

Matching Indices for Thinly-Traded Commercial Real Estate in Singapore

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Outline of Presentation

- Motivations of study
- Commercial real estate (CRE) indices methodologies
 - Hedonic Model
 - Repeat Sales Regression (RSR)
 - Matched Sample Regression
- Singapore's CRE market and indices
- Data and Empirical Analysis
- Conclusion

Motivations of study

- Commercial real estate (CRE) are thinly transacted and transactions are lumpy
- The dearth of CRE transaction data makes it difficult to construct transaction-based indices
- This paper uses a propensity score matching technology to construct CRE indices based on comparable sales occurring in two different periods (treatment versus control)
- Using CRE transaction data from Singapore's markets from 1995Q1 to 2011Q4

Appraisal-based CRE indices

- The appraisal-based NCREIF property indices are the de-facto benchmarks of CRE performance in the US
- Appraisers' reliance on past information caused lagged errors/biases in current appraised values
 - Quan and Quigley, 1991; Cho and Megbolugbe, 1996; Chinloy, Cho and Megbolugbe, 1997; Clayton, Geltner and Hamilton, 2001
- Various de-lagging and de-smoothing procedures are used to uncover the true volatility of appraisal indices
 - Geltner 1989, 1991, 1993; Fisher, Geltner and Webb, 1994; Cho, Kawaguchi and Shilling, 2003; Fu, 2003; An, Deng, Fisher and Hu, 2012

Repeat Sale Regression (RSR) Indices

- RSR indices are widely used in residential property markets
 - Bailey, Muth and Nourse (1963) and Case and Shiller (1987, 1989)
- The first NCREIF transaction based index (NCREIF-TBI) was developed by MIT Center for Real Estate in 2006
- However, the use of RSR in CRE markets is restrictive
 - RSR sampling process restricts data set to properties that sell twice within a sample period
 - Potential sample selection bias occurs when more frequently transacted properties have higher price changes (Haurin and Hendershott, 1991; Munneke and Slade, 2000 and 2001)
 - Asymmetry in the number of transaction activities (liquidity) during up and down markets (Fisher, Gatzlaff, Geltner and Haurin, 2004)

Advancements in RSR estimator in markets with thin transactions

- Bayesian estimators to simulate RSR commercial indices from stock price data (Goetzmann, 1992; Kuo, 1997; Peng, 2002; Goetzmann and Peng, 2002).
- Heckman's two-stage methodology that corrects for biases of unsold properties (Munneke and Slade, 2000 and 2001)
- Constant-liquidity RSR NCREIF commercial real estate indices (Fisher, Gatzlaff, Geltner and Haurin, 2003) that adjust for asymmetric liquidity
- Modeling spatial-temporal variations in price changes across different submarkets (Tu, Yu and Sun, 2004; Hayunga and Pace, 2010)

Matching Methodology in thinly traded CRE markets

- Matching pairs of CRE transactions based on characteristics of location and structure of properties that are sold in the based (control) period and later (treatment) time
- RSR indices are an extreme form of matching in which each observation is paired with its closest neighbor – itself
- Matching estimator overcomes technical constraints in illiquid markets
 - It is not restricted to a small number of non-random repeat transaction
 - It is less sensitive to changes in sample composition across transaction periods
 - It could explicitly account for variations across different price quantiles over time

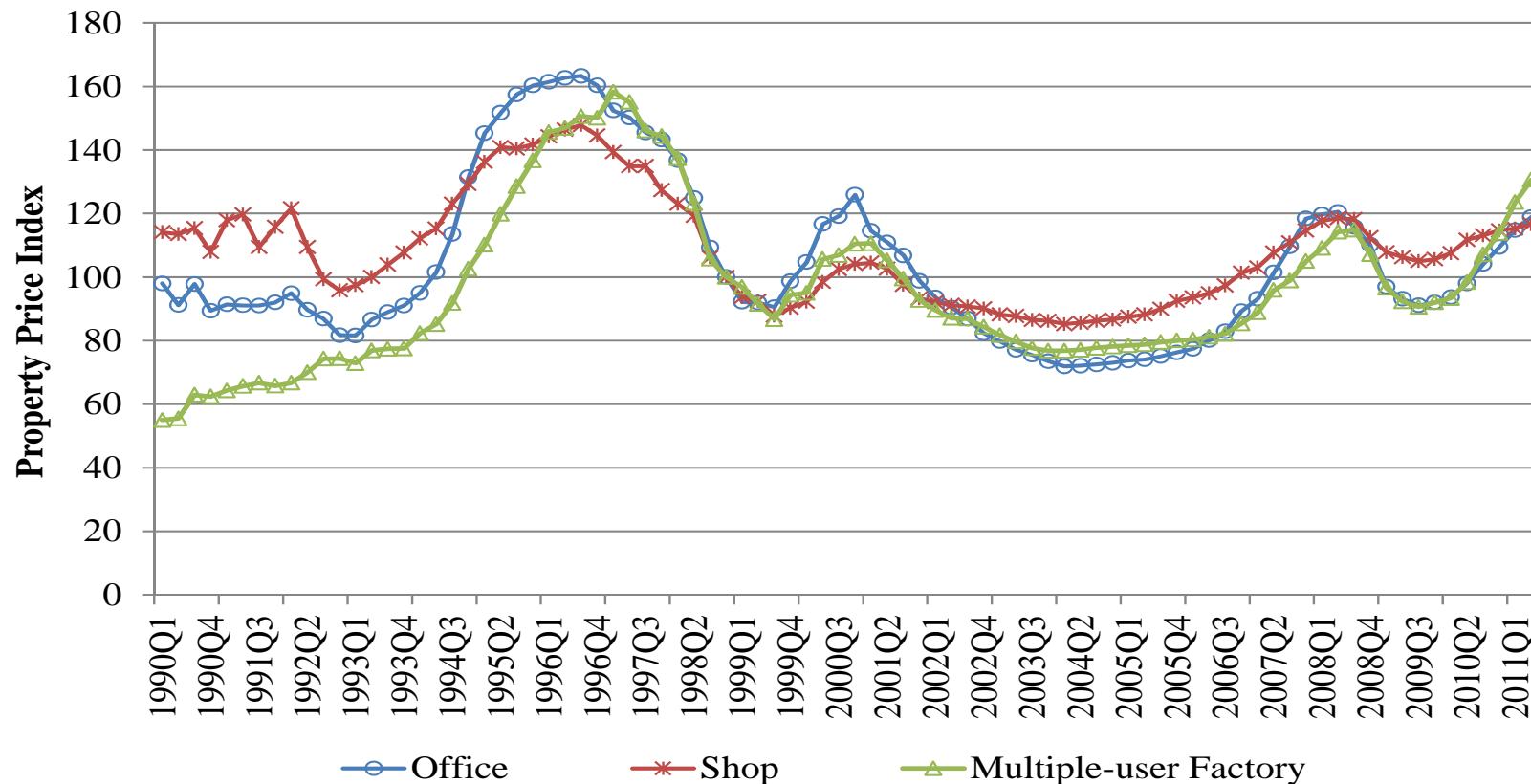
Singapore's CRE markets

- Private developers are the main suppliers of CRE, and lands for commercial developments are primarily sold in the government's land sale programs
- Development strategies:
 - Prior to 2002 – “build and hold” by developers for long-term investment
 - After 2002 – build and inject into S-REITs
- Modes of sales of CRE: whole sales versus strata sales
- Strata-sales involves sale of subdivided space separately to individual buyers, and the buyers jointly own the land rights and they share the common areas in CRE development
- Strata-titled CRE is small and fragmented

