Commercial Property Price Indexes for Tokyo: Sources and Methods

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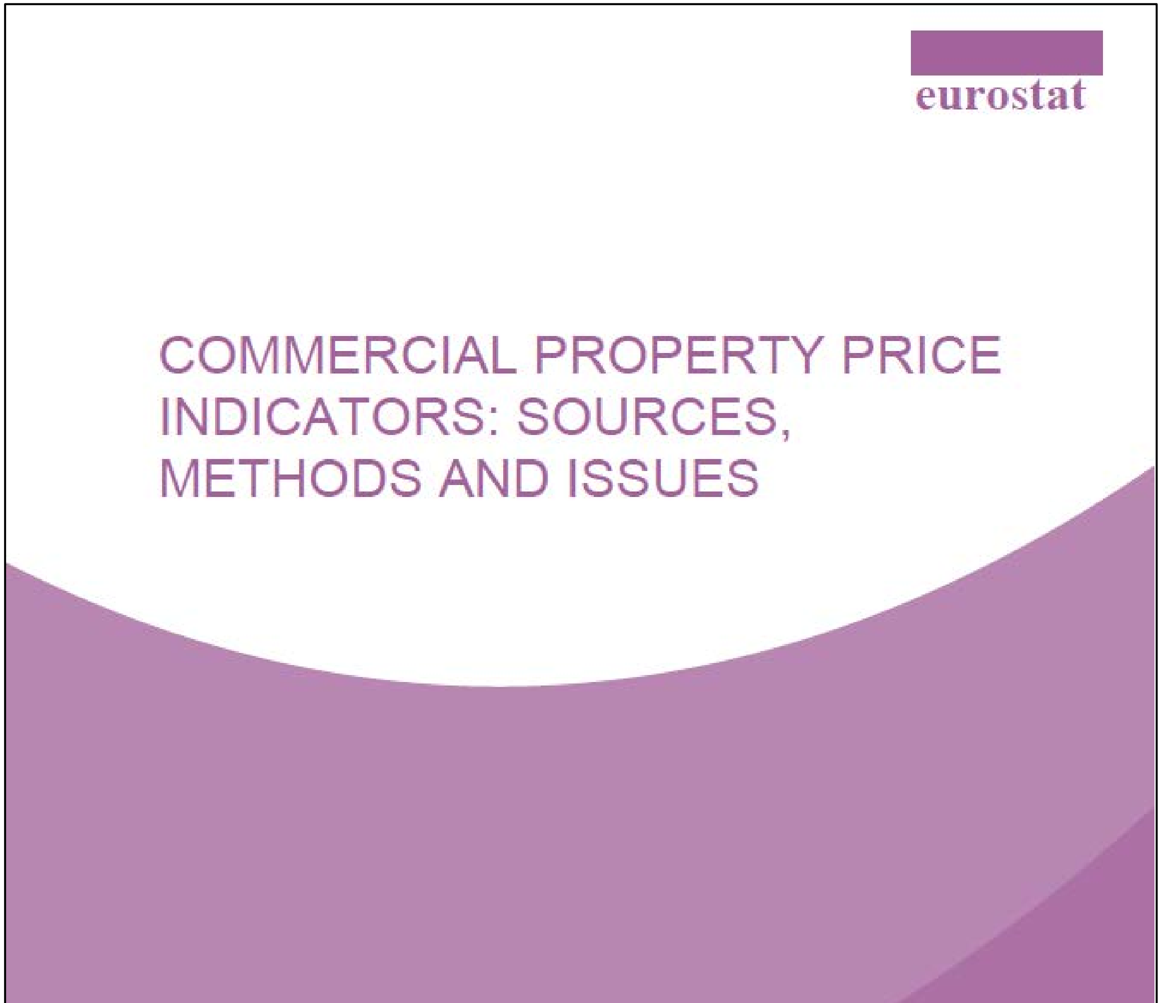
COMMERCIAL PROPERTY PRICE INDICATORS: SOURCES,METHODS AND ISSUES



BIS and ECB CPPI conference 2012 and 2014.

- **Lessons from Japanese experience in Bubble period.**
- **What happen during "Collapse of Bubble" in Japan:**

- J-CPPI's did not work well as **"Early warning signal".**

- Since no ***reliable*** real estate price index/real estate price information existed that made it possible to capture real estate market conditions, it was not possible to calculate **correct bad loan debt amounts**, and it took a long time until policy measures were implemented, **including the injection of tax money to keep *financial stability* in the late 1990's**.

- This was a major factor leading to the prolonged economic stagnation known as the **"lost decade."**

Commercial Property Price Indices in Japan.

