2014

ISSN : 0974 - 7435 Volume 10 Issue 19

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(19), 2014 [11437-11445]

Effect analysis of levying real estate tax on China acro-economy under the perspective of DSGE model

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ABSTRACT

As the lifeline of national economy, real estate industry attracts wide attention from all walks of life, and to solve drawbacks of real estate industry at the current stage, central government of China has proposed the method of levying real estate tax. Through the establishment of closed DSGE(Dynamic Stochastic General Equilibrium) Model, and according to data in recent years, this study analyzed the effect of levying real estate tax(economic variable) on national macro-economy as a whole by numerical simulation method. Main conclusions are drawn as follows: levying real estate tax, though having the effect of effectively curbing housing price in the long run, will reduce the overall social welfare and influence the living standard of residents; rapid rising in housing price, which causes negative effect on national economy for the time being, contributes as the driving force for its development as time goes by; positive currency policy, while having the effect of improving the value of property selling on market, also plays as a driving factor of consumption and total output of society; positive change occurred in customer's preference in terms of housing and consumption, on one hand, weakens the operation of national economy, while on the other hand, it has driving effect on total value of national output and public service. Besides, DSGE Model adopted in this study, compared with display value, has shown out relatively higher degree of agreement in many aspects, signifying that it is feasible for simulating China's economic operation, i.e., economic development situation of China can be objectively reflected by which to a good extent.

KEYWORDS

Housing price; DSGE model; Levying real estate tax; Macro-economy operation.

INTRODUCTION

Real estate industry, which involves many aspects of society and has no small influence thereof, whose development directly determines the level of national economy's development. And there exist lots of problems and loopholes in China's real estate market at the current stage, an important representation of which is the overheated situation where bubbles may be lurking around. For this reason, personnel from relevant governmental sectors and the academic circle are having continuous discussion over how to effectively solve problems existed in property market. Opinion on major works for deepening the reformation of economic system in 2010, which was approved and published by the State Council towards the end of May, 2010, clearly pointed out that in respect of problems occurred in real estate market of China at the current stage, it's of necessity for government to gradually promote the reformation of real estate tax; Report on the development of China's Real Estate, which was published, in May of 2011, by Chinese Academy of Social Sciences, recommends that, pilot project of measures for real estate tax reformation originally launched in such place as Shanghai and Chongqing should be gradually promoted through the whole country. Well, what we would like to ask is will this series of reformation on real estate tax certification have positive and beneficial effects on macro-economy? Meanwhile, heated discussion is developed in the academic circles on this measurement of levying real estate tax, and the main focus thereof lies in the fact that whether expected macro-control can be realized by this. Some supporters, such as Zhichao WEI and Gang YI[1], Weida KUANG[2], Yongmin LUO and Wenzhong Wu[3], think the same can effectively regulate and control the real estate market and solve drawbacks currently existing in it, which in turn will promote the overall development of economy; while opponents, such as, Gangmin GONG[4], who thinks that problems of real estate market can't be fundamentally solved by this as there are all sorts of unreasonableness and imperfection with respect to policy of levying real estate tax.

This study is conducted towards effects might be caused by levying real estate tax, in China and at the current stage, and reformation thereof on macro-economy based on the analysis of DSGE Model.

MODEL ESTABLISHMENT

Selection of model

At present, the academic circles mainly adopts the method of regression analysis for studying the effect of real estate tax adjustment on China's macro-economy. Some scholars study the relationship between levying real estate tax and such economic indicator as property price, population migration and public service, in China, study upon the relationship between real estate tax and macro-economy based on DSGE Model are mainly conducted by Zhengxuan TAN and Cong WANG in terms of the correlation between fluctuation of housing price and stability of national finance, and that between real estate tax and housing price conducted by Weida KUANG. Based on research results mentioned above, this study conducted simulation analysis on existing data by means of establishing closed DSGE Model and found out the relationship between levying real estate tax and reformation thereof with macro-economy.

DSGE model

The DSGE Model adopted for this study involves three economic sectors, and they are family, enterprise and government.

