The Value of Urban Land: Tax Revenue and Beyond

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Madeleine Tan. Victoria Treasury.

Outline

Introduction

- A property is a bundled good composed of an appreciating asset, land, and a depreciating asset, structure.
- The importance of this distinction is increasingly recognised in the real estate literature (see Bostic et al. (2009), Malpezzi et al. (1987)) as well as in the price index construction literature (see European Comission et al. (2013), Chapter 13, Diewert et al. (2011), Diewert et al. (2015), Diewert and Shimizu (2013) and Färe et al. (2015)).

Introduction (cont.)

- Due to the mobility of materials and labor, construction costs are generally uniform within a housing market
- Asymmetric appreciation across properties within a market arise from asymmetric exposure to common shocks to land values.
- At any point in time the value of the structure is its replacement cost less any accumulated depreciation.
- Sufficiently large depreciation can result in the structure declining in value over time
  - Malpezzi et al. (1987), Knight and Sirmans (1996), Bostic et al. (2009), Diewert et al. (2011, 2015)

Outline

Land Values and Taxation

- Valuer General
  - The Valuer General is an independent statutory officer.
  - The role of the Valuer General's office is to provide land values and property advice to government.
  - State Administered System
- Rates are based on VG's land valuations
  - http://www.valuergeneral.nsw.gov.au/council_rates
  - http://www.revenue.act.gov.au/duties-and-taxes/rates/rates-land-valuations
  - https://www0.landgate.wa.gov.au/property-reports/land-values/rating-and-taxing
  - http://www.sro.tas.gov.au/landtax/rates
  - http://www.dtpli.vic.gov.au/property-and-land-titles/valuation/council-valuations
  - https://www.brisbane.qld.gov.au/about-council/council-information-rates/rates-payments/how-rates-are-calculated

Valuer General

- The state of QLD Valuer's Statement
  "When determining statutory land values, our valuers:
  - *research the property market*
  - *examine trends and sales information for each land use category (e.g. residential, commercial, industrial and rural)*
  - *inspect vacant or lightly improved properties that have recently been sold interview vendors and purchasers of property,*
  - *where appropriate consider the land's present use and zoning under the relevant planning scheme take into account physical attributes and constraints on use of the land."*
    (`http://www.qld.gov.au/environment/land/title/valuation/`).

Outline

Model

The valuer's task is to provide the tax authorities and the rate payers with a valuation of their property or land. We write a simple model for the expected value of the property,

$$E_t(V_t) = E_t[(L_t + S_t)|\sum_{j=0}^{\tau} w_{t-j}\,[\text{market sales: } \mathit{Property}, \mathit{Land}]_{t-j}] \quad (1)$$

where,
V_t is the value of the property
L_t is the land component of the value
S_t is the structure component of the property value
w_t is a weight such that $w_{t-1} > w_{t-2} > w_{t-3} > \ldots$

Outline

Econometric Model

This follows previous studies (Bostic et al. (2009) and Diewert et al. (2011, 2015) where three orthogonal components are defined, land (L), structure (S) and noise.

$$PropPrice_{it} = L_{it} + S_{it} + \epsilon_{it} \quad (2)$$

where,
$PropPrice_{it}$ sale price of property (or vacant land) i sold in period t.
L_{it} value of the land component for the i^{th} property sold in period t
S_{it} value of the structure component for the i^{th} property sold in period t, and
$S_{it} = 0$ if the sale is for vacant land
$\epsilon_t \sim N(0, \sigma_\epsilon^2 I)$

Previous Econometric Approaches

- Let X^L hedonic characteristics intrinsic to the land component, e.g. size of the lot, location
- Let X^S hedonic characteristics intrinsic to the structure component, e.g. age, size of the structure
- Price Index for New Construction, Depreciation rate to account for age
  - Used to subtract value of structure and isolate land value (Diewert et al. (2015))
  - Used as an instrument to isolate value of land (Färe et al. (2015))

