Developing Land and Structure Price Indexes for Ottawa Condominium Apartments

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Background

- Accurately measuring condominium apartment economic activity requires breaking down the prices of condominium apartment units into land and structure components
- Land and structure decomposition of condominium apartment prices does not currently exist
- Internationally, there is not yet a standard framework or guideline to create this land-structure split.
- We explore the use of hedonic methods that tease out the land and structure components of condominium apartment values and in turn, construct separate land and structure price indexes, as well as a total property price index.

The Data

The Data

- The source of data for this study is a combination of a residential property price research dataset, City of Ottawa building characteristics data set and some internet data sources.
- For new and resale condo apartments in Ottawa for the period of Q1 1996 to Q3 2009
- Only contains condo buildings with 5 or more stories
- Statistics Canada's Apartment Building Construction Price Index (ABCPI)
- Unit characteristic variables
- Land characteristics
- Building characteristics

Data inclusions

- The data includes:
  - Living area between 300 and 1500 square feet
  - Selling price outlier detection by year
  - 1 to 4 bedrooms
  - 1 to 3 bathrooms
  - Age <50 years

Methodology

The Builder's Model

Builder's Model

$$Price = Land + Structure$$

$$P_{tn} = \alpha_t L_{tn} + \beta_t (1 - \delta_t)^{A_{tn}} S_{tn} + \varepsilon_t$$

Component	Variable	Description
	P_{tn}	Selling price of unit
Land	α_t	Quality adjusted price per square foot of land
	L_{tn}	Land size
Structure	β_t	Quality adjusted price per square foot of structure floor space
	δ_t	Depreciation rate
	A_{tn}	Age of building
	S_{tn}	Condo unit floor size

Considerations for Condominiums

Land Allocation

Land size is by building, not by unit

Equally distribute land

Communal Space

Living area does not capture all of the structure available to the unit

Estimate 25% communal space

Communal space blow up factor:

1/(1-0.25)=1.33

Builder's Model with Land Size and Communal Space

$$P_{tn} = \alpha_t \frac{TL_{tn}}{TU_{tn}} + (1.33)\beta PS_t(1 - 0.02)^{A_{tn}} S_{tn}$$

Component	Variable	Description
	P_{tn}	Selling price of unit
Land	α_t	Quality adjusted price per square foot of land
	TL_{tn}	Total land size for the building
	TU_{tn}	Total units in the buildings
Structure	1.33	Blow up factor for communal space
	β	General structural quality adjustment factor
	PS_t	Price per square foot of structure floor space determined by ABCPI
	0.02	Net geometric depreciation rate
	A_{tn}	Age of building
	S_{tn}	Condo unit living area

Preliminary Results of Builder's Model

- R^2 value is 0.6751
- Most α_t values are negative
- β is 5.03
- β now represents a general quality adjustment to the structure area
- Our assumption is that the model can account for almost all quality adjustment to the structure implying β=1

Determinants of Land Prices

- Focus on determinants of land prices
- Estimate a land value and assume β=1:

$$LV_{tn} = P_{tn} - (1.33)PS_t(1 - 0.02)^{A_{tn}}S_{tn}$$

- Baseline model: $LV_{tn} = \alpha_t \frac{L_{tn}}{TU_{tn}}$

Determinants of Land Prices

Model	Additional Variables	R-Squared	Log Likelihood (LL)	Improvement in LL
1	Baseline	-0.6891	-127456	
2	Forward Sortation Area dummy variables	0.0957	-124339	3117
3	Land proportional to size of unit	-0.0938	-125288	-949
4	Weighted average of land imputation methods	0.1021	-124304	984
5	Height of unit	0.1901	-123789	515
6	Number of units in the building	0.2935	-123108	681
7	Building height dummy variables	0.3608	-122608	500
8	Excess land dummy variables	0.6244	-119956	2652

