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The Impact of Real Estate Taxes on Housing Prices: Analysis based on DSGE Model

Lideng Zhang[1], Zongying Gao[2, *]

[1] School of Economics, Anhui University of Finance and Economic, Bengbu, 233030, China

[2] School of Statistics and Applied Mathematics, Anhui University of Finance and Economic, Bengbu, 233030, China

*Corresponding author: 120220172@aufe.edu.cn

Abstract

By constructing a Dynamic Stochastic General Equilibrium (DSGE) model that includes real estate taxes, to explore the long-term equilibrium and short-term fluctuations of housing prices, as well as the optimal tax rate. Based on actual data from China, through static analysis, dynamic analysis, and welfare analysis, drawing the following conclusions: From the perspective of long-term equilibrium, property tax will reduce housing prices, while the effect of land tax on housing prices is uncertain; From the perspective of short-term fluctuations, under supply shocks, the impact of real estate tax on housing price fluctuations is not significant, but under demand shocks, real estate tax can effectively suppress the rise of housing prices; From the perspective of welfare loss, levying real estate tax can reduce social welfare loss, and the optimal property tax rate is 0.623%, while the optimal land tax rate is 10%.

Keywords

Real Estate Tax; Housing Prices; DSGE Model.

1. Introduction

The imposition of real estate taxes has been a widely discussed issue in recent years, and it has garnered significant attention from the society. Starting from 2010, when China confirmed its intention to gradually implement reforms related to real estate taxes, to the selection of Shanghai and Chongqing as pilot cities for real estate tax reforms in 2011, the government has consistently placed great emphasis on the issue of real estate tax reforms. Therefore, what impact will the nationwide implementation of real estate taxes have on China's housing prices? How should the optimal real estate tax rate be set? The purpose of this study is to answer these two questions, which are of great significance for promoting the reform of China's real estate tax system.

There has been ongoing academic debate regarding the effect of levying real estate taxes on housing prices. Some literature suggests that real estate taxes will lead to a decrease in housing prices. Oates [1] studied the impact of local property taxes and local expenditure items on property values, and found a significant negative correlation between local property values and effective tax rates, as well as a significant positive correlation with public school spending per student. Building on Oates' model, Rosen [2] replaced public service expenditure with test scores and also found a significant negative impact of real estate taxes on housing prices. Kuang [3] used panel data from 30 provinces in China to study the impact of property taxes on housing prices. The research results indicate that the implementation of property taxes can effectively curb the rise in housing prices for the whole country and the eastern region, but the effect of property taxes on the central and western regions is not significant.

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On the other hand, some scholars oppose the implementation of real estate taxes, believing that real estate taxes will lead to an increase in housing prices. Fischel [4] believed that real estate taxes increase housing prices due to urban land use zoning and voting with one's feet. Xia [5] believed that the impact of property taxes on curbing housing prices was uncertain, and real estate taxes not only fail to adjust income inequality, but also result in welfare losses.

Most scholars have used econometric analysis methods to study the relationship between real estate taxes and housing prices. However, empirical analysis based on regression analysis may face the "Lucas critique," that is, economic agents facing policy changes such as real estate tax reform may change their behavior based on the new economic environment, resulting in ineffective policy analysis. At the same time, since real estate taxes have not yet been implemented nationwide in China, there is a lack of sample data to study the impact of real estate taxes. Therefore, based on a micro-founded dynamic stochastic general equilibrium (DSGE) model, which can avoid the "Lucas critique" and conduct policy analysis through counterfactual simulations in the absence of sample data, this study uses it as the analytical tool.

In recent years, many scholars have analyzed the regulatory effects of real estate policies based on the dynamic stochastic general equilibrium (DSGE) model. Luo [6] was the first to use the DSGE model to study the macroeconomic impacts of property tax and housing price changes. However, their research did not cover how China's real estate tax should be set, and their study only considered property taxes levied on housing holding, while real estate tax is a comprehensive concept that includes all taxes directly related to the process of real estate economic activity. From the perspective of foreign real estate tax reform, the United States mainly taxes homeownership, while countries such as Australia and New Zealand only tax land. Considering that property tax and land tax have different mechanisms for macroeconomic impacts, it is also necessary to include land tax in the research scope. Yi [7] analyzed the advantages and disadvantages of housing demand suppression and land supply regulation policies, and found that both suppressing housing demand and increasing land supply can effectively curb rising house prices, and land supply regulation also has positive spillover effects on the macroeconomy. Therefore, from an overall perspective, land supply regulation is a better real estate regulation policy. Chen [8] explored the implementation and exit strategies of real estate regulation policies, and found that housing purchase restrictions are mainly aimed at speculative demand and are suitable for controlling housing prices in first-tier cities, while the down payment ratio policy is mainly aimed at rigid demand and is suitable for controlling housing prices in non-first-tier cities. However, the focus of these studies did not involve property tax policy.

