ECN430 Empirical Methods & Applications in Macro and Finance
Term Paper

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The Effect of Property Tax on Housing Price in South Korea

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Executive Summary

The paper investigates the effect of property tax on the house prices from 1986Q1 to 2018Q4 in South Korea. Controlling for macroeconomic variables (real GDP year-on-year growth rate, quarterly CPI percentage change, seasonal-adjusted long-term government bond rate), we address the relationship between the real housing price index and recurrent taxes on immovable property (percentage of GDP) with impulse response and forecast error decomposition based on a Vector Autoregressive Model. The main findings are as following. Firstly, property tax policies published in 1991 and 2006 in South Korea both caused structural changes in the South Korean housing price according to the results of Chow test. Then, contractionary fiscal policy on property can slow down the speed of housing price growth. However, the contribution of property tax policy to housing price variation is relatively weak. Finally, all the shocks from property tax can only affect the housing price in a short-term, and will gradually die out in long run.

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1. Introduction

1.1 Background

According to the report "World Countries by population density 2019", South Korea is one of the most densely populated countries, ranking 28th in the world. South Korea has a population density of 511/ km², ten times of the global average. The population density in cities is much higher, for example, Seoul's population density is estimated around 16,000/ km². Therefore, the South Korean are sensitive to the housing prices fluctuations. In order to stabilize the house prices, the South Korean government have intervened in the housing market several times with property tax policies. Over the past several decades, the South Korean government implemented a new system for assessing land in 1991 and created the Comprehensive Property Tax (CPT) in 2006, and twice reassessments happened in 1991-1992, 2006-2007 (François & Thomas, 2018). The aim of this paper is to investigate the effect of property tax on the house prices in South Korea.

1.2 Research Questions

The research question is the effect of property tax on housing price in South Korea. To be specific, firstly, if the property tax policy changes cause structural changes in the housing price? Secondly, whether contractionary fiscal policy on property can refrain the housing price growth? Thirdly, how strong is the impact of property tax changes on housing price? Finally, whether the property tax changes can control the housing prices permanently?

According to the results of Chow test, firstly, property tax policies published in 1991 and 2006 in South Korea both caused structural changes in the South Korean housing price. Then, contractionary fiscal policy on property can slow down the speed of housing price growth, as indicated in our impulse response function graph. However, the contribution of fiscal policy to housing price variation is relatively weak, hence, we recommend combined policies to effectively control housing price. Finally, All the shocks from variables can only affect the housing price in a short-term, and will gradually die out in long run.

1.3 Literature Review

François & Thomas (2018) illustrated that “1% of GDP increase in property tax can lead to a reduction in real house prices of approximately 17% after 12 quarters”. They also observed the capitalization effects from the unambiguously decreasing of the price to rent ratio. The landlords have incentive to shift some of the higher property tax on tenants, causing the rents increasing slightly. Then the rents decrease because of “a reduction in prices brought about by the change in GDP”. The capitalization effects between housing prices, rents and the property tax were also referred to by Blöchliger (2015). The author stated that property tax on immovable real estate can weaken house price volatility and stabilize the house market, on the basis of regular updates of property values and hence increasing tax base. He attributed the effect of property tax on housing price to capitalization.

Pingping (2018) used VAR model to conduct dynamic analysis on the effect of property tax on housing prices of the OECD countries, controlling other macroeconomic variables. From the impulse response and forecast error decomposition, the author didn’t observe the medium- and long-term effect of property tax on housing prices. However, the property tax can cause housing prices to decrease in the short term. The author also suggested multiple housing policies should be combined with the property tax policy to ensure a healthy house market.

There are only a few studies about the impact of property tax on housing prices in South Korea, so we expand the range of literatures from property tax policy to housing policies in South Korea. Daeil (2014) used regression analysis to research the effect of housing policies as well as other environmental factors on the South Korean housing prices as well as on northern Seoul and on southern Seoul from January 2000 to January 2015. Regarding to the measurement of policy shocks, he created one dummy variable on the housing policies intended to activate the house market and another dummy variable on the housing policies that were designed to stable housing prices. The dummy variables are “1” if there were housing policies executed at that time and “0” otherwise. He found no statistical evidence that housing policies had effects on housing prices. Neither did the efforts of the South Korean government to cool the overheated housing market nor did the attempt to heat the depressed housing market have their desired effect. Therefore, the author found no effect of housing policies on the housing price in South Korea.

Hyeon & Sugie (2010) got the same conclusion that the housing price stability policies of the South Korean government (2003-2008) didn't have impact on stabilizing the housing market after controlling for macroeconomic variables, with descriptive analyses and a multivariate inter-temporal optimization model. They also explained the reasons why housing policies failed to stabilize the housing price, such as consumers became "numb" to the excessive number of housing stability policies, inadequate housing supply caused imbalance in the housing market and kept the housing prices high, the effects of housing policies were weakened because of political opposition during the process of legislation.

Sae et.al. (2008) concluded that the apartment prices in Kangnam of Seoul, where housing prices increased dramatically from 1999 to 2006, didn't respond to the introduction of comprehensive property taxes in 2006, but rather went up.

