stonnington	2.57	Stonnington	3.09
Glen Eira	1.60	Glen Eira	1.62	Glen Eira	2.48
Boroondara	1.44	Boroondara	1.46	Boroondara	1.60
Moonee Valley	1.29	Moonee Valley	1.29	Moonee Valley	1.41
Maribyrnong	1.19	Maribyrnong	1.19	Maribyrnong	1.27
Darebin	1.17	Darebin	1.20	Darebin	1.21
Kingston	1.14	Kingston	1.12	Kingston	1.19
Moreland	1.11	Moreland	1.15	Moreland	1.15
Bayside	1.03	Bayside	1.12	Bayside	1.13

There are two key features in the table. First, since 1991, there have been no municipalities added to the list. In effect, there has not been sufficient spread of higher density housing to lift the relative shares of this form of housing above the metropolitan level in any municipality beyond those in the ring of municipalities surrounding the City of Melbourne. Second, there has only been very small change in the levels of concentration and the relative ranking of municipalities, which reinforces the impression that the supply of this form of housing has a very limited effect on the overall housing market. Closer study shows that the relative importance of some of the municipalities has increased. The share of high density housing in Stonnington and especially in Glen Eira, two high socio-economic status municipalities in the inner east and south, has increased relative the metropolitan area overall, showing a small shift outwards in the location of this activity in a very small part of the metropolitan area. Hence the geography of the supply of high density development up to 2001 has changed little, and it would seem the overall policy has not been able to disperse this form of housing across the whole market.

C. The Impact of Urban Consolidation on House Prices

The focus of attention now shifts to the way that this policy has been felt in the level of prices paid for housing. This project was conceived initially as an analysis of the price of land. That was stimulated by publicity given to the effect of the new urban growth boundary on the price of fringe urban land (Birrell et al 2005) along with public commentary on the rise in house prices. It became apparent that land price alone is not as readily available, nor as potentially insightful as house prices, especially in the inner city where land sales are rare. It would be possible to separate the land and house component from each house transaction but that would involve a sale-by-sale visit to sites by a registered valuer. Hence the focus shifted to house prices.

Data and Methods

There are several sources of information on house prices. The main one is a data base of residential sales at the individual property level, supplied by the Valuer General's Office of Victoria. In addition there are sources of local area (individual suburb) average prices reported by The Department of Sustainability and Environment of the State of Victoria, in *A Guide to Property Value* every year. Finally, commercial sources report recent sales results. This breadth of information reinforced the shift in focus away from land alone to the price of housing. For the purpose of this paper, aggregated housing price at the suburb level is used.

The study area covers the Melbourne Metropolitan Area which is defined by the Australian Bureau of Statistics. Administratively the area is divided into 31 local councils. Each local council contains a number of suburbs. A database containing median house price and neighbourhood characteristics using the suburb as the spatial analysis unit was constructed using a vector GIS covering the period 1991-2004. Basic map layers are collected from Vicmap – the authoritative spatial data produced and maintained by Land Victoria, Department of Sustainability and Environment. By using a distance measurement program, the distance variable from each centroid of a suburb to the CBD is extracted from the GIS database. Three approaches were used to explore the core issue. The first explored the broad spatial pattern of prices, the second investigated the way that changes in the mix of houses induced by urban consolidation were felt in price and the third looked at the representation of price outcomes in sub regional housing markets. There are a small number of anomalies on the fringe of Melbourne, in particular where one prestige coastal location (Portsea) creates a unique local value. For the sake of the general insight of the research, four fringe data points have been deleted from the data.

1. The Spatial Distribution of House Prices

As shown in the material outlined above, the greatest apparent impact of the urban consolidation policy has been in the inner city. That effort could be expected to re-shape the spatial characteristics of housing prices by manipulating the supply and demand conditions. On the supply side, urban consolidation generates additional number of housing units (in the form of apartments, townhouses and detached houses). Under the condition of constant demand, additional supply means a lower price. On the demand side, urban consolidation increases land productivity, and thus pushes up the demand for land from developers. These outcomes have played out in a context of a changing labour market, and changing residential preferences in favour of inner city living associated with structural change in the Melbourne labour market toward centrally-located advanced service sector jobs. That effect can be seen in the results obtained by O'Connor and Healey (2002) who show the residential re-location of high status workers into the inner city part of Melbourne, and the re-location of lower status workers out of the area over the 1991-1996 period. Hence urban consolidation may have very strong demand side effects.

If however the effect from the supply side was strong, ceteris paribus, it is possible that:

1. The distance decay curve of house prices would shift downwards as a result of additional supply across the metropolitan area caused by urban consolidation, and the gap between the curve in an initial period and the latest curve would be greatest towards the city centre.

Alternatively the effect of supply may not outweigh the effect of demand generated by the policy itself and by the demand associated with labour market changes, so that:

2. The distance decay curve of house prices would shift upwards and the gap between the initial curve and the latest curve again would be greatest towards the city centre;

The testing of hypotheses 1 and 2 outlined above involves curve estimation and simulation of the price gradient both graphically and statistically. The analysis utilised approaches developed elsewhere (e.g., Han 2004; Smith 2003).