Family

Lifetime utility function of consumer derived hereby is:

$$U = E_0 \sum_{t=0}^{\infty} \beta^t u_t \quad \textbf{(1)}$$

in which, U represents for present value of lifetime utility; β represents for discount rate lies within the range of 0 and 1; u represents for utility value. And utility value in this model is calculated by following formula:

$$u_t = \eta_c \theta_c \ln c_t + \theta_m \ln(\eta_{m,t} m_t) + \eta_{h,t} \theta_h \ln h_t + \theta_g \ln g_t \quad \textbf{(2)}$$

Moreover, as there is no distinction made with respect to the utility of different groups of people, utility function showed in formula 2 can be also used for calculating the welfare of whole society. Then function of housing value per capita is:

$$h_t = i_t + (1 - r - d + v_t) h_{t-1} \quad \textbf{(3)}$$

Accumulative way for real money balances per capita in this study is as follows:

$$\eta_{m,t} m_t + (1 + \eta_t \tau_c) c_t + i_t + \eta_{t,t} \tau_h h_t = (1 + r \cdot s)(1 - \pi) \eta_{m,t-1} m_{t-1} + (1 - \eta_{\tau,t} \tau_w) w_t + pr_t \quad \textbf{(4)}$$

Following formulas can be derived with formula 1 and 2 as objective functions and formula 3 and 4 as constraint conditions:

$$\eta_{c,t}\theta_c / c_t = \lambda_t(1+\eta_{r,t}\tau_c) \quad \textbf{(5)}$$

$$\eta_{c,t}\theta_h / \mathrm{h}_t = \lambda_t(1+\eta_{\tau,t}\tau_\mathrm{h}) - \beta \mathrm{E}_\mathrm{t}\left[\lambda_{t+1}(1-\mathrm{r}-\mathrm{d}+\mathrm{v}_\mathrm{t})\right] \quad \textbf{(6)}$$

$$\theta_m / \mathrm{m}_\mathrm{t} = \lambda_t - \beta E_t\left[\lambda_{t+1}\left(1+r\cdot s\right)\left(1-\pi\right)\right] \quad \textbf{(7)}$$

Enterprise

In this model, products produced by the whole society are limited to investment, housing investment and consumer goods. Supposing that there is no difference among enterprises of the same kind, then corresponding measures can be directly added for calculating total value and mean. And in terms of product application: investment is the source of capital goods for three kinds of enterprises; housing investment is the investment of housing made by additional population of society; consumer goods are for individual consumption and government spending. If scale of rewards for enterprise's production remains fixed, then C-D function of enterprise's rewards is as follows:

$$y_{j,t} = A_t k_{j,t}^{a_j} l_{j,t}^{l-a_j},\ j = c,i,h \quad \textbf{(8)}$$

Supposing growth rate of population in society σ equals to L_t/L_{t-1}, equilibrium value of all production factors' labor rate is 1, then accumulation formula of capital k is as follows:

$$k_{j,t} = i_{j,t} + (1-\delta)\mathrm{k}_{\mathrm{j,t}-1}/\sigma,\ \mathrm{j} = \mathrm{c,i,h} \quad \textbf{(9)}$$

With enterprise in this model paying cost of human resources through financing and buying capital goods using private capital, enterprise's profit function can written as follows:

$$pr_{j,t} = y_{j,t} - rw_{j,t}l_{j,t} - i_{j,t} = c,i,h \quad \textbf{(10)}$$

As the ownership of enterprise lies in the hands of family, maximized utility value of profit is as follows:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \lambda_t pr_{j,t},\ j = c,i,h \quad \textbf{(11)}$$

Thus, the first-order condition for enterprise reaching its optimum status is:

$$A_t(1-\mathrm{a}_\mathrm{j})\mathrm{k}_j^{a_j} l_{j,t}^{-a_j} = rw_t,\ j = c,i,h \quad \textbf{(12)}$$

$$\lambda_t = \beta E_t\left[\lambda_{t+1}(1-\delta)/\sigma\right] + \lambda_t A_t a_j k_{j,t}^{a_j-1} l_{j,t}^{1-a_j},\ j = c,i,h \quad \textbf{(13)}$$

Government

As impact of currency policy has to be considered in this study, the implementation if which will generate seigniorage where inflation occurs, and economic budget of government, with the consideration of "seigniroage", when reaching its balance is as follows:

$$g_t = \eta_{\tau,t}(\tau_w w_t + \tau_c c_t + \tau_h h_t) + rw\eta_{m,t}m_t \quad \textbf{(14)}$$