Currently, many scholars are studying the design issues of China's real estate tax. Hou [9] analyzed the design principles and implementation strategies of China's real estate tax, and believed that China should impose real estate taxes sooner rather than later, and that the tax system design should follow the principles of tax fairness, efficiency, sufficient tax revenue, appropriate tax policies, and transparent operation. Zhang [10] constructed an index to measure the tax-paying ability of real estate tax based on the tax capacity theory, and used data from the "China Household Finance Survey" and the "China Family Tracking Survey" to estimate the tax-paying ability of households in different regions, and estimated the feasible and effective tax rates of each province. He [11] discussed the design issues of real estate tax base and tax incentives in China by drawing on the practical experience of developed countries' real estate tax. However, current related research lacks a comprehensive theoretical model to analyze the optimal real estate tax rate setting.

This article attempts to address the shortcomings of existing research by incorporating property tax and land tax into a dynamic stochastic general equilibrium model. Using macroeconomic data from China, the model is estimated and the long-term equilibrium and short-term fluctuations of house prices under the influence of property taxes are analyzed

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through static and dynamic analyses. At the same time, the optimal property tax rate for China is explored from the perspective of social welfare loss, providing a theoretical basis for China's property tax reform.

2. Theoretical Model

Based on the Iacoviello [12] model, this article introduces real estate tax and government finance and constructs a new Keynesian DSGE model that is suitable for China's real estate market characteristics. The entire economic system consists of households, firms, retailers, and government. Households provide labor to firms to earn income and meet their consumption and housing needs, while also depositing their surplus income in banks to earn interest. Firms are divided into consumer goods firms and real estate firms. Consumer goods firms use capital and labor to produce intermediate goods, which are then packaged and processed through retailers and sold to households. Real estate firms use capital, labor, and land as production inputs to produce housing through borrowing and financing. The government is divided into two categories: the central bank, which is responsible for regulating interest rates to stabilize the real economy, and the finance department, which decides public service investment and is subject to budget constraints.

2.1. Households

Assuming that the household sector is composed of a series of homogeneous individuals, households maximize intertemporal utility by choosing consumption, labor, housing investment, and deposit amounts as follows:

$$E_0 \sum_{t=0}^{\infty} \beta^t [lnc_t + j_t lnh_t - \frac{n_t^{1+\eta}}{1+\eta}] \tag{1}$$

$$n_t = [\alpha^{-\tau} n_{c,t}^{1+\tau} + (1-\alpha)^{-\tau} n_{h,t}^{1+\tau}]^{\frac{1}{1+\tau}},\ \tau \geq 0 \tag{2}$$

Where, c_t, h_t and n_t represent household consumption, housing, and labor supply at time t, respectively. β denotes the household's discount factor, η represents the inverse of labor supply elasticity, and j_t represents the housing preference shock, which follows an AR(1) process. α represents the economic size of each sector, τ represents the household's preference for providing labor to the consumption and real estate sectors. Following Iacoviello [12], $\tau = 0$ indicates complete substitutability of labor between the consumption and real estate sectors, while $\tau > 0$ indicates imperfect substitutability, reflecting the heterogeneity across sectors.

Households are subject to the following budget constraints:

$$c_t + q_t h_t + b_t + \Gamma_h q_t h_t \leq r_{t-1} b_{t-1} + (w_{c,t} n_{c,t} + w_{h,t} n_{h,t})(1-\Gamma_w) + (1-\delta_h) q_t h_{t-1} \tag{3}$$

Where q_t is the actual housing price, b_t is the actual savings of the household, r_t is the actual interest rate on savings, $w_{c,t}$ and $w_{h,t}$ are the actual wages paid by the consumption and real estate sectors, respectively. $n_{c,t}$ and $n_{h,t}$ are the labor supplied by the household to the consumption and real estate sectors, respectively. Γ_w and Γ_h are the personal income tax rate and property tax rate, respectively, and δ_h is the depreciation rate of housing.