Identification of the price gradient in Melbourne began with summary statistics displayed in Table 2 that reports the median house price of suburbs in metropolitan Melbourne during the period 1990-2004. The number of transactions varied from year to year; not all areas recorded sales, but there were over 350 suburbs with transactions in any given year. Magnitudes of the minimum and maximum prices showed great variations within the metropolitan region – over ten times differences in more than half of the years shown in Table 2. Mean values show a trend of increasing price over the period, from about AUD $150,000 in the early 1990s to $360,000 in 2004. A slight decline of the price occurred between 1990 and 1992. The coefficients of variation indicate that the median house prices were more varied in 1996 and 1998 than that in other years; it is also discernible that price variations were greater in 2000-2004 than that in 1990-92.

Table 2. Descriptive Statistics of Median House Price, 1990-2004 (AUD $)

	N	Minimum	Maximum	Mean	Std. Deviation	Coefficient of variation
1990	356	79000	650000	150115.38	62286.403	0.41
1992	360	67000	515000	142530.99	59129.946	0.41
1994	377	68000	620000	148714.56	66860.779	0.45
1996	385	60000	980000	153024.24	80501.978	0.53
1998	391	45000	880000	178926.10	93012.863	0.52
2000	400	82000	1000000	226359.05	111134.471	0.49
2002	386	118000	1400000	307752.15	151499.786	0.49
2004	385	165000	1702500	363902.42	169861.149	0.47

Source of data for this table and all following analysis: The Department of Sustainability and Environment, various years,: *A Guide to Property Value.* Melbourne. State of Victoria

The spatial distribution of house prices was then explored in some detail. Four statistical models were used to estimate a curve describing the distribution of median house price in the suburbs against their distance to the CBD. These were linear, logarithmic, cubic and exponential models. Appendix one shows the distribution of the sample points and the different curves for each year. Results showed the cubic model of the form:

$$Y_x = b_0 + b_1 X + b_2 X^2 + b_3 X^3$$

where Y is the median house price in a suburb at distance X from the CBD; b0, b1, b2 and b3 are the parameters to be estimated, had the highest R Square (indicating the best fit) and high F values, which are highly significant (Table 3). The model parameters are outlined in table 3. The low levels of R square (indicating the explanatory power of distance in predicting the price variations) reflect the complex geography of urban settlement in Melbourne where big differences in values can be found at similar distances in different geographic sectors. That aspect will be addressed in subsequent investigations.

Table 3. Model Summary and Parameter Estimates

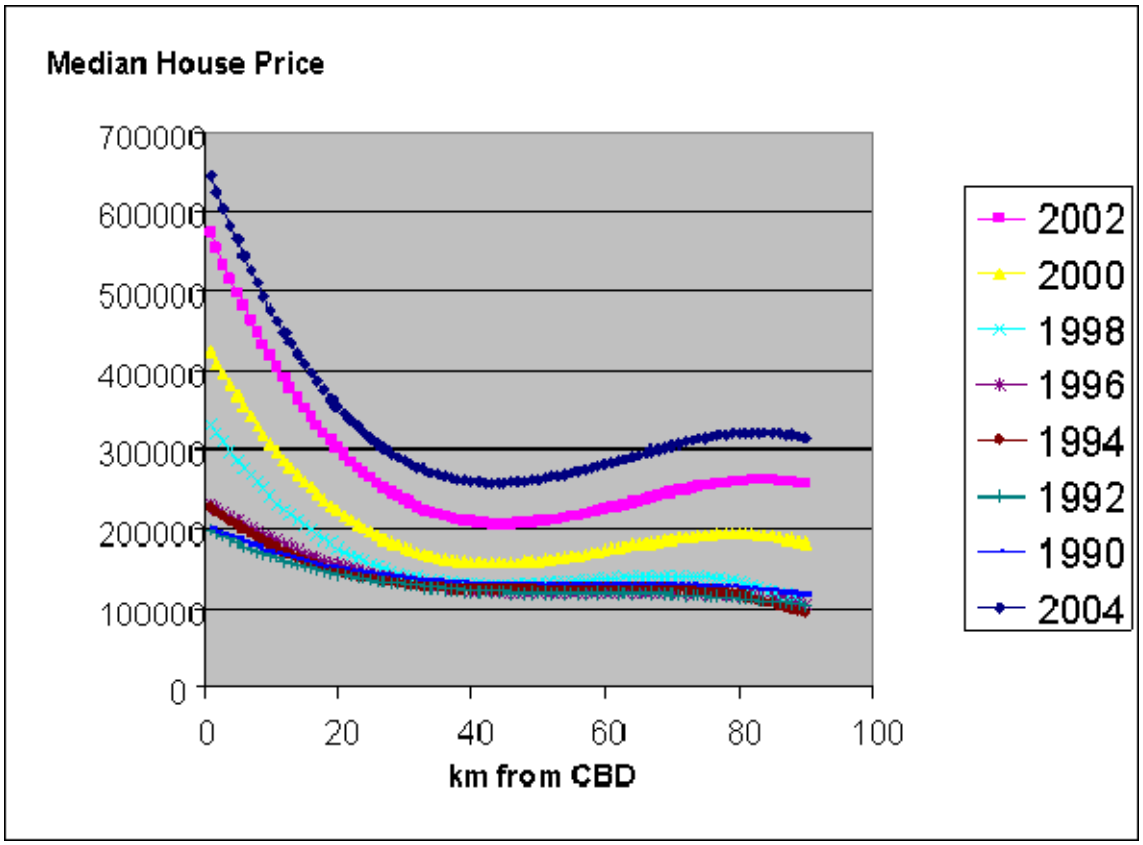
Median house price in year	*Model Summary*					*Parameter Estimates*			
	R Square	*F*	*df1*	*df2*	*Sig.*	*Constant (b0)*	*b1*	*b2*	*b3*
1990	*.098*	*12.672*	*3*	*350*	*.000*	*191162.50*	*-232355.8*	*171937.55*	*53380.07*
1992	*.131*	*17.866*	*3*	*354*	*.000*	*190963.72*	*-303062.4*	*351241.42*	*-89161.6*
1994	*.165*	*24.510*	*3*	*372*	*.000*	*227456.64*	*-593526.2*	*1058335.4*	*-591051.8*
1996	*.171*	*26.216*	*3*	*380*	*.000*	*227591.87*	*-535035.1*	*829648.28*	*-392067.6*
1998	*.288*	*52.168*	*3*	*386*	*.000*	*323802.97*	*-1081398*	*1853323.5*	*-963173*
2000	*.335*	*66.302*	*3*	*395*	*.000*	*410988.96*	*-1330413*	*2081718.3*	*-895730.6*
2002	*.355*	*70.082*	*3*	*382*	*.000*	*554150.46*	*-1751168*	*2570226.4*	*-981829.4*
2004	*.310*	*57.174*	*3*	*381*	*.000*	*619054*	*-1806749*	*2564665*	*-871506.7*