The relationship between g and θ is as follows according to formulas shown above:

$$\theta_g / g_t = \lambda_t \quad \textbf{(15)}$$

Restrain conditions and clearing conditions

Total output : $y_t = c_t + i_t + g_t + i_{i,t} + i_{h,t} + i_{c,t}$ **(16)**

Labor market : $L_t = L_{i,t} + L_{c,t} + L_{h,t}$ **(17)**

Product market : $c_t + g_t = y_{c,t}, i_t = y_{h,t}, i_{i,t} + i_{h,t} + i_{c,t} = y_{i,t}$ **(18)**

Interest in ownership : $pr_t = pr_{i,t} + pr_{c,t} + pr_{h,t}$ **(19)**

Average wage : $w_t = w_{i,t} l_{i,t} + w_{c,t} l_{c,t} + w_{h,t} l_{h,t}$ **(20)**

Capital stock per capita : $k_t = k_{i,t} + k_{h,t} + k_{c,t}$ **(21)**

Total investment per capita : $ital_t = i_{i,t} + i_{h,t} + i_{c,t}$ **(22)**

Exogenous shock

Shock of total factor productivity : $\ln A_t = (1-\varphi_{\mathrm{A}}) \ln \overline{A} + \varphi_{\mathrm{A}} \ln(\mathrm{A}_{\mathrm{t-1}}) + \varepsilon_{\mathrm{A,t}}$ **(23)**

Shock of currency policy : $\ln \eta_{\mathrm{m,t}} = \varphi_{\mathrm{m}} \ln(\eta_{\mathrm{m,t-1}}) + \varepsilon_{\mathrm{m,t}}$ **(24)**

Shock by growth rate in housing price : $\ln v_t = (1-\varphi_v) \ln \overline{v} + \varphi_v \ln(\mathrm{v}_{\mathrm{t-1}}) + \varepsilon_{\mathrm{v,t}}$ **(25)**

Shock of governmental tax : $\ln(\eta_{\tau,\mathrm{t}}) = \varphi_\tau \ln(\eta_{\tau,\mathrm{t-1}}) + \varepsilon_{\tau,\mathrm{t}}$ **(26)**

Shock of consumer preference : $\ln \eta_{\mathrm{c,t}} = \varphi_c \ln(\eta_{\tau,\mathrm{t-1}}) + \varepsilon_{\mathrm{c,t}}$ **(27)**

Shock of housing preference : $\ln \eta_{\mathrm{h,t}} = \varphi_h \ln(\eta_{\mathrm{h,t-1}}) + \varepsilon_{\mathrm{c,t}}$ **(28)**

In which, the mean of residual disturbance is 0, and standard deviation is represented by σ.

PARAMETER CALIBRATION AND EQUILIBRIUM SOLUTION OF MODEL

Parameter calibration

The expression of all endogenous variables can't be derived from formulas shown above, which requires value substitution for conducting simulation analysis in order to get endogenous variables, and concrete numerical value of exogenous variable has to be determined beforehand. Among the various methods of parameter estimation being currently used, what's most suitable for DSGE Model and the most perfect is Bias Estimation method. As number of data sample used in this study is finite, therefore, it is rather suitable for using Bias Estimation method.

Parameters calibrated through research experience and finite data in this study is shown in TABLE 1.

While for other parameters, it is needed to make Bayesian estimation, which requires inspection in-advance of relevant variables' data sample and parameter distribution. In this study, GDP per capita represents for total output; household consumption level represents for consumption; formed capital amount per capita represents for total investment; housing investment per capita represents for housing investment; tax per capita represents for governmental spending. According to data shown in statistical yearbook of different years, for instance, in the case of tax-rate parameter, τ_c stands for business tax, consumption tax and value-added tax, while τ_w stands for income tax of enterprise and individual people. It can be concluded from data of old times that τ_c is about 0.20 and τ_w is about 0.27, so, these two values in subsequent Bayesian estimations are taken as prior mean. Following the same reasoning, it can be concluded that: prior mean of the shock level of productive factors' labor rate, shock by growth rate in house pricing, shock level of consumer preference and currency policy, level of shock generated by levying tax on the governmental part and resident's housing preference are respectively 0.79, 0.38 and 0.53, 0.68, 0.83 and 0.69. The prior distribution of utility parameters needs to be set according to other parameter data and data used for establishing model, which will be tested by means of fixed point iteration, and prior mean get of $\theta_{c,}$ θ_m, θ_h and θ_g are respectively 0.88, 0.53, 0.26 and 0.39. In the final, Bayesian estimation of some parameters are shown as in TABLE 2 below:

TABLE 1 : Value of some parameters directly calibrated through experience and corresponding basis of selection

Parameter	Reference Value	Basis of Value-Selecting
π	0.03	mean of consumer price index(from 1992 to 2010), whose data comes from China Statistical Yearbook of 2011.
r	0.093	mean of the ratio between cash in circulation and total amount of currency, i.e., M0/M2, whose data comes from China Statistical Yearbook of 2011.
δ	0.05	References are made to depreciation rate of capital used in the literature written by Wang and Yao(2003), Lixue WU and so on.
r	0.07	mean of long-term annual interest rate of commercial loans(from 1992 to 2010). Corresponding data comes from International Statistical Yearbook of 2011, Compilation of Statistics In The Sixty Years of PRC Since Its Foundation, China Statistical Yearbook of 2011.
d	0.05	Legal lifespan of housing in China is 70 years, but the lifespan of usage in real life lasts only for 30 years, data of which comes from China's Housing Development Report(2009 to 2010) released by Chinese Academy of Social Science; in consideration of the short history of commercial housing development in China, added by some uncertain factors such as demolition, this article sets the housing depreciation rate at 5%.
σ	1.07	mean of natural population growth rate(1992 to 2010), whose data comes from China Statistical Yearbook of 2011.
β	0.92	References are made to values adopted in corresponding numerical simulation of Yun XIAO and Liutang GONG(2003), Gong and Zou(2002).
w	0.12	mean of MO's growth rate(1992 to 2010), whose data comes from China Statistical Yearbook 2011.
$\bar{v}$	0.08	Growth rate of housing price(1993 to 2010), whose data comes from China Statistical Yearbook of 2011 and China Finance Yearbook of 2011.
$\overline{A}$	1	As value-selecting of productivity will only have impact on the measurement of macroeconomic scale, steady-state level of productivity in general DSGE Model are all set as unit 1, and exogenous shock under steady state is 0(Lixue WU, 2009)
s	0.61	mean of $(M_2-M_1)/M_2$ in circulation(1992 to 2010), whose data comes from China Statistical Yearbook of 2011.

TABLE 2 : Bayesian estimation of some parameters

Parameter	Setting of prior distribution	Posterior mean	Posterior confidence interval of 95%	Parameter	Setting of prior distribution	Posterior mean	Posterior confidence interval of 95%
	Bate[0.5,0.1]	0.6218	[0.4754,0.7580]		Bate[0.53,0.01]	0.5103	[0.4963,0.5255]
	Bate[0.4,0.1]	0.3941	[0.2207,0.5379]		Bate[0.55,0.01]	0.5614	[0.5463,0.5757]
	Bate[0.7,0.1]	0.9133	[0.8564,0.9704]		Bate[0.16,0.005]	0.1617	[0.1536,0.1696]
	Bate[0.8,0.1]	0.7329	[0.6167,0.8358]		Bate[0.25,0.005]	0.2517	[0.2437,0.2598]
	Bate[0.8,0.1]	0.9722	[0.9566,0.9892]		Inv_gamma[0.005,inf]	0.0325	[0.0222,0.0409]
	Bate[0.7,0.1]	0.8328	[0.7780,0.8888]		Inv_gamma[0.005,inf]	0.0241	[0.0174,0.0306]
	Gamma[0.9,0.02]	0.9044	[0.8729,0.9389]		Inv_gamma[0.005,inf]	0.0442	[0.0311,0.0587]
	Gamma[0.55,0.02]	0.5338	[0.5027,0.5642]		Inv_gamma[0.005,inf]	0.0041	[0.0013,0.0072]
	Gamma[0.27,0.02]	0.2906	[0.2602,0.3191]		Inv_gamma[0.005,inf]	0.038	[0.0231,0.0504]
	Gamma[0.4,0.02]	0.4	[0.3696,0.4292]		Inv_gamma[0.005,inf]	0.0372	[2.0270,0.0474]
	Bate[0.49,0.1]	0.4935	[0.4802,0.5113]				

Equilibrium solution of model

According to exogenous variable get from calculation made above, equilibrium solution of DSGE Model's endogenous variable is arrived at by means of fixed point iteration, and value of which represented the long-term state of macro-economy maintained in the model; what's shown in TABLE 3 are the equilibrium value of some more important endogenous variables. For inspecting whether the established DSGE Model is feasible in real sense, TABLE 3 also listed out true data of corresponding endogenous variables of 2010; it is showed in comparison results of true data and calculated data that, they are rather approximate to each other in general, which illustrates that DSGE Model established in this study whose simulation effect is real in terms of simulating real life and has strong feasibility.