Adding Structure to Builder's Model

$$P_{tn} = \alpha_t \left(\sum_{i=1}^{23} \theta_i FSA_{tn,i} \right) \left(1 + \gamma(H_{tn} - 1)\right)\left(1 + \omega(TU_{tn} - 9)\right)$$

$$\left(\sum_{j=1}^{4} \vartheta_j TH_{tn,j} \right) \left(\sum_{\mathrm{m}=1}^{4} \sigma_m EL_{tn,m} \right) \left[\rho \left(\frac{S_{tn}}{TS_{tn}} \right) + (1 - \rho) \left(\frac{1}{TU_{tn}} \right) \right] TL_{tn}$$

$$+$$

$$(1.33) PS_t (1 - \delta)^{A_{tn}} S_{tn} + \varepsilon_{tn}$$

Structural Explanatory Variables

Model	Additional Variables	R-Squared	Log Likelihood (LL)	Improvement in LL
1	Baseline	0.7006	-119934	
2	Bedrooms Dummy Variables	0.7799	-118398	1536
3	Bathrooms Dummy Variables	0.7871	-118232	166

Full Model

$$P_{tn} =$$

Land Component

$$\alpha_t \left(\sum_{i=1}^{23} \theta_i FSA_{tn,i} \right) \left(1 + \gamma(H_{tn} - 1)\right)\left(1 + \omega(TU_{tn} - 9)\right)$$

$$\left(\sum_{j=1}^{4} \vartheta_j TH_{tn,j} \right) \left(\sum_{\mathrm{m}=1}^{4} \sigma_m EL_{tn,m} \right) \left[\rho \left(\frac{S_{tn}}{TS_{tn}} \right) + (1 - \rho) \left(\frac{1}{TU_{tn}} \right) \right] TL_{tn}$$

$$+$$

Structure Component

$$(1.33) PS_t (1 - \delta)^{A_{tn}} \left(\sum_{k=1}^{4} \tau_k BD_{tn,k} \right) \left(\sum_{c=1}^{3} \varphi_c BT_{tn,c} \right) \left(\sum_{z=1}^{2} \epsilon_z CM_{tn,z} \right) S_{tn}$$