URA CRE indices

- Urban Redevelopment Authority (URA) of Singapore construct transaction based CRE indices in Singapore using strata-sales of CRE
- Four CRE indices for office, shop, multiple-user factory and multiple-user warehouse; and sub-indices by location
- URA Indices are Laspeyres median price indices published quarterly
- CRE transactions in each quarter are first grouped by property type and locality, and unit median prices (\$/sqm) for each group are used to compute different sub-indices by type and location (planning areas)
- URA indices are weighted by moving average of the previous 12-quarter CRE transactions

URA[®] Commercial Real Estate Indices



@URA, or Urban Redevelopment Authority, is a government agency that constructs and publishes the widely used private commercial real estate indices in Singapore.



RSR Models

- Hedonic price function for CRE, where y_{it} is the natural log-sale price of property is defined as

$$y_{it} = \sum_{t=1}^T \delta_t D_{it} + \beta_t' X_{it} + \lambda_t' Z_{it} + u_{it}$$

- Repeat sale price function by (Bailey, Muth and Nourse, 1963; Case and Shiller, 1987, 1989) defines price growth (first order difference in log-price) as

$$y_{it} - y_{is} = (\delta_t D_{it} - \delta_s D_{is}) + (u_{it} - u_{is})$$

Matching Strategy

- Matching strategy is a two-period RSR model with constant coefficient, which is defined as

$$y_{i,2} - y_{i,1} = (\delta_2 - \delta_1)D_{i,2} + u_{i,2} - u_{i,1}$$

- The time dummy $D_{i,2}$ estimates the differences in average log-sale prices between control and treatment periods
- The average treatment effect (ATE) is defined as

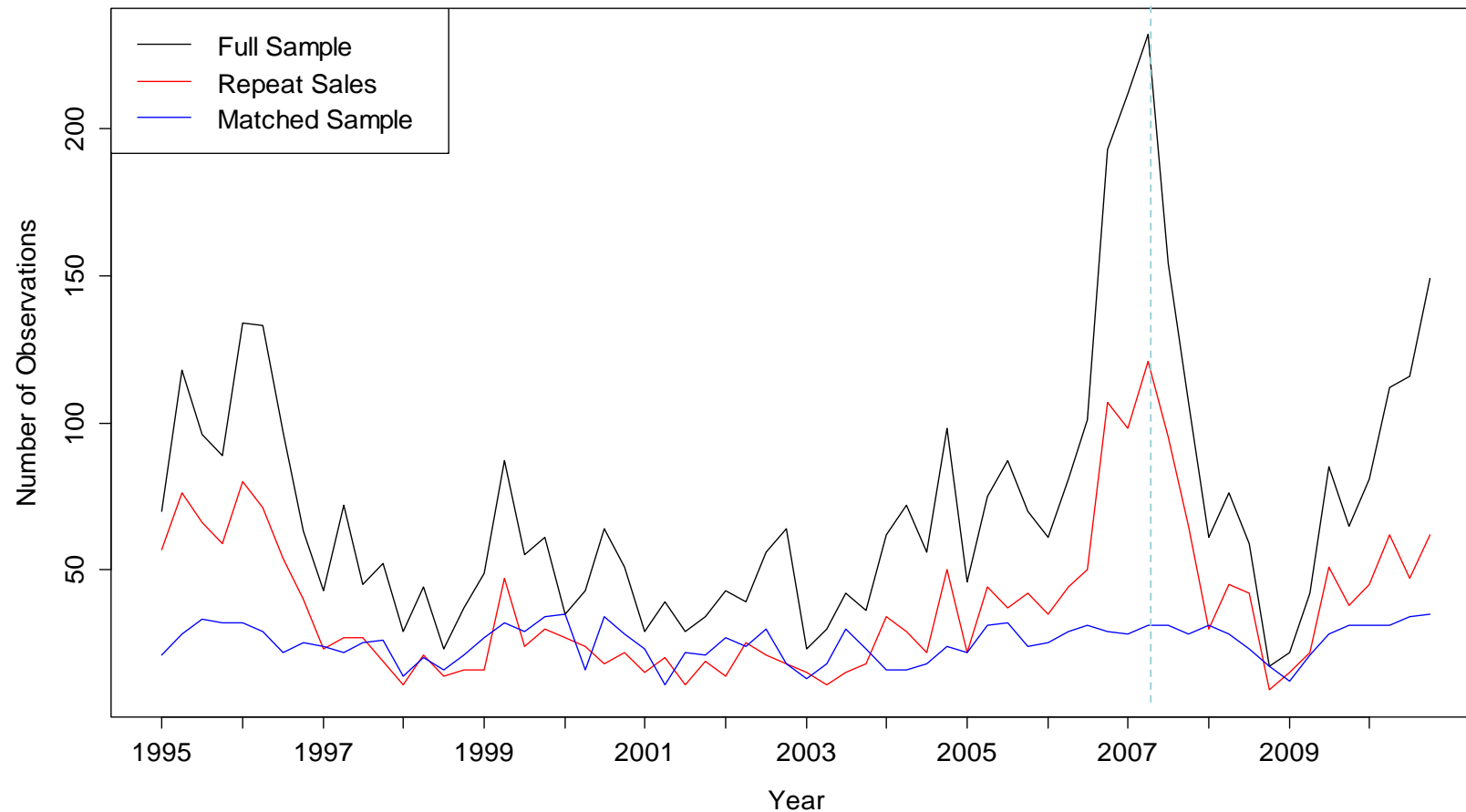
$$ATE(t_j) = \frac{1}{n_j} \sum_{i=1}^{n_j} D_{ij} E[y_i(t_j) - y_i(t_1)]$$

- Based on propensity score approach, the “treatment” is a sale at time t and the “control” is a sale at time 1, and the predicted value from a Probit model of sale time is used to construct the matches.