TABLE 3 : Equilibrium solution of model and corresponding true value of 2010(unit: million yuan)

Variable	y	g	c	m	i	k	h
Equilibrium Solution	2.83	0.63	1.1	5.91	0.24	7.65	5.95
Real Value of 2010	3	0.55	1	5.41	0.34	8.03	5.99

NUMERICAL SIMULATION ANALYSIS

Static analysis

We can find out from data shown in TABLE 4 that, levying real estate tax has negative correlation of different degrees with household consumption, total output of society, buildup of social capital, housing investment, total value of housing and money balance, and positive correlation with public construction & service.

TABLE 4 : Impact of levying real estate tax on the equilibrium solution of DSGE model

Rate of real estate tax	y	g	c	m	i	k	h	u
τ_h =0.000	2.8389	0.577083	1.13399	6.09096	0.266281	7.68214	6.65694	1.43077
τ_h =0.005	2.83191	0.604296	1.11668	5.99799	0.251452	7.66374	6.28623	1.40023
τ_h =0.010	2.82566	0.628637	1.10119	5.91482	0.238188	7.64728	5.95463	1.37042
τ_h =0.015	2.82003	0.650539	1.08726	5.83999	0.226253	7.63247	5.65626	1.34146
τ_h =0.020	2.81494	0.670351	1.07466	5.7723	0.215457	7.61907	5.38636	1.31343
τ_h =0.025	2.81032	0.688359	1.06321	5.71078	0.205644	7.60689	5.14105	1.28635

For reasons to be made is that, levying or increasing real estate tax actually reduces the total income of family from another perspective, and family with reduced income is more tended to reduce consumption and investment, which explains why the levying of real estate tax brings about the decreasing of total social welfare.

In addition, equilibrium solution of DSGE Model will also be influenced by the variance in growth rate of property price. TABLE 5 shows out the relationship between growth rate in property price and equilibrium solution of DSGE Model under the supposition of rate of real estate tax being 1%.

TABLE 5 : Analysis of the relationship between growth rate in housing price and equilibrium solution of DSGE model

Balanced growth rate of housing price	y	g	c	m	i	k	h	u
$\bar{v}$ =0.06	2.84719	0.61312	1.06397	5.71491	0.301458	7.74533	5.02431	1.22865
$\bar{v}$ =0.07	2.83733	0.620221	1.08101	5.8064	0.272503	7.70043	5.45006	1.29566
$\bar{v}$ =0.08	2.82566	0.628637	1.10119	5.91482	0.238188	7.64728	5.95463	1.37042
$\bar{v}$ =0.09	2.8116	0.638771	1.1255	6.04538	0.196866	7.58327	6.56221	1.45477
$\bar{v}$ =0.10	2.79434	0.651208	1.15533	6.20561	0.146157	7.50471	7.30783	1.55119

We can find out from data shown in TABLE 5 that, increased growth rate will lead to the reduction of total output of society, investment in property industry and accumulation of general social capital, with the remaining variables being

increased, which in all will contribute to the rising in overall welfare of society. This is for the fact that, rapid rise in housing price leads to the increasing of total value of house in society, which reduces the convenient utility of property investments, thus, less investments are made in realty industry and total output of society reduces as a result thereof.

Shock experiment

Endogenous variable changes in coordination with shock changes occurred to exogenous variable, and shock experiments in this study are mainly made according to formula 23 to 28. Figure 1 to 5 are the profiles of some important endogenous variables when DSGE Model is under the shock of different endogenous variables.