Distinct from previous literatures, our report uses quarterly data to ensure enough observations to fit the model. Many literatures used annual data and couldn't make sure the accuracy of models. What's more, given that the tax base and the tax rate of property tax are usually dependent of property type and property value, it is impossible to use them to fit a model. Most literatures use property tax revenue as the representative of property tax policy, as what we did in the report. However, we also created two dummy variables based on the property tax reforms and reassessments, which can identify the twice property tax changes happened recently. Finally, we focused on the property tax instead of the extensive housing policies that are difficult to quantify and evaluate.

1.4 Paper Outline

The report contains five sections. The first section is introduction, including background, research questions and main findings, literature review and paper outline.

The section 2 is about data source, data description and data processing. We extract five data series of South Korea from 1986Q1 to 2018Q4, including the real housing price index, real GDP year-on-year growth rate, quarterly CPI percentage change, seasonal-adjusted long-term government bond rate, recurrent taxes on immovable property (percentage of GDP). What's more, we made two dummy variables at time point 1991Q1 and 2006Q1. In order to confirm whether the break points have a structural changing effect on housing price, we conducted chow tests and applied linear regression to test the changes on slope and intercept.

In section 3, a Vector Autoregressive Model was constructed to analysis the short-run dynamics, which consists five endogenous factors and two exogenous dummy variables. Section 4 is about impulse response and section 5 is about forecast error decomposition based on the VAR model. Section 6 is the conclusion and the limits in the paper.

2. Data

2.1 Choice of variables

Refer to previous relavent literature and basic economic theories, we decide to choose GDP growth rate, CPI, property tax and long-term interest rate, these four economic indicators as other endogenous variables in our model. Factors that can influence housing price are mainly due to unbalanced demand and supply. GDP growth rate, CPI and long-term interest rate can all affect the demand of housing. Because as GDP growth rate increases, citizens' disposable income also increases, and they are more capable of purchasing a house. In addition, if inflation rate increases or long-term interest rate decreases, citizens are more likely to invest their money in immovable properties to prevent depreciation, thus causing more demand on housing (Pingping, 2018). In our later analysis of the model, all these assumptions are verified.

2.2 Data Source

We have used data from OECD and Datastream. We prioritize the data from OECD, but for the data that are not satisfactory on OECD statistic page, we turned to a database called "Datastream".

Housing price. We use the quarterly data of South Korea from OECD account of analytical house price indicators. The link of the data is https://data.oecd.org/price/housing-prices.htm. Under drop-down list of data perspectives, we decide to use real housing price index, which has a base year of 2015=100. The reason we choose this index is that it is inherently free of the problem of price level adjustment, and it will be ideal for us to study on real data rather than nominal data.

Macroeconomy aggregates. We extract the quarterly data series of South Korea GDP from OECD quarterly national accounts statistics. The data can be traced through this link: https://data.oecd.org/gdp/quarterly-gdp.htm#indicator-chart. We choose to use data of percentage change compared to the same period of previous year. The data we used is real rather than nominal. Using real GDP year-on-year growth rate can avoid adjustment of price level, and also do not need to consider the problem of seasonality and non-stationarity, so we believe this series is ideally to be adopted.

Inflation. We adopt consumer price index (CPI) as an indicator of inflation. The primary source of our CPI data is from OECD consumer prices account. We extract time series data of quarterly CPI percentage change compared to same period in previous year in South Korea, and we choose CPI for all items. The data is available to be traced back using this web address: https://data.oecd.org/price/inflation-cpi.htm. The reason we prefer this series is that it is free of the problem of seasonality and non-stationarity.

Long-term interest rate. Similar to unemployment rate data, there are no long-term interest data before year of 2000 available on OECD database, so we also turned to Datastream. But we did not find any long-term interest relevant data as well, on Datastream. Finally, we decided to use seasonal-adjusted long-term government bond rate as an alternative.

Property tax revenue. We adopted tax property tax revenue relevant data from OECD statistic website https://stats.oecd.org/#. The specific source of the data on OECD database is from public sector, taxation and market regulation, then choose revenue statistic. We use the specific category "4100 Recurrent taxes on immovable property". We use the indicator of "percentage of GDP", and the reason why we use percentage of GDP rather than real amount of tax revenue is because in this way we can avoid dealing with the price level adjustment. In addition, in most cases, because taxes are closely related to GDP, and the ratio should be consistent, excepting for the time when significant shifts in taxation law or severe economy downturns. Hence, adopting an indicator of "percentage of GDP" of property taxation revenue is ideal in our case. The data is annual, from 1972 to 2018. Then we use Eviews to convert the annual series to quarterly series, through the method of "quadratic-match sum".

2.3 Summary Statistics

In total we have five time series, namely *hp* for real housing price index, *gdp* for real GDP year-on-year growth rate, *cpi* for CPI year-on-year growth rate, *ir* for long-term interest rate and *tr* for tax revenue accounting percentage of GDP. All of these data are quarterly data.

2.3.1 General statistics

Table 1 demonstrates the means and standard errors of each time series we got from previously mentioned sources.