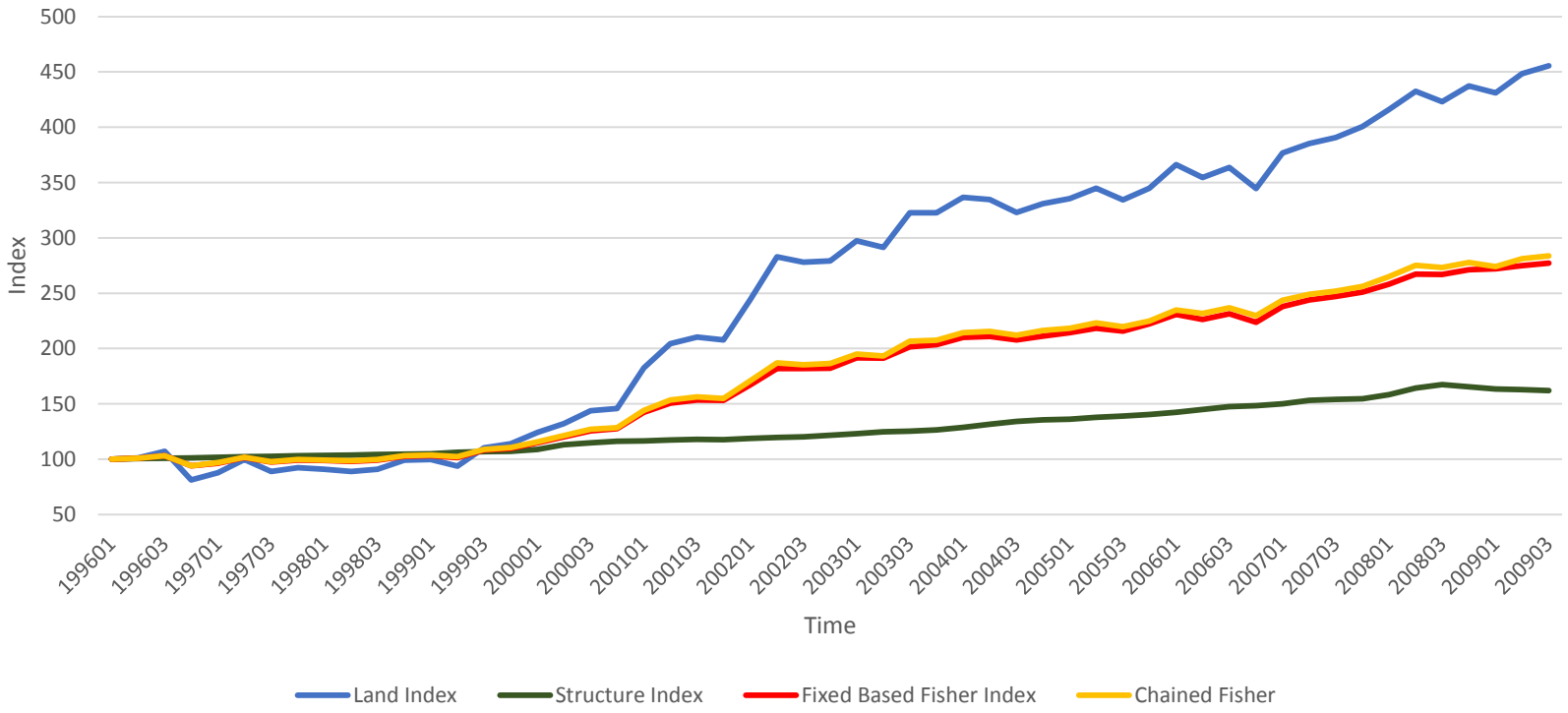
$$+\varepsilon_{tn}$$

Important Model Results

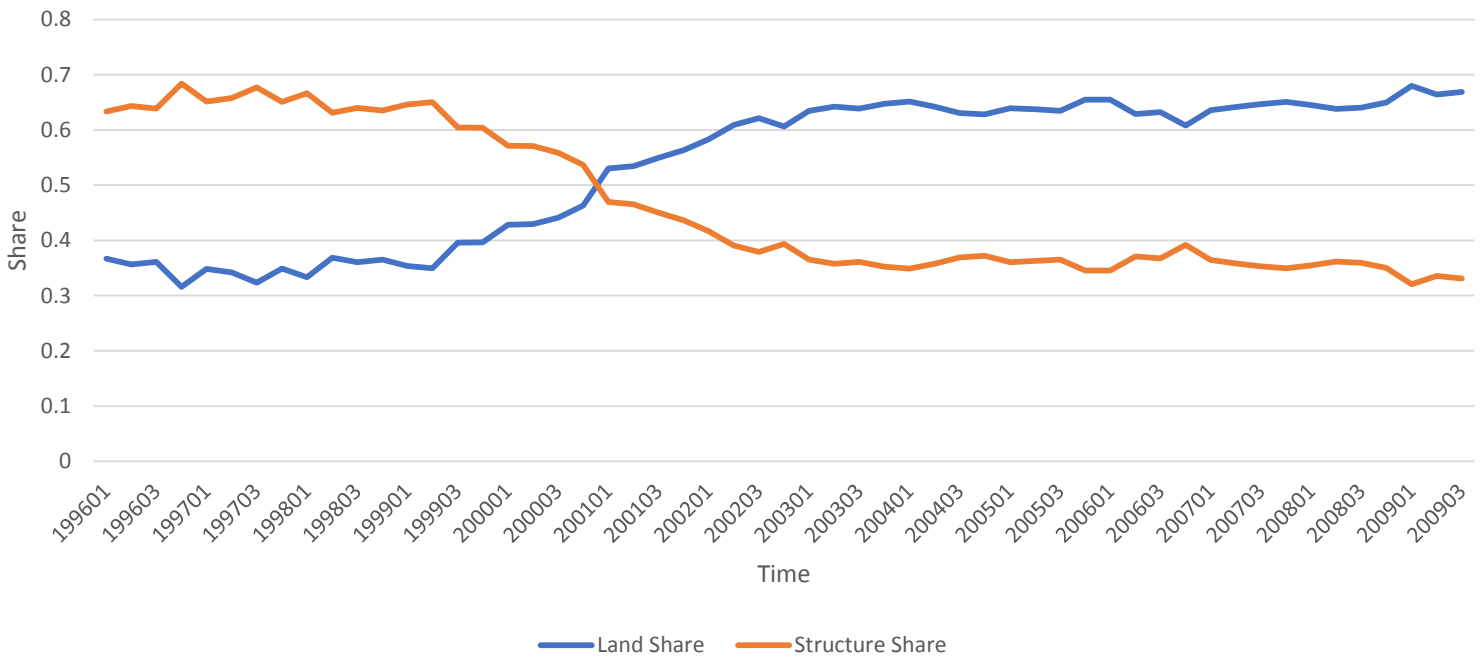
- 90% of the imputed land value is estimated by the equal distribution of land
- The depreciation rate is 2.4%
- Coefficient estimates for excess land decreases when excess land increases