Survey	Organisation	Use	Source	Data	Frequency	Availability*
Japan Commercial Property Price Index	**Ministry of Land, Infrastructure, Transport and Tourism**	**Office, Retail, Logistics, Hotel and Land**	**Transaction price**	**Index**	**Quarterly**	**2008 (Tokyo, Osaka, Nagoya1985)**
Land Market Value Publication (Published Land Price: PLP)	Ministry of Land, Infrastructure, Transport and Tourism	Land for commercial, residential and industrial real estate	**Assessment value**	Appraisal value per unit and average change rate	Annual	1970
Urban Land Price Index	Japan Real Estate Institute	Land for commercial, residential and industrial real estate	**Assessment value**	Average change rate	Biannual	1955
ARES Japan Property Index	THE ASSOCIATION FOR REAL ESTATE SECURITIZATION	Office, Residential, Retail, Logistics, Hotel and others	**Appraisal value**	Return	Monthly	2001
MSCI-IPD Japan Monthly Property Index	IPD: Investment Property Databank	Office, Residential, Retail, Logistics, Hotel and others	**Appraisal value**	Return	Monthly	2001

*Availability means that the data is available from this year.

	(1)	(2)	(3)	(4)	(5)	(6)
Green label dummy	0.217**	0.236*	0.030	0.010	0.060	0.096
	(0.089)	(0.124)	(0.103)	(0.111)	(0.092)	(0.097)
Log gross building area	0.052*	0.085**	0.073	0.035	0.083*	0.058
	(0.028)	(0.033)	(0.049)	(0.046)	(0.043)	(0.062)
Number of stories above ground	0.011**	0.003	-0.013	0.005	-0.002	-0.000
	(0.005)	(0.008)	(0.018)	(0.024)	(0.017)	(0.017)
Time to the nearest station	-0.030***	-0.045***	-0.019	-0.033	-0.011	-0.013
	(0.009)	(0.012)	(0.025)	(0.021)	(0.020)	(0.020)
Building age	-0.008***	-0.011***	-0.012*	-0.008	-0.011*	-0.009
	(0.002)	(0.003)	(0.007)	(0.006)	(0.006)	(0.008)
Zone air conditioning dummy	0.079	0.038	-0.247***	-0.157*	-0.184**	-0.212
	(0.055)	(0.121)	(0.087)	(0.091)	(0.087)	(0.135)
Card-key system dummy	-0.004	0.095	0.080	-0.040	0.168	0.189
	(0.081)	(0.125)	(0.108)	(0.100)	(0.111)	(0.134)
Building renovation dummy	0.045	0.095	0.031	0.205	0.014	0.018
	(0.053)	(0.083)	(0.140)	(0.150)	(0.111)	(0.134)
Log maintenance costs		-0.034				-0.046
		(0.067)				(0.170)
Log repair costs		0.059**				-0.018
		(0.028)				(0.057)
Log electricity usage			-0.209**		-0.309***	-0.305***
			(0.099)		(0.102)	(0.112)
Log water usage				0.098	0.159**	0.170**
				(0.068)	(0.065)	(0.070)
Constant	8.103***	7.571***	8.733***	8.528***	8.985***	9.571***
	(0.258)	(0.565)	(0.715)	(0.619)	(0.571)	(0.826)
Submarket fixed effects	YES	YES	YES	YES	YES	YES
Quarter-year fixed effects	YES	YES	YES	YES	YES	YES
Observations	480	332	165	162	162	158
Adjusted R-squared	0.758	0.775	0.779	0.769	0.801	0.805

Why J-CPPI were not effective in Bubble period for policy management?

- The question of **why these property price indices were not effective in policy management** during the bubble era and the subsequent collapse process is a vital one.

- → One cause suggested during the series of policy-related discussions following the bubble's collapse was that **there were significant errors in the real estate assessment and appraisal prices** forming the raw data for creating the indexes.

- **Smoothing problem, Valuation error problem, Lagging problem, Client influence problem.**
- (Nishimura and Shimizu(2003), Shimizu and Nishimura(2006), (2007)

1. Motivations

- 1. Applies the ***Builder's Model*** to the Tokyo office market, is to extract land price indexes from the transaction prices

- 2. Compare commercial property price indexes according to the ***different data source*** used.

- a) **Transaction prices**;
- b) **Appraisal prices** compiled by real estate markets, e.g. the REIT market; and
- c) **Assessment prices** for property tax purposes.

Advantages in Builder's Model (1)

- The International System of National Accounts asks countries to **provide estimates for the value of assets** held by the various sectors in the economy.

- These estimates are supposed to appear in the **Balance Sheet Accounts** of the country. An important asset for the Country **is the stock of Land and Structure.**

- For many modeling purposes, it is important to not only have estimates for the value of the property stock but to decompose the overall value into (additive) land and structure components and then to further decompose these value aggregates into constant quality price and quantity components.

Advantages in Builder's Model (2)

- This is not an easy task. **When a commercial property is sold, the selling price values the sum of the structure and land components** and so a structure-land decomposition must be obtained by a modeling exercise.
- The problem of obtaining ***constant quality*** price components for the land and structure components of a commercial property is further complicated by **heterogeneity**.

