Land Value Indices and The Land Leverage Hypothesis in Residential Housing

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INTERNATIONAL CONFERENCE ON REAL ESTATE STATISTICS.
20-22 February 2019

Introduction

- The unobserved nature of land values poses significant challenges to policy making and planning especially in urban areas where very few vacant land transactions occur.
- Bostic et al (2007) proposed the hypothesis that house price appreciation and house price volatility are directly related to land leverage
- The land leverage hypothesis proposes that the land component of property prices grows faster than that of the structure component.

$$\text{Land Leverage} = \frac{Land\ Value}{Total\ Value} \tag{1}$$

This Work

- We apply a new methodology where a state-space model produces the decomposition of property values into the values of the land and the structure.
  - Literature on separating values of land and structure: Clapp (1979), Bostic et al (2007); Glaeser and Gyourko (2003), Davis and Palumbo (2008), Davis and Heathcote (2007); Diewert et al (2015)
- Two parameters in the model determine the degree of asymmetric behaviour of the land and structure components.
- Land and structure price indices are computed for the Inner, Metro and Outer regions of Greater Melbourne (1995-2018Q2)
- Land valuations from the model are compared to those of Valuer-General Victoria
- Strong evidence for the land leverage hypothesis is provided via three approaches.

Findings Consistent with Leverage Hypothesis

- Price shocks influence the value of the land and structure components asymmetrically. The land component absorbs a larger proportion
- Land values' growth rates (1995-2017) are larger than those of the structure components in all three regions of Greater Melbourne.
- Bostic et al (2007)- regression: Year-on-year price change on intercept and land leverage. The coefficient of land leverage is positive.

Methodology

- The basic model following the literature looks as follows:

$$P_{it} = L_{it} + S_{it} + \varepsilon_{it}; \qquad \varepsilon_{it} \sim N(0, \sigma_\varepsilon^2 I) \tag{2}$$

  where P_{it} is the sale price of property i sold in period t
  L_{it} is the value of the land component for the $i-th$ property sold in period t
  S_{it} is the value of the structure component for the $i-th$ property sold in period t
- We use the decomposition proposed by Rambaldi et al (2016). The model follows the hedonic approach of the literature.
  - The components are mapped to k_l land hedonic characteristics (e.g. lot size or location) and to k_s structure hedonic characteristics (e.g. age of structure, size of the structure, number of bedrooms or bathrooms).

Methodology - (cont)

- The model is given by:

$$P_{it} = L(\alpha_t^L, X_{it}^L) + S(\alpha_t^S X_{it}^S) + \varepsilon_{it} \tag{3}$$

where, α_t^c is the vector of shadow prices capturing the trends for land (L) or structure (S) at time t; $c = L, S$; and $\varepsilon_t \sim N(0, \sigma_\varepsilon^2 I_{n_t})$.

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$$\alpha_t = [\alpha_t^L \alpha_t^S]; \qquad t = 1, \ldots, T \tag{4}$$

$$G_{t|t} = E(\alpha_{t|t} \alpha_{t|t}') \tag{5}$$

$$G_{t|t-1} = \begin{bmatrix} \delta_L^{-1} G_{t-1|t-1,[1:k_L,1:k_L]} & 0 \\ 0 & \delta_S^{-1} G_{t-1|t-1,(k_L+1):(k_L+k_S)} \end{bmatrix} \tag{6}$$

▸ Filter ▸ Asymmetric

Methodology - (cont)

- Estimating this model requires to first estimate σ_{ε}^{2},δ_L,δ_S which are then used in the modified Kalman filter algorithm to obtain the estimates of $\alpha_t^c; c = S, L$.
- Then the model is used to predicted Land, Structure and Property Values:

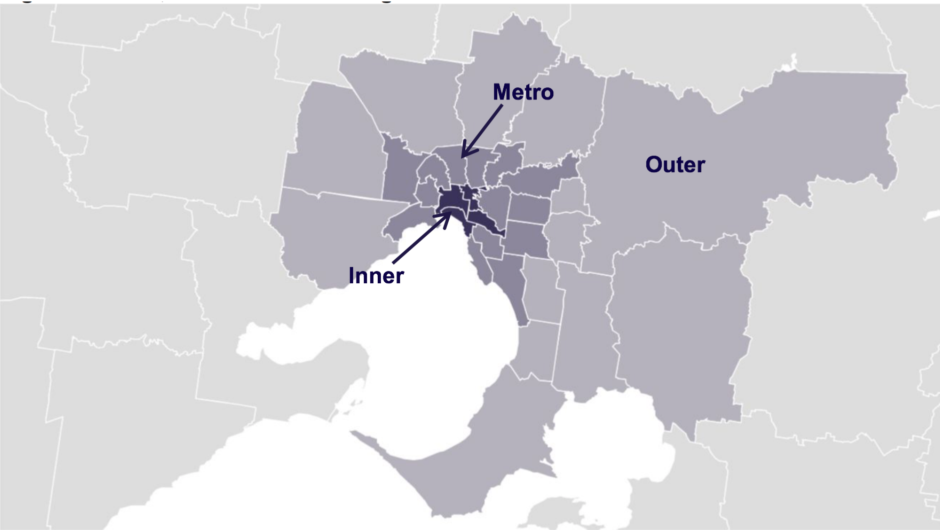
$$\hat{L}_{i\tau}; \hat{S}_{i\tau}; \hat{P}_{i\tau}; \quad \tau = \text{base,comparison}$$

- These are used to construct Fisher hedonic imputed price indices for the property and each component.