Data

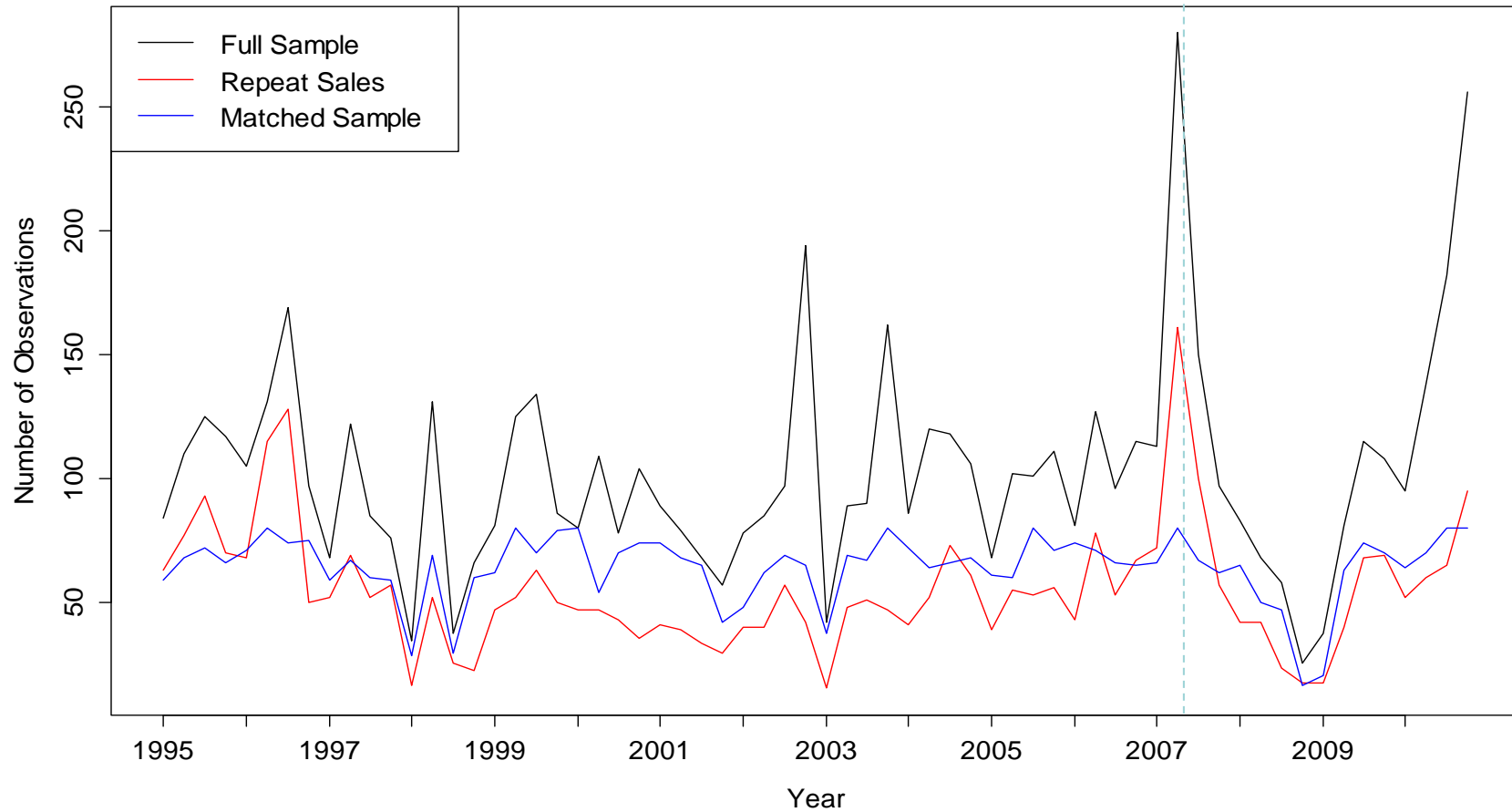
- This study uses CRE transaction data from URA's Real Estate Information System (REALIS), which is the same data source used to construct the URA CRE indices
- Cover the sample period from 1995Q1 to 2011Q2
- A total of 22,842 sales consisting of 4,646 office, 6,601 shop and 11,595 multiple-user factor sales
- Units sold at least twice (repeat sales) during the sample period account for 2,434 (office), 3,526 (shop) and 4,486 (multiple-user factory)
- For matching samples, we have 1,622 (office), 4,103 (shop) and 7,298 (multiple-user factory) using 1995Q1 as the base period

Number of transactions by quarter (1)



Office

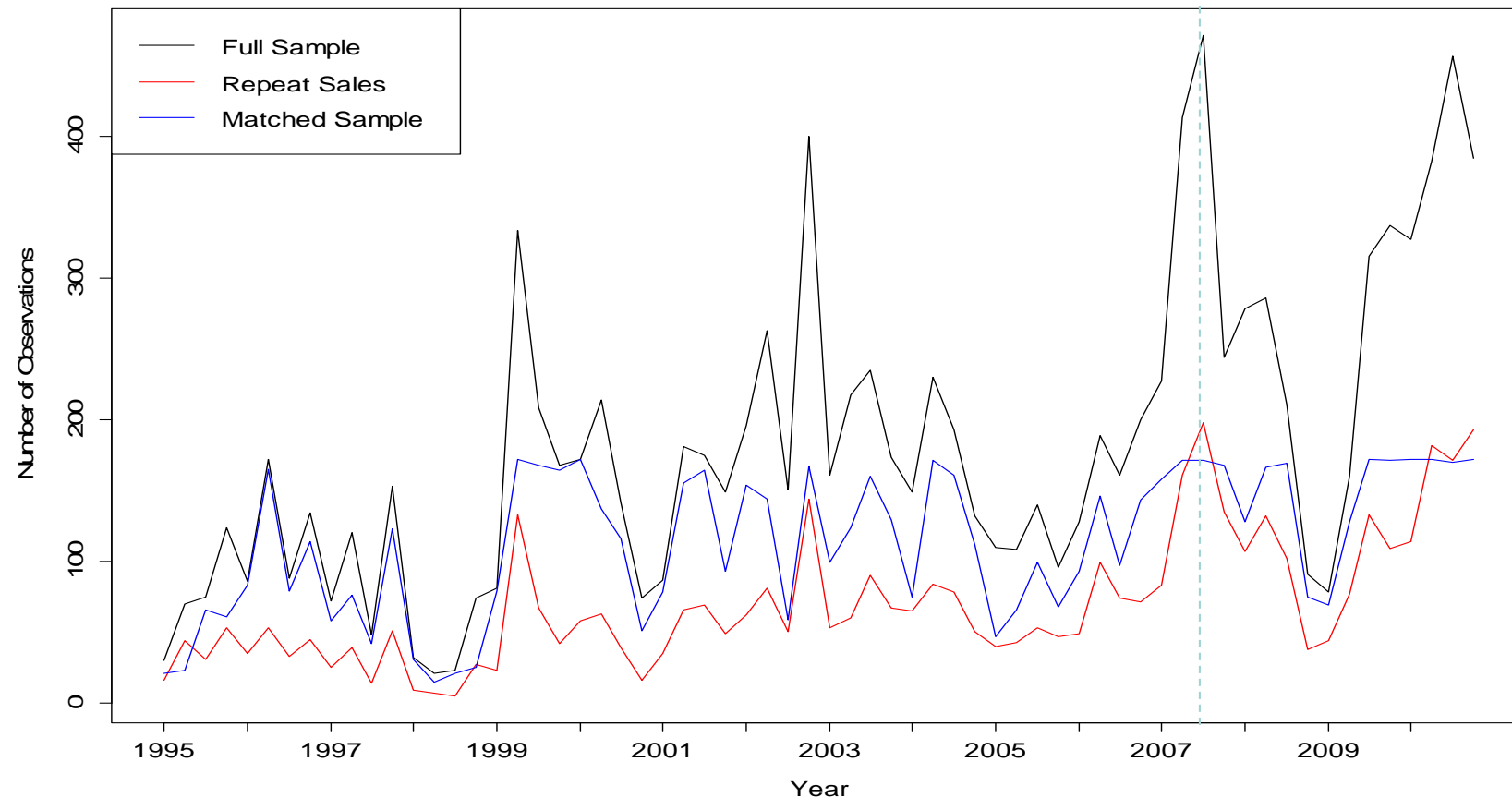
Number of transactions by quarter (2)