- The transactions in commercial property market is ***sparse*****.**

- The paper fits a hedonic regression model to the Commercial Property in Tokyo over the period 2005-2015.
- We compared 3 sources for CPPI: **Transaction prices, Appraisal prices and Assessment Prices.**

2. Data Description

- Our basic data set is on sales of commercial property located in the central area of Tokyo **over the 44 quarters starting at the first quarter of 2005 and ending at the forth quarter of 2015**.

- There were a total of **1,968 observations** (after range deletions) in our sample of sales of office properties in Tokyo.

Tokyo Special District:
-Area: 626.70 km^2
-Population: 9,256,625

Data Description

- **V** = The value of the sale of the commercial property;
- **S** = Floor space area for the *entire building*;
- **L** = Lot area for the *entire building*;
- **A** = Age of the structure in years;
- **H** = The total number of stories in the building;

- **DS** = Distance to the nearest subway station in meter;
- **TT** = Subway running time in minutes to the Tokyo station from the nearest station during the day (not early morning or night);

Data Description

- In addition to the above variables, we also have information on which Ward of Tokyo the sales took place. We used this information to create **ward dummy variables, $D_{W,tn,j}$**.

- In order to reduce multicollinearity between the various independent variables listed above (and to achieve consistency with national accounts data), we assumed that the value of **a new structure** in any quarter is proportional to a **Construction Cost Price Index** for Tokyo from Statistics Bureau of Japan.

→We denote the value of this index during quarter t as p_{St}.

3. The Builder's Model

- The ***builder's model*** for valuing a commercial property postulates that the value of a commercial property is the sum of two components:
- ***the value of the land*** which the structure sits on **plus** ***the value of the commercial structure*.**
- The total cost of the property after the structure is completed will be equal to **the floor space area of the structure**, say **S** square meters, times the **building cost** per square meter, β say, plus **the cost of the land**, which will be equal to the cost per square meter, α say, times **the area of the land site, L**.

$$\textbf{(1)}\ V_{tn} = \alpha_t L_{tn} + \beta_t S_{tn} + \varepsilon_{tn}\ ;\ \ t = 1,\ldots,44;\ n = 1,\ldots,N(t).$$

The Builder's Model

- **For older structures, we modify eq (1) and allow for *geometric depreciation* of the structure:**

(2) $V_{tn} = \alpha_t L_{tn} + \beta_t(1 - \delta_t)^{A(t,n)} S_{tn} + \varepsilon_{tn}$;

where the parameter δ_t reflects the ***net geometric depreciation rate*** as the structure ages one additional period and

- L_{tn} is **the unit's share of the total land plot area of the structure**, α_t is the price of land (per meter squared), β_t is the price of commercial space (per meter squared), A(t,n) is the age of the structure in years and S_{tn} is the floor space of the unit (in square meters).
- δ_t is regarded as a ***net depreciation rate*** because it is equal to a "true" gross structure depreciation rate less an average renovations appreciation rate.

Preliminary land price estimate

- In model 1-4, we assumed that the ***structure value*** for unit n in period t, V_{Stn}, is defined as follows:

(3) $V_{tn} = \alpha_t L_{tn} + p_{St}(1-0.025)^{A(t,n)} S_{tn} + \varepsilon_{tn}$;

(4) $V_{Stn} \equiv p_{St}(1-0.025)^{A(t,n)} S_{tn}$; $t = 1,...,44;\ n = 1,...,N(t).$

- Once the imputed value of the structure has been defined by (6), we define the imputed land value for condo n in period t, V_{Ltn}, by subtracting the imputed structure value from the total value of the condo unit, which is V_{tn}:

(5) $V_{Ltn} \equiv V_{tn} - V_{Stn}$; $t = 1,...,44;\ n = 1,...,N(t).$

Model 1: Basic Model: *Time Dummies* + *Ward Dummies*

- In order to take into account possible neighbourhood effects on the price of land, we introduce *ward dummy variables*, $D_{W,tn,j}$, into the hedonic regression:

(6) $V_{Ltn} = \alpha_t L_{Stn} + \varepsilon_{tn}$.

(7) $D_{W,tn,j} \equiv 1$ if observation n in period t is in Ward j of Tokyo;

$\equiv 0$ if observation n in period t is *not* in Ward j of Tokyo.

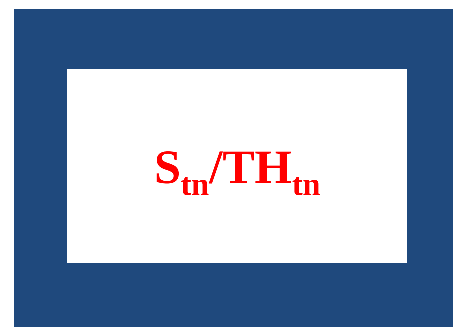
(8) $V_{Ltn} = \alpha_t(\sum_{j=1}^{14} \omega_j D_{W,tn,j}) L_{Stn} + \varepsilon_{tn}$.