The independent variable is DISTANCE.

The cubic model was then used to estimate the distribution of prices in each year, and the results are shown in Figure 2. Among the eight curves the 2004 simulation forms the upper bound and the 1992 curve forms the lower bound. All the curves shifted upwards from that of the previous year, except in 1992 when the curve shifted downward from the 1990 curve. Within the 30 km radius from the CBD, the price increase was the largest nearer the CBD, thus forming a 'funnel' narrowing down towards the outer suburbs. Remarkable gaps between inner city suburbs and the middle and outer suburbs in price increase occurred in the 1990s, as the steep upward shift of the 1998 curve shows. Nevertheless, the absolute increase of median house price was the highest in the period 1998-2004. Suburbs in the range of 30 km to 60 km from the CBD registered slight increases in price before 1998; but the post 1998 period shows major increases. Suburbs beyond the 60 km radius also show great increases in price post 1998, and limited changes in the early and mid 1990s. The gaps between the curves post 1998 increase the further away from the CBD beyond the 60 km radius, which is a reflection of the development in the Mornington Peninsula.

These observations basically confirm hypothesis number 2, i.e., the distance decay curve of house prices shifted upwards and the gap between the initial curve and the latest curve is greatest towards the city centre. That result suggests the demand effects associated with urban consolidation in the inner city area were the strongest expression of the policy over this time period.

Figure 2. Estimated relationship of house price to distance from the CBD 1990-2004



Data Source for this and all subsequent analysis:

2. Finer Spatial Analysis of Local Area Housing Mix

Here the attention of the research shifts to an investigation of the effect of change in the mix of type of housing induced by urban consolidation. Put simply, the policy will shift the mix of local housing stock in favour of multi-unit development compared to separate houses. The greater the increase in multi-unit houses, the more intensive the implementation of the urban consolidation policy. As shown earlier this mix has a broad spatial pattern; the analysis here explores that pattern at a small scale.

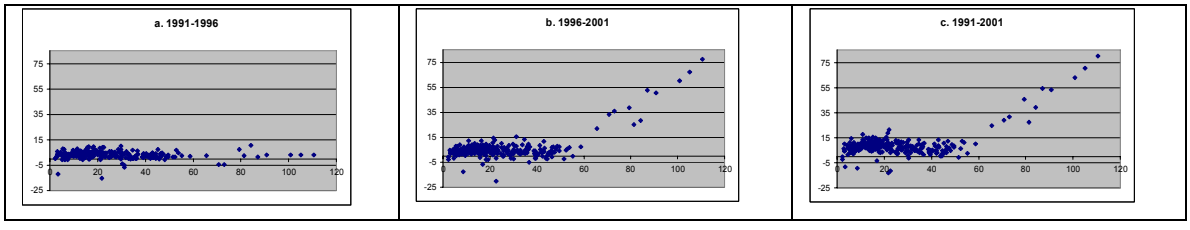
Table 4 reports the descriptive statistics of changes in proportions of multi-unit houses in suburbs. Among the 270 cases, the mean values are all positive indicating an overall increase in the share that multi-unit houses have of the stock of housing in metropolitan Melbourne. This did not happen uniformly among the suburbs. Some suburbs registered a decrease in the proportion of multi unit houses (by 13% in Roxburgh Park, 11% in Notting Hill, 9% in Kooyong and 8% in Albert Park), while other suburbs recorded a remarkable increase in multi- unit houses (by 80% in Portsea, 70% in Sorrento, 63% in Blairgowrie, 54% in Tootgarook, 53% in Rye, 45% in McCrae, 39% in Rosebud West, although here the construction is predominantly aimed at a tourism market).

