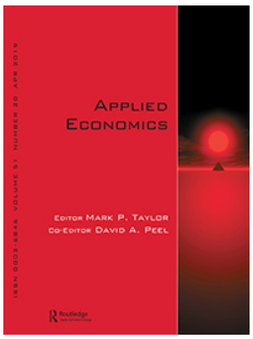

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Numerical simulation on property tax reform: evidence from China

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ABSTRACT

This article analyses the property tax reform in China in a computable general equilibrium model that recognizes the interaction between and among housing markets in different provinces and macroeconomic development. Using real data in 2010, we present the benchmark equilibrium for reference property and income tax rates. Then, we examine different property and income tax policies and make a comparison of their production, consumption, welfare and national income. We find that the implementation of property tax would decrease the house production at the expense of welfare in taxed area. The expansion of the taxed regions may increase the total social welfare and national income. Even though property tax policy may not be able to change the income distribution in China, increasing income tax rate could narrow the income disparity. Finally, this article shows the reliability of the conclusions when sensitivity analysis on optimal condition of equilibrium computation is performed under varied property tax policy.

KEYWORDS

General equilibrium; property tax; income tax; taxation reform

JEL CLASSIFICATION

D58; H21

I. Introduction

On 28 January 2011, the local governments introduced property tax policy in Shanghai and Chongqing as a pilot measure and then the central government in China planned to expand this policy to the overall country. According to Cho and Choi (2014), Shanghai and Chongqing both took different property tax rates on newly purchased homes according to their market prices. In Shanghai, the houses whose market prices were twice over average were taxed at 6% and otherwise at 4%. In Chongqing, homes with less than twice of the average were exempt from tax and those ranged from twice to more than quadruple were taxed from 5% to 12%. The purpose of the introduction of property tax is to change the relative housing price in order to suppress both supply and demand and reduce the income disparity. Since that announcement, considerable effort has been expended by Chinese researchers on what procedures this policy should take and the likely effects of such a move (Cho and Choi 2014; Zheng and Zhang 2013; Tang, Wong, and Liu 2011). This research mainly focused on its effectiveness on curbing price and feasibility. Zheng and Zhang (2013) studied the effects of the property tax implemented in Shanghai and Chongqing on the housing price. They estimated that the average housing price in Shanghai was to be lower after the introduction of property tax, but there was no significant evidence that the housing price in Chongqing would be suppressed effectively. Tang, Wong, and Liu (2011) evaluated the prospect of implementing market-value-based property tax reforms in mainland China. They proposed that property tax as an institutional arrangement requires complementary mechanisms in land registration, property appraisal, tax administration and dispute resolution, and this reform would also have extensive social, political and legal repercussions for Chinese society.

However, few literatures have analysed the property tax by quantifying the interactions between housing markets and macroeconomy development. This omission is significant because a growing body of evidence shows that housing is a large share of the overall macroeconomy and constitutes a considerable share of household expenditure and total wealth (Chetty and Szeidl 2004; Greenwood and Hercowitz 1991; Davis and Heathcote 2007). The implementation of property

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tax would have an influence on the housing markets, and thus have a significant impact on macroeconomic development.

In addition, the consequences of property tax depend fundamentally on the level of income, which is widely varied among provinces in China. Recent research shows that the disparity in income would influence the housing price. Favara and Song (2014) proposed that the dispersion of city income, a proxy for information dispersion, would affect the equilibrium housing price and its volatility. The level of income would not only influence housing demand, but also shape expectations of future house prices. Thus, it is necessary to incorporate the income dispersion in the issue of housing price.

This article makes a numerical simulation on quantifying the effects of different property tax policies on macroeconomic development and social welfare in a computable general equilibrium in which housing is incorporated in both production and consumption as an important sector, and heterogeneity of agents is taken into account, where we have 31 agents to represent each province in China with different endowments and preferences. By applying the computable general equilibrium (CGE) model, this article explores the effects of property tax in China through the following steps. In the general equilibrium model, we have two production sectors: goods and housing production. The wage rate and capital return are decided by the marginal product with respect to the input in each province under the assumption that labour and capital flow freely within the province. Based on the data of 2010, we calibrate the parameters of production function and the utility function in the model and obtain production, consumption, welfare and national income in every province under different property tax policies, including Policy P0 with no property tax, Policy P1 with property tax on only Shanghai and Chongqing, Policy P2 with property tax on municipalities directly under the central government, Policy P3 with property tax on all eastern coastal provinces, Policy P4 with property tax on all high gross domestic product (GDP) per capita provinces and Policy P5 with property tax on the whole country. Compared with the situation with no property tax, there are increments on social welfare and total income when taxing the regions with high GDP per capita. We also make a comparison among these different policies of property tax when increasing the income tax rate to find that these equilibria are very close. At last, this article performs the sensitivity analysis on the optimal condition of equilibrium by changing the measure of best fit in General Algebraic Modelling System (GAMS). It shows the reliability of the conclusion.