Index Results

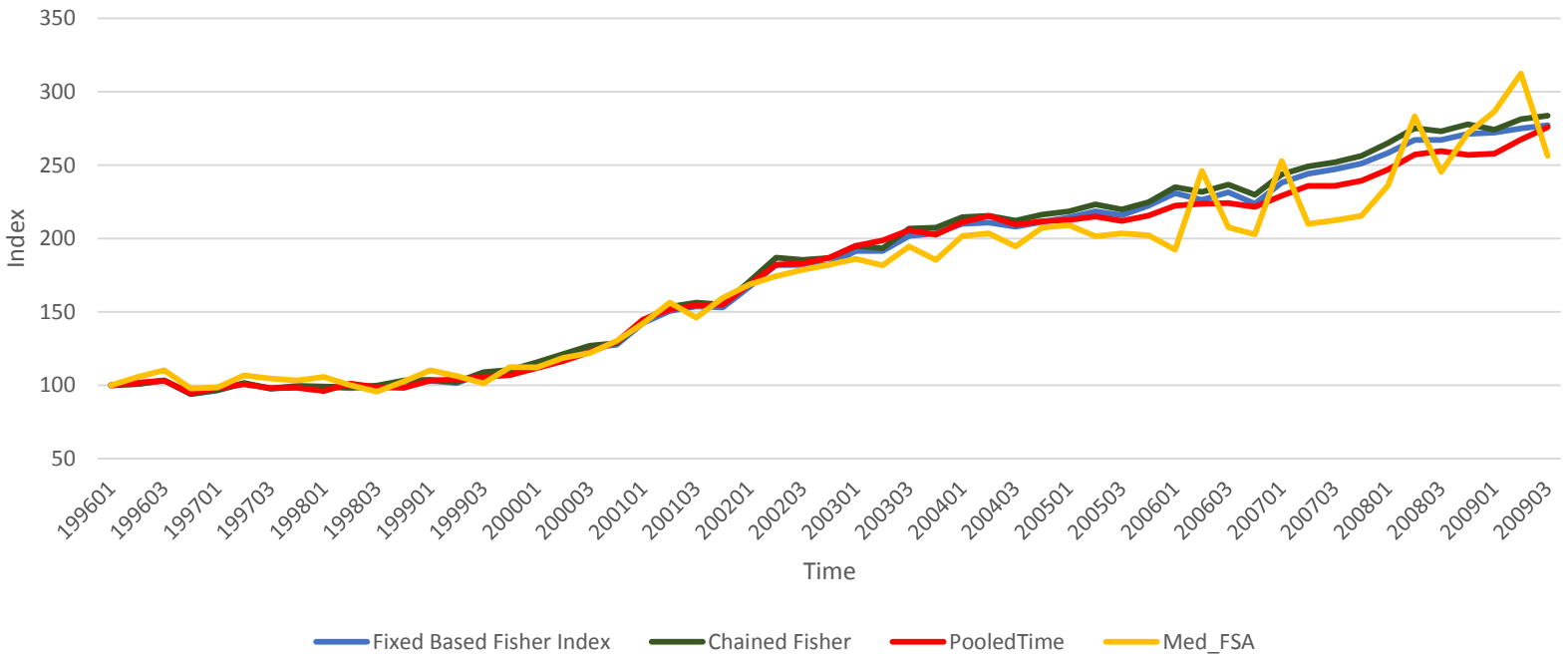
Land, Structure and Total Indexes



Land and Structure Value Shares



Comparison with Other Models



Conclusions

- We now have an index for land prices
- Similarities between the Fisher indexes created from the Builder's Model and other hedonic and stratification methods
- Determined significant land and structure variables that could be helpful for designing a survey to effectively collect required information
- Builder's Model provide additional statistics for National Accounts