Our Econometric Approach

- Let X_t^L be an $N_t \times k_l$ matrix of hedonic characteristics intrinsic to the land component, e.g. size of the lot, location
- Let X_t^S be an $N_t \times k_s$ matrix of hedonic characteristics intrinsic to the structure component, e.g. age, size of the structure
- Then we define,

$$L_{it} = f(X_{it}^L | X_{it}^S, \alpha_t^L) \tag{3}$$

$$S_{it} = g(X_{it}^S | X_{it}^L, \alpha_t^S) \tag{4}$$

where,
α_t^c are vectors of shadow prices capturing the trends, $c = L, S$

Econometric Method

- Let $\hat{\alpha}_{t|t}$ denote the estimate of α_t. At time t given all past information up to and including the current period,

$$\hat{\alpha}_{t|t} = \hat{\alpha}_{t|t-1} + K_t \nu_t \tag{5}$$

  - $Var(a_{t|t}) = P_{t|t}$ is the mean squared error variance
  - K_t is an adjustment factor (known as Kalman gain) - function of the X_t data, $P_{t-1|t-1}$ and F_t^{-1}
  - $v_t = y_t - \hat{y}_{t|t-1}$ is prediction error with variance-covariance F_t

Modified Filter (Kalman Gain Term)

- Dynamic discounting literature (see Harrison (1965),West and Harrison (1999)) uses smoothing constants to separate time series components. We adapt this idea, leading to a modified Kalman Gain term.
- The two components (land, structure) are assumed:
  - *Land* component bearing adjustments due to supply and demand pressures
  - *Structure component* value evolve due to construction costs (wages, CPI) and depreciate with Age.
- These two components are treated asymmetrically
  - Shocks to prices have an asymmetric effect with land bearing the largest proportion.
- See Rambaldi et al. (2015) for details

Indices - Land component

- The **Fisher index** is defined as:

$$F_{(t-s),t} = \sqrt{\sum_{h=1}^{N_{(t-s)}} w^h_{(t-s)} \left(\frac{\hat{L}^h_t(x^L_{(t-s)})}{\hat{L}^h_{(t-s)}(x^L_{(t-s)})} \right) \times \left[\sum_{h=1}^{N_t} w^h_t \left(\frac{\hat{L}^h_{(t-s)}(x^L_t)}{\hat{L}^h_t(x^L_t)} \right) \right]^{-1}} \tag{6}$$

where,
$\hat{L}^h_{(t-s)}(x^L_t)$ for $s \geq 0$ is an *imputation* of the land component of property h, sold at time t with characteristics x^L_t, using a vector of shadow prices for time period $t - s$

- If w^h_t are value shares: $w^h_t = \frac{PropPrice^h_t}{\sum_{n=1}^{N_t} PropPrice^n_t}$. The index is "**Plutocratic**"
- If $w^h_t = 1/N_t$ the index is "**Democratic**"
- Similarly an index can be computed for the Structure Component

Outline

Empirical Evidence

1. Moreton Bay Area - Monthly Data, 1991-2010 (urban expansion)
   - Homogeneous urban area north of Brisbane, $\approx$ 40 KM from CBD
   - Large proportion of commuters to Brisbane
   - Close to ocean and other waterways
2. Brisbane Suburb - Annual Data, 1970 - 2010
   - $\approx$5 KM from CBD
   - Old, well established suburb
   - No close to the river to have "views"
   - Parts are close to waterways that lead to storm surge flooding

Outline

Data

	Min	Max	Mean	Median	St.Dev
Sale Price (in 1000)	15.5	1250	191.77	161.50	129.44

Total number of Sales	13088	
Number of Months	233	
Number of Vacant Sales	3303	
Sample period	1991:5	2010:9