The present article contributes to the analytical and empirical literature in three ways. First, it investigates the property taxation in China by quantifying its effects on macroeconomic development and social welfare. This is an important extension because the use of a CGE model enables us to employ a realistic specification of taxes and adopt a fairly detailed representation of the interactions between housing markets and macroeconomic development. Second, the article extends the analytical literature by considering the heterogeneity of agents. These new specifications of representatives are motivated by the two concerns of developing a general equilibrium analysis of property tax policy where the levels of endowments and income are distinct among regions, and of assessing the effects of tax policies where property tax rate is varied in different regions. Thus, our article combines the strengths of analytical and numerical approaches. The third contribution of the article is its numerical simulation of different property tax policies in the presence of income tax. Since the purpose of property tax is also to reduce the income disparity, the income tax policy, as an important measure to redistribution, may influence on or act as a complementary mechanism to this goal. We find that the effects of change in the income tax rate are independent of property tax policies. Thus, it provides a reference for the Chinese government in policy-making.

The structure of this article is organized as follows. We build a general equilibrium model of production and consumption to analyse the effects of property tax policy in Section 2. In Section 3, based on the dataset of Chinas economy in 2010, we calibrate the parameters of the production function and utility function. Sections 4 and 5 compare and analyse the equilibria under different policies of property tax and income tax. Section 6

executes the sensitivity analysis as to the measure of best fit in GAMS when computing equilibrium. Section 7 concludes.

II. Basic model

The general equilibrium model will be set up on production economies with N provinces in one country. The GDP is made up by two parts for goods and housing contributions. The consumption goods are mobile in the whole country, but the housing is immobile across provinces. Therefore, we consider a small close price-taking economy with 1 commodity and N housings where each housing is mobile only within the corresponding province.

The price is denoted as P_{nj} for province n, goods $j = 0$ and house $j = 1$. Prices of consumption goods are equalized throughout the country for all provinces,

$$P_{n0} = P_{00} \qquad \text{for} \qquad n = 1, \cdots, N, \tag{2.1}$$

while the prices, P_{n1} for $n = 1, \cdots, N$ of housing must not be equalized for different provinces. This article explores the property taxation system, and we denote the property tax rate to be t_n in province n. For convenience, we provide the following notation:

$$t_{nj} = \begin{cases} 0 & \text{if} \quad j = 0 \\ t_n & \text{if} \quad j = 1 \end{cases}. \tag{2.2}$$

We consider a small close price-taking economy with 1 commodity and N housing production. For simplicity, we assume the production function to be Cobb–Douglas form, for $j = 0, 1$,

$$Y_{nj}(L_{nj}, K_{nj}) = \phi_{nj} L_{nj}^{\alpha_{nj}} K_{nj}^{\beta_{nj}} \tag{2.3}$$

where Y_{nj} is the goods and housing output, L_{nj} and K_{nj} are the labour and capital input for goods and housing production, ϕ_{nj} is units term (scalar parameter) in goods and housing production function, α_{nj} and β_{nj} are the production exponent for labour and capital in goods and housing production function ($\alpha_{nj} + \beta_{nj} = 1$). The wage rate and return of capital are determined from the marginal products with respect to labour and capital. For $j = 0, 1$,

$$\begin{aligned} W_{nj} &= (1 + t_{nj}) P_{nj} \frac{\partial Y_{nj}}{\partial L_{nj}} \\ &= \alpha_{nj} (1 + t_{nj}) P_{nj} \phi_{nj} L_{nj}^{\alpha_{nj} - 1} K_{nj}^{\beta_{nj}} \\ &= \alpha_{nj} \frac{(1 + t_{nj}) P_{nj} Y_{nj}}{L_{nj}} \end{aligned} \tag{2.4}$$

$$\begin{aligned} R_{nj} &= (1 + t_{nj}) P_{nj} \frac{\partial Y_{nj}}{\partial K_{nj}} \\ &= \beta_{nj} (1 + t_{nj}) P_{nj} \phi_{nj} L_{nj}^{\alpha_{nj}} K_{nj}^{\beta_{nj} - 1} \\ &= \beta_{nj} \frac{(1 + t_{nj}) P_{nj} Y_{nj}}{K_{nj}}. \end{aligned} \tag{2.5}$$