- We need to impose at least one identifying normalization on the above parameters:

(9) $\alpha_1 \equiv 1.$

Model 2: Model 1 + *Splines on excessed land*

- The *footprint* of a building is the area of the land that directly supports the structure.
- An approximation to the ***footprint land*** for unit n in period t is the total structure area S_{tn} divided by the total number of stories in the structure TH_{tn}.
- If we subtract footprint land from the total land area, TL_{tn}, we get ***excess land*, EL_{tn}** defined as follows:
- **(10) $EL_{tn} \equiv L_{tn} - (S_{tn}/TH_{tn})$;**
  $t = 1,\ldots,44;\ n = 1,\ldots,N(t).$



- This is land that is usable for purposes *other* than the direct support of the structure on the land plot.

Model 2: Model 1 + *Splines on excessed land*

- We grouped our observations into 3 categories, depending on the amount of excess land that pertained to each observation.
- Group consists of observations tn where
- **1: $EL_{tn} < 50$;**
- **2: observations such that $50 \leq EL_{tn} < 125$;**
- **3: $125 \leq EL_{tn}$.**
- Now define the excess land dummy variables, $D_{EL,tn,m}$:
- (11) $D_{EL,tn,m}$
- $\equiv$ 1 if observation n in period t is in excess land group m;
- $\equiv$ 0 if observation n in period t is *not* in excess land group m.
- **(12) $V_{Ltn} = \alpha_t(\sum_{j=1}^{14} \omega_j D_{W,tn,j})(\sum_{m=1}^{3} \chi_h D_{EL,tn,m})L_{tn} + \varepsilon_{tn}$;**
- **$t = 1,\ldots,44;\ n = 1,\ldots,N(t)$.**

Model 3: Model 2 + ***Building Height***

- Height of the building increases the value of the land plot supporting the building.
- The height of the building (the H variable) ranged from 3 stories to 14 stories. There are a few observations in upper stories. We combined them and made 8 Hight dummies.
- Thus we define the building height dummy variables:
- **(14) $D_{H,tn,h}$**

≡ 1 if observation n in period t is in building height category h;

≡ 0 if observation n in period t is *not* in building height category h.

- The new nonlinear regression model is the following one:
- **(15) $V_{Ltn} = \alpha_t(\sum_{j=1}^{14} \omega_j D_{W,tn,j})\,(\sum_{m=1}^{5} \chi_h\, D_{EL,tn,m})\,(\sum_{h=1}^{8} \mu_m\, D_{H,tn,h})\, L_{tn} + \varepsilon_{tn}$;**
- **$t = 1,\ldots,44;\ n = 1,\ldots,N(t)$.**

Model 4: Model 3 + ***DS+TT***

- There are two additional explanatory variables in our data set that may affect the price of land.
- Recall that ***DS*** was defined as the distance to the nearest subway station and ***TT*** as the subway running time in minutes to the Tokyo station from the nearest station.
- DS ranges from 0 to 1,500 meters while TT ranges from 1 to 48 minutes. These new variables are inserted into the nonlinear regression model (15) in the following manner:

- **(17)** $V_{Ltn} = \alpha_t(\sum_{j=1}^{14} \omega_j D_{W,tn,j}) (\sum_{m=1}^{5}\chi_h D_{EL,tn,m}) (\sum_{h=1}^{10} \mu_m D_{H,tn,h})\times(1+\eta(DS_{tn}-0))(1+\theta(TT_{tn}-1))L_{tn}+\varepsilon_{tn};$
-

$t = 1,\ldots,44;\ n = 1,\ldots,N(t).$

Model 5:Replace V_{Ltn} to V_{tn}.

- Our final builder's model for commercial property, we use V_{tn} as the dependent variable and use the same specification for the land component of the property that we used in Model 4 but now we add the term $(1-\delta)^{A(t,n)}S_{tn}$ to account for the structure component of the value of the commercial property.
- Note that we will now estimate **the annual depreciation rate δ** in new model, rather than assuming that it was equal to **2.5%**.

- (18) $V_{tn} = \alpha_t(\sum_{j=1}^{14} \omega_j D_{W,tn,j})\ (\sum_{m=1}^{5} \chi_h\ D_{EL,tn,m})\ (\sum_{h=1}^{10} \mu_m\ D_{H,tn,h}) \times (1+\eta(DS_{tn}-0))(1+\theta(TT_{tn}-1))L_{tn} + \beta_t(1-\delta_t)^{A(t,n)}S_{tn} + \varepsilon_{tn}$;
-

$t = 1,...,44;\ n = 1,...,N(t)$.