Land Component Characteristics

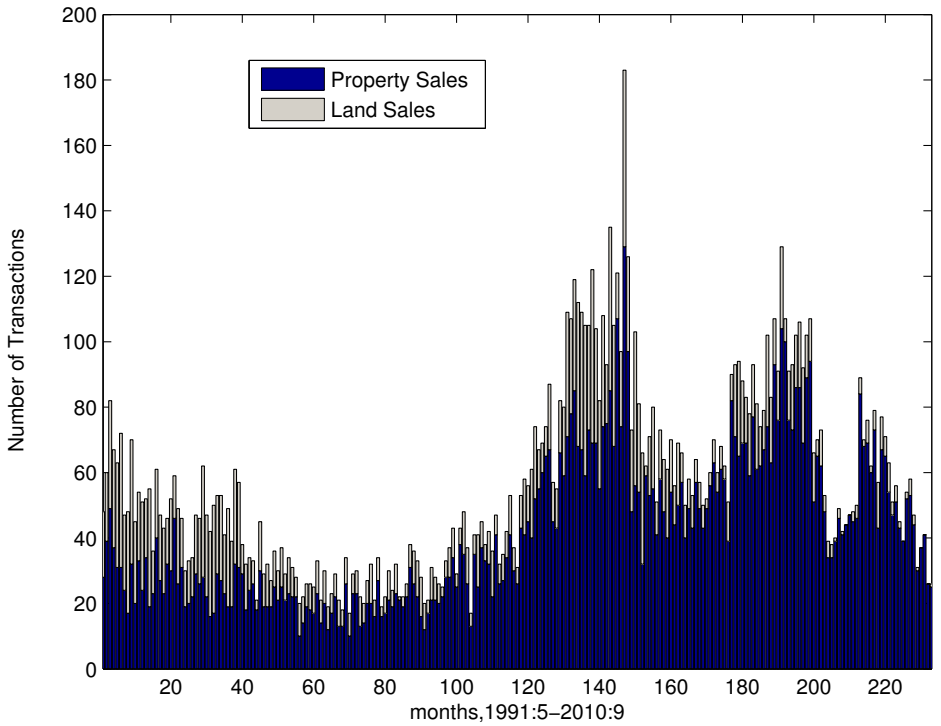
$$L_t = f(Land, Land^2, distances)$$

	Min	Max	Mean	Median	St.Dev
Land area (hectarea)	0.03	1.06	0.10	0.06	0.11
dist_coast (Km)	0.02	5.78	1.39	1.38	0.93
dist_waterway (Km)	0.01	0.86	0.27	0.25	0.16
dist_OffenIndus (Km)	0.18	8.38	2.87	2.27	1.83
dist_parks (Km)	0.01	0.98	0.13	0.11	0.11
dist_busStop (Km)	0.02	4.35	0.47	0.22	0.80
dist_Schools (Km)	0.01	6.55	0.65	0.32	1.09
dist_Shops (Km)	0.01	4.80	0.53	0.40	0.49
dist_BoatRamp (Km)	0.06	6.29	1.97	1.60	1.46

