Construction of Stock Based Property Price Index Controlling Debt and Transaction Costs.

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0. Motivations.

G20 Data Gap Initiative 2009.

- International Conference on Commercial Property Price Indicators on 10-11 May 2012 in the European Central Bank (Frankfurt).

“Biases in Commercial Property Price Indexes”

Lessons from Japanese experience in Bubble period.

- **What happen during "Collapse of Bubble" in Japan:**
- The most typical problem was the one surrounding financial institutions' **disposal of bad loans**.

- Since no 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 public funds**.

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

Commercial Real Estate Price Information in Japan.

Survey	Organisation	Type1	Type2	Frequency	Availability
Published Land Price Survey	The Ministry of Land, Trafic and Infrastructure	Appraisal	Price & index	Annual	1970
Urban Land Index	Japan Real Estate Association	Appraisal	Index	Bi-annually	1955
IPD Property Index	IPD: Investment Property Databank	Appraisal	Index	Monthly	2001
ARES JREIT Property Index	The Association fro Real Estate Securitization	Appraisal	Index	Quarterly	2001
MUTB-CBRE Real Estate Investment Index	Mitsubishi-UFJ Trust Bank & CB Richard Ellis	Appraisal	Index	Yearly	1968

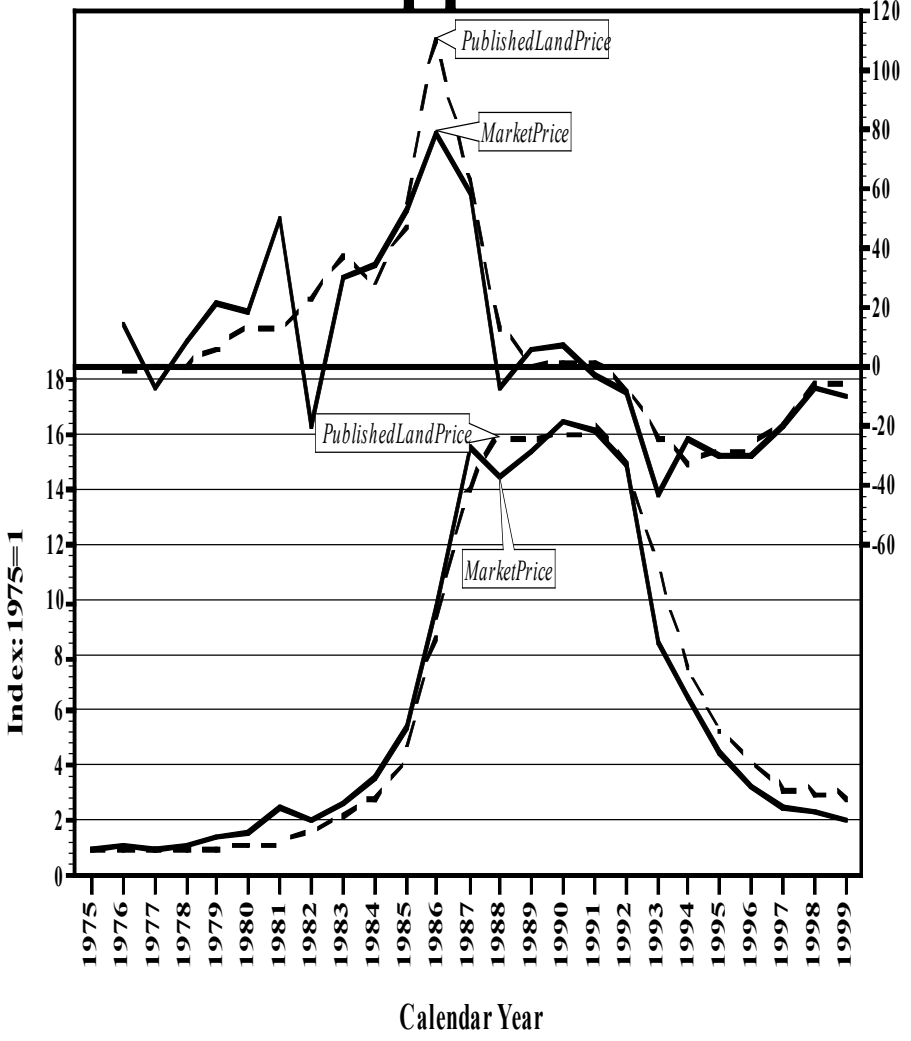
Why J-CPPI were *not effective* in policy management?

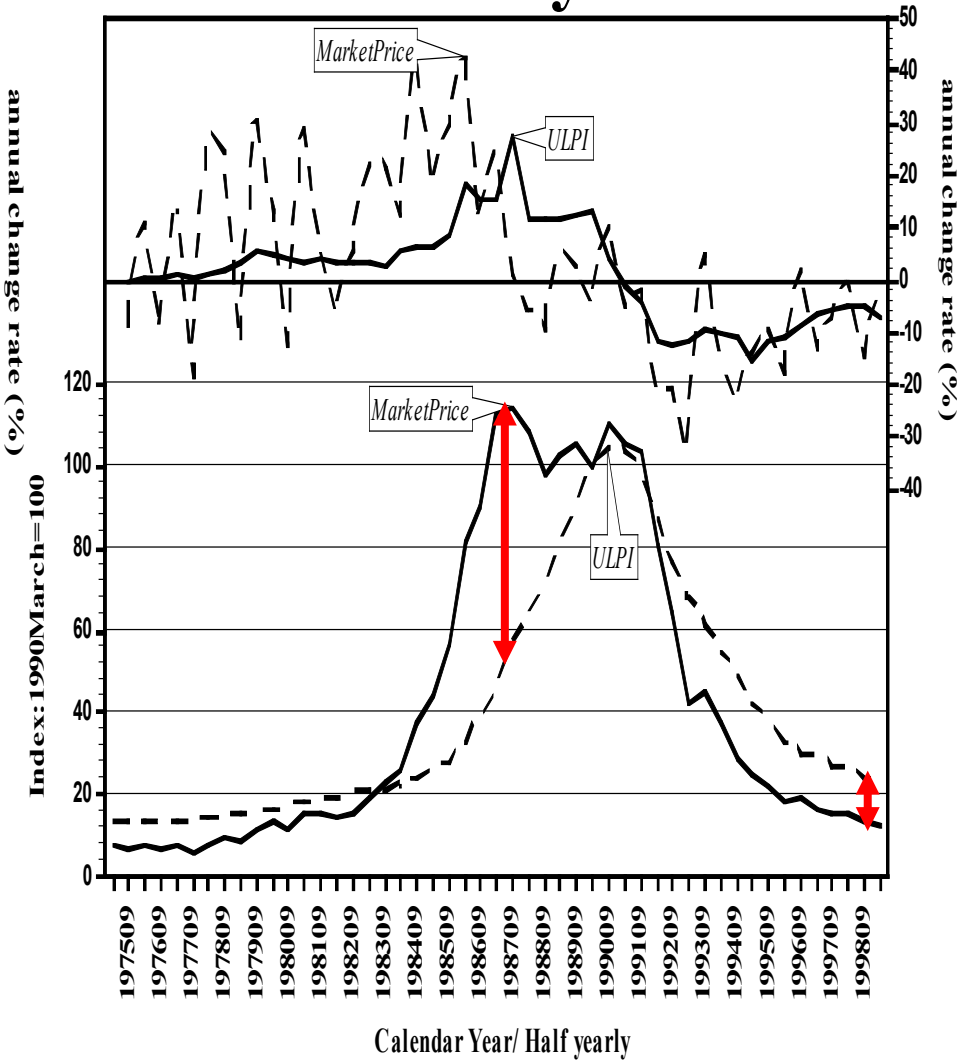
- The question **of** **why these real estate price indexes were not effective in policy management** during the bubble era and the subsequent collapse process is a vital one.

- → 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 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)

Transaction price-based index and Appraisal value based index in Tokyo.





Lessons from Japanese experience.

- 1. Appraisal-based information has ***systematic problem***.

- 2. This kind of problem was a major factor in the delay in disposing of bad loans at financial institutions following the bubble's collapse and one of the factors leading to the subsequent stagnation of the Japanese economy.

- **Additional Comment:**
  - Who should supply policy-making indicator?⇒**Early Warning Signal.**
  - Reporting of multiple real estate investment indexes supplied by the private sector ceased during the 2000s, **due to companies going under, finding it difficult to collect data, or abandoning the index business, which caused confusion in the market.**

How should we estimate CPPI?

Theoretical **and** ***Practical*** **(Certified Appraiser).**

Present Value:

$$V_v^t = \frac{y_v^t}{1+r^t} + \frac{y_{v+1}^{t+1}}{(1+r^t)(1+r^{t+1})} + \cdots + \frac{y_{m-1}^{t+m-v-1}}{\prod_{i=t}^{t+m-v-1}(1+r^i)} - \frac{O_v^t}{1+r^t} - \frac{O_{v+1}^{t+1}}{(1+r^t)(1+r^{t+1})} - \cdots - \frac{O_{m-1}^{t+m-v-1}}{\prod_{i=t}^{t+m-v-1}(1+r^i)}$$

- V_v^t : the initial asset value for the period t,
- y_v^t : the income corresponding to V_v^t ,
- O_v^t : the expenses paid at the end of the period ,
- r^t : the expected nominal discount (interest) rate for period t

Several methods of CPPI estimation.

- **Repeat sales price method: (Transactions).**
  - The depreciation problem and renovation problem
  - (Diewert, 2007; Shimizu, Nishimura, and Watanabe, 2010).

- **Hedonic price method: (Transactions).**
  - The hedonic price method, it is necessary to collect considerable property price-related attribute data.→**Omitted variable bias**

- **Present value method: (Rent or Income).**
  - In the appraisal practice, appraiser usually use Discounted Cash Flow approach or Income approach. (not comparable approach using transaction prices)
  - Present Value Theory

J-REIT data: Tokyo metropolitan area:2001-2010

Appraisal price

	Mean	Std.Dev	Min	Max
Appraisal price (**4,993** Observations)				
V^A : Appraisal price (million yen)	8,428.35	11,767.37	323.00	138,000.00

Transaction price

	Mean	Std.Dev	Min	Max
Transaction data (**559** Observations)				
V^T : Transaction price (million yen)	7,229.37	11,110.93	324.00	110,000.00

Rent, Price & Rent-Price ratio

	Mean	Std.Dev	Min	Max
NOI, Appraisal price and NOI Price ratio (**4,926** Observations)				
y^A : Net Operating Income (Rent - Operating	413.06	501.45	15.68	5,268.89

Empirical Model : Hedonic model for rent, price and discount rate

Rent Model

$$\ln y_{it} = \alpha_0 + \sum_J \alpha_j X_{ij} + \sum_T \nu_t D_t + \nu_{1i}$$

Price Model

$$\ln V_{it} = \beta_0 + \sum_J \beta_j X_{ij} + \sum_T \xi_t D_t + \nu_{2i}$$

$$\ln(y_{it} / V_{it}) = (\alpha_0 - \beta_0) + \sum_J (\alpha_j - \beta_j) X_{ij} + \sum_T (\nu_t - \xi_t) D_t + (\nu_{1i} - \nu_{2i})$$

Discount rate Model

$$\ln r_{it} = (\alpha_0 - \beta_0) + \sum_J (\alpha_j - \beta_j) X_{ij} + \sum_T (\nu_t - \xi_t) D_t + \varepsilon_i$$

$$(\alpha_j - \beta_j) = \frac{\partial \ln y_{it}}{\partial x_{ij}} - \frac{\partial \ln p_{it}}{\partial x_{ij}}$$