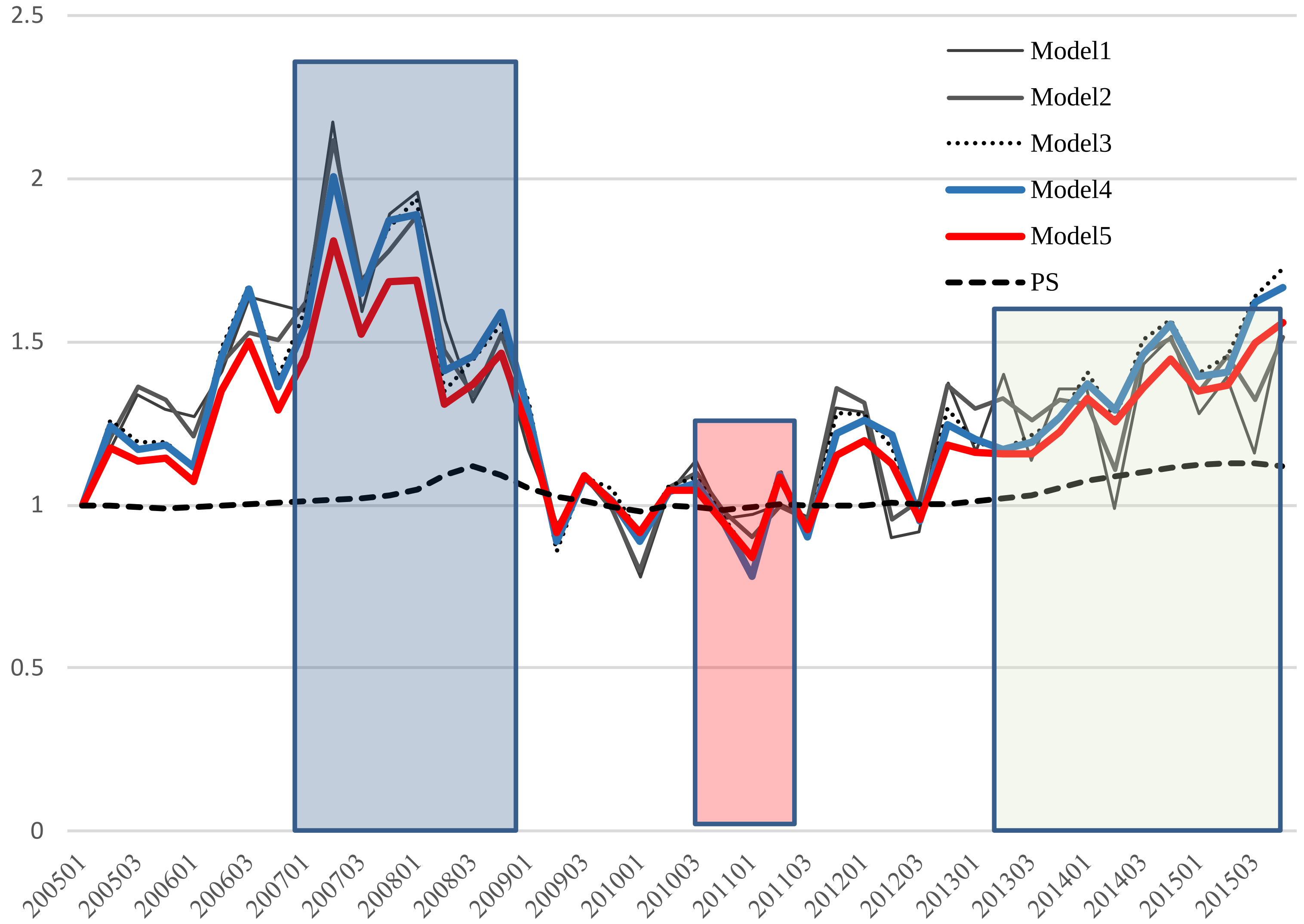
4. Results using the Builder's Model with Transaction Prices

Table3. Estimated Results of Builder's Model for Transaction Prices in Tokyo

Estimation Method	NL				
Number of Observations	1,968				
Dependent Variable	PL				V
Model	Model.1	Model.2	Model.3	Model.4	Model.5
A : Depreciation rate	-	-	-	-	0.065 (6.739)
DS:Distance to the nearest station (metre)	-	-	-	-0.0003 (-5.197)	-0.0002 (-4.972)
TT:Time to the Tokyo station (minutes)	-	-	-	-0.003 (-1.192)	-0.004 (-1.619)
WD_k(Location dummy)	Yes				
Dt (Time dummy)	Yes				
R-SQUARE	0.640	0.659	0.730	0.733	0.734
LOG-LIKELIHOOD FUNCTION	-13421.67	-13373.05	-13136.04	-13373.05	-13122.71