Shop



Number of transactions by quarter (3)



Multiple-user factory

Descriptive statistics

Descriptive Statistics	Office			Shop			Multiple-user Factory		
	Full	Repeat Sales	Matched	Full	Repeat Sales	Matched	Full	Repeat Sales	Matched
Number of Observations	4646.0	2434.00	1622.00	6601.00	3526.00	4103.00	11595.00	4486.00	7298.00
<u>A) Property Attributes:</u>									
Log Sale Price (in Singapore Dollars)	13.63 [1.20]	13.52 [1.09]	13.26 [1.04]	13.26 [0.91]	13.15 [0.82]	13.20 [0.86]	13.22 [0.72]	13.18 [0.71]	13.29 [0.72]
Log Floor Area of Unit (in square meters)	4.42 [1.00]	4.28 [0.87]	4.18 [0.85]	3.72 [0.85]	3.65 [0.73]	3.63 [0.77]	5.39 [0.73]	5.36 [0.74]	5.47 [0.71]
<u>B) Location Attributes (km):</u>									
Log Distance to CBD	0.75 [0.92]	0.76 [0.87]	0.71 [0.75]	1.17 [0.85]	1.11 [0.79]	1.07 [0.81]	2.25 [0.49]	2.21 [0.49]	2.22 [0.52]
Log Distance to Airport	2.78 [0.16]	2.79 [0.15]	2.77 [0.17]	2.77 [0.25]	2.76 [0.24]	2.78 [0.23]	2.81 [0.44]	2.78 [0.44]	2.72 [0.40]
Log Distance to Seaport	1.06 [0.66]	1.04 [0.64]	1.17 [0.67]	1.59 [0.58]	1.55 [0.54]	1.53 [0.53]	2.38 [0.46]	2.34 [0.47]	2.38 [0.49]
Log Distance to nearest MRT or LRT Station	-1.32 [1.22]	-1.34 [1.22]	-0.99 [0.85]	-1.16 [1.04]	-1.14 [1.03]	-1.22 [1.05]	0.02 [0.63]	0.02 [0.63]	-0.01 [0.63]
Log Distance to Expressway	-0.65 [0.71]	-0.67 [0.72]	-0.53 [0.59]	-0.42 [0.77]	-0.42 [0.74]	-0.38 [0.70]	-0.59 [1.27]	-0.69 [1.26]	-0.44 [1.24]

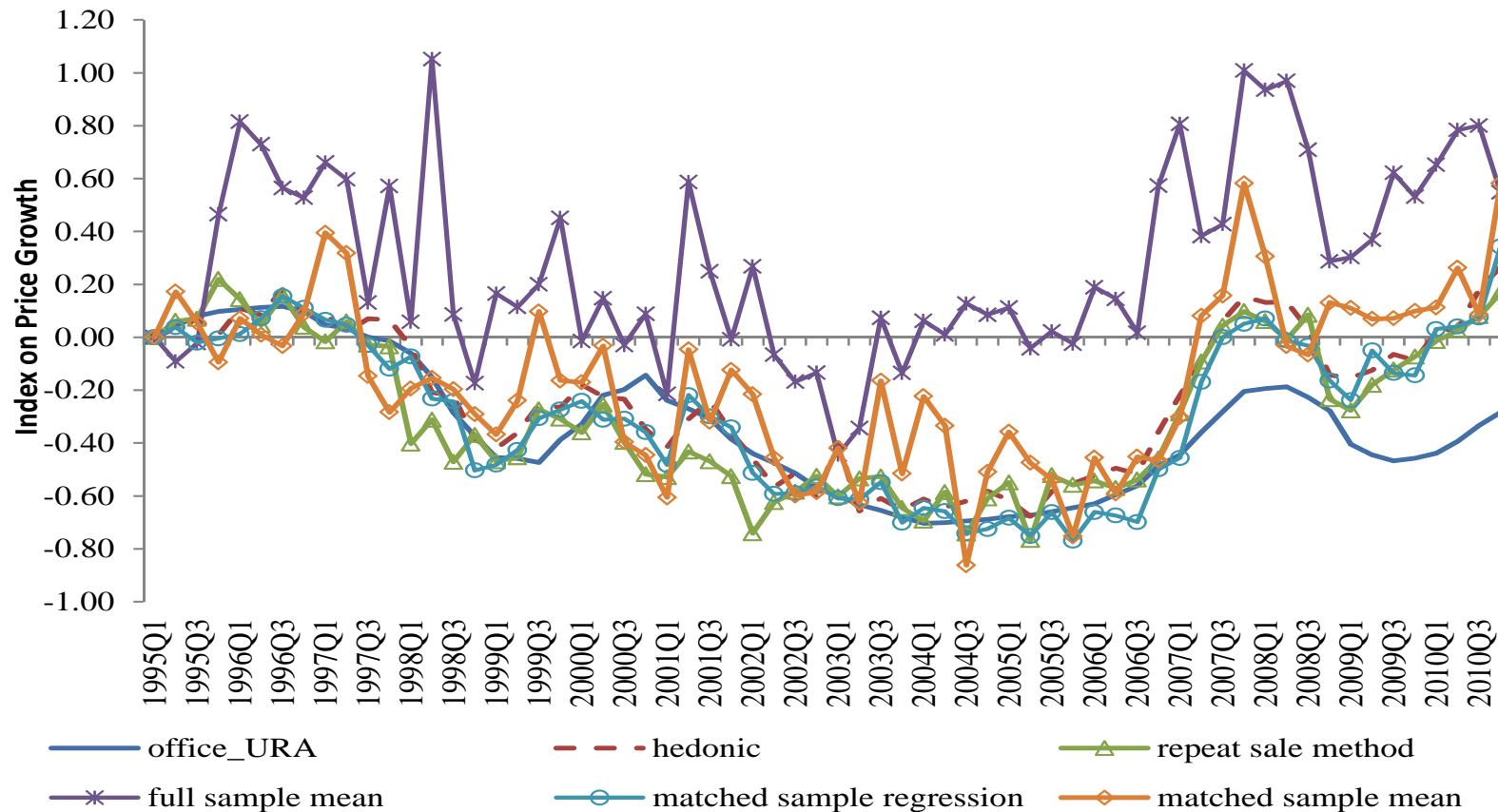
Descriptive statistics (2)