X: Characteristics of property

D: Time Dummy

Estimation result of hedonic equation: Income, Price and Discount rate

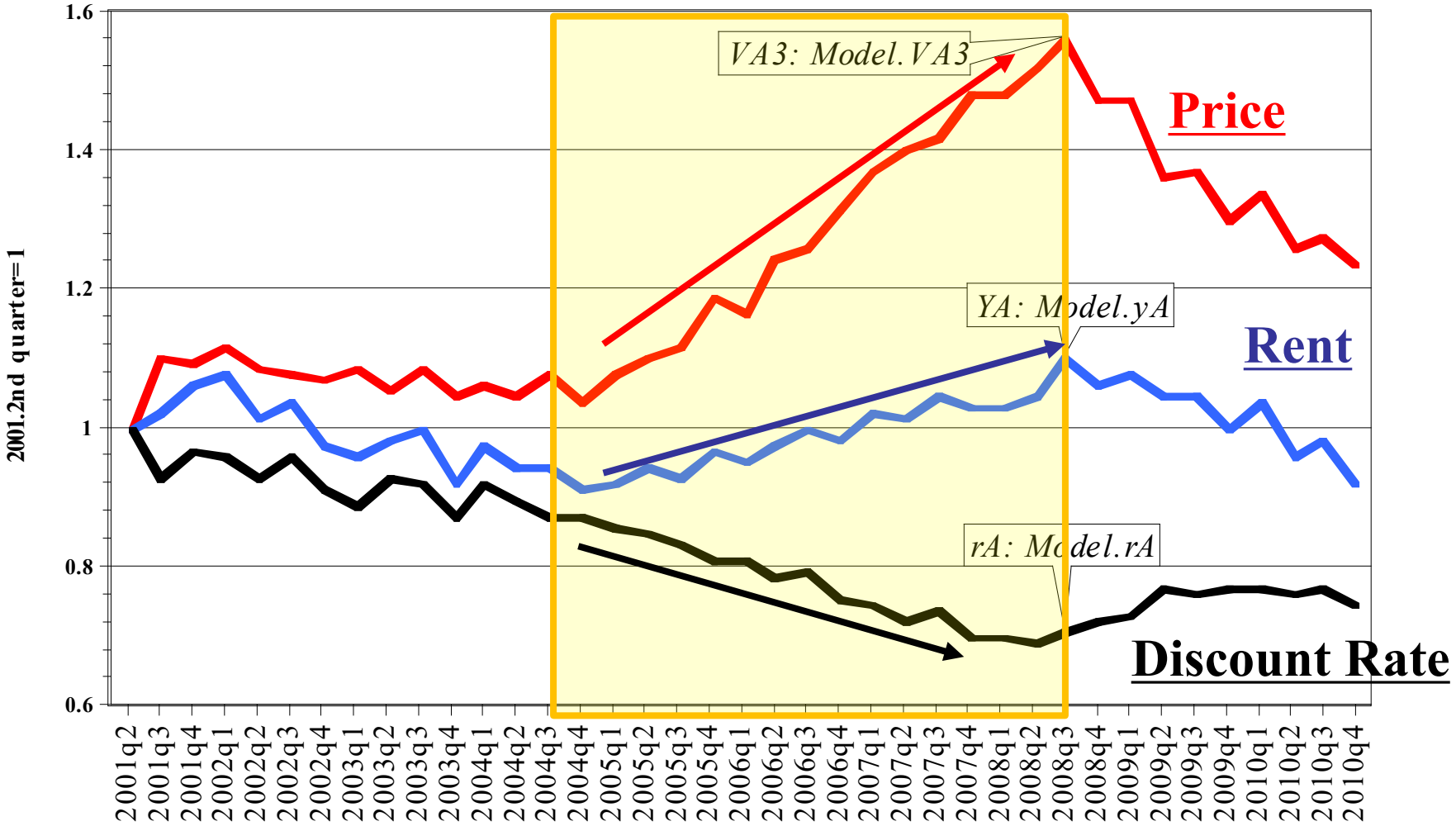
α β α-β

	Model. y_A			Model. V_{A3}			Model. r_A			$\alpha - \beta$
	α : Coef	std err		β : Coef	std err		Coef	std err		
Constant	**11.057**	0.130	***	**13.614**	0.117	***	**-2.557**	0.078	***	**-2.557**
S : Floor space (m^2)	**0.006**	0.003	*	**0.002**	0.003		**0.005**	0.002	**	**0.005**
A : Age of Building (years)	**-0.006**	0.001	***	**-0.009**	0.001	***	**0.003**	0.001	***	**0.003**
H : Number of stories (stories)	**-0.001**	0.002		**0.006**	0.002	***	**-0.007**	0.001	***	**-0.007**
TS : Time to the nearest station: (mimutes)	**-0.004**	0.005		**-0.018**	0.004	***	**0.014**	0.003	***	**0.014**
TT : Travel Time to Central Business District (minutes)	**-0.015**	0.006	***	**-0.023**	0.005	***	**0.008**	0.003	***	**0.008**
LD_k $(k=0,\ldots,K)$	Yes: Census			Yes: Census			Yes: Census			-
TD_q $(q=0,\ldots,Q)$	Yes			Yes			Yes			-
	0.773			0.889			0.672			
	4,926			4,926			4,926			

*P<.01, **P<.0.05, ***<.0.01

Note: The dependent variable in each case is the log of the price.

Appraisal Price, Rent and Discount Rate.



Stickiness of Appraisal Value = Smoothing

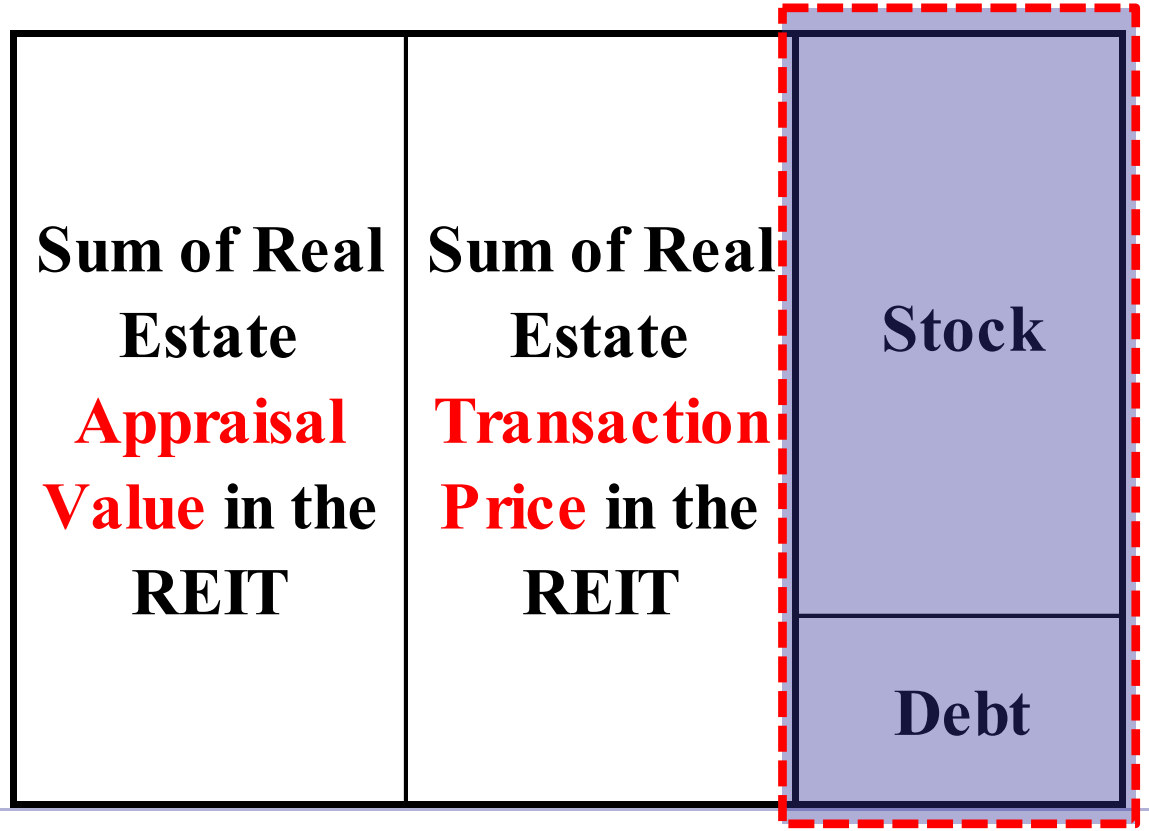
$$V = \frac{y}{r}$$

- **Rigidity of Discount Rate(r).**

- **Rigidity of Rent(y).**
- Shimizu, C, K.G.Nishimura and T.Watanabe (2010), Residential Rents and Price Rigidity: Micro Structure and Macro Consequences, *Journal of Japanese and International Economy,* Vol.24, pp.282-299.

Tobin's Q.

$$r = \frac{y : \text{property income (Net Operating Income)}}{\text{Property Market} \qquad \text{Stock Market}}$$



Tobin's Q

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Estimating quality adjusted commercial property price indexes using Japanese REIT data

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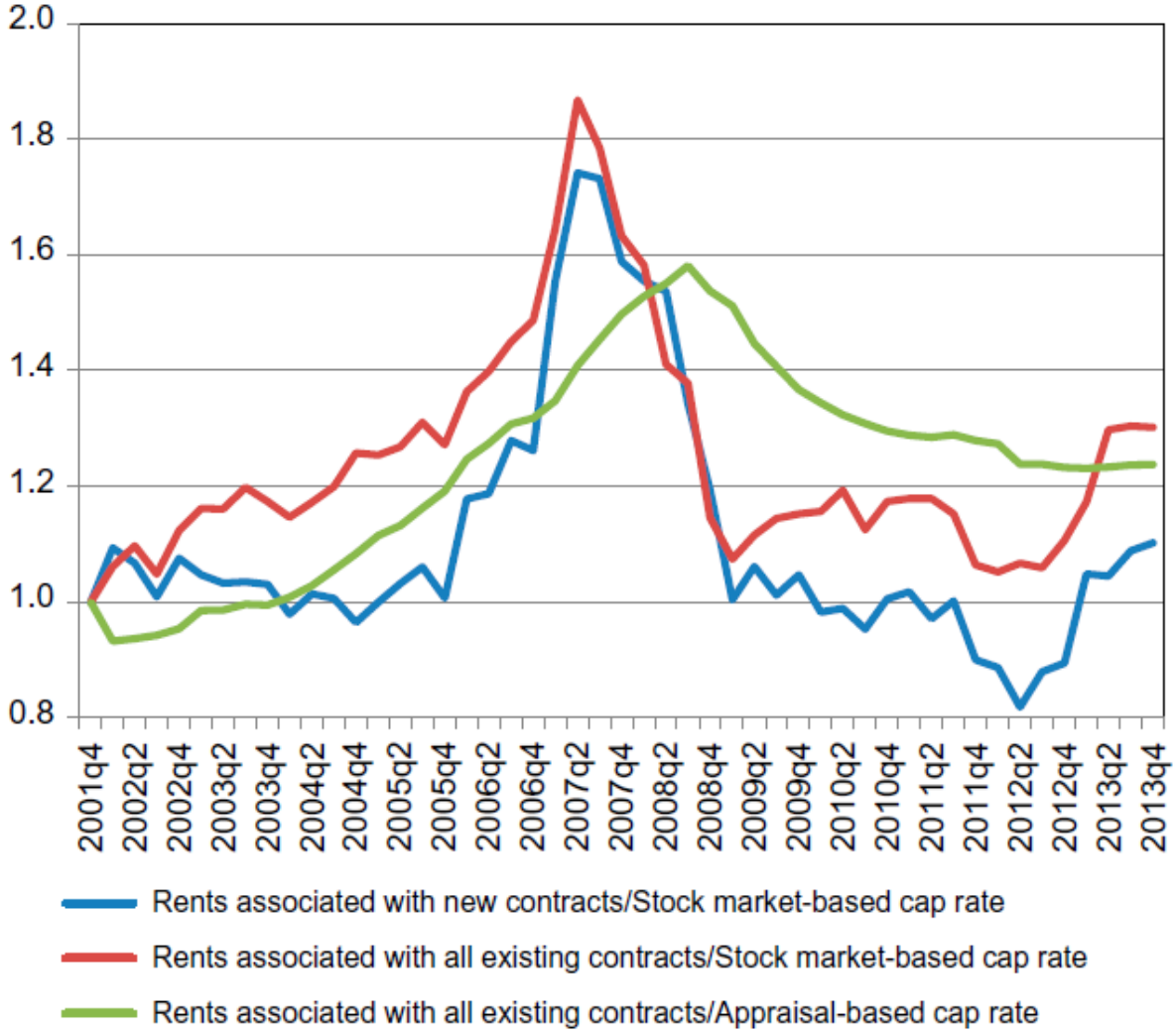


Figure 5. Estimates of property price indexes.