Table 1: Summary Statistics

	mean	std.
Housing price	105.48	22.24
GDP growth rate	7.12	4.65
CPI growth rate	7.09	6.98
Long-term interest rate	8.55	4.68
Tax revenue (% of GDP)	0.14	0.04

Figure 1 displays the quarterly housing price index from 1986Q1 to 2018Q4, with a base year of 2015=100. We divide the time into four periods and try to find a relationship between the property tax changes to the ups and downs of housing price.

The first period is a real estate speculation peak period (1987-1990), partially due to the 1986 Asian Games and the 1988 Olympic Games held in South Korea. During that period, South Korea carried out a large-scale of land and housing development and experienced low interest rate. In 1990Q4, the housing price index peaked at 164.17, with a YOY growth rate of 16.13%.

Then the South Korean government implemented the first property tax reform in 1991, followed by the housing price oscillation and falling period (1991-2000). The South Korean government implemented a new system for assessing land and the reassessments took place in 1991 and 1992. The 1997 financial crisis also contributed in cooling down the housing market. The housing price index fell from 162.20 (1991Q1) to 74.69 (2000Q4).

The third period is the steady increasing period (2001-2005). In order to bring South Korea out of the recession, the South Korean government has imposed a variety of relaxed real estate policies, resulting in a retaliatory rebound in 2002 and 2003.

The last period is the steady period (2006-present). In 2006, the South Korean government created the Comprehensive Property Tax (CPT), which was intended to impose a quite heavy tax on housing with a combined assessed value exceeding 900 million won. Furthermore, the tax base rose a lot and was closer to market value after the reassessments. After the national property tax shocks and the external shock of 2008 global financial crisis, the South Korean housing market maintained in a steady level until now.

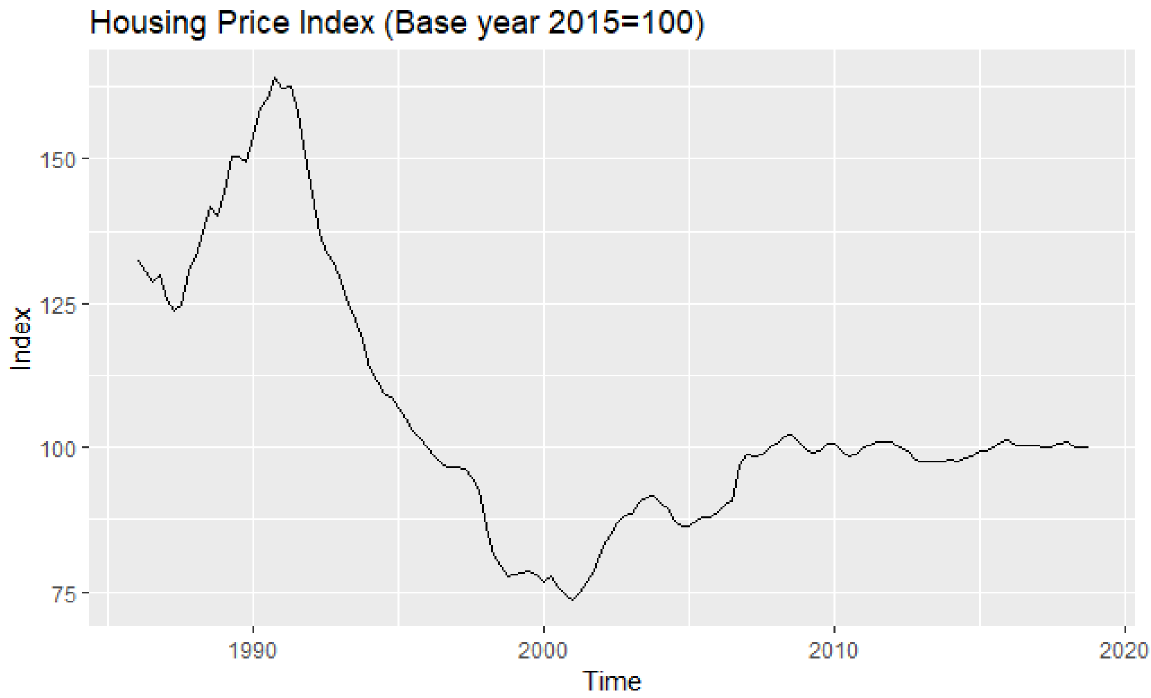

Figure 1: Housing price index (base year 2015 = 100)