Descriptive Statistics	Office			Shop			Multiple-user Factory		
	Full	Repeat Sales	Matched	Full	Repeat Sales	Matched	Full	Repeat Sales	Matched
Number of Observations	4646.00	2434.00	1622.00	6601.00	3526.00	4103.00	11595.00	4486.00	7298.00
<u>C) Neighborhood Attributes (Yes =1; No =0)</u>									
Inside of CBD	0.52 [0.50]	0.52 [0.50]	0.54 [0.50]	0.28 [0.45]	0.31 [0.46]	0.29 [0.45]	0.00 [0.00]	0.00 [0.00]	0.00 [0.00]
MRT or LRT Station within 0.3km	0.92 [0.27]	0.94 [0.25]	0.93 [0.26]	0.87 [0.34]	0.87 [0.34]	0.89 [0.31]	0.32 [0.47]	0.34 [0.47]	0.36 [0.48]
Expressway with 0.3km	0.88 [0.33]	0.90 [0.30]	0.89 [0.31]	0.71 [0.45]	0.72 [0.45]	0.71 [0.46]	0.62 [0.49]	0.64 [0.48]	0.59 [0.49]
Shopping Center within 0.3km	1.00 [0.02]	1.00 [0.00]	1.00 [0.00]	0.98 [0.14]	0.98 [0.13]	1.00 [0.06]	0.34 [0.47]	0.35 [0.48]	0.31 [0.46]
Public Housing within 0.3km	0.84 [0.37]	0.83 [0.37]	0.85 [0.36]	0.82 [0.39]	0.80 [0.40]	0.80 [0.40]	0.69 [0.46]	0.75 [0.43]	0.74 [0.44]
Building with Car-park	0.64 [0.48]	0.67 [0.47]	0.80 [0.40]	0.71 [0.45]	0.75 [0.43]	0.77 [0.42]	0.11 [0.31]	0.10 [0.29]	0.08 [0.27]

Matching indices for Singapore's CRE markets

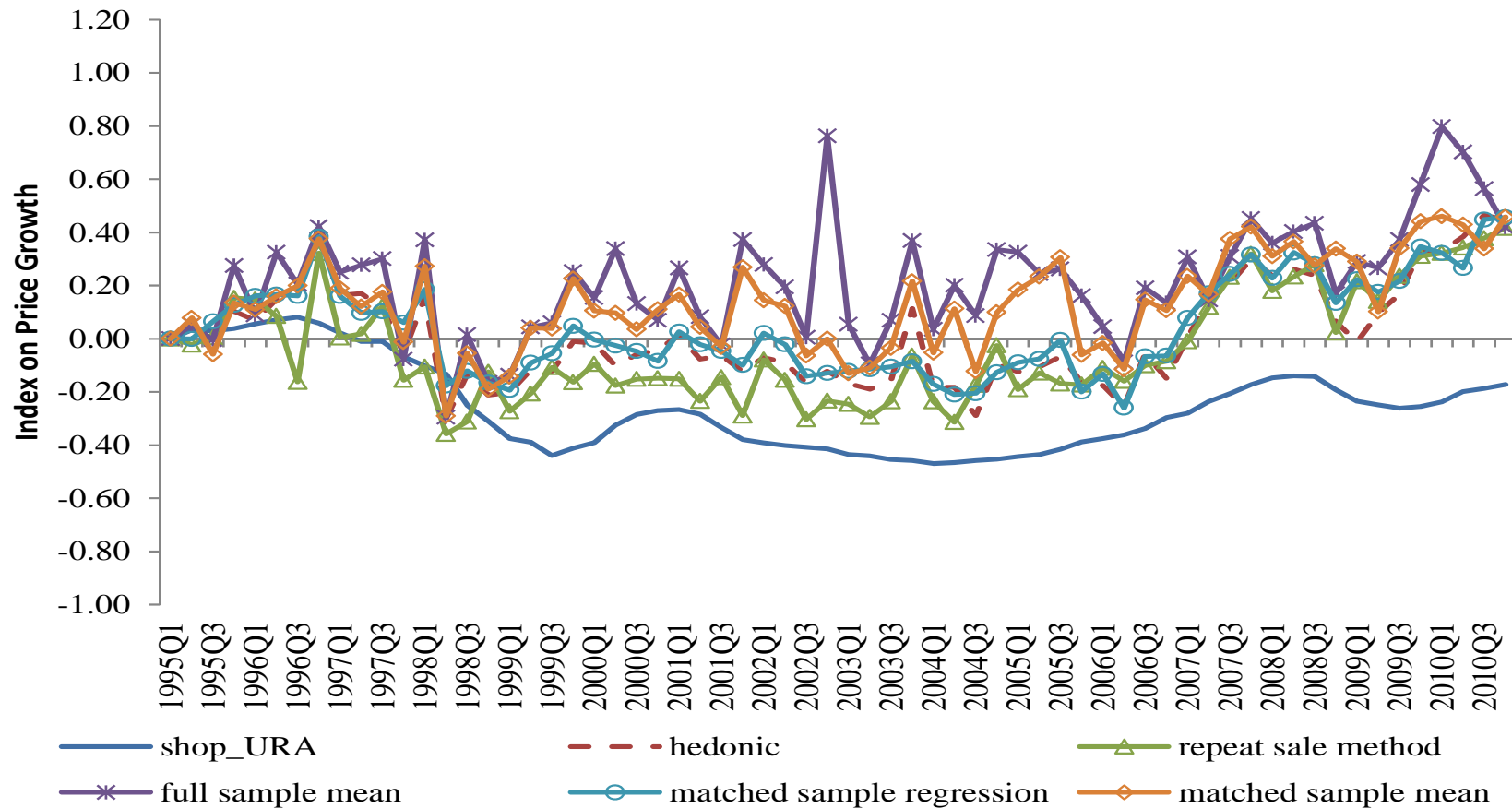
- We estimate the hedonic, repeat sale sample and matched sample price indices
- We plot the indices alongside with the full-sample and matched-sample means and URA CRE indices (see figures)
- The indices are much more volatile than URA CRE indices but they closely track the long-term movements
- We recovered the unmatched samples and compare the indices estimated using matched and unmatched samples (see figures)
- We plot the kernel density of log-price distributions the two periods in 1998 and 2008 (figures)
- The quantile distributions are also analyzed (figures)

Matched CRE indices and other indices (1)