In this case, the zero-profit condition holds. For $j = 0, 1$,

$$(1 + t_{nj}) P_{nj} Y_{nj} = W_{nj} L_{nj} + R_{nj} K_{nj}. \tag{2.6}$$

We assume that labour and capital flow freely within the province, then wage rate and capital return are equal, respectively, between goods and housing markets. For $j = 0, 1$,

$$W_{nj} = W_n \tag{2.7}$$

$$R_{nj} = R_n. \tag{2.8}$$

We assume that there exists a representative consumer in each province, then there exist N representative consumers in our model. We assume the utility function to be Cobb–Douglas form, for $n = 1, \cdots, N$,

$$U_n(X_{n0}, X_{n1}) = \prod_{j = 0,1} X_{nj}^{\delta_{nj}} \tag{2.9}$$

where U_n is welfare level, X_{nj} are consumptions of goods and housing for $j = 0, 1$, and δ_{nj} is the utility exponents for $j = 0, 1$ ($\delta_{n0} + \delta_{n1} = 1$).

The budget constraints are, for $n = 1, \cdots, N$,

$$\sum_{j = 0,1} (1 + t_{nj}) P_{nj} X_{nj} = I_n, \tag{2.10}$$

where I_n will be defined later.

Utility maximization subject to the budget constraint implies, for $j = 0, 1$,

$$X_{nj} = \frac{\delta_{nj} I_n}{(1 + t_{nj}) P_{nj}}. \tag{2.11}$$

Now we define the income for each province from income tax revenue. The total income tax revenue is

$$ITR = \sum_{n=1}^{N} \tau_n (WL_n^0 + RK_n^0) \tag{2.12}$$

where τ_n is the individual income tax rate, L_n^0 and K_n^0 are labour and capital endowments in province n and W and R are defined as the average wage rate and average capital return

$$W \sum_{n=1}^{N} L_n^0 = \sum_{n=1}^{N} W_n (L_{n0} + L_{n1}) \tag{2.13}$$

$$R \sum_{n=1}^{N} K_n^0 = \sum_{n=1}^{N} R_n (K_{n0} + K_{n1}). \tag{2.14}$$

The income tax revenue is redistributed between local government and central government. The central government transfer the revenues to different regions at different rates. The income tax revenue for province n is

$$\begin{aligned} ITR_n = {} & \tau_n \beta \ (WL_n^0 + RK_n^0) \\ & + \theta_n \ (1 - \beta) \ ITR \end{aligned} \tag{2.15}$$

where β is the proportion of ITR between central and local governments, and θ_n for $n = 1, \cdots, N$ are transfer shares with $\sum_{n=1}^{N} \theta_n = 1$. Assume that the revenues from property tax are utilized for improving public services and revenues from income tax are returned to consumers. Then, for each province, income is

$$I_n = (1 - \tau_n) (WL_n^0 + RK_n^0) + ITR_n. \tag{2.16}$$

The revenues for local government B_n are composed of two parts: property tax revenue PTR_n and income tax revenue ITR_n.

$$B_n = PTR_n + ITR_n \tag{2.17}$$

The property tax revenue is used for public goods.

$$PTR_n = \sum_{j=0,1} t_{nj} P_{nj} X_{nj} = t_n P_{n1} X_{n1} \tag{2.18}$$

A general equilibrium for this model is characterized by the wage rate and return of capital. So the equilibrium involves exogenously specifying factor endowments (L, K), with an equilibrium determined by the value of $(Y_{nj}, L_{nj}, K_{nj}, W_{nj}, R_{nj}, X_{nj}), n = 1, \cdots, N, j = 0, 1$. The equilibrium conditions are listed as follows:

[1] Goods and housing markets clear.