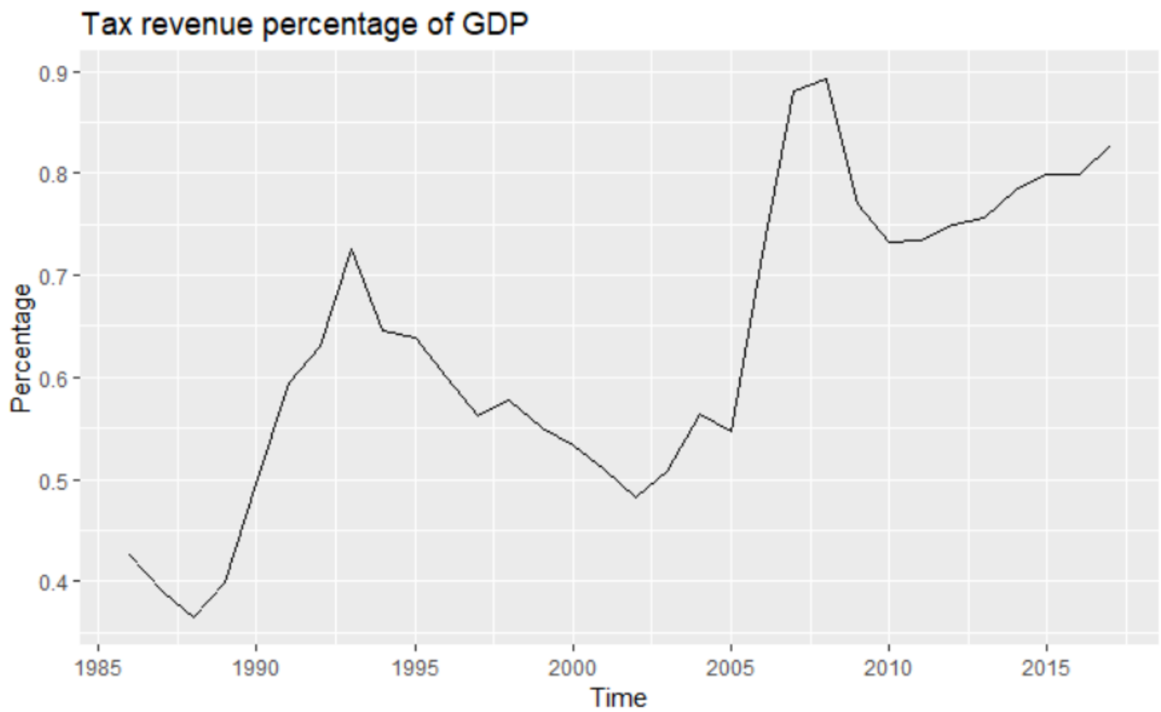

Figure 2: Tax revenue (% of GDP)

Figure 2 displays the annual recurrent taxes on immovable property (percentage of GDP). It fluctuates from 0.3% to 0.9 % over the decades. We observe twice significant increase around 1991 and 2006 when the South Korean implemented twice assessments and property tax reform. It increased from 0.5% in 1990 to 0.6% in 1991 and rose from 0.5% in 2005 to 0.7% in 2006. We also observed 0.1% decreases after the 1998 Asian financial crisis and 2008 Global financial crisis. Hence, the series is ideal in presenting the property tax changes and revealing the economy downturns.

2.3.2 Data sample

Table 2 demonstrates the basic features of each time series data samples, including numbers of observations and time horizons.

Table 2: Data sample

	nobs	period
Housing price	132	1986Q1-2018Q4
GDP growth rate	200	1969Q1-2018Q4
CPI growth rate	200	1969Q1-2018Q4
Long-term interest rate	147	1982Q3-2018Q4
Tax revenue (% of GDP)	188	1972Q1-2018Q4

2.3.3 Structural changes

As discussed in previous context, South Korea government has published relevant property tax policies in 1991 and 2006. Therefore, we treated time point 1991Q1 and 2006Q1 as break points and made dummy variables for them. For the first dummy variable (*td91*), the value is 0 before 1991 and becomes 1 since 1991Q1. The value of the second dummy variable (*td06*) is 0 before 2006 and turns into 1 starting from 2006Q1. In order to confirm whether the break points have structural changing effects on housing price, we conducted chow tests for the two break points respectively. As shown in Table 3, both the points have significant structural change, so the property tax policy changes in South Korea in 1991 and 2006 both have obvious structural impact on housing price in South Korea.

Table 3: Chow test results

	H0	p-value	F-statistic	conclusion
Break Point 1991	No Structural Change	0.00	24.34	Reject H0 (exist structural change)
Break Point 2006		0.00	101.76	Reject H0 (exist structural change)

However, we cannot determine whether the difference between the two regressions before and after break points is due to the difference in slope terms or difference in intercept terms. Hence, we then research on the four possible situations (Damondar, 2004):

I. Coincident Regression where both the intercept and the slope coefficients are the same in the two sub-period regressions;

II. Parallel Regression where only the intercepts in the two regressions are different but the slopes are the same;

III. Concurrent Regression where the intercepts in the two regressions are the same, but the slopes are different;

IV. Dis-similar Regression where both the intercepts and slopes in the two regressions are different.

We examined each scenario for both break-points in 1991 and 2006, and obviously scenario I is impossible as there exists structural changes so the slopes and intercepts are not likely be the same simultaneously. The test results of the remaining three scenarios on two break points are shown in Table 4, which indicates that in parallel model, both break-points have significant change on intercept, and in con-current model, both break-points also have significant change on slopes. However, in dis-similar model, the structural change point at 1991 only caused significant change in intercept while the break-point at 2006 have significant changes on both slope and intercept. We visualize the strucatural change regressions in Figure 3, and we can come to same conclusions as we got from Table 4.