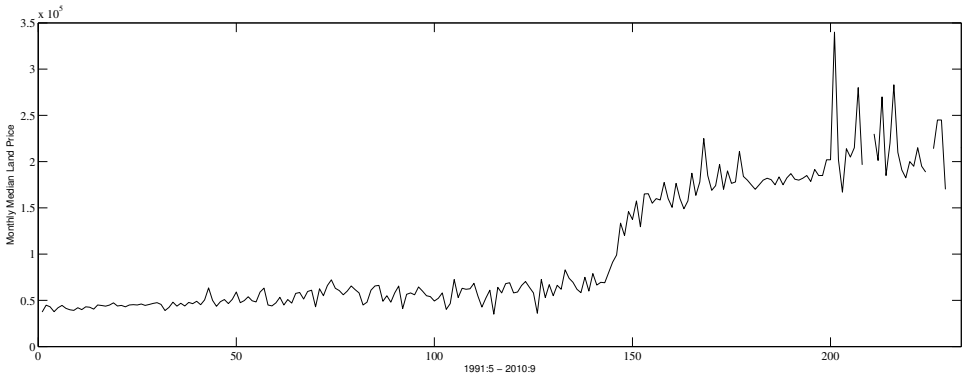
Structure Component Characteristics

$$S_t = f(Age, Age^2, Footprint, Footprint^2, Bath, Beds, Cars, Structure)$$

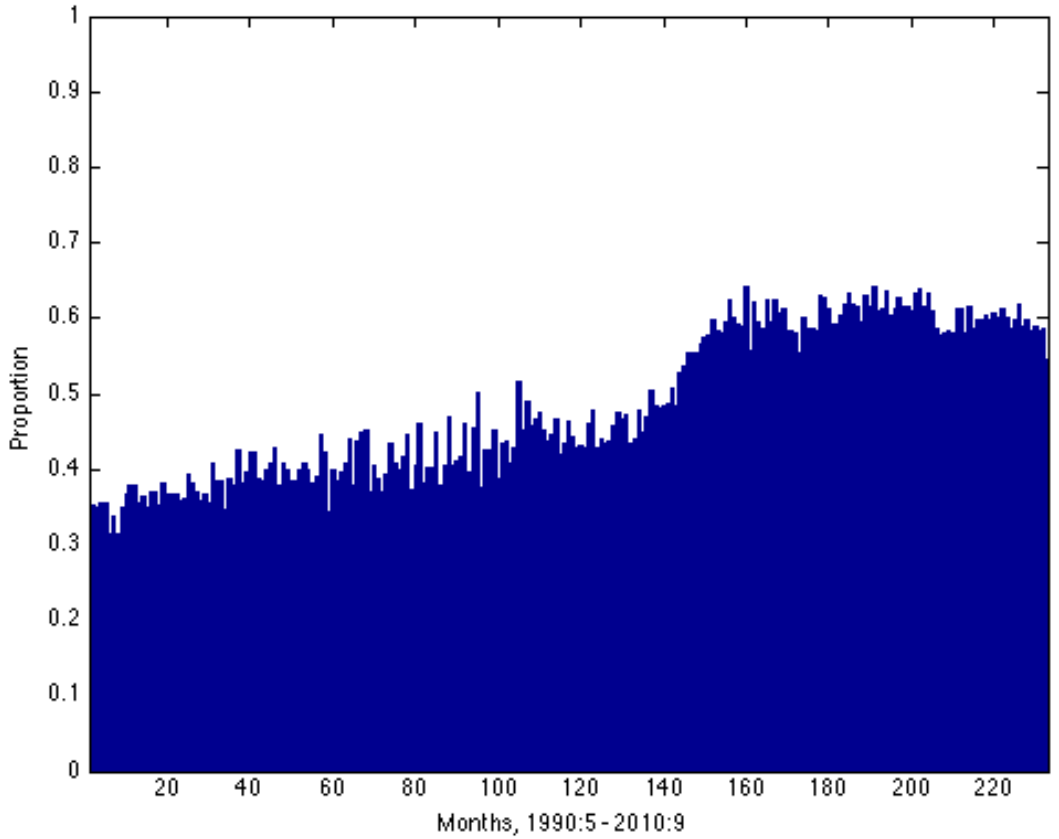
	Min	Max	Mean	Median	St.Dev
Structure=1	0.00	1.00	0.75	1.00	0.43
Age (years)	0.00	86.00	11.94	10.00	11.44
Structure Footprint (hectarea)	0.00	0.09	0.02	0.02	0.01
Number of Bathrooms	0.00	4.00	1.06	1.00	0.78
Number of Bedrooms	0.00	8.00	2.52	3.00	1.58
Number of Parking Spaces	0.00	5.00	1.39	1.00	1.12