$$\sum_{n=1}^{N} X_{n0} = \sum_{n=1}^{N} Y_{n0}, \tag{2.19}$$

$$X_{n1} = Y_{n1} \qquad \text{for} \qquad n = 1, \cdots, N. \tag{2.20}$$

[2] Factor markets clear.

$$\begin{aligned} & \sum_{n=1}^{N} \sum_{j=0,1} L_{nj} = \sum_{n=1}^{N} L_n^0 \qquad \text{and} \\ & \sum_{n=1}^{N} \sum_{j=0,1} K_{nj} = \sum_{n=1}^{N} K_n^0. \end{aligned} \tag{2.21}$$

III. Data, calibration and benchmark equilibrium

This aritcle employs the formulation set out above to conduct numerical analyses on tax policy. We calibrate the model form to a 2010 benchmark equilibrium dataset capturing the welfare analysis for property tax rate in housing.

We draw on data from the Chinese National Bureau of Statistics, including the China Statistical Yearbook 2011, China Building Industry Statistical Yearbook 2011 and the China Regional Input-output Statistical Yearbook 2007, for our calibrations.

As for tax policies, we set the property tax rate to be zero in 2010, since property tax was introduced in January 2011. The individual income tax rates are calculated as the proportion of income tax revenue in the total income of each province. Those data are drawn from Tables 3–13, 8–7 and 10–15 in the China Statistical Yearbook 2011. As to GDP, the housing production is computed through the approach by Yuan and Wei (2012). Goods production is the difference between GDP and the computed housing production in each region. We obtain labour earning from data drawn from the China Regional Input-output Statistical Yearbook 2007. We set the lowest wage (Heilongjiang) as numeraire, and wage rate in other provinces is calculated as the ratio of its average wage and the lowest wage. Those data are drawn from Tables 4–12 in the China Statistical Yearbook 2011. The net trade in each province is computed as the difference between consumption and production. The consumption in goods is calculated as the difference between the total consumption and the consumption in housing, whose

data are from the China Regional Input-output Statistical Yearbook 2007. We calculate the labour endowment considering the labour population and efficiency. These data are from Tables 2–15 and Table 4–2 in the China Statistical Yearbook 2011. After taking the total capital and production into account, we obtain capital endowment from the China Statistical Yearbook 2011. The transfer share is calculated by market clearing.

These data source thus yields a benchmark dataset that we are able to use in calibrating our model. From (2.1) we set the domestic price $P_{n0} = 1$ and $P_{n1} = 1$ for $n = 1, \cdots, 31$. The production Y_{n0} and Y_{n1}, wage rate W_n, capital return R_n and the value of labour earning $W_{nj}L_{nj}$ are provided by Table 1. From (2.4) or (2.5), we have the production exponents α_{n0} and α_{n1}, which are share of labour earning to GDP in goods and housing, respectively. From (2.6), we get the value of capital input $R_{nj}K_{nj}$, then from (2.8), we obtain capital input in goods K_{n0} and in housing K_{n1}. Similarly, we have labour input in goods L_{n0} and in housing L_{n1}. From (2.3), we can calculate the unit terms (scalar parameters) ϕ_{n0} and ϕ_{n1}.

From (2.20), we have the consumption for housing X_{n1}. We get Z_{n0} from Table 1. From (2.19), we have the consumption for goods X_{n0}. Then, from (2.10), we obtain the income I_n. Exponential parameters δ_{n0} and δ_{n1} are calculated from (2.11). We get an average wage rate W and average capital return R through (2.13) and (2.14), and then total income tax revenue ITR by (2.12). Since β is fixed as 0.399874 and θ_n are provided in Table 1, from (2.15) we have income tax revenue in each province ITR_n. We obtain the property tax revenue for each region PTR_n from (2.18).

We have performed numerical simulation analyses for various forms of property tax in China using the model formulation set out above. Using the model parameterizations generated by calibration, we then parametrically vary the property tax rate and assess the economy-wide behavioural

Table 1. Base case 2010 Chinese data used in calibrating alternative formulation.