Table 4. Descriptive Statistics of changes in proportion of Multi-Unit Houses, 1991-2001

	N	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*	*Co-efficient of Variation*
1991-1996	*270*	*-15.10000*	*10.70000*	*3.1248148*	*2.81937247*	*0.90*
1996-2001101	*270*	*-20.21860*	*77.19266*	*5.9006846*	*9.48143809*	*1.60*
1991-2001	*270*	*-13.30686*	*80.19266*	*9.0254994*	*9.61173112*	*1.06*

Figure 4 shows the distribution of the changes in proportion of multi-unit houses in the suburbs. The majority of the observations cluster within the distance of about 50 km from the CBD. The shape of the cluster shows greater variations in the proportions of multi-unit houses among inner suburbs. Within about 22 km radius from the CBD, there were the greatest ranges in the proportions. Some suburbs showed significant declines in the proportion of multi-unit houses (e.g., Notting Hill had 20% less multi-unit houses in the period 1996-2001; Kooyong was 12% less, and Moorabbin was 6% less in the same period of time); while other suburbs showed significant increases (e.g., Heatherton reported 14% more multi-unit houses; Clayton, Mont Albert North and Essendon West each recorded 12% more in the period 1996-2000). Beyond 50 km from the CBD, suburbs showed remarkable increase in the shares of multi unit houses. These are the locations along the coast of the Mornington Peninsula, as identified above. There is a major difference between the diagrams for the period 1991-1996 and that for the period 1996-2001, which is associated with change on the Mornington Peninsula. In the first half of the 1990s, there was hardly any significant multiunit development in the suburbs beyond the 50 km radius in Melbourne; this situation obviously changed in 1996-2001, especially when suburbs in the Mornington Peninsula began to accommodate more apartment and townhouse projects.

Figure 4. Changes in the proportions of multi unit houses in metropolitan Melbourne, 1991-2001



The research then turned to analyse the effect that changes in local area housing mix induced by urban consolidation policy are associated with changes of median house price and neighbourhood characteristics. Two-tailed Pearson correlation tests are conducted between the changes in the proportion of multi-unit houses in a period and the median house price at the beginning of that period. Here the median house price is an indicator of the affluence level of the local area. A significant positive correlation would show that affluent neighbourhoods were more likely to attract multi-unit housing development; a significant negative correlation would show the opposite. Alternatively, there might have no significant correlation between the changes of house mix and the level of affluence of the local area.

In terms of residents' income, the average income of a local area at the end of the testing period is used to compute its correlation with the changes in house mix in the testing period. A significant positive correlation would indicate that increases in multi unit houses were associated with higher income neighbourhoods; but a significant negative correlation would suggest that increases in multi unit houses were associated with depressing the income of neighbourhoods. There could be no significant correlation between the two variables at all as changes in multi unit houses could happen randomly across the metropolitan area.

Table 5 reports the Pearson correlation results. Across all three time periods, there is no significant correlation between changes in mult-unit houses and the neighbourhood affluence (as measured by the median house price at the beginning of the testing period). In other words, data for the testing periods shows a rather random distribution of multi- unit housing projects among affluent and less-affluent neighbourhoods. However, there is a significant negative correlation between the proportion of multi-unit houses and the income level of the local area. More multi-unit housing developments were associated with lower income.

Table 5. Pearson correlation results, changes in multi unit houses vs. neighbourhood characteristics (1991-2001)

	Neighbourhood affluence		
House mix	1991	1996	Residents income 2001
1991-1996	-0.006 (269)	--	--
1996-2001	--	-0.095 (270)	-0.195* (249)
1991-2001	-0.095 (269)	--	-0.220* (263)

Note: * correlation is significant at the 0.01 level (2-tailed). Numbers in brackets are the number of cases in each test.

The same analysis method (i.e., two-tailed Pearson correlation statistics) is applied to the changes in median house price and in the proportion of multi-unit houses, for the overall period and the two sub-periods (Table 6). Significant correlations are revealed for the 1996-2001 data only. In the period 1996-2001, suburbs that gained in median house price were associated with the increase of multi-unit housing development. This observation, however, does not hold for the periods 1991-1996, nor for 1991-2001. That outcome suggests the effect of the urban consolidation policy only began to bite after 1996. In turn that could mean that the price rises could be associated with the maturation of other demand forces (the change in

the inner area labour market and the shift in preferences in favour of inner area medium density dwellings) along with the build up of developer demand rather than the supply effect of additional dwellings.

Table 6. Pearson correlation results, changes in median house price vs. changes in proportion of multi unit house

Period	Pearson correlation coefficient	Significance level (2-tailed)	Number of cases
1991-1996	0.011	0.852	269
1996-2001	0.171*	0.005	270
1991-2001	0.058	0.341	269

Note: * correlation is significant at the 0.01 level (2-tailed).