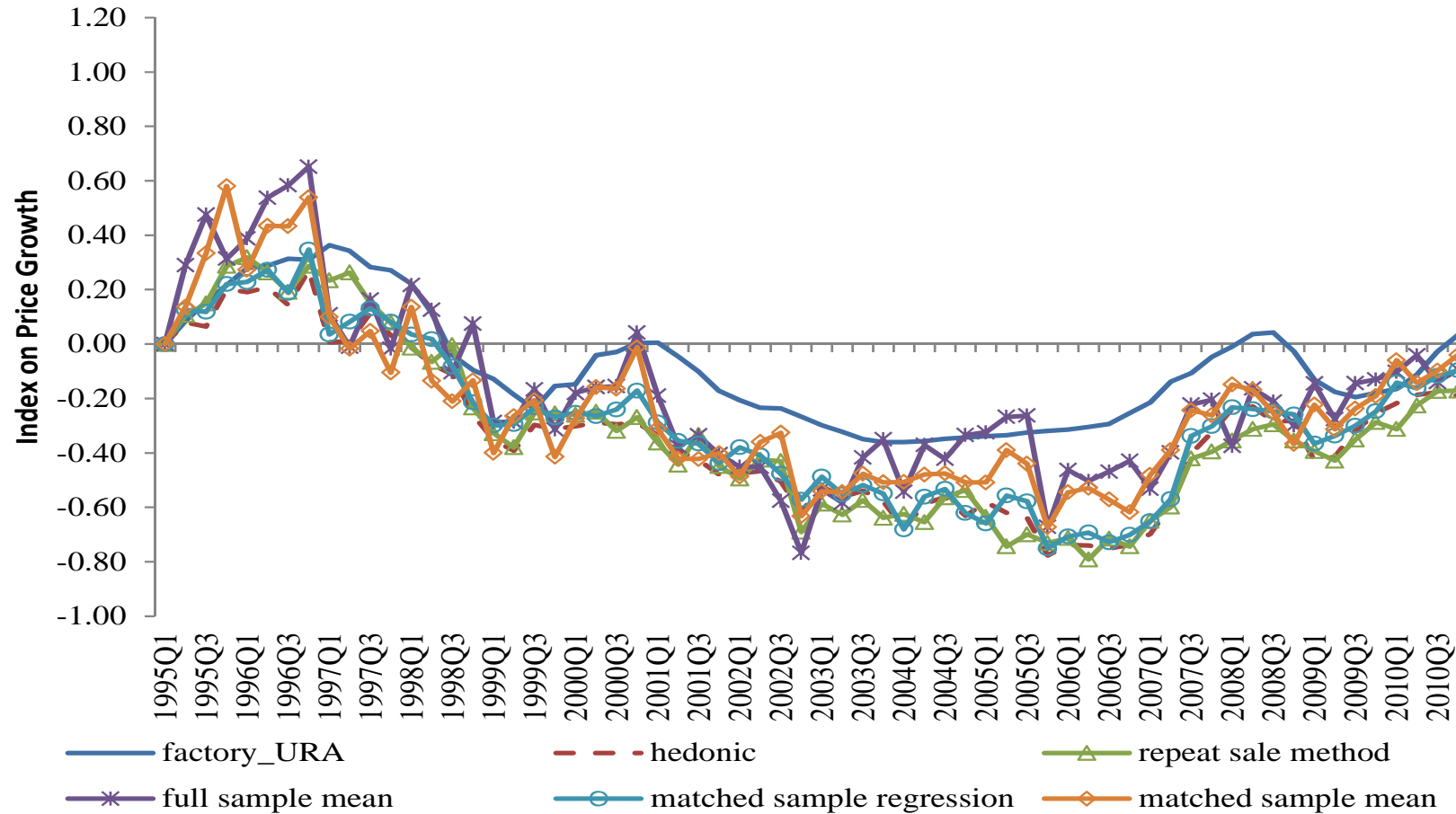
Office

Matched CRE indices and other indices (2)



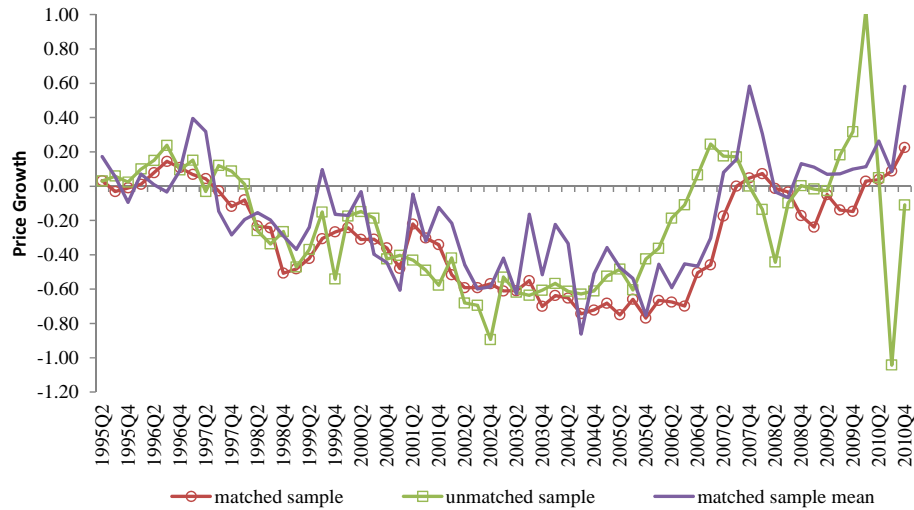
Shop

Matched CRE indices and other indices (3)