1. Stock Based Property Price Index.

This study: Outlines

Question: How should we estimate CPPI?

Construction of *Stock Based Property Price Index*
Controlling Debt and Transaction Costs.

1. Introduction.
2. Data and Methodology.
3. Results.
4. Conclusion and Remarks.

Introduction.

- The aim of this paper is to incorporate debt or transaction costs pertaining property into the construction of ***stock-based property price index***.

- From the view of the connection between property price and debt (borrowing), most policy maker or international institutions acknowledge this relationship and assert that monitoring the property market of each country is the critical task.

Introduction.

- This is because the significant impact of collapse of a property market transmit beyond the market itself to the financial sector, potentially precipitating a crash in the financial market.

- Furthermore, the ensuing turmoil within the financial market can lead to prolonged economic stagnation. Indeed, both Japan and the U.S. have suffered from such negative scenarios due to crashes instigated by turmoil in the property market.

Introduction.

- Thus, there is a strong demand for property price indices that accurately reflect the conditions of the property market to enable preventative measures against market collapse.
  - **Early Warning Signal.**
- In response to these concerns, **international institutions are keen to develop property price indices that allow for cross-country comparisons and provide guidelines on the construction of these indices**, as well as the characteristics derived from each method. (Diewert et al., 2020; Eurostat, 2013, 2017; **Hill and Steurer, 2020**)."

Introduction.

- What did we do
  - This study uses Japanese REIT database and constructs **stock based commercial property price indices**.
  - Our approach first begins by constructing index motivated by Shimizu et al. (2015).
  - Second, we extend Shimizu et al.'s (2015) method by incorporating **debt (borrowing) or transaction costs** connected commercial property.
  - Comparing property price index based on Shimizu et al.'s (2015), we try finding out whether our new indices differently move or not.

Debt (borrowing) or Transaction Costs.

- Why we focus on debt (borrowing) or transaction costs
- Debt (borrowing)
  - There are numerous suggestions and evidence that property markets are closely tied with financial markets.
  - In terms of suggestions, many previous studies investigate **how the two market interact**. For example, Kiyotaki and Moor (1997) suggest there is a ***credit cycle*** in terms of debt and borrowing.
  - Other studies investigate **the impact of monetary policy** on property price. (Iacoviello and Minetti; 2008, Rahal; 2016).

Debt.

- Why we focus on debt (borrowing) or transaction costs
- Debt (borrowing)
  - Moreover, the corporate finance literature suggests that an increase in property prices, which **elevates collateral value**, can alleviate corporate financial constraints and stimulate business activities. (Campello & Giambona, 2013; Chaney et al., 2012; Cvijanović, 2014) Recently, studies have shown an interest in property market bubbles, with a primary focus on mortgage lending. (Mian & Sufi, 2010, 2011)
  - In contrast, while much of the literature on property price indices discusses the context of these two markets, there has been a **lack of effort to incorporate debt considerations into the development of property price indices**.

Transaction costs.

- Why we focus on debt (borrowing) or transaction costs
- Transaction costs
  - Previous studies suggest that several issues arise when calculating property prices, including: (1) the lagging problem, (2) the valuation problem, and (3) the smoothing problem.
  - In an informationally frictionless world, there would be no issues related to estimating property prices. However, in the real world, where information friction exists**, it is unrealistic to expect property prices to immediately adjust to their ideal values from their current prices**.

Summary.

- **Summary of our new indices.**
  - Stock based index, motivated by Shimizu et al. (2015), shows trends similar to the market value of REIT: Shimizu, C., Diewert, W. E., Nishimura, K. G., and Watanabe, T. (2015). "Estimating quality adjusted commercial property price indexes using Japanese REIT data," Journal of Property Research, 32(3), 217-239.
  - Our index, which merely incorporates **the size of the debt**, demonstrates a downward movement compared to the index of Shimizu et al. (2015).
  - In contrast, when including **debt growth (specifically 2 and 3-year growth)** in our estimation, our index exhibits an upward trend compared to Shimizu et al.'s (2015) index.
  - Compared with **transaction-based indices disclosed by the public sector**, our indices can accurately reflect the property market conditions.
  - Regarding the adjustment of transaction costs using a dynamic panel model, **the index can exceed the baseline index**.

2. Data and Methodology.

Data.

- **Data**
  - Japan REIT Database provided by Prop Tech plus Inc.
  - Our sample is publicly-listed REIT in Japan, and we limit properties located in Tokyo prefecture. Finally, largest sample size 26,871 for 39 REITs from **2009Q1 to 2022Q4**.
  - Market value$_{i,j,t}$ = log of $\left(\frac{Appraisal\ value_{i,j,t}}{Total\ Appraisal\ value_{j,t}} * (Stock\ value_{j,t} + short\ term\ debt_{j,t} + long\ term\ debt_{j,t})\right)$
  - The below is summary statistics for our sample.

variable	N	mean	min	p1	p10	p50	p90	p99	max
Market value	26,871	9.241	6.195	7.068	7.872	9.182	10.683	11.814	13.145
Appraisal value	26,871	8.566	5.930	6.657	7.403	8.472	9.962	11.256	11.984
Debt size	26,871	11.987	9.124	10.275	11.160	12.067	12.956	13.219	13.266
1 year-debt growth	24,765	0.050	-0.748	-0.202	-0.033	0.027	0.177	0.406	0.960
Rent income	26,871	4.001	-4.576	1.824	2.935	3.926	5.340	6.539	7.242
Rentable floor	26,857	8.406	6.198	6.849	7.439	8.323	9.604	10.620	11.469
Land	26,871	7.124	4.386	5.243	5.971	6.876	8.797	10.587	10.954
Distance	26,871	5.356	0.000	0.000	4.394	5.485	6.330	6.686	6.868
Size	26,871	8.937	6.284	7.056	7.650	8.693	10.757	12.480	12.999
Story	26,871	2.508	1.386	1.792	2.197	2.398	3.135	3.871	4.111
Age	26,871	3.008	0.000	1.099	2.197	3.178	3.526	3.932	4.111

Except for 1-year debt growth, this study transforms variables into logged variables.

Methodology.

- **Methodology**
  - Our approach is based on Shimizu et al. (2015) approach, who utilize the balance sheet information of REIT.
  - In Japan, publicly-listed REIT are mandated to hold more than 70 % of their assets in property, similar to the requirement for US-REIT.
  - Shimizu et al. (2015) make use of this requirement and approximate the total value of property by summing its market value with the value of debt. The concept can be visualized as follows:

Asset	Liabilities/Equity
property	Equity
	Debt (Loans + Bond)

Methodology ①

- **Methodology: Adjustment *Debt* SB-CPPI Model.**
  - We employ hedonic regression, which is one of conventional approach when constructing property price index.
  - We start with the same manner as Shimizu et al. (2015) and then add variables related debt (debt size and debt growth) into the baseline model.
  - The estimation model is below:

$$Markt\ value_{i,j,t} = const + \sum_{k=1}^{n} \beta_k * X_{k,i,t} + \sum_{t=2009Q2}^{t=2020Q4} \gamma_t * Time_t + \epsilon_{i,t} \cdots (1)$$

$$Market\ value_{i,j,t} = const + \boldsymbol{\beta_{debt} * Debt_{j,t}} + \sum_{k=1}^{n} \beta_k * X_{k,i,t} + \sum_{t=2009Q2}^{t=2020Q4} \gamma_t * Time_t + \epsilon_{i,t} \cdots (2)$$

Methodology ②

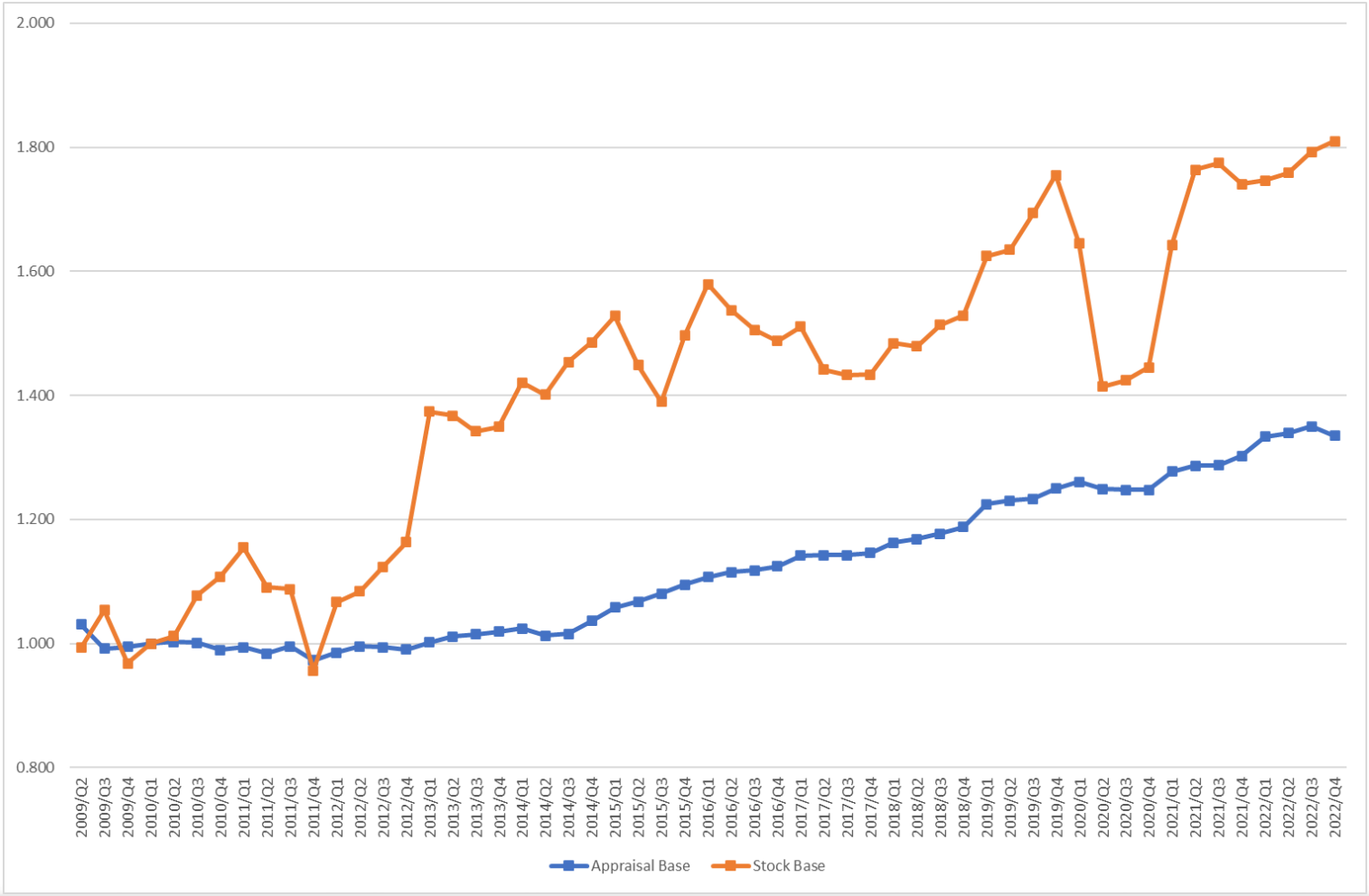
- **Methodology: Adjustment *Cost* SB-CPPI Model.**
  - Next, we employ dynamic panel model to consider ***transaction cost*** of property price decision.
  - We begin by using 1 quarterly-lagged property price, and next include 1, 2 yearly-lagged property price are into an estimation model. The estimation model is below:
  - The estimation model is below:

$$Market\ value_{i,j,t} = const + \beta_{lagged\ Market\ value} * \boldsymbol{lagged} * Market\ value_{i,j,t} + \sum_{k=1}^{n} \beta_k * X_{k,i,t} + \sum_{t=2009Q2}^{t=2020Q4} \gamma_t * Time_t + \epsilon_{i,t} \cdots (3)$$

3. Results (Adjustment *Debt* SB-CPPI Model).

SB-CPPI(Base) vs. Appraisal-Based CPPI.

- **Appraisal based index vs Stock based index (2010/Q=1)**



Adjustment *Debt* SB-CPPI Model.

- **Regression Results for (a) Baseline, (b) Debt *size*, and (c) Debt *growth*.**

Panel (A) Baseline

Dependent variable: Market Value	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Rent income	0.300	0.007	44.520	0.000	0.287	0.313
Rentable floor	0.518	0.011	47.150	0.000	0.496	0.539
Land	-0.272	0.014	-18.930	0.000	-0.301	-0.244
Distance	-0.017	0.004	-4.610	0.000	-0.025	-0.010
Size	0.445	0.019	23.950	0.000	0.409	0.482
Story	-0.175	0.020	-8.840	0.000	-0.214	-0.137
Age	-0.200	0.007	-29.800	0.000	-0.213	-0.186

Panel (B) Debt size

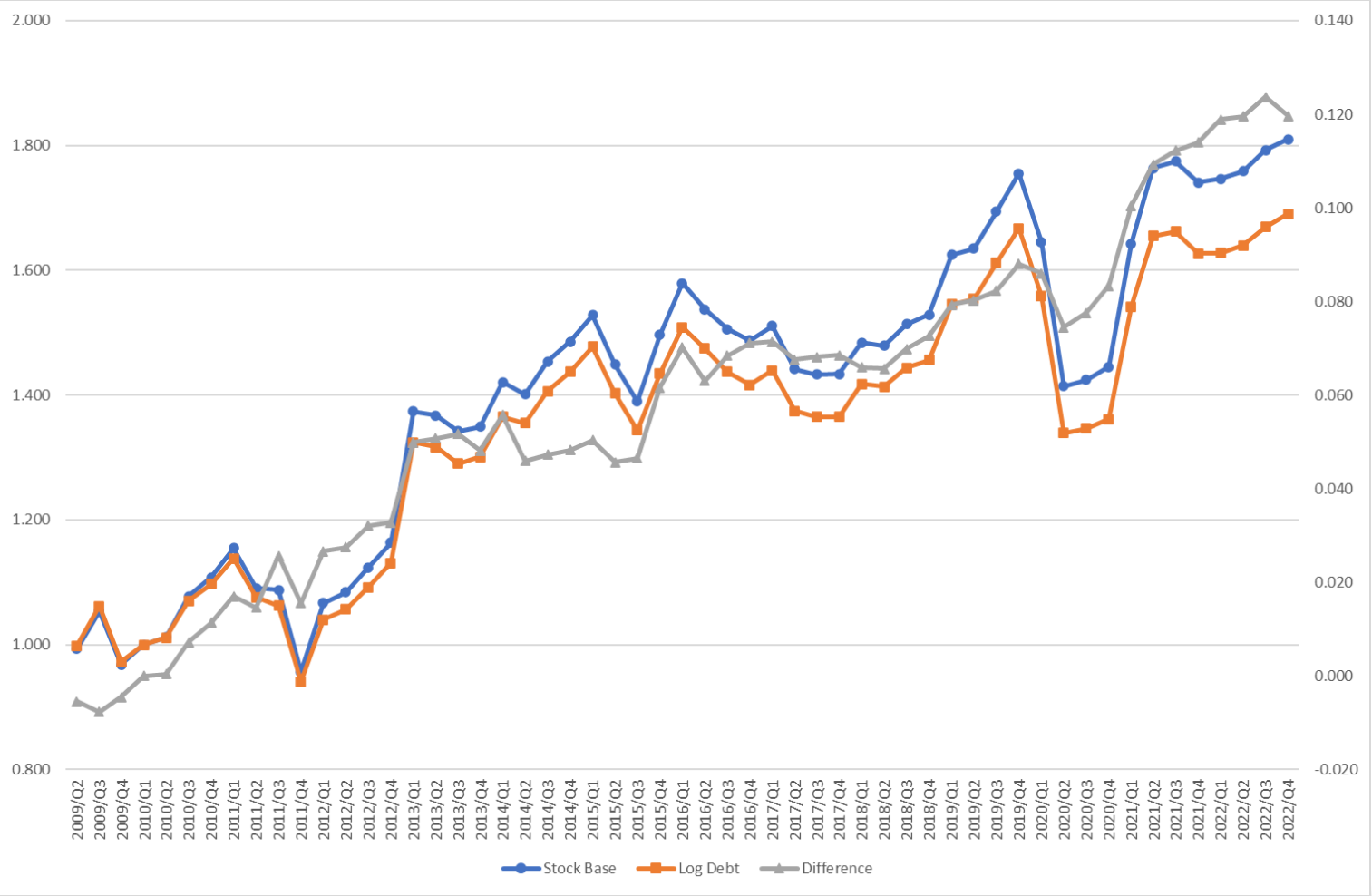
Dependent variable: Market Value	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Debt size	0.130	0.006	22.050	0.000	0.119	0.142
Rent income	0.287	0.007	42.870	0.000	0.274	0.301
Rentable floor	0.493	0.011	45.080	0.000	0.472	0.514
Land	-0.245	0.014	-17.150	0.000	-0.274	-0.217
Distance	-0.014	0.004	-3.680	0.000	-0.021	-0.006
Size	0.417	0.018	22.570	0.000	0.381	0.453
Story	-0.144	0.020	-7.280	0.000	-0.182	-0.105
Age	-0.180	0.007	-26.800	0.000	-0.193	-0.166

Panel (C) Debt Growth

Dependent variable: Market Value	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
1 year-debt growth	0.106	0.006	17.140	0.000	0.094	0.118
Rent income	0.326	0.007	44.370	0.000	0.312	0.341
Rentable floor	0.462	0.012	39.680	0.000	0.439	0.485
Land	-0.233	0.015	-15.650	0.000	-0.262	-0.204
Distance	-0.015	0.004	-4.110	0.000	-0.023	-0.008
Size	0.404	0.019	20.990	0.000	0.367	0.442
Story	-0.143	0.020	-7.020	0.000	-0.183	-0.103
Age	-0.178	0.007	-24.120	0.000	-0.193	-0.164

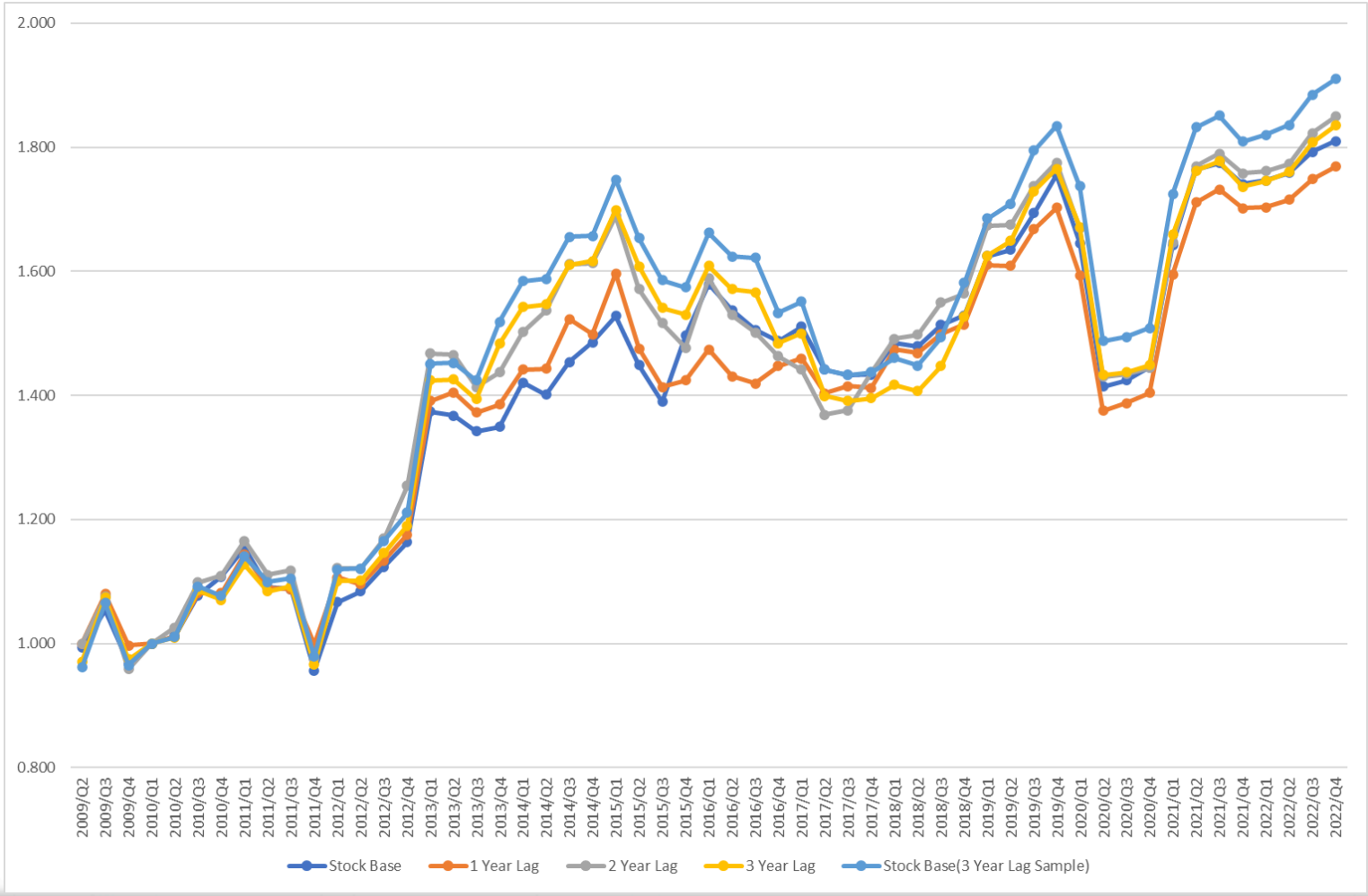
Adjustment *Debt* SB-CPPI Model (*Size*).