To further explore the impact of house mix on changes in house price, the analysis incorporated a hedonic function in the assessment. Mills (1969), Cowell and Munneke (1997) used a similar function in assessing property price changes associated with neighbourhood, location and structural attributes. In the Melbourne case, it can be hypothesized that P_{it}, i.e., changes in median house price in suburb i in time period t, is a function of the neighbourhood, location, structural attributes, and a policy outcome of urban consolidation. The neighbourhood, location and structural attributes are included in N_{it} in suburb i at time t in the hedonic model outlined below. The housing mix variable was included as Γ_i at time t in the model below:

$$P_{it} = \alpha + \beta \mathrm{N}_{it} + \gamma \Gamma_i + \omega_{it}$$

where P_{it} is the changes in median house price of suburb i at time t; α is constant; β and γ are parameters to be estimated; and ω_{it} is an error term.

For the purpose of this paper, the non-policy variables are removed from the equation and thus the model is simplified as

$$P_{it} = \alpha + \gamma \Gamma_i + \omega_{it}$$

A large proportion of the variance of P_{it} could be explained by the housing mix variable if urban consolidation led to significant changes in median house price; otherwise the explanation power of the policy variable would be weak.

Table 7 reports the model results using a linear regression procedure. Among the three models tested, only model no 3 for the period 1996-2001 shows some explanatory power. The R Square in model no 3 is 0.029, indicating that about 3% of the variance of the price changes could be explained by the housing mix at the start of the time period. In models 1 and 2 the relationship is even weaker. This means that the policy of urban consolidation, when measured by changes of multi-unit house mix, showed some limited impacts on the house price changes in the late half of the 1990s. The positive signs of the coefficients (B) do indicate that the greater changes in multi unit house mix, the more changes in house price.

Table 7 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	B	F	Sig.
1. 1991-2001	.058	.003	.000	40.83	0.250	.910	.341
2. 1991-1996	.011	.000	-.004	13.42	0.059	.035	.852
3.1996-2001	.171	.029	.026	26.37	0.481	8.041	.005

The limited explanation power of the above models confirms that the changes in housing mix associated with urban consolidation has had limited effects on the level of house prices in suburbs of Melbourne. In terms of the current research it is the demand side forces, as well as other supply side effects (i.e., the neighborhood, location and structural attributes) that have been the main influence on price levels. It is possible of course that these effects are intertwined: the supply effect that has changed the mix of housing in a suburb might have facilitated the residential re-location of households with higher family incomes. The results show however that outcome may only hold in certain areas; across the metropolitan area the urban consolidation policy variable is not powerful in explaining the price changes.

3. Submarkets in the Metropolitan Area

The analysis to date has relied upon distance from the CBD and selected neighbourhood characteristics as its framework for analysis, connecting it to a well established tradition in house price research. However, distance from the CBD to suburbs in Melbourne is asymmetric due to the historic bias in housing in favour of the eastern and southern side of the metropolitan area. Houses 20 kilometres from the centre are near the fringe on the west but in the middle suburbs on the east. In addition social differences in different parts of the metropolitan area mean that the mix of housing types in locations at similar distance from the CBD varies markedly (e.g. Glen Eira (east) and Hobsons Bay (west) in 2006; the former had 20% more multi unit house than the latter) that means localities with a similar distance to the CBD may have felt the effect of urban consolidation policy very differently. In terms of the selected neighbourhood features, the analysis so far has been limited to individual suburbs without considering the larger housing market areas that could be formed by a number of adjoining suburbs.

As a result a third perspective on the effects of urban consolidation has been developed. This involves recognising the existence of housing sub-markets. It is possible that urban consolidation has worked differently in different housing sub markets. The existence of submarkets as a characteristic of metropolitan areas is not new (see Maclennan et al (1987), Maclennan and Tu (1996) and Watkins (2001)). In fact analysis has been carried out on this theme in Melbourne (Bourasa et al 1999). The current research utilises that perspective, but applies it in a different way, drawing upon the concept of spatial autocorrelation applied in this case of the level of house prices. That provides an opportunity to identify areas of Melbourne where prices have moved in similar directions, which can then be linked to the housing mix variable.

This approach involves drawing upon Local Indicators of Spatial Autocorrelation (LISA) statistics of Anselin (1995) and follows Han's (2005) use of LISA in analysing the

impact of regional centre development on property price clustering. The submarkets are seen as clusters of suburbs that may be characterized by either rapid or slow changes in median house price. These clusters are identified by using local indicators of spatial autocorrelation statistics in the following form (Anselin 1995):