Vacant Land Prices - Monthly Median -



PREDICTED LAND PROPORTION IN PROPERTY SALES



Outline

Data

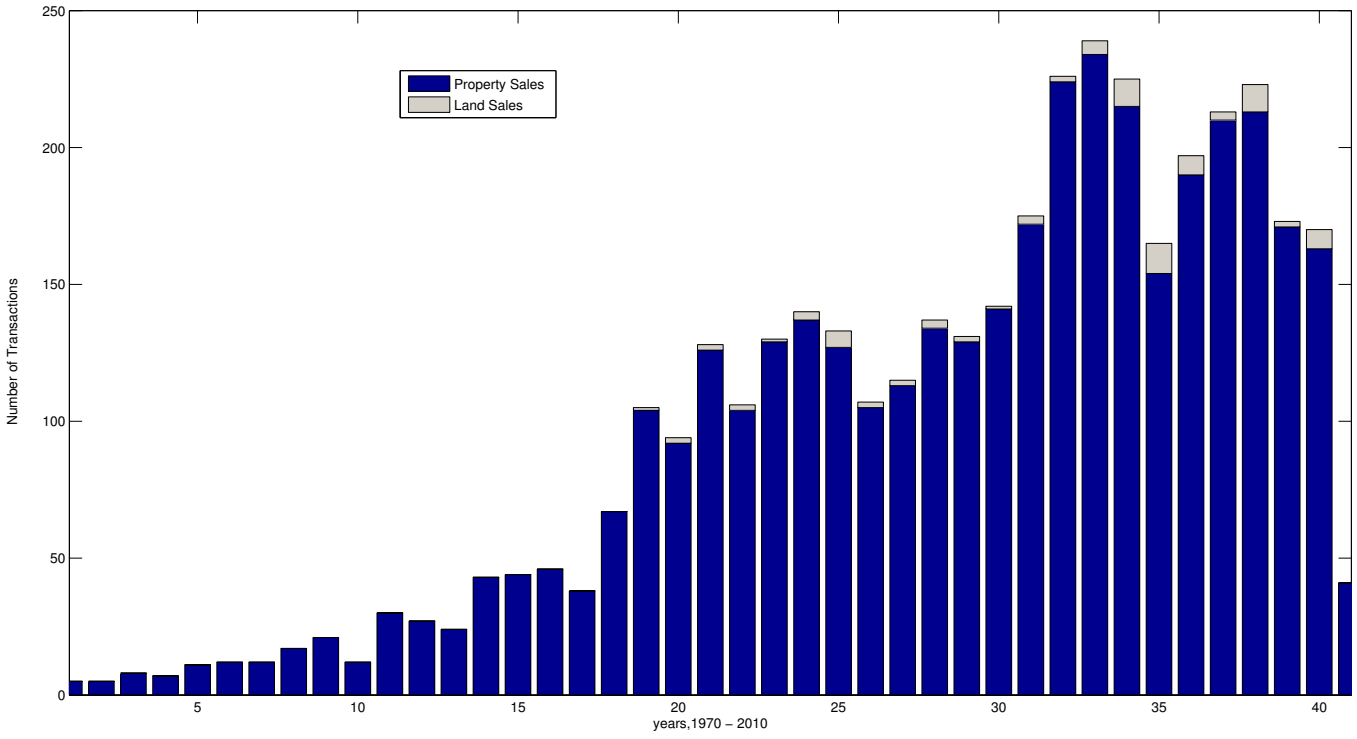
	Min	Max	Mean	Median	St.Dev
Sale Price (in 1000)	2.60	4710.00	305.22	215.00	269.48
Total number of Sales	3944				
Number of Years	41				
Sample Period	1970	2010			

Land Component Characteristics

	Min	Max	Mean	Median	St.Dev
Land area (hectareas)	0.02	0.22	0.06	0.06	0.02
dist_waterway (Km)	0.01	1.62	0.57	0.53	0.38
dist_river (Km)	0.95	4.77	2.97	3.04	0.87
dist_industry (Km)	0.00	2.62	1.00	0.91	0.66
dist_park (Km)	0.01	0.56	0.18	0.16	0.12
dist_bikeway (Km)	0.01	1.51	0.57	0.56	0.35
dist_busstop (Km)	0.01	0.50	0.20	0.18	0.11
dist_TrainStn (Km)	0.01	3.17	1.38	1.40	0.82
dist_school (Km)	0.04	1.23	0.47	0.45	0.24
dist_shops (Km)	0.00	1.09	0.36	0.33	0.19
dist_CBD (Km)	2.46	5.77	3.97	3.97	0.82