Table 4: Structural change in slope and intercept

	Parallel	Concurrent	Dis-similar
d91 (measurement of intercept)	***	NA	
dt91 (mesure of slope)	NA	***	**
d06 (measurement of intercept)	***	NA	***
dt06 (mesure of slope)	NA	***	***

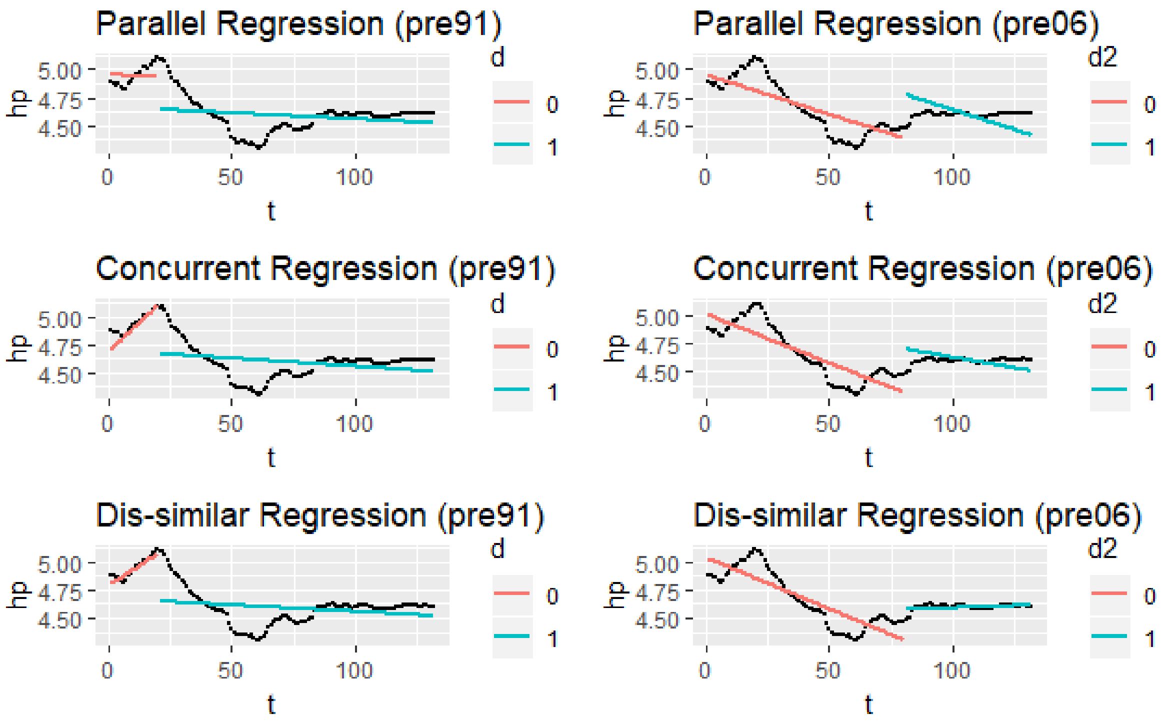

Figure 3: Visualization on intercept and slope changes

2.3.4 Unit root test

If two unrelated time series with unit roots are fitted in a regression model, it would cause a spurious correlation problem. Therefore, before we construct a regression model, we need to assure the series we included are stationary. Before conducting ADF test, we made log-transformation on *hp*, *ir* and *tr*, because there are increases in the variance with level, so we can stabilize the variance by taking logarithms.

Table 5: Argumented Dikey-Fuller test

	test-statistic	critical value	H0	conclusion
Housing price (hp)	-1.33			non-stationary
GDP growth rate (gdp)	-6.23			stationary
CPI growth rate (cpi)	-4.32			stationary
Long-term interest rate (ir)	-2.98	1% (-3.99) 5% (-3.43) 10% (-3.13)	unit root (non-stationary)	non-stationary
Tax revenue (% of GDP) (tr)	-3.71			stationary(0.05)
YoY housing price change rate (sdhp)	-3.97			stationary(0.05)
YoY long-term interest rate change (sdir)	-7.45			stationary
YoY tax revenue change rate (sdtr)	-5.56			stationary

Table 5 shows the ADF test results of each time series in order to make sure all series are stationary.As shown in Table5, series of *gdp* and *cpi* are stationary at 0.01 significance level, *tr* is stationary at 0.05 significance level, while series of *hp* and *ir* are non-stationary.

2.4 Preliminary Data Processing

According to the test results of ADF tests in previous context, we made fourth difference on the series of *hp* and *ir*, making them into *sdhp* and *sdir*, which means year-on-year housing price growth rate and year-on-year long-term interest rate growth rate. As shown in Table 5, series *sdir* is stationary at 0.01 significance level and series *sdhp* is stationary at 0.05 significance level. In addition, to make all the series comparable, we also made fourth difference on series of log-transformed *tr*, making it into *sdtr*, which means year-on-year tax revenue change. From now, our five time series data *sdhp*, *gdp*, *cpi*, *sdir* and *sdtr* are all year-on-year percentage change rates, which are stationary and comparable. In addition, data of percentage change compared to same period in previous year can naturally eliminate the seasonality, and this is also an important reason why we made such preliminary data processing.

To prepare for the model fitting in next part, we adjusted the horizons of each time series to the same. In order to have as many as observations as possible, we finally made every series begin from 1987Q1 and end at 2018Q4, with 128 observations in total. The reason why we would like to have more observations is to avoid bias, especially when we fit a VAR model, which may contain several lags, causing the decrease of degree of freedom. However, finally we have 128 observations so we should not worry too much about bias.