- Stock based index vs index controlling debt size (2010/Q1) and difference (right axis)



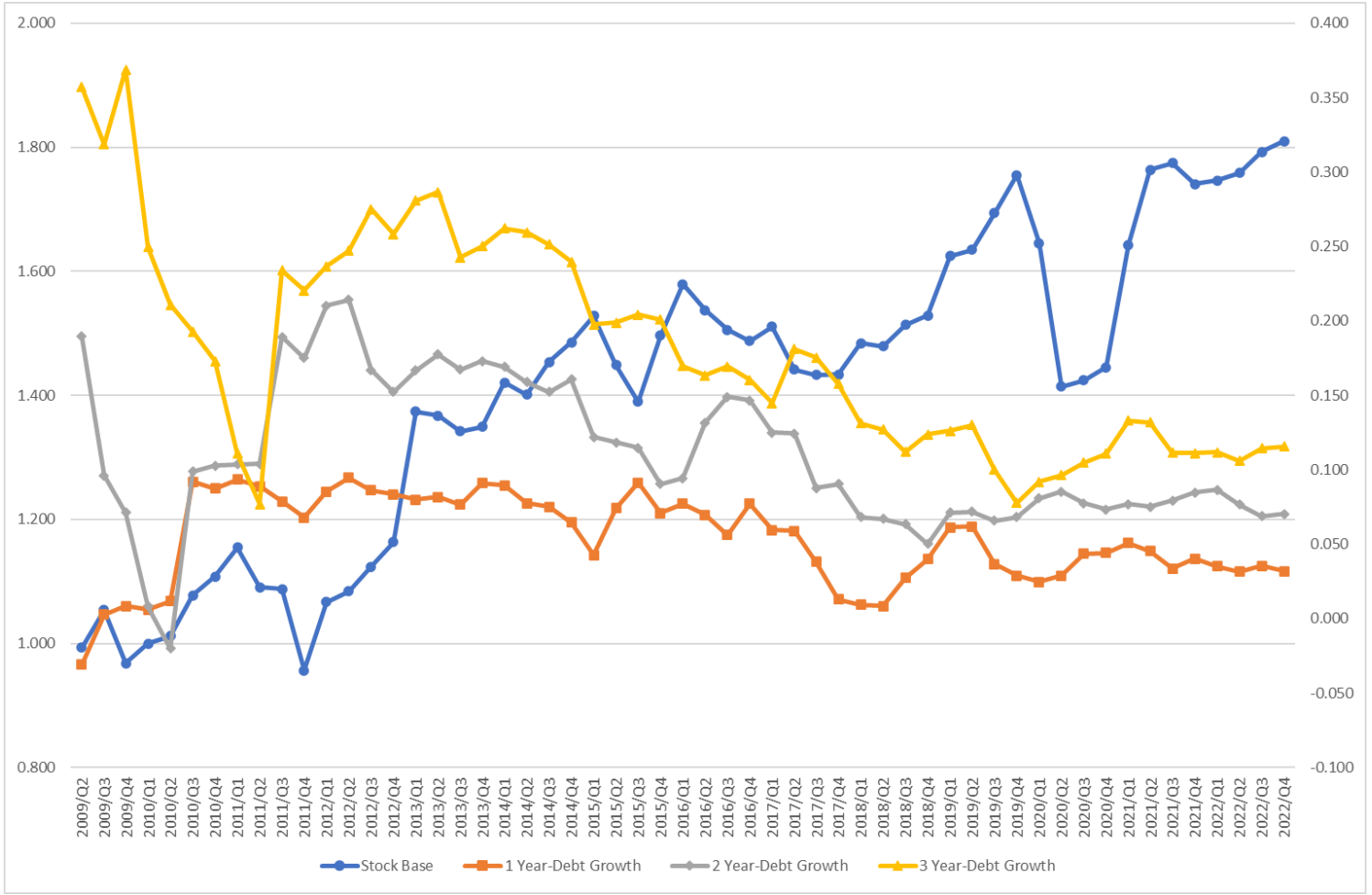
Adjustment *Debt* SB-CPPI Model (*Size*).

- Stock based index vs index controlling lagged debt size (2010/Q1=1).



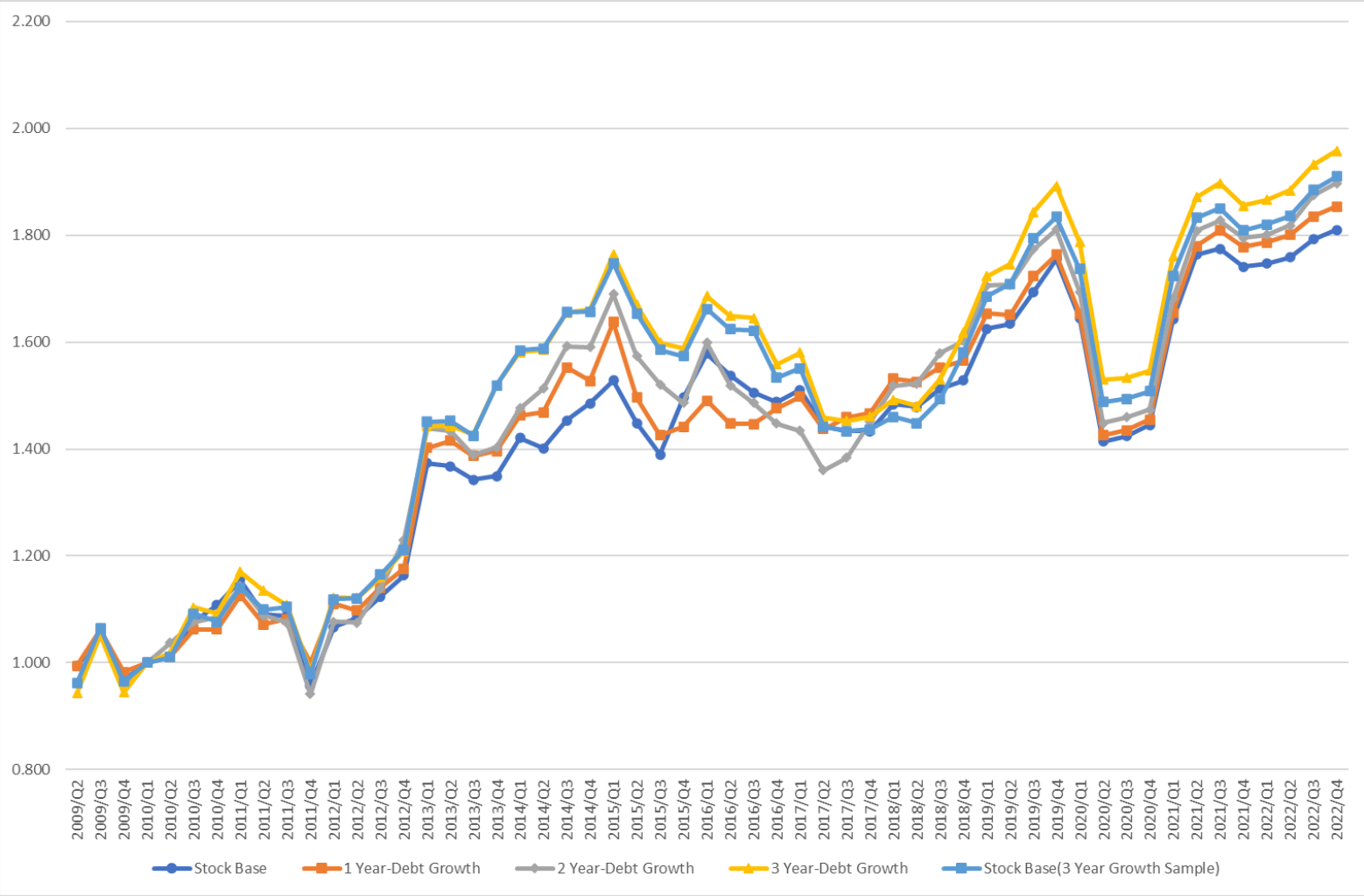
Adjustment *Debt* SB-CPPI Model (*Growth*).

- Stock based index (2010/Q1=1) vs debt growth (right axis).



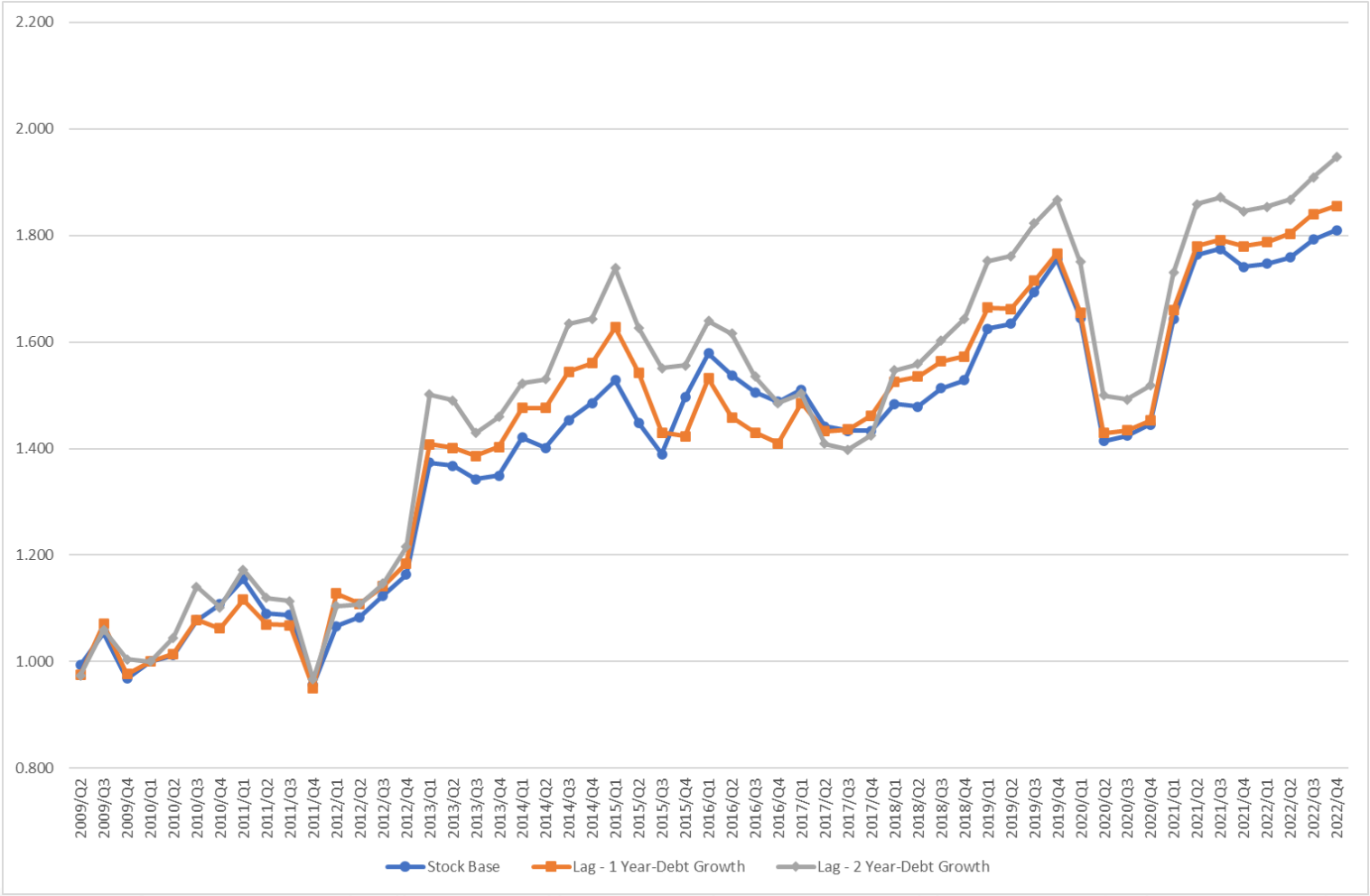
Adjustment *Debt* SBCPPI Model (*Growth*).