( ): t-Value

Figure 1. Quarterly Trends of PL and PS in Tokyo: Builder's Model



5. Comparison with Appraisal Prices and Assessment Prices

Table4. Estimated Results with Three Data Source in Tokyo

Estimation Method		NL	
DataSet	MLIT	REIT	PLP
Number of Observations	1,968	1,804	6,242
Dependent Variable	V	V	PL
A : Depreciation rate	0.067	0.036	
	(7.388)	(0.005)	
DS: Distance to the nearest station	-0.0002	0.0000	-0.0009
	-(5.689)	(0.000)	(0.000)
TT :Time to the Tokyo station	-0.004	-0.005	-0.022408
	-(2.125)	(0.002)	(0.001)
WD_k(Location dummy)		Yes	
Dt (Time dummy)		Yes	
R-SQUARE	0.728	0.869	0.857

( ): t-Value

Figure 2. Comparison of PL's from Three Data Sources and PS in Tokyo

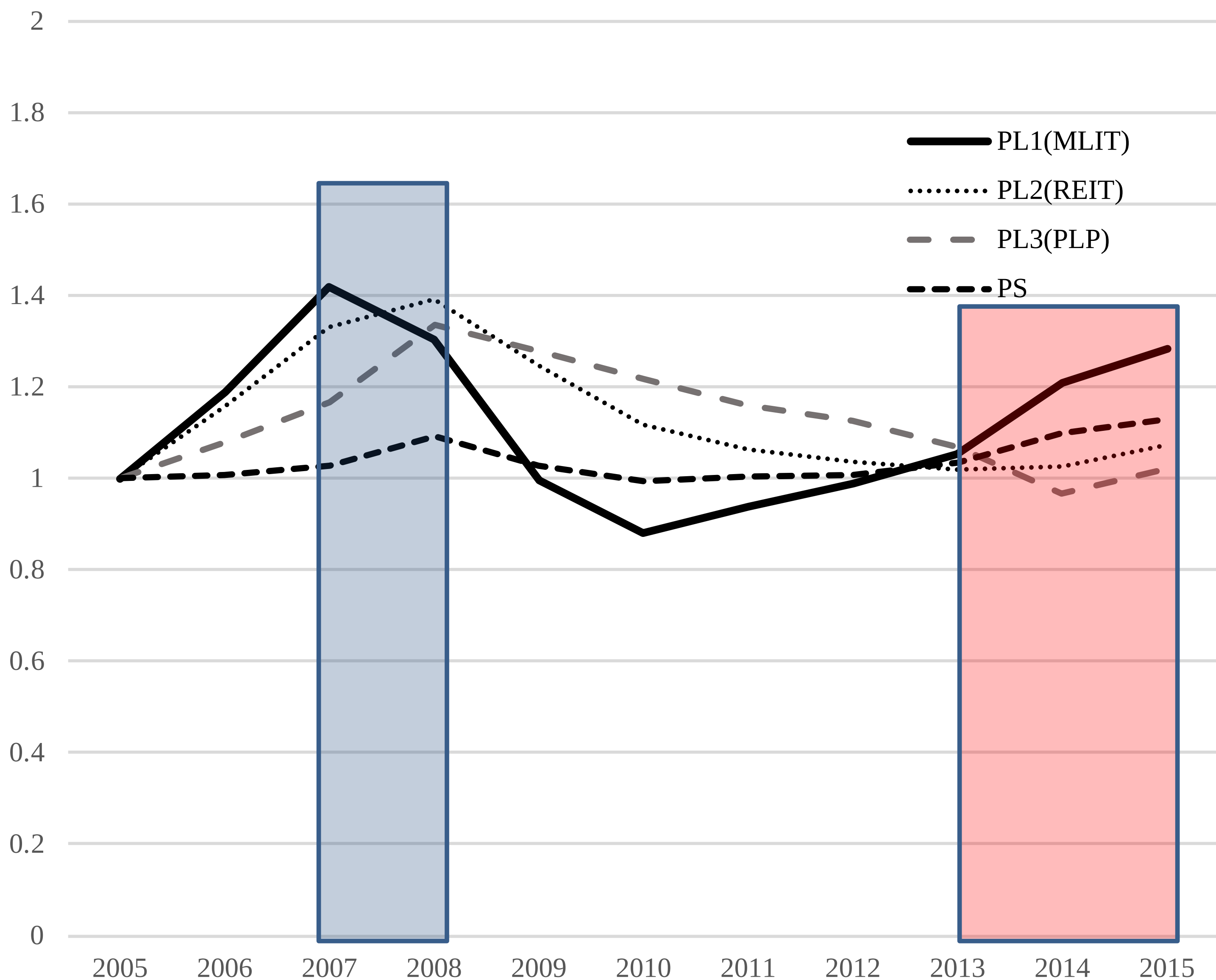
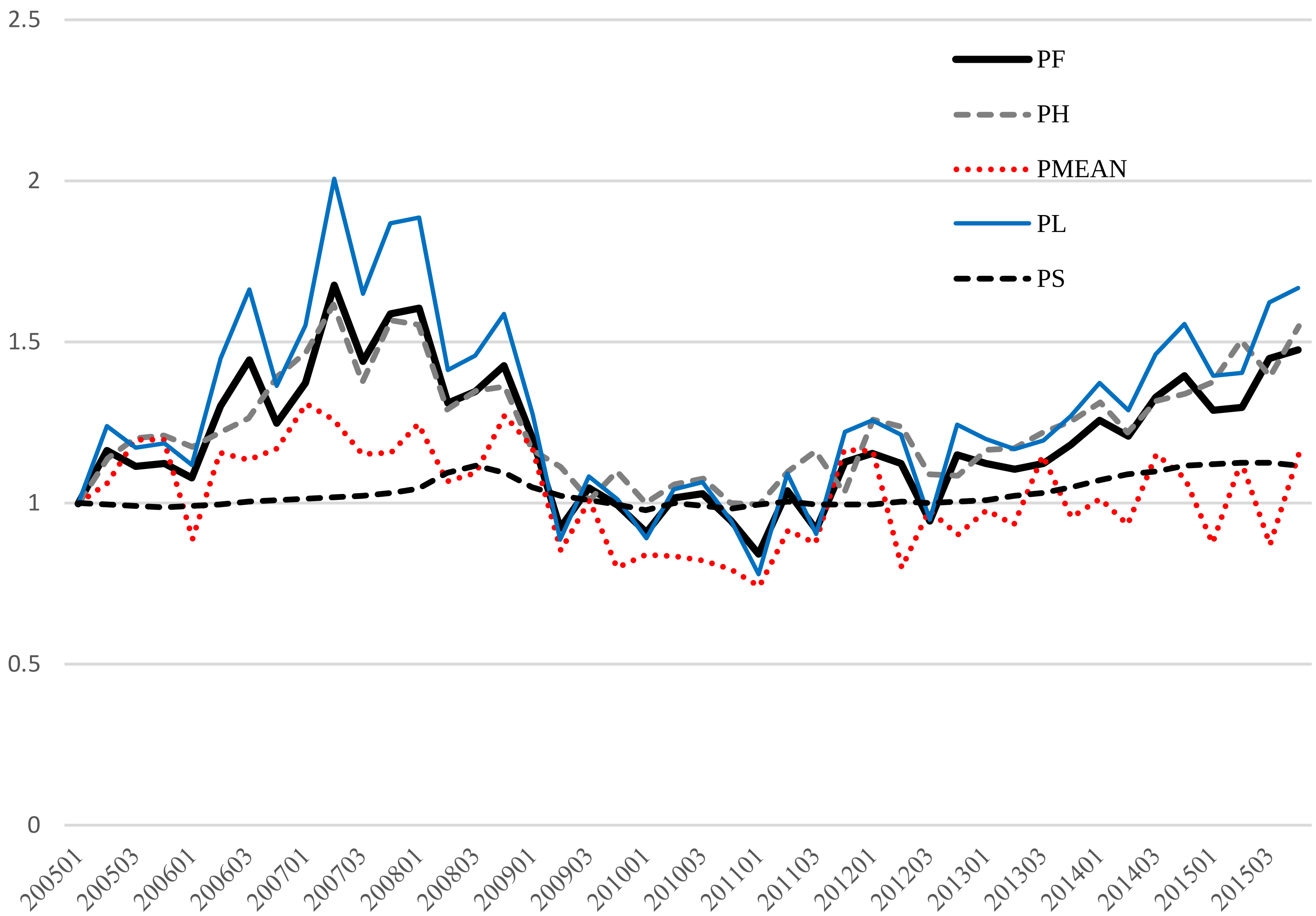