Structure Component Characteristics

	Min	Max	Mean	Median	St.Dev
Pre-War	0.00	1.00	0.49	0.00	0.50
War/Post War	0.00	1.00	0.37	0.00	0.48
Late 20th C	0.00	1.00	0.07	0.00	0.26
Contemporaneous	0.00	1.00	0.04	0.00	0.20
Structure=1	0.00	1.00	0.98	1.00	0.15
Structure footprint	0.00	0.10	0.02	0.02	0.01
Number of Levels	0.00	4.00	1.10	1.00	0.36
Number of Bathrooms	0.00	6.00	1.37	1.00	0.67
Number of Bedrooms	0.00	8.00	3.04	3.00	0.91
Number of Parking Spaces	0.00	8.00	1.66	2.00	0.78


Property Sales
Land Sales
Number of Transactions
years,1970 – 2010
0
50
100
150
200
250
5
10
15
20
25
30
35
40

Model vs Valuer - Properties sold in 2009

- VE_i = **valuer's land valuation**$_i$/**property sale price**$_i$

Month Sold	Median VE	# Properties
Jan-09	0.721	13
Feb-09	0.704	11
Mar-09	0.762	16
Apr-09	0.741	17
May-09	0.746	16
Jun-09	0.675	9
Jul-09	0.738	11
Aug-09	0.673	13
Sep-09	0.734	14
Oct-09	0.617	19
Nov-09	0.683	12
Dec-09	0.716	15
Median 2009	**0.716**	**166**

- Model Median for the 166 properties sold in 2009 = 0.669

Outline

Town of A (Netherlands)

- Used in Diewert et al. (2015). A shorter and earlier version was used by Färe et al. (2015).

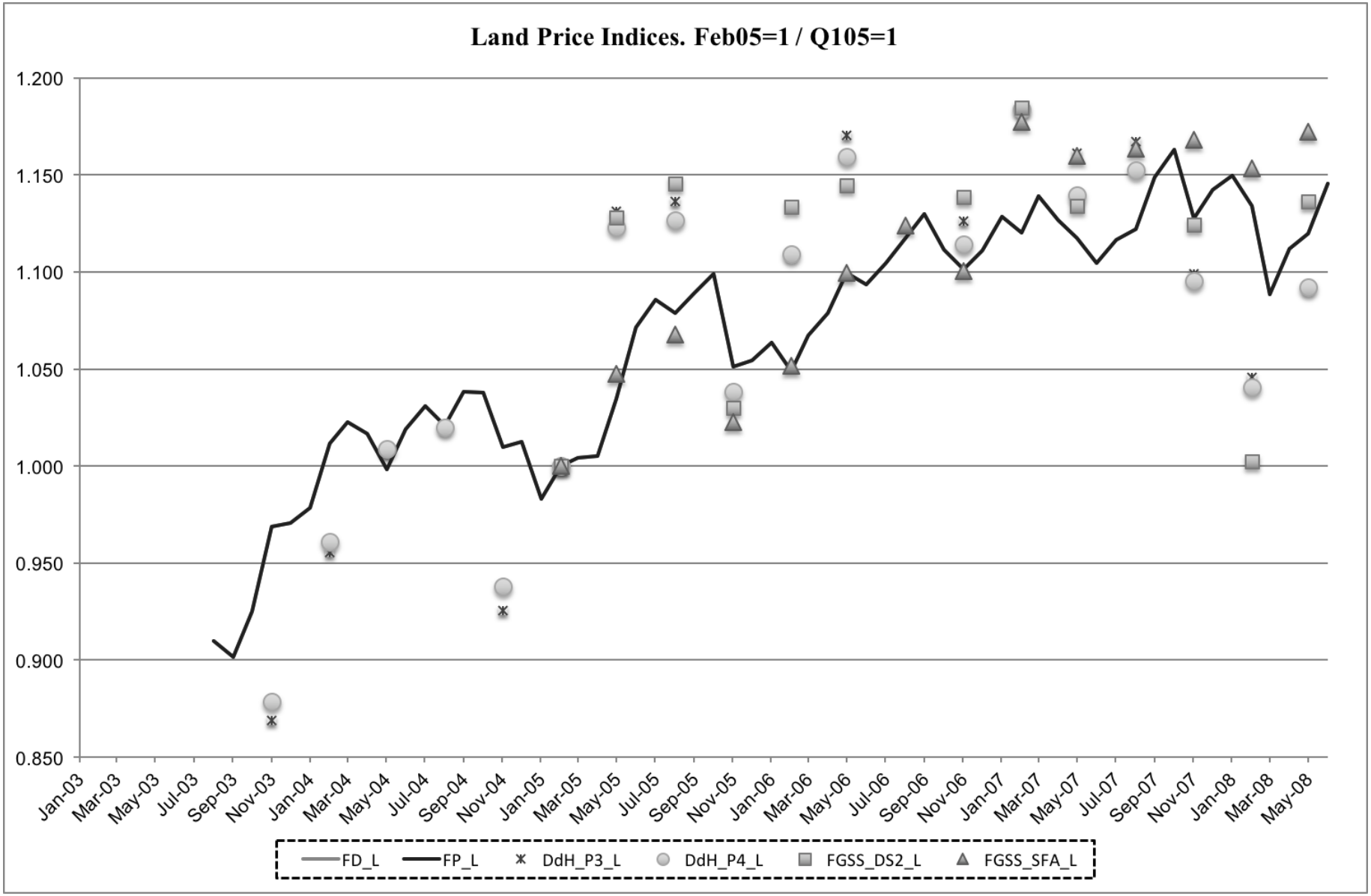
	min	max	mean	median	stdev
Price (000 Euros)	70	550	182.260	160	71.316
Land Characteristics					
Land (sq mts)	70	1344	258.060	217	152.310
Structure Characteristics					
House (sq mts)	65	352	126.560	120	29.841
Age (years)	0	4	1.895	2	1.231
floors	1	6	2.878	3	0.478
rooms	2	10	4.730	5	0.874
Number of Transactions	3487				
Number of months	66	(2003:1	2008:6)		
The data were cleaned following Diewert et al (2015). See footnotes 11,12,13.					