Solving the household's intertemporal utility maximization problem subject to the budget constraints, we obtain the following optimality conditions:

Housing demand equation:

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$$\frac{j_t}{h_t} = \frac{q_t}{c_t}(1 + \Gamma_h) - \beta(1 - \delta_h)E_t\frac{q_{t+1}}{c_{t+1}} \tag{4}$$

Consumer goods production labor supply equation:

$$\alpha^{-\tau}n_{c,t}^{\tau}[\alpha^{-\tau}n_{c,t}^{1+\tau} + (1 - \alpha)^{-\tau}n_{h,t}^{1+\tau}]^{\frac{\eta-\tau}{1+\tau}} = \frac{1}{c_t}w_{c,t}(1 - \Gamma_w) \tag{5}$$

Real estate production labor supply equation:

$$(1 - \alpha)^{-\tau}n_{h,t}^{\tau}[\alpha^{-\tau}n_{c,t}^{1+\tau} + (1 - \alpha)^{-\tau}n_{h,t}^{1+\tau}]^{\frac{\eta-\tau}{1+\tau}} = \frac{1}{c_t}w_{h,t}(1 - \Gamma_w) \tag{6}$$

The consumption Euler equation:

$$\frac{1}{c_t} = \beta\frac{r_t}{c_{t+1}} \tag{7}$$

2.2. Firms

The firms use capital ($k_{c,t}$ and $k_{h,t}$), labor ($n_{c,t}$ and $n_{h,t}$), and land (l_t) to produce intermediate goods y_t and housing Ih_t. It is assumed that the firms have a Cobb-Douglas production function with constant returns to scale:

$$y_t = A_{c,t}k_{c,t-1}^{\mu}n_{c,t}^{1-\mu}G_t^{\nu} \tag{8}$$

$$Ih_t = A_{h,t}k_{h,t-1}^{\mu_k}n_{h,t}^{\mu_n}l_t^{1-\mu_k-\mu_n}G_t^{\nu} \tag{9}$$

Where, $A_{c,t}$ and $A_{h,t}$ represent the exogenous technological shocks in the consumption and real estate sectors, respectively. G_t represents the government's public service investment. μ, ν, μ_k, and μ_n represent the output elasticity of the corresponding production factors.

The firms aim to maximize their discounted utility:

$$E_0\sum_{t=0}^{\infty}\beta_e^t\ln c_{e,t} \tag{10}$$

Subject to the budget constraints:

$$c_{e,t} + w_{c,t}n_{c,t} + w_{h,t}n_{h,t} + r_{t-1}d_{t-1} + q_{l,t}l_t + \Gamma_l q_{l,t}l_t + i_{c,t} + i_{h,t} = \frac{y_t}{X_t} + q_tIh_t + d_t \tag{11}$$

Where, β_e is the discount factor of the firms and $\beta_e < \beta$, indicating that the firms are less patient than households. $c_{e,t}$ represents the consumption of the firms, $d_t$represents the loan amount of the firms, $q_{l,t}$ represents the land price, $i_{c,t}$ and $i_{h,t}$ represent the capital investment of the consumption and real estate sectors, respectively. X_t represents the market markup, and Γ_l represents the land use tax.

The firms need to mortgage land and borrow capital during the housing production process and are subject to the following credit constraints:

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$$d_t \leq mE_t(q_{l,t+1}l_t + k_{h,t})/r_t \tag{12}$$

Capital accumulation equation:

$$k_{c,t} = (1-\delta)k_{c,t-1} + i_{c,t} \tag{13}$$

$$k_{h,t} = (1-\delta)k_{h,t-1} + i_{h,t} \tag{14}$$

where m represents the loan-to-value ratio and δ is the capital depreciation rate. The optimality conditions of the firms are as follows:
Consumer goods production capital demand equation:

$$\beta_e \frac{1}{c_{e,t+1}}\left(\frac{\mu y_{t+1}}{X_{t+1}k_{c,t}} + 1 - \delta\right) = \frac{1}{c_{e,t}} \tag{15}$$