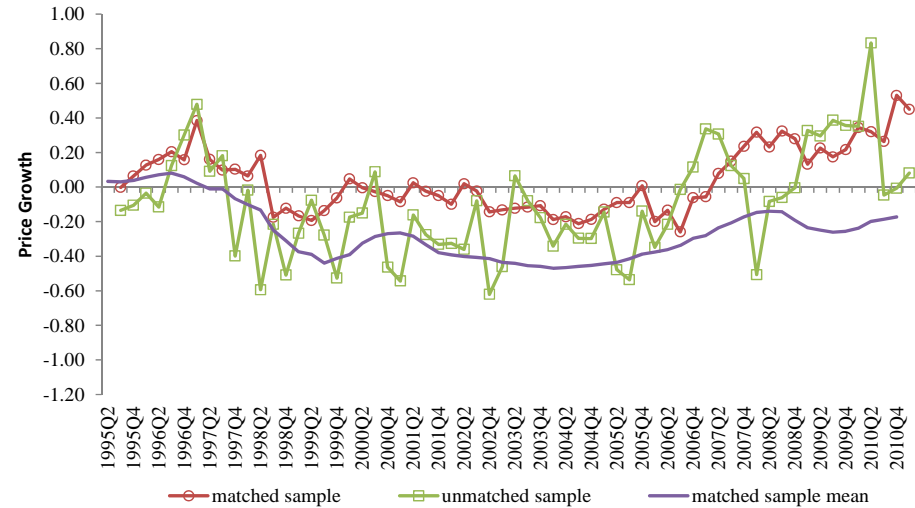


Multiple-user factory

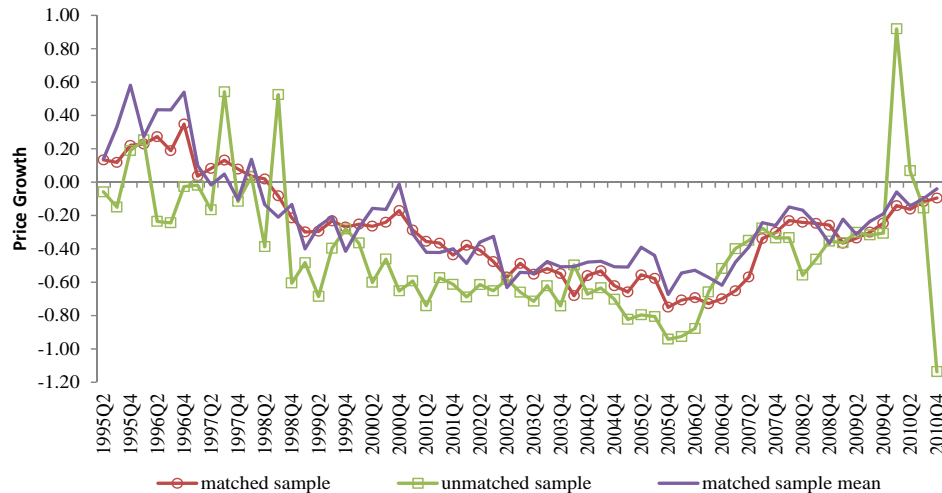
Matched and Unmatched Indices



Office



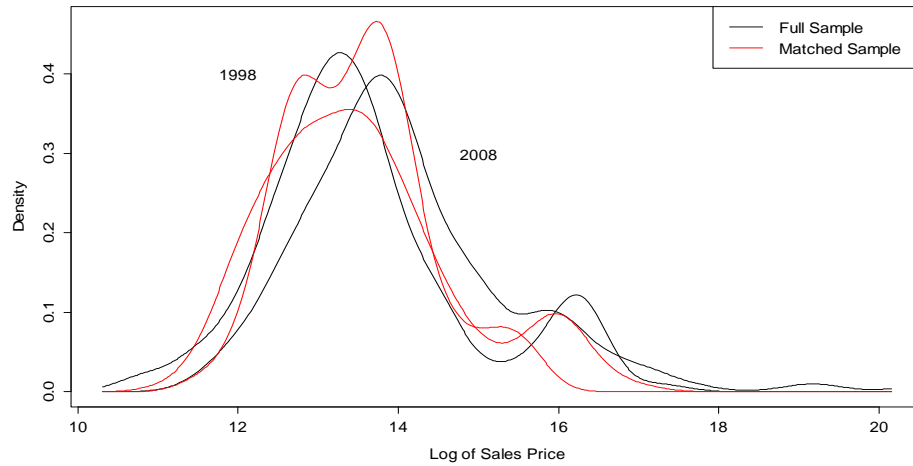
Shop



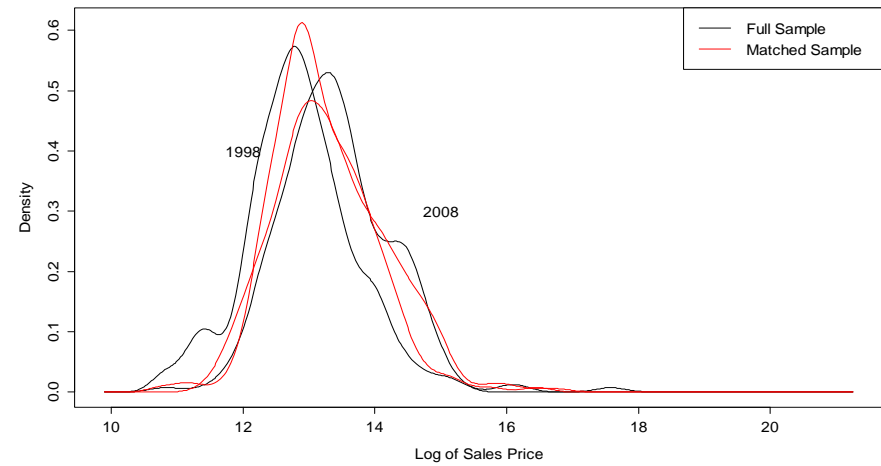
Multiple-user factory



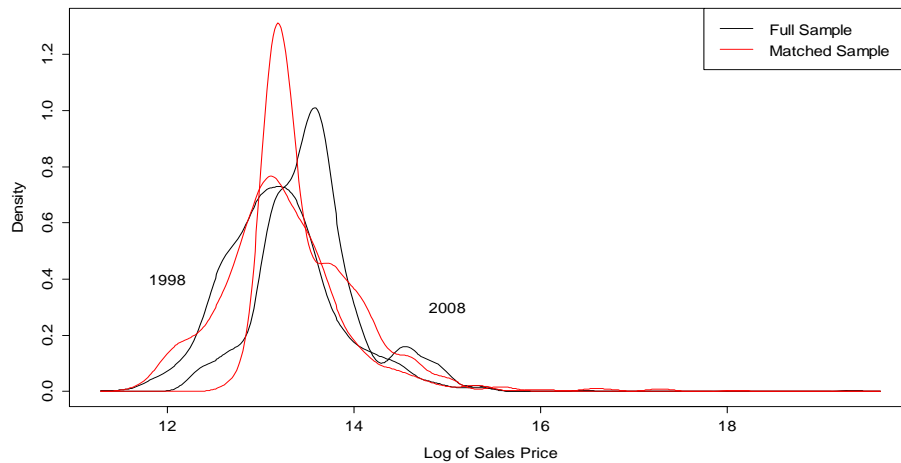
Sale Price Density



Office

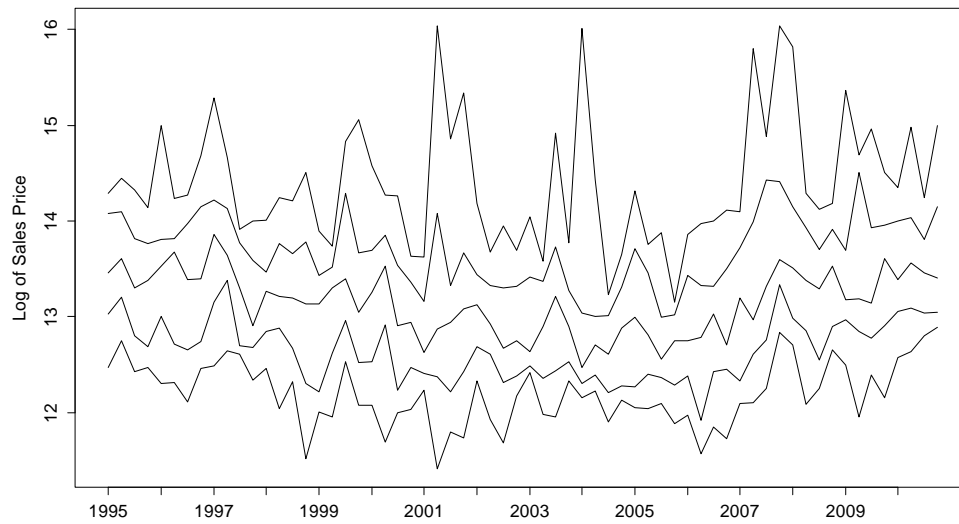


Shop



Multiple-user factory

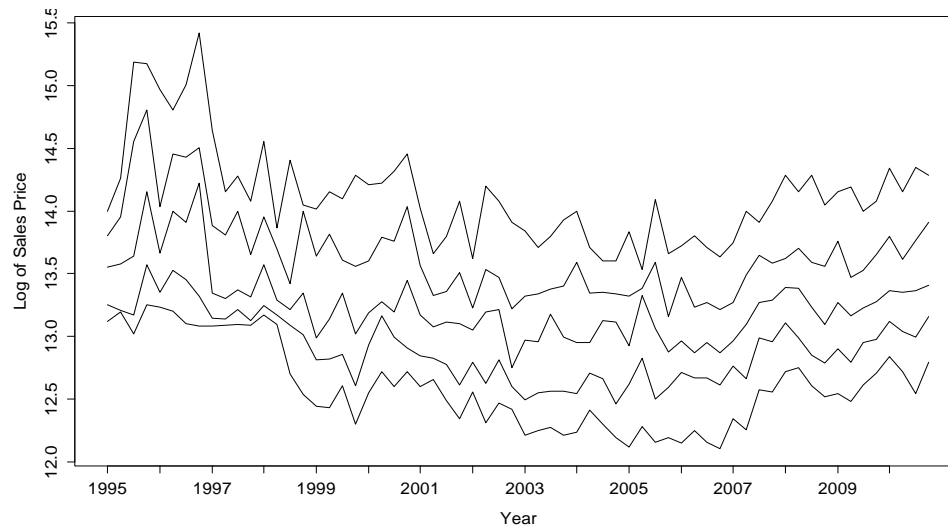
Price Quantiles for Matched Sample



Office



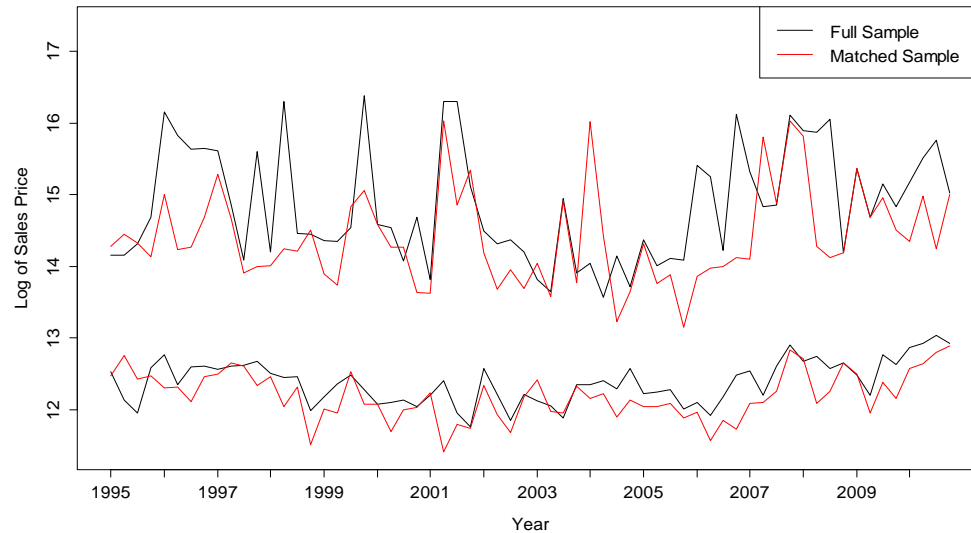
Shop



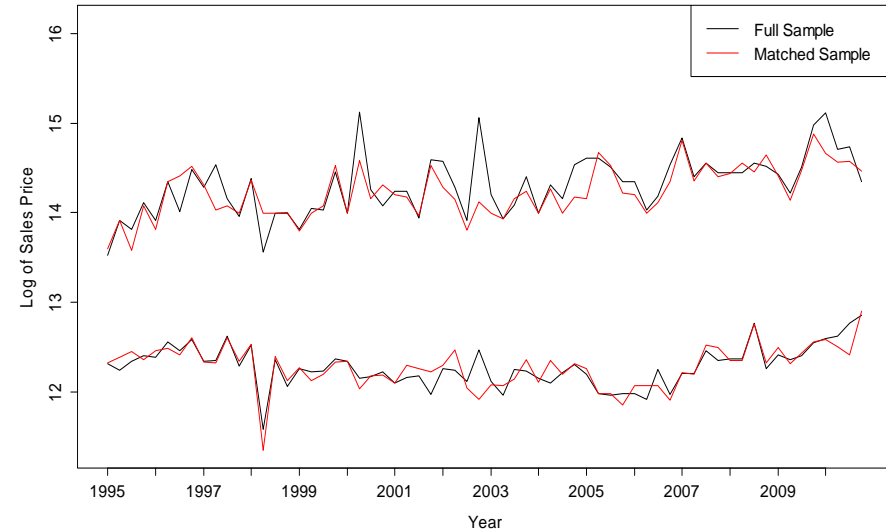
Multiple-user factory



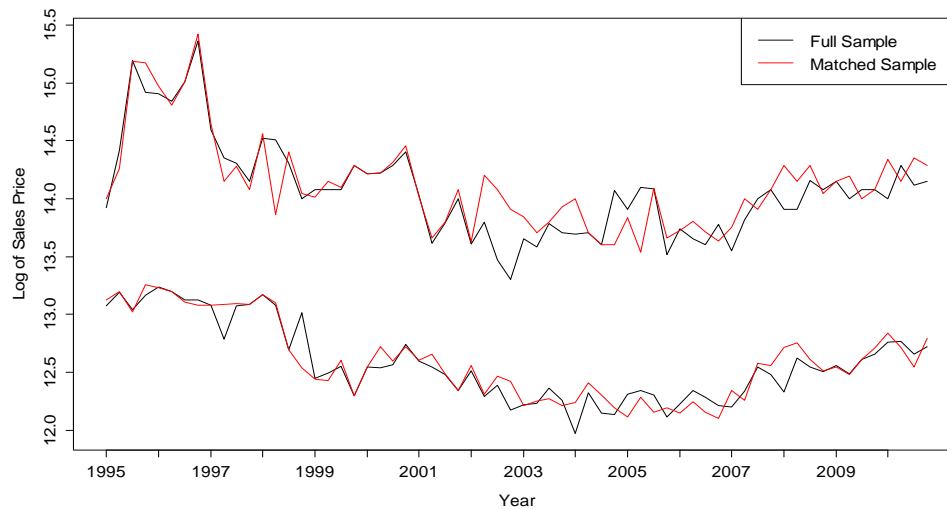
10th and 90th Percentiles of Log Sale Prices



Office



Shop



Multiple-user factory



Conclusion

- Non-random and thin transactions in CRE markets have been challenging for researchers of CRE indices
- RSR methodology that restricts the samples to pairs of identical properties sold at least twice over time could be restrictive in an illiquid CRE market
- Matching procedure offers an alternative way of dealing with the non-random and thin transactions in CRE markets
- The conventional RSR could be a special case of matching
- Matched indices are less sensitive to small number of unrepresentative repeat sales
- Percentile distributions generated by matched samples add further information on time variations in CRE prices

THANK YOU!