Price Indices Compared

	Model	Estimation	Label	Symbol
Diewert et al. (2015) Builder's Model with linear splines (*New Construction Index*)	Model3: land, house,age	2003:Q1 - 2008:Q2 quarter-by-quarter	DdH_PL3 (DdH_PS3)	
	Model4: Model 3 + other hedonic characteristics	2003:Q1 - 2008:Q2 quarter-by-quarter	DdH_PL4 (DdH_PS4)	
Färe et al (for structure uses SFA_L as exogenous index)	Model 4	2005:Q1 - 2008:Q2 quarter-by-quarter	FGCS_DS2_L (FGCS_DS2_S)	
	Model 4	2005:Q1 - 2008:Q2 **Distance Function Approach - whole sample**	FGCS_SFA_L (FGCS_SFA_S)	

Price Indices Compared (cont)

- Our Model
  $Price = f(\text{land, house, age, rooms}, rooms^2, \text{floors}, floors^2)$
- Monthly 2003:1-2008:6. Estimation for time τ uses $t = 1, \ldots, \tau - 1, \tau$.
- Indices labels
  1. FP_L (FD_L)
  2. FP_S (FD_S)


Land Price Indices. Feb05=1 / Q105=1
1.200
1.150
1.100
1.050
1.000
0.950
0.900
0.850
Jan-03
Mar-03
May-03
Jul-03
Sep-03
Nov-03
Jan-04
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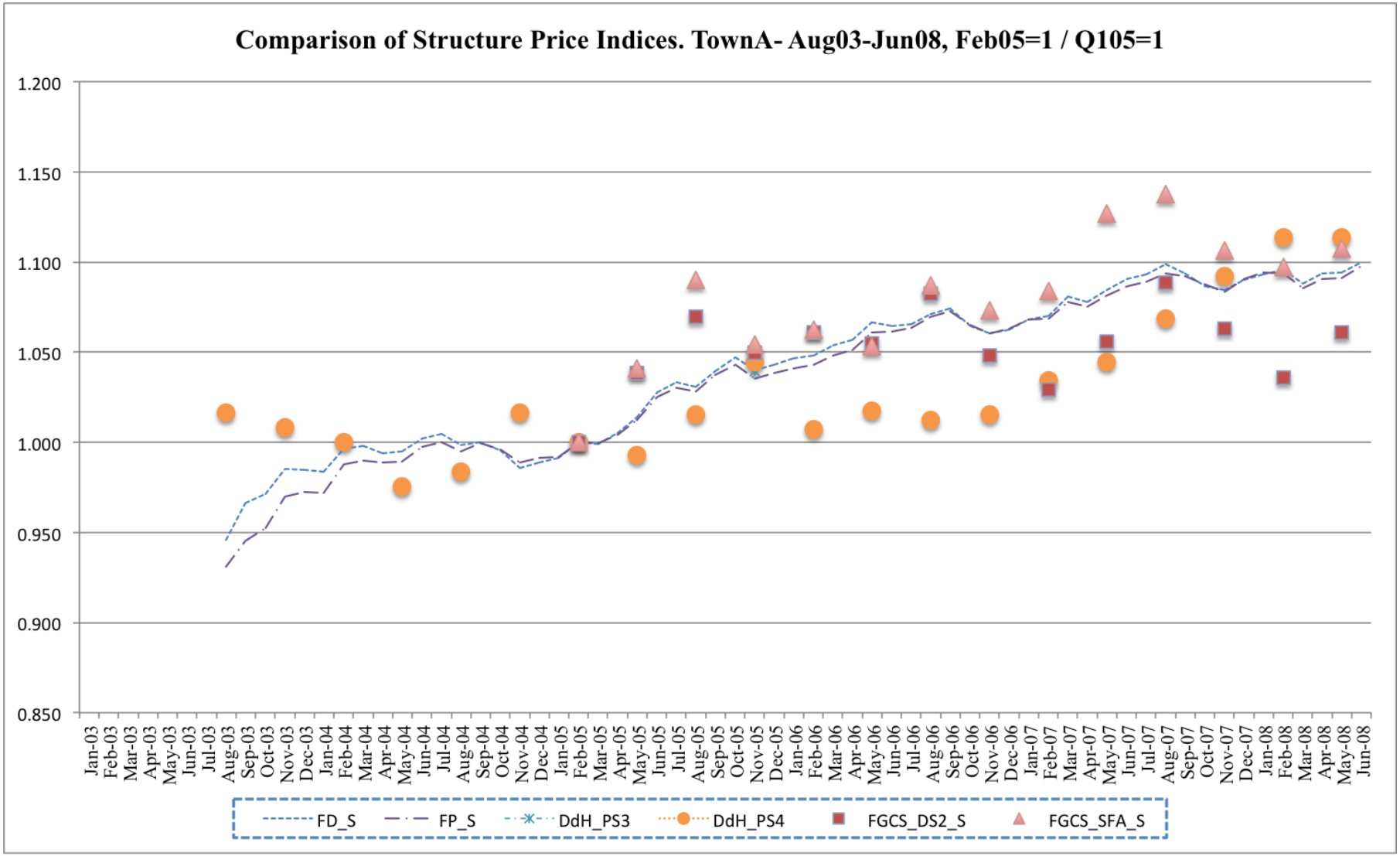
FD_L
FP_L
DdH_P3_L
DdH_P4_L
FGSS_DS2_L
FGSS_SFA_L


Comparison of Structure Price Indices. TownA- Aug03-Jun08, Feb05=1 / Q105=1
1.200
1.150
1.100
1.050
1.000
0.950
0.900
0.850
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May-08
Jun-08
FD_S
FP_S
DdH_PS3
DdH_PS4
FGCS_DS2_S
FGCS_SFA_S

Outline

Victoria Data (Outskirts of Melbourne)

Jan 2001=1

Outline

Measuring GDP and Urban Planning

- New standard on the System of National Accounts -EuroStat-OECD (2015) "Compilation Guide On Land Estimation"
- Urban Planning and Zoning
  - Land component proportion
  - Single structure no longer viable
  - Model $\Rightarrow$ counterfactuals

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