Real estate production capital demand equation:

$$\beta_e \frac{1}{c_{e,t+1}}\left(\frac{\mu_k q_{t+1} Ih_t}{k_{h,t}} + 1 - \delta\right) + \lambda_t = \frac{1}{c_{e,t}} \tag{16}$$

Consumer goods production labor demand equation:

$$\frac{(1-\mu)y_t}{X_t n_{c,t}} = w_{c,t} \tag{17}$$

Real estate production labor demand equation:

$$\frac{\mu_n q_t Ih_t}{n_{h,t}} = w_{h,t} \tag{18}$$

Land demand equation:

$$\frac{1}{c_{e,t}}\left[(1-\mu_k-\mu_n)q_t\frac{Ih_t}{l_t} - (1+\Gamma_l)q_{l,t}\right] + \lambda_t m q_{l,t+1} = 0 \tag{19}$$

Credit demand equation:

$$\frac{1}{c_{e,t}} - \beta_e \frac{1}{c_{e,t+1}} r_t - \lambda_t r_t = 0 \tag{20}$$

Where, λ_t is the Lagrange multiplier of the credit constraint for firms.

2.3. Retailers

In the economy, there is a series of consecutive retailers i, and $i \in [0,1]$. These retailers purchase intermediate goods from firms, produce differentiated final goods $y_i(i)$, and sell them to consumers in a monopolistically competitive market at a price of $p_t(i)$. Each retailer i faces the demand function as follows:

$$y_i(i) = y_t(\frac{p_t}{p_t(i)})^{\psi} \tag{21}$$

The price index is as follows:

$$p_t = [\int_0^1 p_t\,(i)^{1-\psi}di]^{\frac{1}{1-\psi}} \tag{22}$$

Where, $\psi > 1$ indicates the substitution elasticity of the product.
Retailer i chooses the optimal price $p_t^*(i)$ in period t to maximize its real discounted profit:

$$E_t \sum_{j=0}^{\infty} \beta^j \frac{U\prime(c_{t+j})}{U\prime(c_t)} [\frac{p_t^*(i)}{p_{t+j}} y_{t+j}(i) - \frac{X}{X_{t+j}} y_{t+j}(i)] \tag{23}$$

Where X_t represents the markup ratio, and $X = \frac{\psi}{\psi-1}$ in steady state. $\beta\frac{U'(c_{t+1})}{U'(c_t)}$ represents the retailer's actual stochastic discount factor. Solving the first-order condition yields:

$$p_t^*(i) = \frac{\psi}{\psi-1} \frac{E_t \sum_{j=0}^{\infty} \beta^j U\prime(c_{t+j}) y_{t+j}(i) p_{t+j} \frac{1}{X_{t+j}}}{E_t \sum_{j=0}^{\infty} \beta^j U\prime(c_{t+j}) y_{t+j}(i)} \tag{24}$$

According to the assumption of Calvo [13], only a fraction of $1-\theta$ of intermediate goods firms will adjust their product prices to the optimal level $p_t^*(i)$ each period, while the remaining firms will keep their prices at the previous period's level. Thus, the evolution equation of the price level can be derived as follows:

$$p_t^{1-\psi} = \theta p_{t-1}^{1-\psi} + (1-\theta)(p_t^*)^{1-\psi} \tag{25}$$

By log-linearizing equations (24) and (25), we can derive the forward-looking New Keynesian Phillips curve:

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} - \frac{(1-\beta\theta)(1-\theta)}{\theta} \hat{X}_t \tag{26}$$

In the text, all superscripts "^" denote the deviation of a variable from its steady-state value.

2.4. Government

The government sector includes the monetary and fiscal departments. The central bank adopts the form of Taylor rule when formulating monetary policy decisions, that is, mainly targeting inflation and output gap when adjusting the nominal interest rate, with the following specific form:

$$\hat{R}_t = \phi_R \hat{R}_{t-1} + (1-\phi_R)[(1+\phi_\pi)\hat{\pi}_t + \phi_y \hat{y}_t] \tag{27}$$

Where ϕ_R, ϕ_π, and ϕ_y represent the interest rate smoothing coefficient, the responsiveness of monetary policy to inflation and output, respectively.