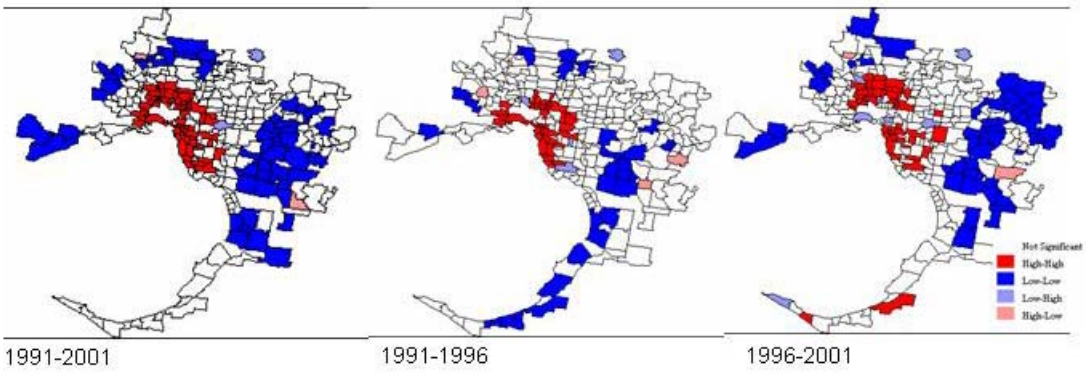
$$Ii = z_i \sum_j w(i,j) z_j = \frac{x_i - \bar{x}}{\frac{\sum_{j=1, j \neq i}^{N} x_j^2}{N-1} - \bar{x}^2} \sum_{j=1}^{N} w(i,j)(x_j - \bar{x})$$

$$\bar{x} = \sum_{i=1}^{N} x_i \Big/ N$$

where I_i is the local Moran's I for suburb i; x_i and x_j are the value of changes in median house price in suburbs i and j respectively; W (i, j) is a spatial weight matrix where W (i, j) = 1, if suburb i and suburb j are contiguous, and W (i, j) = 0 otherwise; z_i and z_j are the standardized forms of x_i and x_j.

Figure 5 shows the clusters of rapid growth and slow change in median house prices in suburbs for the period 1991-2001. Over the decade 1991-2001, the rapid growth cluster appears as a ring of the CBD whilst the low price change cluster is in outer suburbia, confirming the uneven effect that distance from the CBD does play a part in Melbourne house prices. However the separation into two time periods provides more refined insight. It shows that the earlier ring has developed into two distinct submarkets where price gains have been similar, one to the east and south (associated with Bayside, Glen Eira, Stonnington, Boroondara) and the second to the north (Darebin, Moreland). The focus of attention now is whether the application of urban consolidation, felt differently among the submarkets, is associated with this outcome.

Figure 5. Clusters of Fast and Slow Growth Areas in Median House Price, 1991-2001



By using suburbs as the spatial units for analysis, this section of the paper examines the implementation and effects of urban consolidation in submarkets that differentiated themselves in median house price changes. There are four submarkets comprising of suburbs with: 1) high median house price with rapid price increase; 2) low median house price with slow price changes; 3) low median house price with rapid price increase and 4) high median house price with slow price change. If the urban consolidation policy was implemented

differently among the submarkets, the nonparametric procedures would detect the differences in the changes of multi unit house mix; and the linear regression model performed to each submarket would return different impacts.

The empirical results from the LISA statistics make it possible to organize the suburbs into four submarkets and a group of suburbs which belong to none of the four, for two analysis periods (i.e., 1991-1996 and 1996-2001). Summary statistics are reported in Table 8. In both periods of study, submarkets with low median house price but rapid changes in price (the LH group) and those with high median house price but slow changes in price (the HL group) had small number of suburbs. The comparison therefore focuses on the submarkets with the high median house price with rapid changes in price (HH group) and the low median house price with slow changes in price (LL group) and areas where price movements were not defined so clearly (OTHERS). All the groups had a mean value of changes in multi unit house mix around 3 in the period 1991-1996; but in the period 1996-2001, the mean value in the LL group was about 2/3 of the mean values for the HH group and the Others group. Pair comparison between the means of the LL group and the HH as well as the OTHERS group means show some degree of statistical significance in the differences (i.e., at 0.088 level of confidence).[1]

Table 8. Summary statistics of the changes in multi unit house mix in submarkets 1991-2001

	OTHERS	HH	LL
1991-1996			
N	193	37	32
Minimum	-15.1	-12.2	-4.4
Maximum	10.2	8.1	10.7
Range	25.3	20.3	15.1
Mean	3.15	2.96	3.01
Std. Deviation	2.67	3.41	3.28
Coefficient of Variance	0.85	1.15	1.09
1996-2001			
N	171	42	48
Minimum	-20.22	-6.72	-4.90
Maximum	67.31	60.32	11.80
Range	87.53	67.04	16.70
Mean	6.02	6.28	3.96
Std. Deviation	9.05	10.22	3.39
Coefficient of Variance	1.50	1.63	0.86

Note: 1. N is the number of suburbs in each submarket/Others group; 2. Changes in multi unit house mix are computed as $MUHX_{t1} - MUHM_{t0}$ where $MUHM_{t1}$ denotes multi unit house mix at the end of a study period and $MUHM_{t0}$ denotes multi unit house mix at the beginning of a study period.