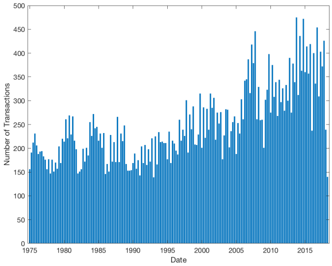
Data

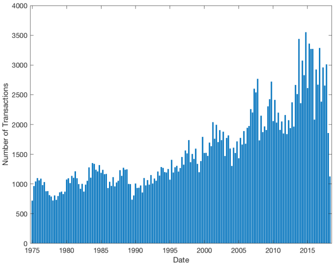
- CoreLogic's settled sales data residential detached properties. It includes unit record level characteristics for all properties transacted - 1975Q1 and 2018Q2, across Victoria's 79 local government areas (LGAs).
- Greater Melbourne grouped into three regions: inner, metropolitan and outer areas of Melbourne. 677,460 cleaned observations.
- There were 362,564 observations in the outer region, 271,628 observations in the metro region and 43,268 observations in the inner region.
- The model was estimated separately for each of these groups in order to accommodate the different natures of their respective property markets.

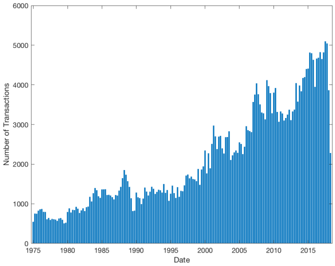
Greater Melbourne Three Regions



Transactions Per Quarter







Comparison of two year revaluation outcome versus model estimates

Region	Revaluation year	VGV	Model	Difference	|Difference|
Inner					
	2016-18	TBA			
	2014-16	30.90%	25.30%	5.60%	5.60%
Metro					
	2016-18	TBA			
	2014-16	34.40%	30.97%	3.43%	3.43%
Outer					
	2016-18	TBA			
	2014-16	18.70%	19.48%	-0.78%	0.78%

VGV = Valuer-General Victoria

Result 1: Price shocks have an asymmetric effect

Land absorbs the largest proportion (lower discount factor)

Gmatrix

Land	Structure	Model Lowest MSE		
		Inner	Metro	Outer
0.75	0.95			
0.75	0.99			
0.8	0.8			
0.8	**0.9**		**X**	
0.8	0.95			
0.8	0.99			
0.85	0.85			
0.85	**0.9**	**X**		**X**
0.85	0.95			
0.85	0.99			
0.9	0.9			
0.9	0.99			
0.95	0.95			
0.95	0.99			

Result 2. Annualised Growth in Components (1995-2017)

Land Growth>Property Growth>Structure Growth

	Land	Structure	Property
Inner	29.9	25.8	28.9
Metro	33.7	24.3	28.3
Outer	27.2	19.8	23.3

Result 3: Coefficient of Land Leverage > 0

Regression: Year-on-Year Chained Indices on intercept and land leverage

	Inner	Metro	Outer
Q1	90.781	67.528	44.360
Q2	88.319	71.891	54.721
Q3	106.297	73.244	42.456
Q4	69.576	71.785	41.487

Conclusions

- The land leverage hypothesis proposes that the land component of property prices grows faster than that of the structure component.
- We apply a new methodology where a state-space model produces the decomposition of property values into the values of the land and the structure.
- Two parameters in the model determine the degree of asymmetric behaviour of the land and structure components.
- Land and structure price indices are computed for the Inner, Metro and Outer regions of Greater Melbourne (1995-2018Q2)
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Filter

$$P_t = Z_t \alpha_t + \varepsilon_t$$

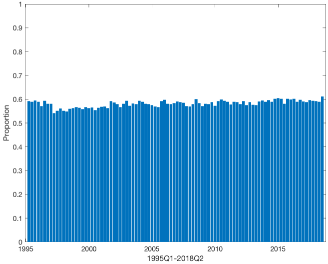
$$Z_t = [X_t^L \quad X_t^S]$$

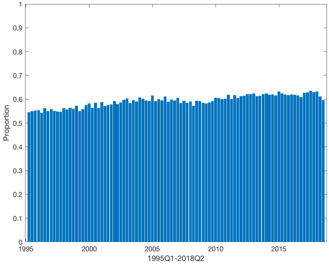
$$\begin{array}{rcl} a_{t|t} & = & a_{t-1|t-1} + K_t v_t \\ v_t & = & y_t - Z_t a_{t|t-1} \\ K_t & = & G_{t|t-1} Z_t^{'} F_t^{-1} \\ G_{t|t} & = & G_{t|t-1} - K_t F_t K_t^{'} \\ F_t & = & Z_t G_{t|t-1} Z_t^{'} + \sigma_\varepsilon^2 I_{n_t} \end{array} \quad (7)$$

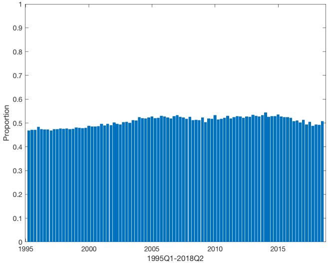
n_t = Number of transactions at time t

Discount Factors

Land Leverage $= \frac{\textit{Land Value}}{\textit{Property Value}}$







Price Indices