Government revenue includes property taxes, land taxes, personal income taxes, and land income. Government revenue is used for public service investments, as follows:

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$$\Gamma_h q_t h_t + q_{l,t} l_t + \Gamma_l q_{l,t} l_t + (w_{c,t} n_{c,t} + w_{h,t} n_{h,t})\Gamma_w = \mathrm{G}_t \tag{28}$$

Assuming short-term land supply is constant, we define $\bar{L}$ as the land supply and ζ_t as the land supply shock, then we have:

$$\mathrm{l_t} = \zeta_t \bar{\mathrm{L}} \tag{29}$$

2.5. Market Clearing

In macroeconomic equilibrium, all markets must satisfy the clearing condition:
Goods market clearing:

$$\frac{y_t}{X_t} = c_t + c_{e,t} + i_{c,t} + i_{h,t} + G_t \tag{30}$$

Housing market clearing:

$$Ih_t = h_t - (1 - \delta_h) h_{t-1} \tag{31}$$

Credit market clearing:

$$b_t = d_t \tag{32}$$

Fisher equation:

$$\hat{r}_t = \hat{R}_t - \hat{\pi}_{t+1} \tag{33}$$

2.6. Exogenous Shocks

Housing preference shock:

$$\hat{j}_t = \theta_j \hat{j}_{t-1} + e_{j,t} \tag{34}$$

Consumption technology shock:

$$\hat{A}_{c,t} = \theta_c \hat{A}_{c,t-1} + e_{c,t} \tag{35}$$

Real estate technology shock:

$$\hat{A}_{h,t} = \theta_h \hat{A}_{h,t-1} + e_{h,t} \tag{36}$$

Land supply shock:

$$\hat{\zeta}_t = \theta_l \hat{\zeta}_{t-1} + e_{l,t} \tag{37}$$

Where, θ_j, θ_c, θ_h, and $\theta_l$represent the first-order autocorrelation coefficients of corresponding shocks. $e_{j,t}$, $e_{c,t}$, $e_{h,t}$, and $e_{l,t}$ are the random disturbance terms, with standard deviations of ε_j, ε_c, ε_h, and ε_l, respectively.

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3. Parameter Calibration and Estimation

Based on the Chinese macroeconomic data from the first quarter of 2011 to the third quarter of 2022 and the research results of classical literature, this paper calibrated and estimated the parameters in the model. The data used in this study are all from the WIND database. The results of parameter calibration are shown in Table 1.

Table 1. Calibration Values of Parameters in the Model

Parameter	Calibration Value	Parameter	Calibration Value	Parameter	Calibration Value
β	0.997	β_e	0.98	$\bar{X}$	1.05
θ	0.75	α	0.9	m	0.7
δ	0.025	δ_h	0.01	ν	0.5
μ	0.5	μ_k	0.2	μ_n	0.3
Γ_w	0.25	Γ_h	0.00125	Γ_l	0.1247

To make the parameter settings in the model more consistent with the facts of China's macroeconomic fluctuations, this article uses Bayesian estimation to estimate the remaining parameters. To avoid the problem of stochastic singularity, this article selects output, real estate development investment completed, consumption, and expenditure as the observed variables, and first adjusts the original data for inflation to transform it into real data, and then uses X12 seasonally adjusted to remove seasonal fluctuations in the data. To match the data with the logarithmic linearized variables, take the logarithm of the adjusted data, and use the HP filter to remove the long-term trend, retaining only the fluctuation term of the data.

The prior distributions of the parameters refer to the settings in the literature such as Smets [14], Cheng [15]. The MCMC algorithm (Markov Chain Monte Carlo) is used to simulate the posterior distribution characteristics of the parameters. The specific computation process is completed using the Dynare toolbox in Matlab, with 10,000 simulation samples, using two Markov chains, and the interval length is set to the 90% confidence interval of the parameters. The specific results of Bayesian estimation of parameters are shown in Table 2:

Table 2. Bayesian estimation results of parameters in the model

Parameter	Prior distribution			Posterior distribution	
	Distribution	Mean	Standard	Mean	90% confidence interval
η	Gamma	0.500	0.1000	0.4684	[0.3159, 0.6178]
τ	Normal	1.000	0.1000	0.9752	[0.7874, 1.1552]
ϕ_R	Beta	0.750	0.1000	0.3027	[0.2413, 0.3679]
ϕ_π	Normal	0.500	0.1000	0.2710	[0.1864, 0.3529]
ϕ_y	Normal	0.500	0.1000	0.9682	[0.8473, 1.0933]
θ_c	Beta	0.850	0.1000	0.8962	[0.8531, 0.9303]
θ_i	Beta	0.850	0.1000	0.9925	[0.9904, 0.9951]
θ_h	Beta	0.850	0.1000	0.2879	[0.1912, 0.3797]
θ_l	Beta	0.850	0.1000	0.9320	[0.9145, 0.9499]
ε_c	InvGamma	0.250	2.0000	0.0644	[0.0563, 0.0727]
ε_j	InvGamma	0.250	2.0000	0.0524	[0.0385, 0.0652]
ε_h	InvGamma	0.250	2.0000	0.1736	[0.1446, 0.2036]
ε_l	InvGamma	0.250	2.0000	0.3671	[0.3082, 0.4229]

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4. Simulation Analysis

4.1. Steady-State Analysis of the Model

This article first analyzes the impact of levying a property tax on the steady-state value of house prices through static analysis of the economy in a long-term equilibrium state. From the general equilibrium framework constructed in this article, the long-term impact of property taxes on house prices is mainly reflected in two aspects: First, property taxes reduce housing demand and cause house prices to fall. From the housing demand equation (equation 4), it can be seen that at the steady-state, $\frac{\bar{q}\bar{h}}{\bar{c}} = \frac{\bar{j}}{[1+\Gamma_h-\beta(1-\delta_h)]}$, where the superscript "-" represents the steady-state value of the variable. Under the determined parameters, levying a property tax (Γ_h) will reduce the proportion of household housing investment to consumption expenditure and reduce housing demand. Therefore, levying a property tax can to some extent restrain the phenomenon of "speculative house-buying". Second, property taxes reduce house prices by increasing housing supply. From the government budget equation (equation 28), it can be seen that levying a property tax will increase government public service expenditure, and government infrastructure construction is conducive to enterprise production, thereby increasing housing supply. Overall, whether by reducing housing demand or increasing housing supply, the government's imposition of a property tax will lead to a long-term decline in house prices.

The long-term impact of a land tax on house prices is also reflected in two aspects: First, a land tax will affect land demand, reduce enterprise housing production, and cause house prices to rise. From the land demand equation (equation 19), it can be seen that at the steady-state, ($\frac{\overline{qIh}}{\overline{q_l l}} = \frac{1+\Gamma_l-m\bar{\lambda}\bar{c}_e}{1-\mu_k-\mu_n}$). From equation 7 and equation 20, it can be obtained that: $\bar{\lambda}\bar{c}_e = \beta - \beta_e$. Under the condition of other variables being constant, the steady-state value of house prices is directly proportional to the land tax (Γ_l). Second, like property taxes, a land tax will also increase government public service expenditure, thereby increasing enterprise housing supply and causing house prices to fall. Overall, the government's imposition of a land tax on house prices in the long-term depends on the size of the land demand effect and the government expenditure effect.

4.2. Pulse Response Analysis

This article analyzes the short-term impact of real estate taxes on house price fluctuations under different exogenous shocks through pulse response analysis. As a comparative analysis, this article takes the absence of real estate taxes as the base case (solid line in the figure), and takes the cases where only property taxes (dotted line in the figure) or only land taxes (dashed line in the figure) are levied as the control group.