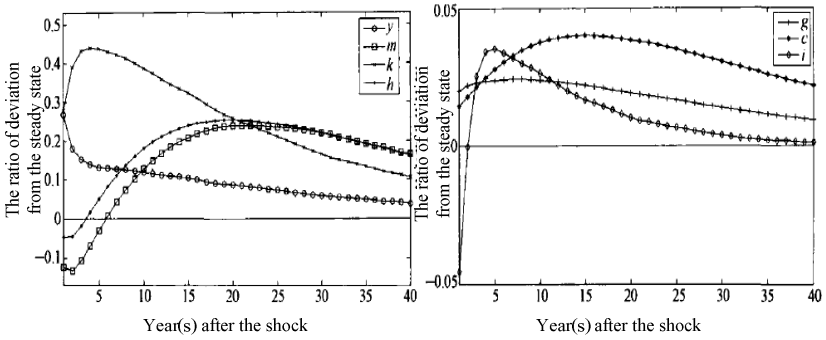

Figure 1 : Model's profile under the shock of variable productivity

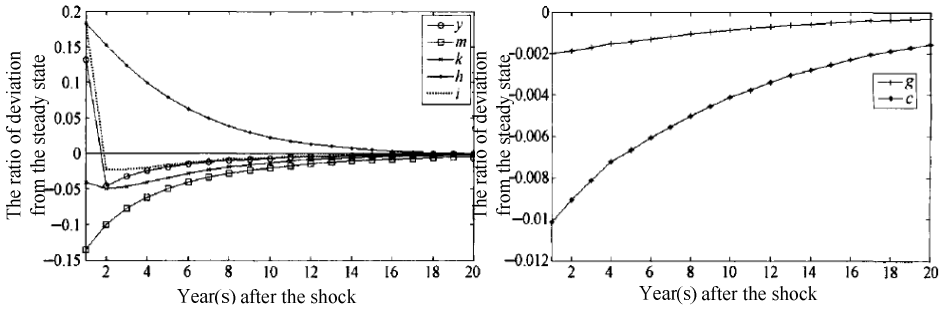

Figure 2 : Model's profile under the shock of variance in housing preference

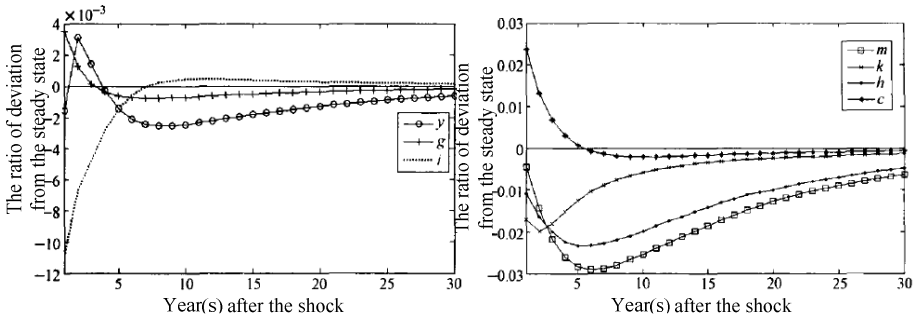

Figure 3 : Model's profile under the shock of variance in consumer preference

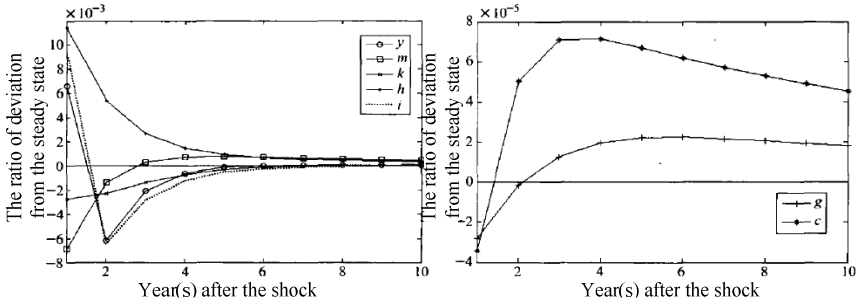

Figure 4 : Model's profile under the shock of variance in growth rate of housing price