- Stock based index vs index controlling debt growth(2010/Q1=1).



Adjustment *Debt* SBCPPI Model (*Growth*).

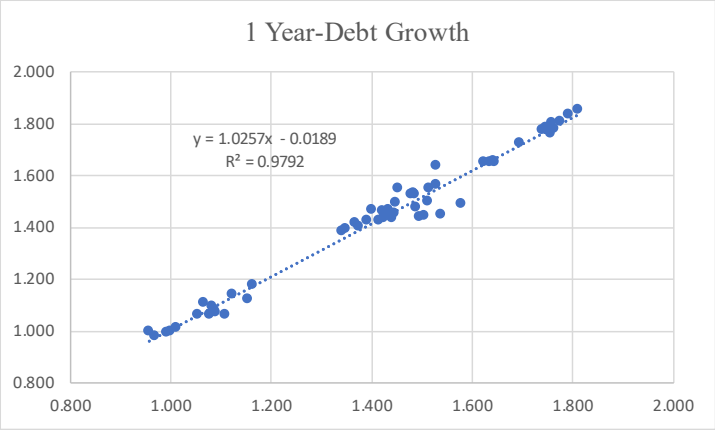
- Stock based index vs index **controlling lagged debt growth** (2010/Q1=1).

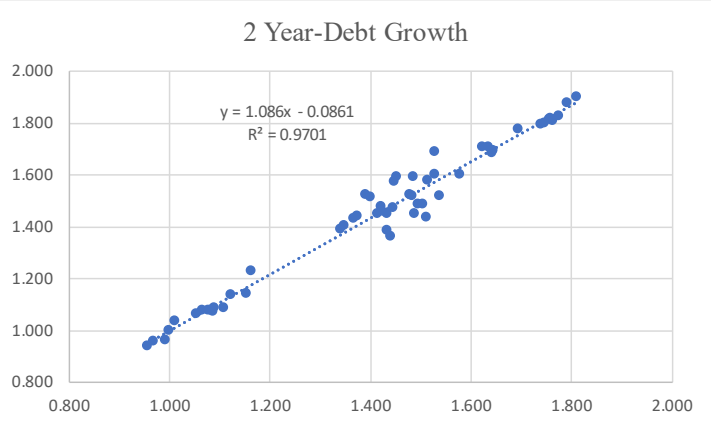


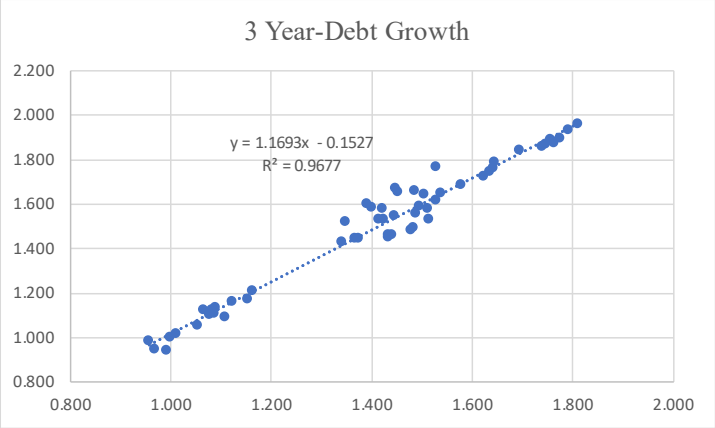
4. Analysis.

Comparison: SB-CPPI (Base) vs. SB-CPPI (*Debt Growth*).

- Scatter plot of Stock based index (horizontal axis) and index controlling debt growth (vertical axis)

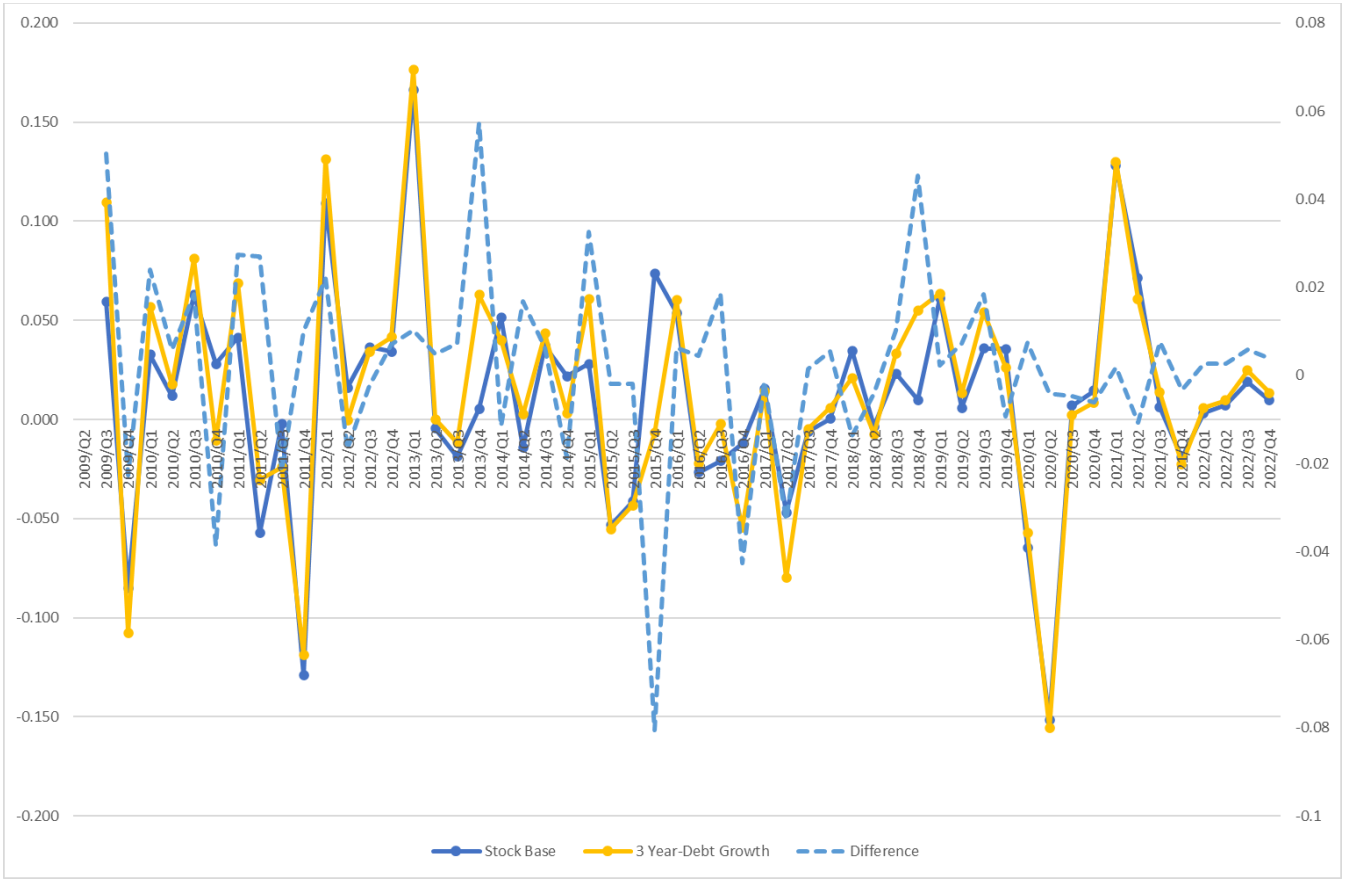






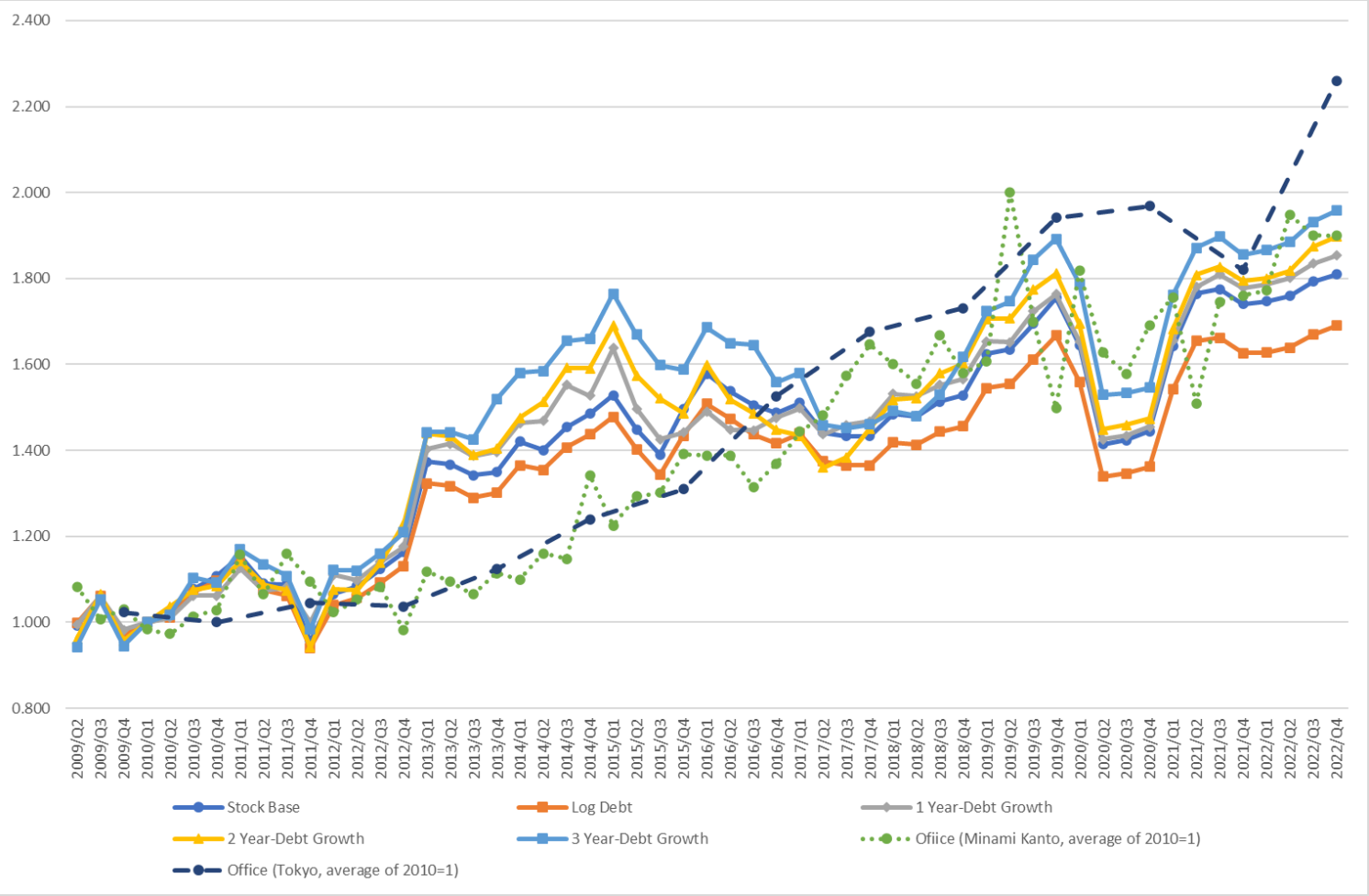
Comparison: SB-CPPI (Base) vs. SB-CPPI (*Debt Growth*).