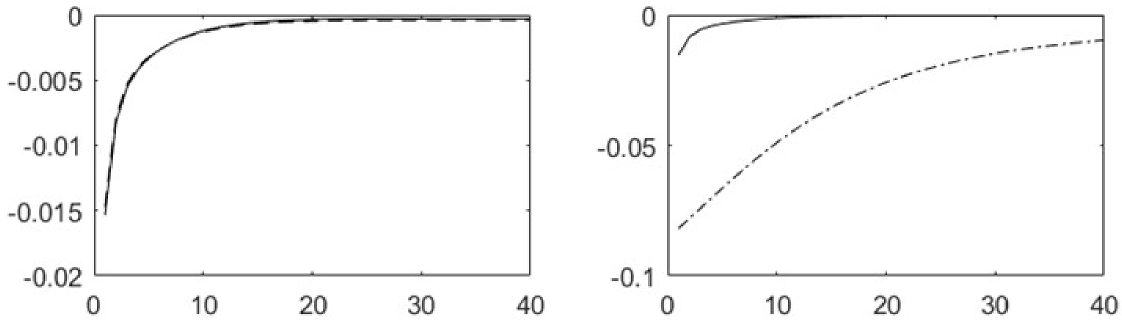

Figure 1. The impact of real estate technology shock on housing prices

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Firstly, analyzing the case of real estate technological shock, as shown in Figure 1, without real estate taxes, a unit of positive exogenous real estate technological shock will cause house prices to drop by about 1.5%, and then gradually return to the steady-state. This is because improving the production technology of real estate companies will increase housing supply. According to the theory of total supply and demand, house prices will fall when total demand remains unchanged. Levying a property tax has almost no impact on house price fluctuations, while a land tax will significantly amplify house price fluctuations. This indicates that if the sudden drop in house prices is due to the technological progress of real estate companies, levying a land tax can further reduce house.

Figure 2 shows the impact of land supply shock. In the absence of a real estate tax, a unit of positive external land supply shock will lead to an approximate 8% decrease in housing prices, which gradually returns to a stable state. This is because increasing land supply will increase housing supply, thereby causing a decrease in housing prices. The real estate tax will slightly amplify housing price fluctuations, while the land tax will significantly reduce housing price fluctuations. It is worth noting that the inhibitory effect of the land tax on housing price fluctuations under the land supply shock is similar to the amplification effect of the real estate technology shock, and the two cancel each other out. That is, the land tax under the supply shock (real estate technology and land supply shocks) hardly affects housing price fluctuations.

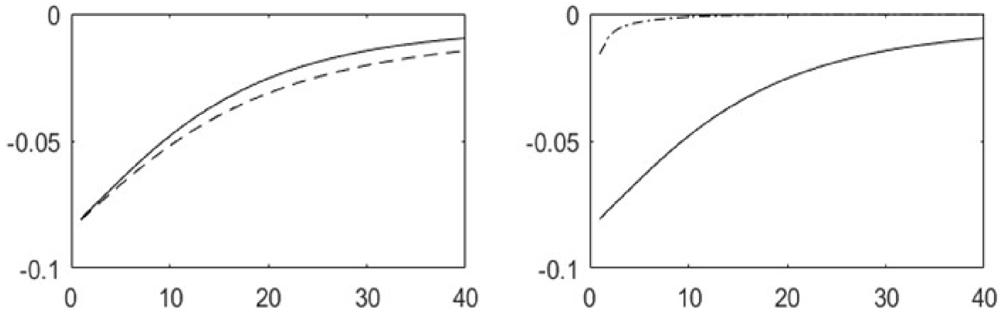

Figure 2. The impact of land supply shock on housing prices.

As shown in Figure 3, a unit of positive external housing preference shock will increase housing prices. This is because the housing preference shock will increase the household members' preference for housing, thereby affecting the total demand for housing and causing an increase in housing prices. At this time, both the real estate tax and land tax will reduce housing price fluctuations, with the effect of the real estate tax being more significant. This indicates that if the sudden increase in housing prices is caused by a demand shock (housing preference shock), the government can effectively curb the rise in housing prices in the short term by imposing a real estate tax.

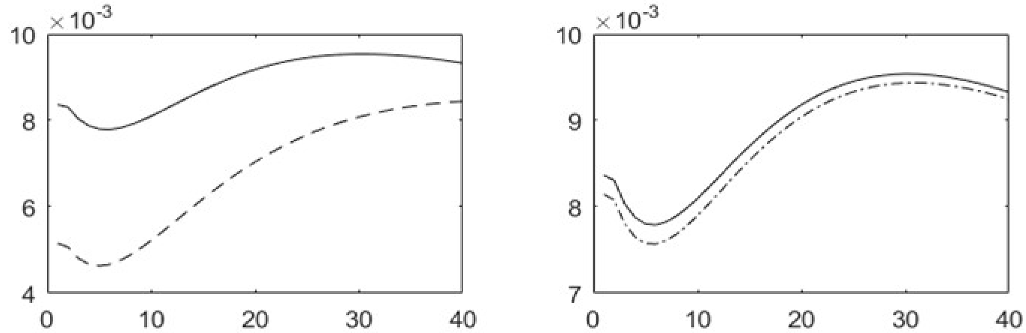

Figure 3. The impact of housing preference shock on housing prices.