3. Vector Autoregressive Model (VAR)

3.1 Construct a model

Because we have time series of several variables, and we would like to look through the influence of those variables and their historical data on each other, so we decide to construct a Vector Autoregressive Model (VAR).

A VAR can be written as a formula:

$$y_t = \mu + A_1 y_{t-1} + A_2 y_{t-2} + A_p y_{t-p} + e_t$$

where y_t is a (K*1) vector of endogenous variables, A_p is a (K*K) matrix of coefficients, μ denotes a (K*1) matrix of intercept terms, and e_t is a K dimensional white noise innovation process (Hilde & Leif, 2015).

3.1.1 Variables included and the order

We will have five endogenous variables in our VAR model, including *sdtr*, *sdir*, *gdp*, *cpi* and *sdhp*. We will have two dummy variables, *td91* and *td06* as exogenous variables.

It is essential to decide a reasonable order in a recursive form of VAR model, because order will directly affect the later impulse response function analysis and variance decomposition (Hilde & Leif, 2015). The variables that have a front order can affect the following ones, but in converse, latter variables cannot affect preceding ones. Therefore, we should place the most exogenous variables at top of the order. Property tax revenue is not contemporaneously affected by other macroeconomic variables (François & Thomas, 2018), only affected by lags of these variables. In our data, based on our research objective, we will definitely put property tax revenue at beginning and housing price index at the end. In addition, long-term interest rate will be also relatively exogenous, and inflation will be relatively endogenous. Hence, the order we finally decide is *sdtr*, *sdir*, *gdp*, *cpi* and *sdhp*.

3.1.2 Selection of lag length

Before we constructing a VAR model, we have to determine the optimal number of lags to include in our model. We should make a balance on lag length and degree of freedom (Pingping 2018). We make decision according to various information criteria, such as AIC, BIC, HQ and so on. The lag suggestion based on our data is showed in Table 6:

Table 6: Lag selections by information criteria

	AIC	HQ	BIC	FPE
Selection	10	2	2	10

As different information criterion suggests different lag length, we further conduct likelihood ratio (LR) tests to determine the lag length. The test results indicate that 2-lag model is significantly better off than the 10-lag one. Furthermore, a shorter time lag model ensures the brevity and avoids decreasing the degree of freedom. Hence, we finally decide to use lag length as 2 when constructing our VAR model.

3.2 Result of model

3.2.1 Stability of VAR model

Before we study the results of the model and further conduct some tests, we should firstly confirm our VAR model is stable, then the following analysis like impulse response function and variance decomposition can be reliable. In order to test the stability of a VAR model, we should ensure that all the eigen roots reciprocals of VAR characteristic polynomial fall inside the unit circle (Hilde & Leif, 2015). According to Figure 4, in our model, all the points representing eigen roots reciprocals fall inside the unit circle, so our VAR model is stable and ready for further study.

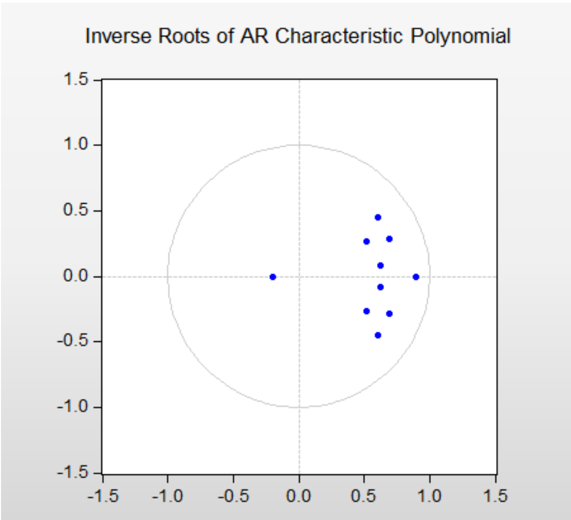

Figure 4: Inverse roots of AR characteristic polynomial

3.2.2 Fitting accuracy

The adjusted goodness of fit (adjusted R^2) of the five formulas are $R^2_{sdtr} = 0.893$, $R^2_{sdir} = 0.684$, $R^2_{gdp} = 0.773$, $R^2_{cpi} = 0.883$ and $R^2_{sdhp} = 0.913$. Generally speaking, all the five functions fit quite well, therefore, the conclusion based on this model should be reliable.