Table 9 reports the test results of linear regression, using median house price as dependent variable and multi unit house mix as predicting variable, within each of the three groups for each of the two periods. No significant linear regression function is found for the

period 1991-1996, though within the LL group the changes in multi unit house mix might explain up to 2% of the variations in median house price change. For the period 1996-2001, the changes in multi unit house mix in the OTHERS group could explain about 6% of the changes in median house price; while in the LL group, the explanation power was about 7% (Table 9). Rapid changes in median house price in the high house value group did not show any explanation power by the changes in multi unit house mix. In other words, changes in multi unit house mix were not associated with submarket which moved upwards in price; but they were associated with suburbs that belong to none of the submarkets.

Table 9. Model Summary of Linear Regression by Submarket and Period of Study, 1991-2001

Model	1991-1996				1996-2001			
	R	R Square	F	Sig.	R	R Square	F	Sig.
1(submarket = none)	.051	.003	.498	.481	.247	.061	11.013	.001
2 (submarket = HH)	.001	.000	.000	.996	.057	.003	.129	.721
3 (submarket = LL)	.139	.019	.595	.446	.265	.070	3.461	.069

Note: The B values for models No 1 and No 3 for the period 1996-2001 are 0.712 and -0.959 respectively.

It is also possible to explore the suburbs which changed their affiliation to particular submarkets between the two time periods. These include suburbs changed from the OTHERS group to HH, LL, LH and HL, and changes from any of the submarkets to another one (including the OTHERS group). 120 suburbs actually shifted from one group to another in the 1990s. Summary statistics of the changes in multi unit house mix are reported in Table 10. The variations of the changes were wider in the late half of the 1990s than that in the first half, but the mean values between the 'shifted' and 'not shifted' groups were close. A Mann-Whitney test returns no significant difference from the pair-wise comparisons.[2]

The changes in multi unit house mix showed some power in explaining the changes in median house price in the 'not shifted' group, but not in the 'shifted' group (Table 11). About 5% of the changes in median house price could be explained by the changes in house mix, in the 'not shifted' group. The positive sign of the regression coefficient indicate that greater increase in housing mix toward multi-units, the greater the growth of the median house price in suburbs that are not classified into any of the four submarkets.

Table 10. Summary statistics of changes in multi unit house mix in the 'shifted' and 'not shifted' groups

	1991-2001		1991-1996		1996-2001	
	Not shifted	Shifted	Not shifted	shifted	Not shifted	Shifted
N	150	120	150	120	150	120
Minimum	-13.31	-8.51	-15.1	-12.2	-20.22	-6.72
Maximum	70.31	80.19	9.5	10.7	67.31	77.19
Range	83.62	88.71	24.6	22.9	87.53	83.91
Mean	8.38	9.83	3.07	3.19	5.31	6.64
Std. Deviation	7.96	11.33	3.00	2.58	7.87	11.17
Coefficient of variation	0.95	1.15	0.98	0.81	1.48	1.68

Note: 1. N is the number of suburbs in the 'shifted'/'not shifted' groups; 2. Grouping is based on comparison of each suburb between its grouping status (i.e. HH, LL, HL, LH and OTHERS) in 1991-1996 and that in 1996-2001.

Table 11. Summary Statistics of Regression Models for the 'shifted' and the 'not shifted' groups

Model	R	R Square	B	F	Sig.
1 (not shifted)	.230(a)	.053	1.142	8.173	.005
2 (shifted)	.074(a)	.005	-0.283	.648	.422

D. Conclusion

Urban consolidation, which has been introduced to metropolitan Melbourne for more than 20 years, encourages the development of a higher density urban form by promoting the construction of multi-unit housing and by further subdividing larger land blocks into smaller ones. The implementation of this policy generates a series of countervailing forces on house price as it simultaneously induces changes in the supply and demand of housing. Taken to the limit, increase in multi-unit housing could squeeze the supply of conventional houses on large land blocks, which symbolize the conventional low-density Australian style of suburban living. Ceteris paribus, the increasing housing stock could be expected to lead to a downward shift of housing price, while the increasing demand for separate houses on land blocks could push the housing price upward. The supply side effect is created by demand for land from developers, who are keen to acquire older houses and to recycle old industrial land for subdivision and subsequent multi-unit supply. These simple supply and demand effects have been complicated as the policy was applied in a time period when the character of the labour market in the inner city shifted in favour of higher skill higher wage paying jobs, making inner area residential sites more attractive to a sub-set of the market who can afford to pay higher prices.

This paper has used an array of different analytical tools, and all have confirmed that change in the mix of housing in a locality toward more multi-unit development has some effects on the increase in house prices. Concentration of multi-unit development in and near the inner city lifts the typical price distance gradient. At the same time clusters of suburbs that recorded rapid price increases were associated with the rapid increase in multiunit developments while areas of lower housing price change had less multi-unit development.

It is evident that urban consolidation has invoked higher density development in metropolitan Melbourne and by inducing changes in supply and demand conditions in housing submarkets has been associated with price increases. However, it is not possible to assign causality here, as simultaneous labour market dynamics have yet to be incorporated into the analysis of house price changes in a comprehensive way; detailed measurements of location and neighbourhood characteristics could also be improved. It is important to note that after 2001, house prices in Melbourne rose sharply so that these latter factors may have begun to be more significant.