- Quarterly change rate in ***Stock based index* (Base)** and ***index controlling debt growth***, and difference between two indices (right axis)



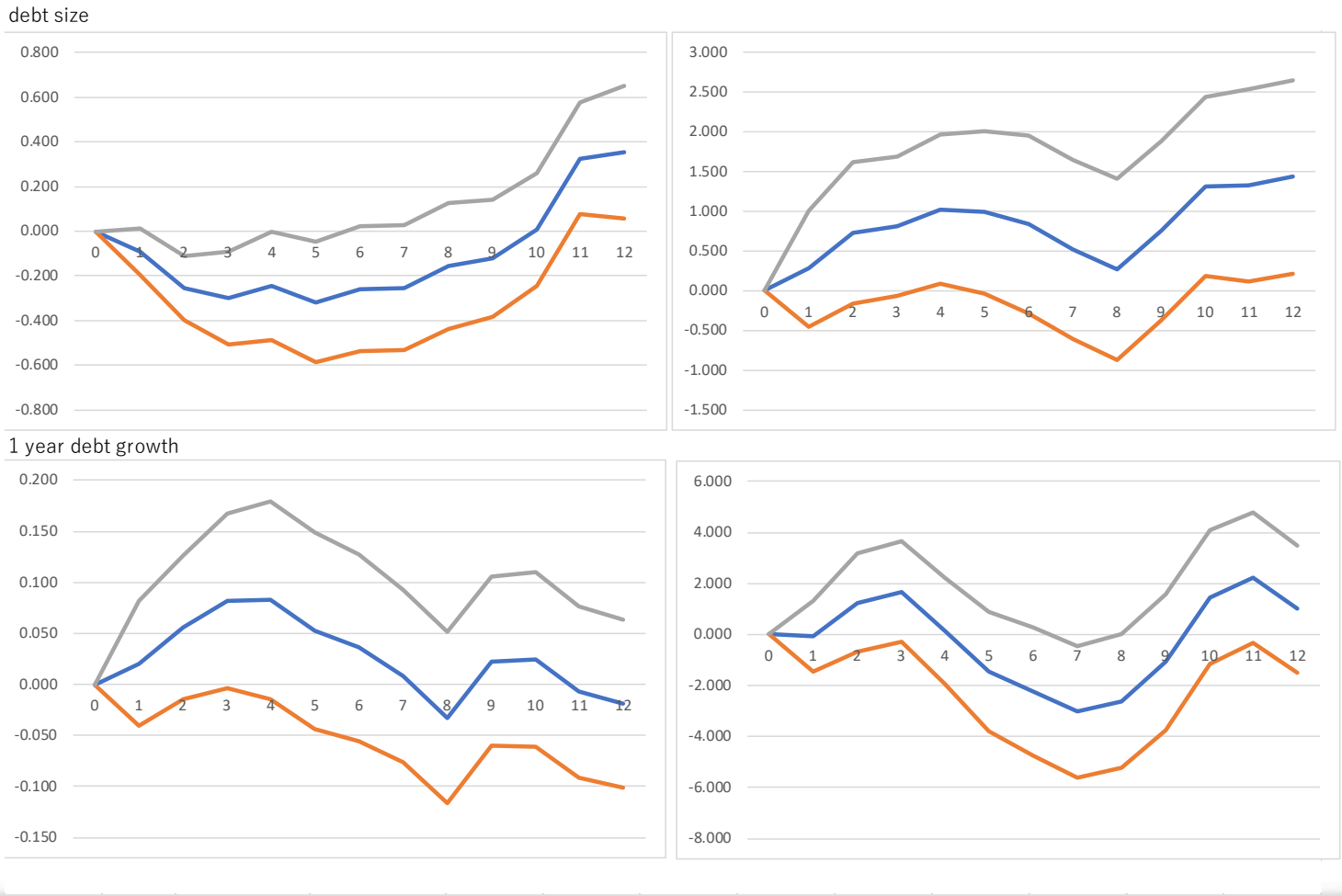
Comparison: SB-CPPI *vs.* Transaction-Based CPPI.

- Estimated index vs **index provided by Ministry of Land, Infrastructure and Transport** (2010/Q1=1).



Impulse response.

- Impulse response of property price (left) and that of debt (right).



Granger causality.

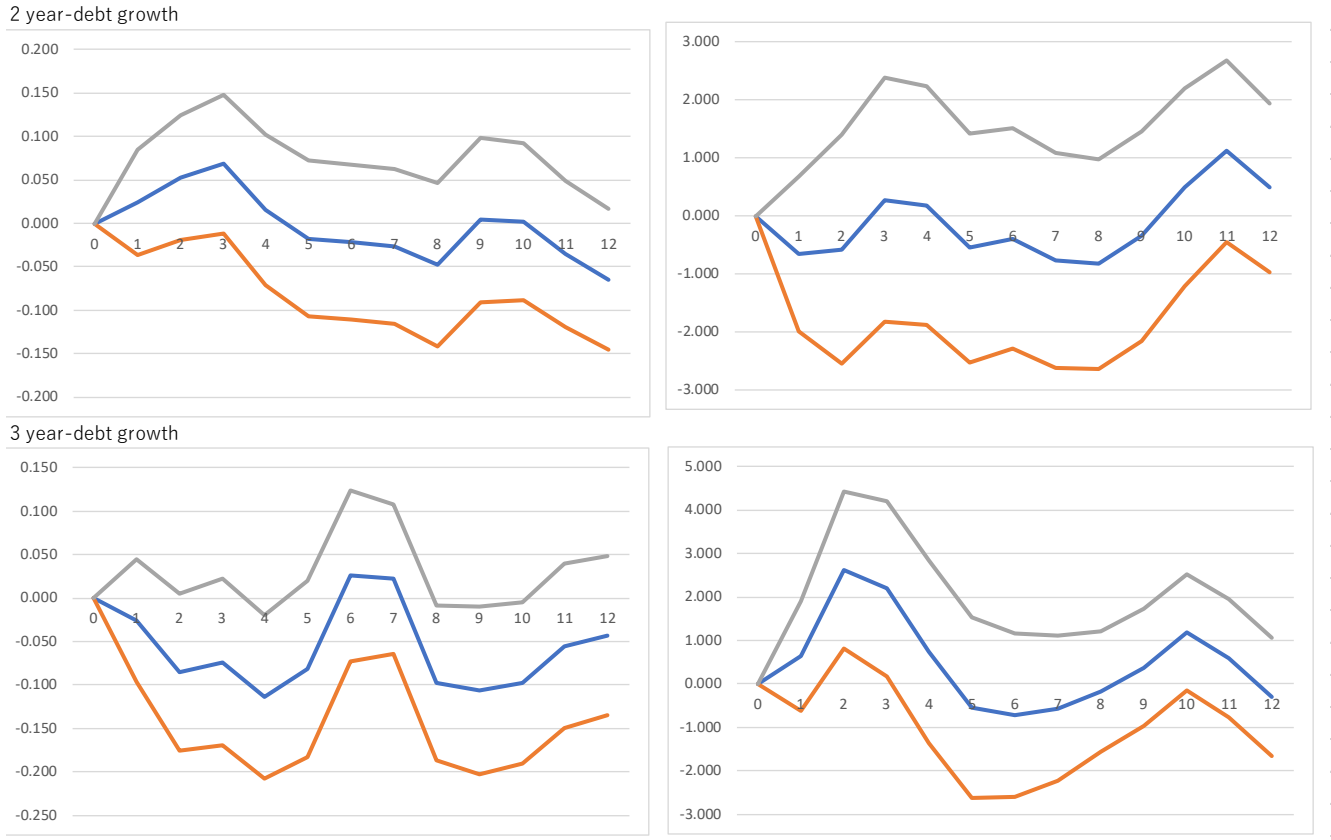
- **Granger causality** .

Impulse	Response	F	Prob > chi2
property price	debt size	32.928	0.001***
debt size	property price	72.982	0.000***
property price	1 year debt growth	39.161	0.000***
1 year debt growth	property price	19.185	0.084*
property price	2 year debt growth	17.040	0.148
2 year debt growth	property price	18.290	0.107
property price	3 year debt growth	33.018	0.001***
3 year debt growth	property price	37.318	0.000***

***, **, * represent statistically significant at 1, 5, 10 % level respectively. Lag length is 12.

Impulse response.

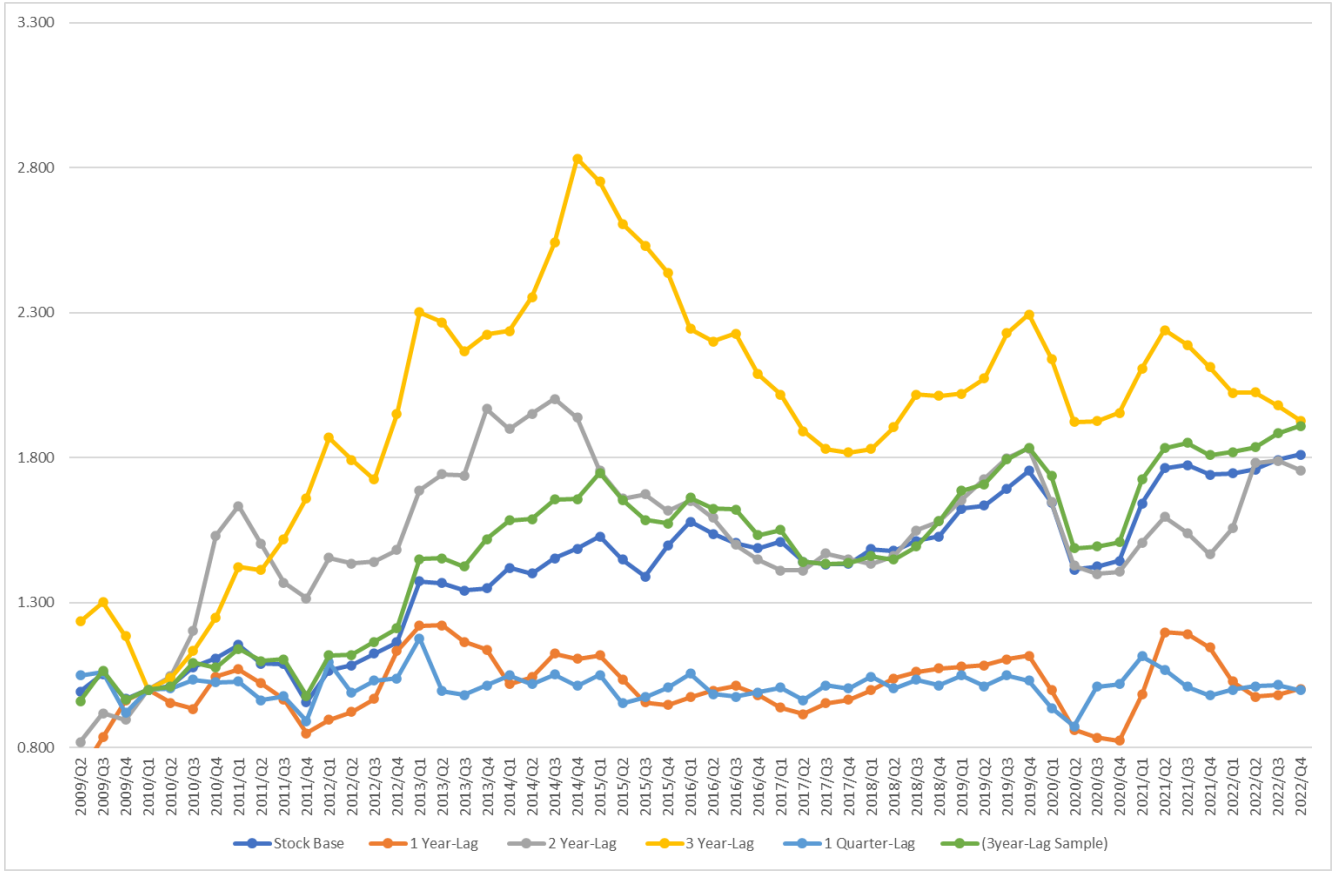
- Impulse response of property price (left) and that of debt (right).