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4.3. Optimal Tax Rate Analysis

To evaluate the macroeconomic stability effects of different real estate tax rate systems, this study refers to the social welfare evaluation method, considering housing price fluctuations, and expresses the welfare loss function in the following form:

$$\alpha_1 var(y_t) + \alpha_2 var(\pi_t) + \alpha_3 var(q_t) \tag{38}$$

where α_1, α_2, and α_3 are the weights of the government's concern for output, inflation, and housing prices, respectively.

Table 3 compares the fluctuations of major macroeconomic variables and welfare losses under several different real estate tax rate systems. From the simulation results, only imposing a real estate tax can minimize housing price fluctuations, but it will significantly increase output and inflation fluctuations, causing significant welfare losses, which is not conducive to macroeconomic development. Compared with the case of no tax rate, a single land use tax will also increase social welfare losses to some extent, while using both real estate tax and land tax can slightly reduce social welfare losses. Therefore, the government needs to coordinate and match housing use taxes and land use taxes when imposing real estate taxes.

From the perspective of optimal tax rate setting, based on the original tax rate setting of the model, the government can minimize social welfare losses by increasing the real estate tax rate from 0.125% to 0.623% and reducing the land tax rate from 12.47% to 10%. A higher real estate tax can replace the position of land finance in local government fiscal expenditures and increase the government's investment in public services, bringing overall social welfare improvement. Therefore, when setting real estate tax rates, the government should appropriately increase the real estate tax rate and reduce the land tax rate. It should be emphasized that the optimal tax rate obtained through the simulation analysis in this study is based on the assumptions of the model, estimated using historical data, and may differ from actual conditions. The research conclusion only provides a reference for setting the real estate tax rate by the fiscal authorities. The specific tax rate setting still needs to be adjusted according to the actual economic situation.

Table 3. Welfare Loss Comparison of Different Tax Rate Systems

	Tax Rate		Fluctuation of Economic Variables			Welfare Loss
	Property Tax	Land Tax	Output	Inflation	House Price	
No Tax	0	0	0.0084	0.0941	0.0775	0.1800
Only Property Tax	0.00125	0	0.0126	0.4402	0.0537	0.5065
Only Land Tax	0	0.1247	0.0101	0.1080	0.0667	0.1848
Real Estate Tax	0.00125	0.1247	0.0096	0.0968	0.0720	0.1784
Optimal Tax Rate	0.00623	0.1000	0.0072	0.0641	0.0827	0.1540

5. Conclusion and Policy Recommendations

This paper analyzes the long-term and short-term effects of property taxes on housing prices and studies the setting of property tax rates through welfare analysis by constructing a new Keynesian dynamic stochastic general equilibrium model that includes property taxes. The main conclusions are as follows: Firstly, from the perspective of long-term equilibrium, the impact of property taxes on housing prices depends on the type of tax. Property taxes will lower housing prices, while the impact of land taxes on housing prices is uncertain. Secondly, from the perspective of short-term fluctuations, the impact of property taxes on housing prices depends on the type of exogenous shock. Under supply shocks, the impact of property taxes on housing price fluctuations is relatively small. Under demand shocks, property taxes can

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effectively suppress housing price increases. Thirdly, from the perspective of welfare losses, imposing property taxes can reduce social welfare losses, and the optimal property tax rate is 0.623%, while the optimal land tax rate is 10%.

Based on the economic situation in China and the research conclusions of this paper, the following policy recommendations are proposed for China's implementation of property taxes: Firstly, we should correctly understand the regulatory effect of property taxes on housing prices. The high and low prices of housing are mainly determined by supply and demand, and the main role of property taxes is to regulate income distribution and raise government revenue. Secondly, property taxes can be levied together with land taxes, and the two can have a certain policy "overlay" effect.

To be frank, this paper still has some shortcomings and needs further improvement in future research. The model constructed in this paper only considers representative households and does not take into account the tax-paying ability and tax preferential policies of different groups. However, the theoretical framework constructed in this paper can fit the real situation well and is suitable for studying the policy impact of the government's implementation of property taxes. Subsequent work can consider heterogeneous households, formulate tax preferential policies based on the tax-paying ability of different households, and thus more comprehensively and specifically study the macroeconomic effects of property taxes.

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