3.2.3 Estimation results

$$
\begin{pmatrix} sdtr \\ sdir \\ gdp \\ cpi \\ sdhp \end{pmatrix} = \begin{pmatrix} -0.010 \\ -0.027 \\ -1.153 \\ -0.432 \\ -0.027 \end{pmatrix} + \begin{pmatrix} -0.000 \\ 0.013 \\ -0.561 \\ -0.184 \\ 0.002 \end{pmatrix} + \begin{pmatrix} 1.364 & 0.064 & 0.001 & -0.004 & 0.130 \\ -0.004 & 1.130 & -0.000 & 0.000 & 0.620 \\ 0.323 & 0.029 & 0.805 & -0.466 & 29.188 \\ -0.138 & 1.329 & -0.042 & 0.931 & 3.685 \\ -0.026 & -0.033 & 0.001 & -0.000 & 1.327 \end{pmatrix} \begin{pmatrix} sdtr_{t-1} \\ sdir_{t-1} \\ gdp_{t-1} \\ cpi_{t-1} \\ sdhp_{t-1} \end{pmatrix} +
$$

$$
\begin{pmatrix} -0.492 & -0.039 & -0.002 & 0.005 & -0.063 \\ 0.025 & -0.518 & 0.004 & 0.002 & -0.495 \\ 3.190 & -0.960 & -0.073 & 0.483 & -32.501 \\ 1.463 & -1.132 & 0.113 & -0.113 & -3.386 \\ 0.015 & 0.026 & -0.001 & -0.002 & -0.470 \end{pmatrix} \begin{pmatrix} sdtr_{t-2} \\ sdir_{t-2} \\ gdp_{t-2} \\ cpit-2 \\ sdhpt-2 \end{pmatrix} + \begin{pmatrix} 0.014 \\ -0.029 \\ 2.235 \\ 0.727 \\ 0.033 \end{pmatrix} + \begin{pmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \\ e_{5t} \end{pmatrix}
$$

The coefficients estimation is demonstrated in the above matrix multiplication formula. The two constant matrices in first row are the coefficients of two dummies, and the constant matrix in second row is of coefficients of constant term.

The estimated coefficients of dummy variables can be interpreted so see their influence on other endogenous variables, but the estimated coefficients of other variables are of no meaning and cannot be interpreted (Yunyun, 2017). However, the coefficient of dummy variable can be interpreted meaningfully (Helmut, 2005). Among the estimated coefficients of both dummies, only that of *td91*in the equation of *sdhp* is significant at 0.01 significance level. The meaning is, once the property tax revolution on 1991 published, bringing a negative effect on housing price in South Korea, and the growth rate of housing price decreases by 2.7%.

4. Impulse response function (IRF) analysis

A very key part in studying a VAR model is construction and interpretation of the impulse response function. An impulse response function describes how a structural shock affects an endogenous variable in VAR model over time (Hilde & Leif, 2015). In the following impulse response functions, all the shocks are with standard deviation normalized to 1.