Figure 3. Overall Commercial Property Price Index



Conclusions

- The estimation of commercial property price indexes is ranked as one of **the most difficult measurements in economic statistics**.
- It is also one of the important components of SNA measurements. **For this purpose, indexes that separate land from structure are necessary**.
- When actually measuring these indexes, **the problem of selecting the estimation method and the data sources** must be confronted.
- It was demonstrated that the Builder's Model proposed by Diewert and Shimizu (2005a), (2006a) as an estimation method **for a Commercial Property Price Index** that separates land from structure, can also be used with a certain level of precision in the office market, which is ***highly heterogeneous*** compared to the residential housing market.

Conclusions

- Aside from transaction prices, the data source options used are: ***appraisal prices*** obtained from the real estate investment market and ***assessment prices*** for property tax purposes. However, it was established that compared to transaction price-based indexes, those based on ***appraisal and assessment prices exhibit a certain degree of lagging***.

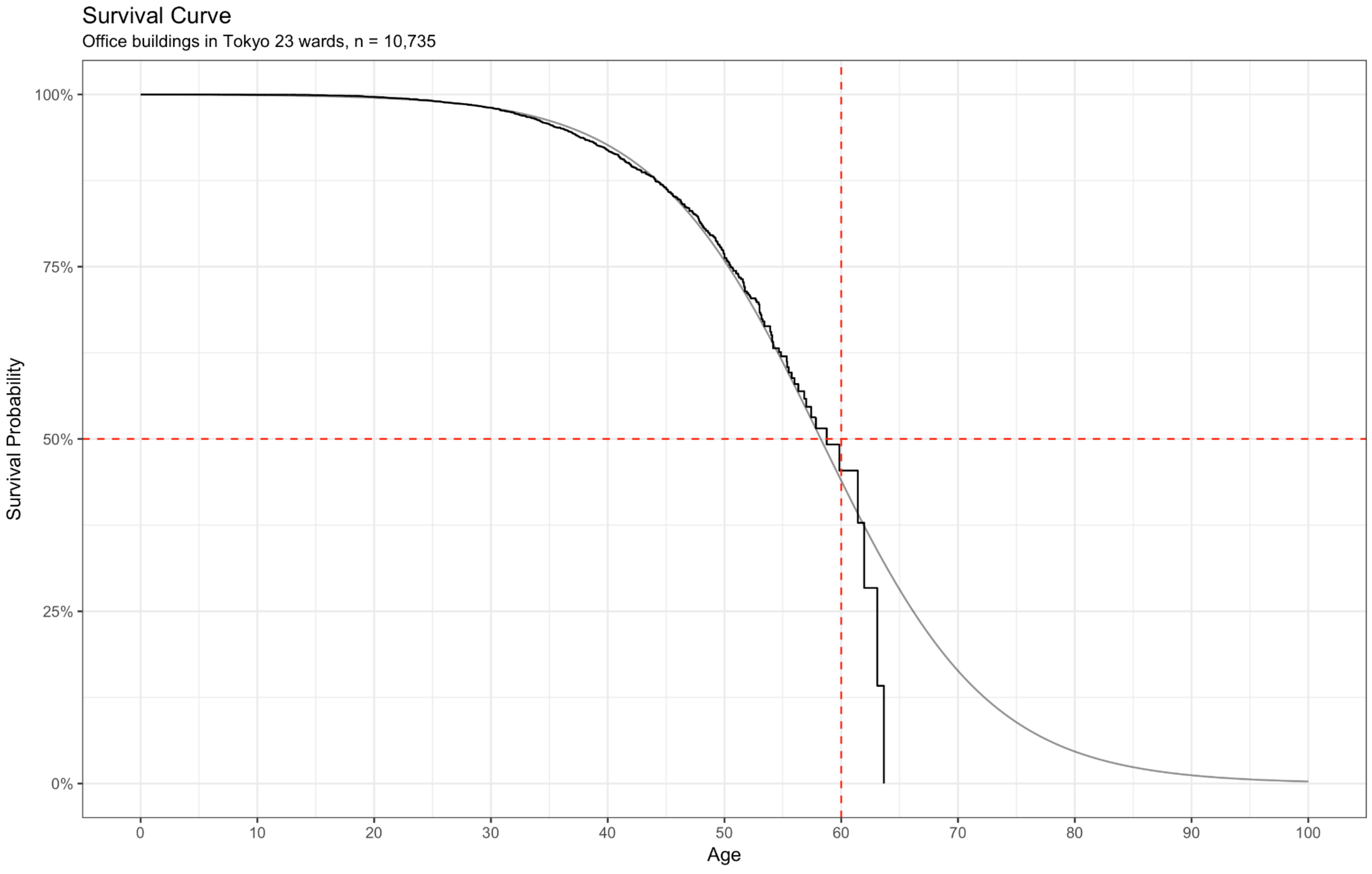
- Numerous problems still remain. In the realm of commercial properties, there are many other structures with **diverse uses, e.g. commercial establishments, hotels, and warehousing & distribution facilities**.

- In such markets, it is to be expected that transactions prices are even ***more scarce***, and properties, even more ***heterogeneous***, when compared to the office market.

Future Works

Research	Location	Depreciation Rate	Physical/ Functional Obsolescence	Demolition	Capital Improvement
Hulten, Wykoff (1981)	US	2.02% - 4.32%	Yes	No	No
Hayashi (1991) and ESRI (2011)	Japan	5.7%-7.2%	Yes	Yes	No
Diewert, Shimizu (2015)	Japan	2.5%	Yes	Yes	No
Yoshida(2016)	Japan	11.7%	Yes	Yes	No
Geltner, Bokhari (2016)	US	3.14% (Net Depr.)	Yes	Yes/No	No
		4.83% - 9.66% (Gross Depr.)	Yes	Yes/No	Yes
This Research	**Japan (Tokyo)**	**6.5% (Net Depr.)**	**Yes**	**No**	**No**

Future Works: Survival Curve



Future Works: Capital Improvement Expenditures/Age Profile