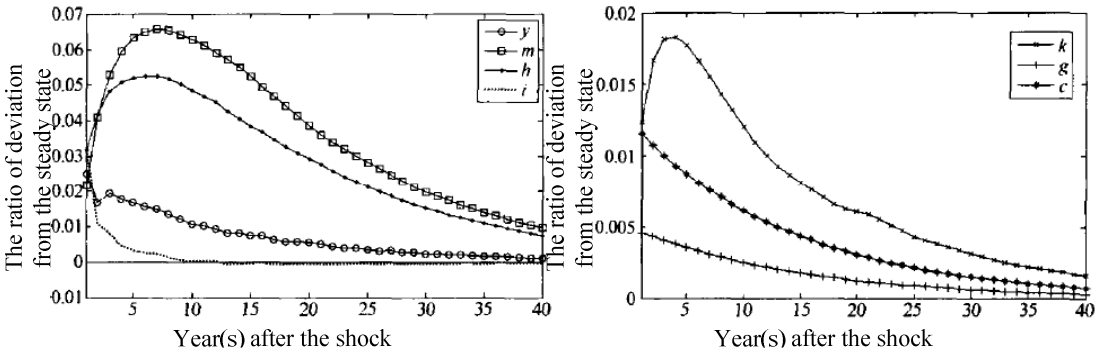

Figure 5 : Model's profile under the shock of variance in currency policy

We can find out from the series of comparison figures shown above that: changes in productivity gradually reduce national total output and expending of governmental public service; capital & property investment reaches the peak position at phase 5 before going down gradually; consumption, total value of real estate and money balance are at their peak around the period of phase 16. Measurements of these indicator parameters are basically in agreement with the research result and value of real data of corresponding year, therefore, from the perspective of time, it is to made that shock simulation experiment of DSGE Model in this study matches to a good extent with the overall development situation of China's economy, having relatively high practical value of usage and reasonableness. Moreover, another point that needs to be illustrated in comparison figures shown above is that, shock of housing preference can promote the immediate increasing in the investment of property market, which, however, is not good for the long-term development of economy by crowding out other products; the shock of consumer preference also has negative impact on macro-economy, but, due to the fact that sustainability parameter of consumption is lower than that of housing, driving effect caused by the stimulation of household consumption towards economy is more effective and lasting; acceleration of growth rate in housing price may have negative effect on economy, which will be turned to a positive one when looking from the long run; finally, currency policy can easily lead to rapid rise in housing price, which in turn will promote the long-term development of economy.

Evaluation of real estate tax as built-in stabilizer after reformation

The levying of real estate tax may promote the function of built-in stabilizer which lies within the domain of governmental macro-control, and we can find out from TABLE 6 that whether this function has any effect or not. Standard deviation of all endogenous variables are gradually decreasing expect that of government's public service, which indicates that impact caused by variance in real estate tax is gradually decreasing. Thus it can be concluded that real estate tax levied in China and reformation thereof can inhibit volatility of economy and play the role of internal stabilizer.

Figure 6 : Impact of growth rate in housing price on different endogenous variables

τ_h	y_v	g_v	c_v	m_v	i_v	k_v	h_v
0.000	0.00174	2.99E-05	2.68E-05	0.001377	0.002193	0.000677	0.002295
0.004	0.001634	2.01E-05	2.48E-05	0.001289	0.002065	0.000648	0.002159
0.008	0.001537	1.20E-05	2.30E-05	0.001208	0.001947	0.000622	0.002034
0.012	0.001448	7.05E-06	2.14E-05	0.001134	0.001838	0.000596	0.001919
0.016	0.001366	8.72E-06	2.00E-05	0.001066	0.001737	0.000573	0.001813
0.020	0.00129	1.37E-05	1.86E-05	0.001004	0.001644	0.00055	0.001715

CONCLUSION

Through the establishment of closed DSGE Model, this study analyzed effects of levying real estate tax on overall macro-economy of the country according to data published in *China Statistical Yearbook(s)* and by means of numerical simulation. Following conclusions are made out of this study: levying real estate tax can effectively inhibit housing price in the long run, which, however, will reduce the overall social welfare and have influence on the living standards of residents; rapid rise in housing price, while having negative effect on macro-economy for the time being, has driving effect on the national economy from a long-term perspective; positive currency policy will increase the value of house selling on market and, promote total output of society and household consumption; positive change occurred in customer's preference in terms of housing and consumption, on one hand, weakens the operation of national economy, while on the other hand, it has driving effect on total value of national output. Besides, DSGE Model adopted in this study, compared with display value, has shown out relatively higher degree of agreement in many aspects, signifying that it is feasible for simulating China's economic operation, i.e., economic development situation of China can be objectively reflected by which to a good extent.

ACKNOWLEDGEMENT

Subject Information: planned project of Hebei Province Social Science Fund: Study on the Economic Integration Degree in terms of Improving Surplus Rural Labor in Hebei Province under the Background of Co-development of Beijing, Tianjin and Hebei Province(no. HB14SH036).

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