5. Results (Adjustment *Cost* SB-CPPI Model).

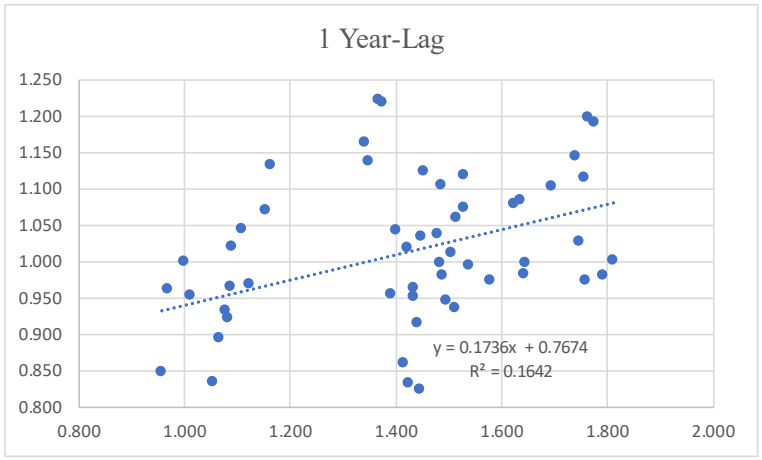
Adjustment *Cost* SB-CPPI Model.

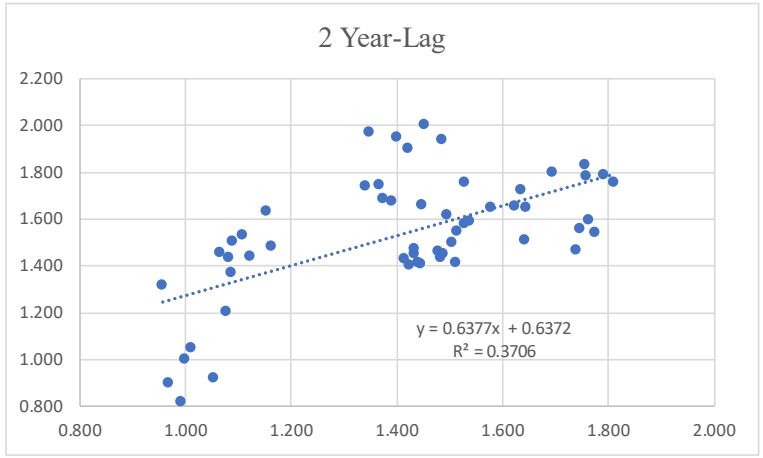
- **Stock based index vs index controlling transaction costs (2010/Q1=1)**

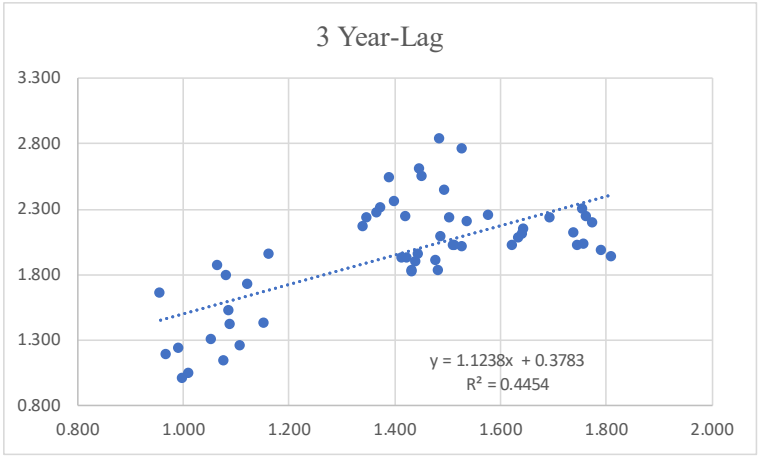


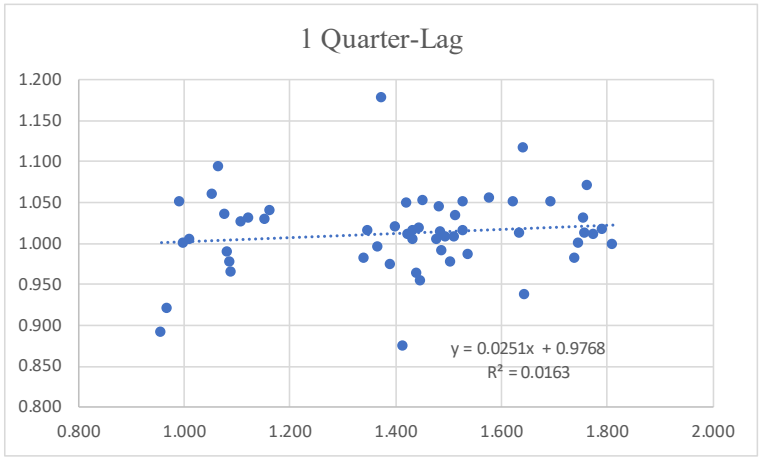
Comparison: SB-CPPI (Base) vs. SB-CPPI (Adjustment cost).

- Scatter plot of Stock based index (horizontal axis) and index controlling transaction costs (vertical axis).



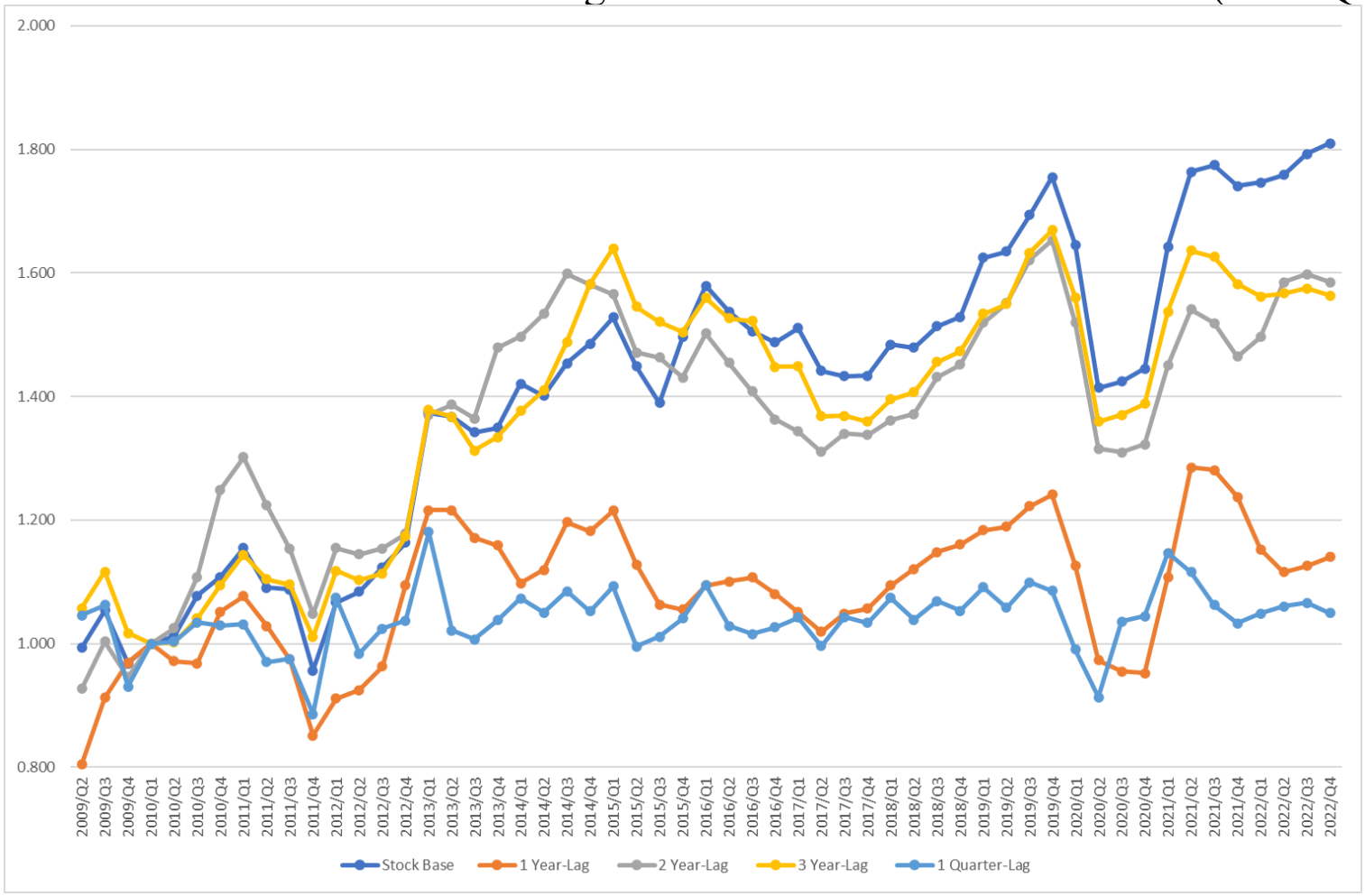






Stock based index *vs.* index controlling transaction

- Stock based index vs index controlling transaction costs with fixed effect (2010/Q1=1)



6. Conclusion and remarks.

Conclusion and remarks.

- Our study is the first to develop a novel approach to constructing a property price index that takes into account **debt (borrowing)** and **transaction costs**.

- When it comes to incorporating *debt*, ***debt growth***, rather than the size of the debt at the current period, is a key factor for property pricing, as highlighted in finance literature.

- As for transaction costs, the movement of the property price index controlling the costs exhibits the same trend as that of the stock-based index.

Future tasks.

- Future tasks
  - In the current version, we treat variables related to debt as exogenous. However, **various factors influence the decision to use debt**. Therefore, we need to identify appropriate instrumental variables to address the endogeneity issue.
  - Regarding the transaction costs, we must also find a suitable method, as the OLS and FE models yield biased coefficients in a **dynamic panel model**. One potential solution is System-GMM model. While this method may address the issue, we must carefully consider whether it is an appropriate approach for constructing a property price index.
  - Finally, we should benchmark our index against stock-based indices in other countries.

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