The results do show however that the supply-inducing effects of urban consolidation may have been too weak in the face of shifts in demand, and perhaps the countervailing effect of developer demand. That result indicates that simple regulatory change as represented by urban consolidation legislation is unlikely to be a powerful influence upon house prices in a complex housing market. In effect then one of the costs of urban consolidation, which was stated to address concerns with urban sprawl, has been a loss in housing affordability in parts of the housing market. That needs to be assessed as a social consequence of efforts to contain

urban sprawl. Analysis of the impact of the urban growth boundary introduced in 2004 will need to be aware of a similar impact.

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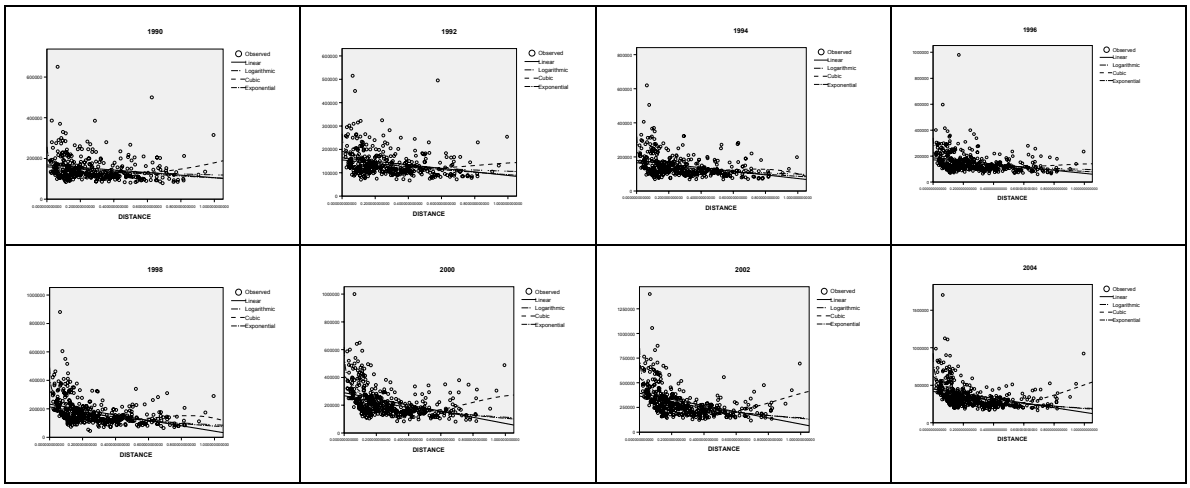
Appendix 1: Sample points and curve estimation for house price distribution in Melbourne 1990-2004.



[1] The Mann-Whitney Test was used to assess the means from two sample groups. Table A below shows the group combinations, number of cases, and the mean and sum of ranks. The Mann-Whitney U, Wilcoxon W and the Z values are reported in Table B.

Table A Pair-wise comparison statistics: **Ranks**

	1991-1996			1996-2001		
Group	N	Mean Rank	Sum of Ranks	N	Mean Rank	Sum of Ranks
1	37	35.77	1323.50	42	49.79	2091.00
2	32	34.11	1091.50	48	41.75	2004.00
0	193	114.11	22024.00	171	113.87	19471.00
2	32	106.28	3401.00	48	96.23	4619.00
0	193	115.80	22349.50	171	107.92	18455.00
1	37	113.93	4215.50	42	103.24	4336.00

Note: Group '0' includes suburbs that belong to none of the submarkets; '1' refers to the HH group; '2' refers to the LL group.

Table B Mann-Whitney statistics

	1991-1996			1996-2001		
	1,2	0,2	0,1	1,2	0,2	0,1
Mann-Whitney U	563.500	2873.000	3512.500	828.000	3443.000	3433.000
Wilcoxon W	1091.500	3401.000	4215.500	2004.000	4619.000	4336.000
Z	-.343	-.631	-.156	-1.456	-1.704	-.441
Asymp. Sig. (2-tailed)	.732	.528	.876	.145	.088	.659

Note: Group '0' includes suburbs that belong to none of the submarkets; '1' refers to the HH group; '2' refers to the LL group.

[2] The means values of the changes in multi unit house mix are close to each other. The mean ranks from the Mann-Whitney test confirm the above (Table C). No significant difference was found between the 'shifted' and 'not shifted' groups (Table D).

Table C Pair-wise comparison between the 'shifted' and the 'not shifted' groups

	shift	N	Mean Rank	Sum of Ranks
1991-2001	0	150	135.55	20332.00
	1	120	135.44	16253.00
1991-1996	0	150	134.94	20241.00
	1	120	136.20	16344.00
1996-2001	0	150	137.59	20639.00
	1	120	132.88	15946.00

Table D Mann-Whitney test results, by 'shifted' and 'not shifted' groups

	1991-2001	1991-1996	1996-2001
Mann-Whitney U	8993.000	8916.000	8686.000
Wilcoxon W	16253.000	20241.000	15946.000
Z	-.011	-.132	-.492
Asymp. Sig. (2-tailed)	.991	.895	.622