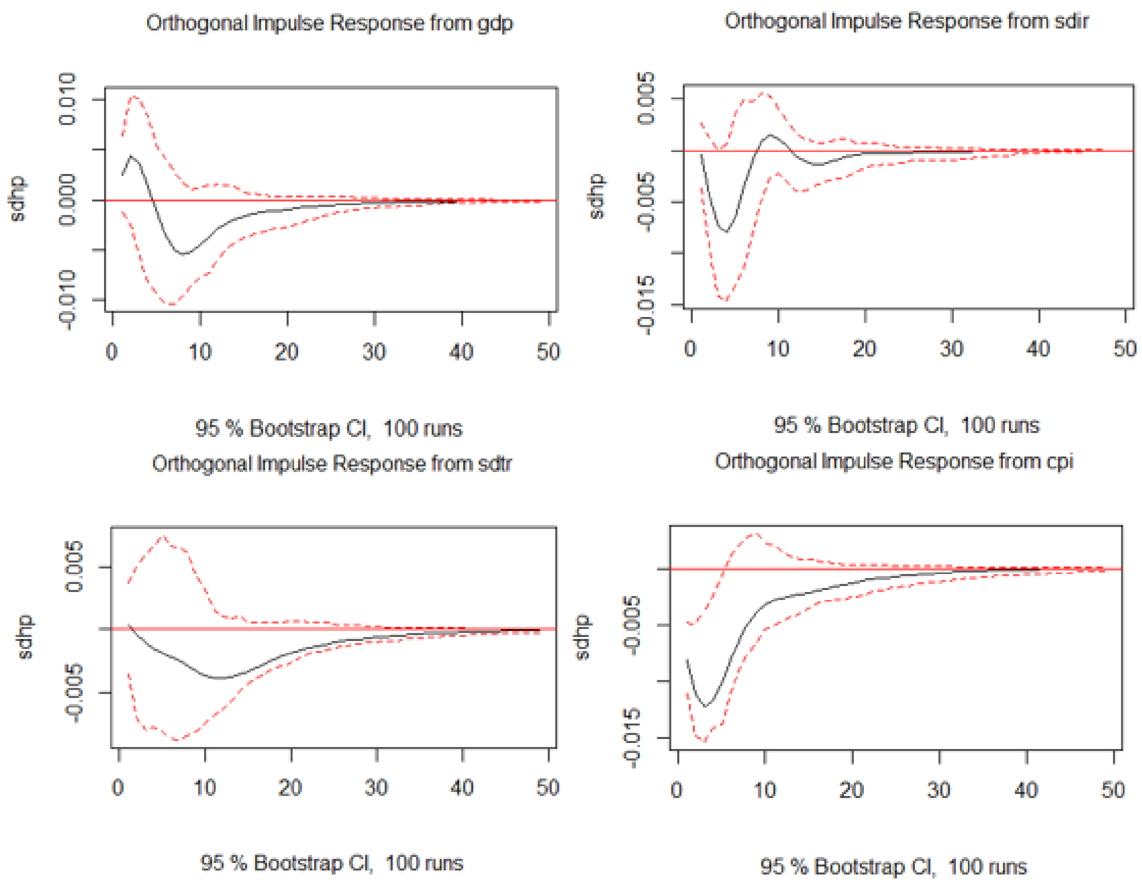

Figure 5: Orthogonal impulse response

As shown in top left subgraph of Figure 5, a temporary contractionary fiscal policy shock on South Korean real estate industry that increase the property tax has an immediate negative effect on the growth of housing price, and the negative effect will take 8 periods (8 quarters) to reach the maximum impact about 0.005 unit of standard deviation, and then gradually and slowly rebound, and the shock will take about another 24 quarters to finally die out. In top right subgraph of Figure 5, a temporary positive shock to increase the long-term interest rate, can lead to a temporary negative effect on growth of housing price. The negative effect reaches its maximum at about 0.0075 unit of standard deviation after 4 periods, and then quickly rebounds at 10th period. Then in bottom left subgraph of Figure 5, a temporary positive shock on GDP growth will cause negative temporary effect on housing price growth. The effect will become largest in 12th period at about 0.005 unit of standard deviation and then rebound gradually at about 30th period. Finally, in the bottom right subgraph of Figure 5, a temporary positive shock on CPI, that the inflation rate growing more rapidly, will cause a temporary negative impact on housing price growth rate. It takes around 4 periods to reach the maximum negative impact of about 0.0012 unit of standard deviation and the impact dies out in another 24 quarters.

To sum up, all the positive shocks of four variables, property tax, long-term interest rate, GDP and CPI have a negative impact on housing price, and this verified our previous assumption in section 2.1. But the scale and time of impact differ. Generally speaking, the impacts from shocks on long-term interest rate and CPI are stronger than those from shocks on fiscal policy and GDP growth rate. But the impacts from shocks on long-term interest rate and CPI last shorter than those from shocks on fiscal policy and GDP growth rate. So, concentrating on what we are interested in, imposing a contractionary fiscal policy on property tax should effectively slow down the growth speed of housing price in short run, about 2 years, and the strength of such impact is not as strong as that of other shocks like CPI and long-term interest rate, and the impact will eventually die out after 7 years since the shock occurred.

5. Forecast error variance decomposition (FEVD)

In order to clarify the contributions of every endogenous variables on housing price variation, it is essential to conduct a forecast error variance decomposition (FEVD) on *sdhp*. FEVD is to account for variance in prediction of error of a variable, for example *sdhp* in our case, due to a specific shock at a given horizon (Hilde & Leif, 2015). As we are studying the factors that affect the housing price, we conduct a FEVD on *sdhp* in our case. In Table 7, shows the contributions of all five endogenous variables in our VAR model to the variance of prediction errors of variable *sdhp*, over a horizon of 8 periods, that is, 8 quarters.

Table 7: Variance decomposition of sdhp

	sdtr	sdir	gdp	cpi	sdhp
1	0.0003	0.0006	0.0156	0.1735	0.8100
2	0.0002	0.0174	0.0235	0.1733	0.7855
3	0.0008	0.0668	0.0209	0.1875	0.7510
4	0.0016	0.0581	0.0168	0.2035	0.7201
5	0.0027	0.0668	0.0156	0.2189	0.6961
6	0.0042	0.0678	0.0193	0.2309	0.6778
7	0.0063	0.0660	0.0272	0.2381	0.6624
8	0.0090	0.0649	0.0364	0.2410	0.6487

As demonstrated in Table 7, the most majority of contribution to forecast the variance of housing price is the historical data of itself, accounting for 81% at 1st period, 72% at 4th period and 65% at 8th period. Additionally, another major contribution of housing price variance is from CPI, accounting for 17%, 20% and 24% at 1st, 4th and 8th period, respectively. Long-term interest rate plays a third important role, accounting for 0%, 6% and 6% in previously mentioned three periods respectively. Although fiscal policy factor also can explain some variance in housing price, but its contribution is too tiny when compared to other variables. Hence, from the results of FEVD, it is unreliable to adjust housing price growth by solely depending on one factor, and combined policies should be used, including contractionary fiscal policy on property tax, contractionary monetary policy on long-term interest rate, then realize ideal control of housing price (Pingping 2018).

6. Conclusion

6.1 Findings

First, property tax policies published in 1991 and 2006 in South Korea both caused structural changes in South Korean housing price.

Second, contractionary fiscal policy on property can slow down the speed of housing price growth, as indicated in our impulse response function graph.

Third, according to FEVD, variance of housing price mainly relies on its own historical data, and other factors can only have a little contribution, and the contribution of variable of fiscal policy is even tiny. Therefore, combined policies should be adopted to effectively control housing price, including contractionary fiscal policy on property tax, contractionary monetary policy on long-term interest rate.

Fourth, all the shocks from variables can only affect housing price in a short-term, and will gradually die out in long run.

6.2 Limitations in the paper

Due to the difficulty in accessing data divided by cities, the model didn't distinguish the overheated housing markets such as Seoul and the depressed housing market. The effect of the property tax may be diverse in different kinds of markets.

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