	Tax rate	GDP Y_{nj}		Labor earning $W_{nj}L_{nj}$							
$t_n = 0$	τ_n	Goods	Housing	Goods	Housing	Net trade of goods Z_{n0}	Wage rate W_n	Capital return R_n	Labor endowment L_n^0	Capital endowment K_n^0	Transfer share θ_n
Beijing	0.082	1282.572	128.786	620.793	23.522	−110.021	2.349306	1.000	572.287	608.451	0.064153
Tianjin	0.031	864.077	58.369	277.252	8.889	−319.084	1.856463	1.000	291.150	244.670	0.002044
Hebei	0.009	1897.024	142.402	742.674	8.100	−334.034	1.133982	1.000	445.943	1136.374	0.025962
Shanxi	0.013	866.653	53.433	284.378	3.437	−103.787	1.191888	1.000	298.589	431.151	0.025277
Inner Mongolia	0.021	1086.394	80.806	447.638	17.392	−360.224	1.269551	1.000	399.609	282.512	0.053534
Liaoning	0.018	1696.100	149.627	709.718	16.592	−255.025	1.241644	1.000	658.850	732.055	0.078425
Jilin	0.013	801.834	64.924	321.651	5.341	279.029	1.045718	1.000	491.536	501.427	0.057475
Heilongjiang	0.011	956.067	80.793	353.478	14.722	−13.513	1.000000	1.000	389.980	524.740	0.021169
Shanghai	0.079	1592.222	124.376	607.458	15.340	224.759	2.383811	1.000	864.246	938.246	0.009292
Jiangsu	0.023	3715.326	427.222	1488.163	33.698	−734.849	1.434000	1.000	1035.419	2123.581	0.036914
Zhejiang	0.023	2525.446	246.785	1083.085	36.953	−89.473	1.465297	1.000	1013.296	1412.025	0.045872
Anhui	0.008	1122.739	113.194	532.442	15.479	252.575	1.202127	1.000	375.416	1011.876	0.014776
Fujian	0.016	1332.932	140.780	589.447	12.296	−63.627	1.166036	1.000	491.082	755.464	0.086788
Jiangxi	0.007	857.932	87.194	447.544	44.376	158.017	1.022643	1.000	294.754	716.470	0.033761
Shandong	0.010	3601.929	315.063	1292.760	73.142	26.910	1.201406	1.000	745.821	2969.348	0.100009
Henan	0.006	2151.936	157.300	881.603	16.358	−226.994	1.075140	1.000	443.545	1500.822	0.051840
Hubei	0.009	1476.163	120.598	747.512	72.033	127.400	1.146962	1.000	546.828	1037.769	0.004531
Hunan	0.008	1492.636	111.160	687.405	9.528	116.230	1.069767	1.000	655.842	882.238	0.028838
Guangdong	0.026	4240.360	360.946	1738.380	48.355	512.058	1.457797	1.000	876.618	4068.526	0.025918
Guangxi	0.007	875.776	81.209	419.244	6.848	117.235	1.105931	1.000	344.224	621.965	0.039800
Hainan	0.014	175.298	31.152	76.698	4.484	18.442	1.109609	1.000	140.741	46.268	0.004075
Chongqing	0.012	718.739	73.819	327.765	16.909	76.999	1.252100	1.000	397.470	366.653	0.010542
Sichuan	0.010	1576.990	141.558	739.478	22.864	205.330	1.174220	1.000	392.348	1406.999	0.060579
Guizhou	0.013	431.050	29.166	189.516	3.470	237.798	1.097278	1.000	257.072	374.374	0.006438
Yunnan	0.010	666.160	56.258	307.001	4.082	165.963	1.052641	1.000	264.631	545.030	0.025461
Tibet	0.010	44.018	6.728	18.860	0.731	75.904	1.799099	1.000	81.195	21.000	0.006700
Shaanxi	0.014	924.688	87.660	385.634	9.525	−102.563	1.203678	1.000	390.801	401.519	0.039316
Gansu	0.008	379.727	32.348	179.687	3.169	137.125	1.049072	1.000	197.696	289.242	0.022763
Qinghai	0.010	125.002	10.041	61.797	1.236	−5.080	1.302362	1.000	67.244	45.334	0.000380
Ningxia	0.013	151.988	16.977	68.432	6.723	−9.504	1.340040	1.000	105.756	22.961	0.007025
Xinjiang	0.020	503.470	40.277	259.922	7.680	−3.997	1.153885	1.000	241.902	234.415	0.010342
Total	0.018	40,133.251	3570.948	16,887.417	563.274	0.000	1.301724	1.000	13,771.892	26,253.508	0.032258

Table 2. Calibrated model parameters and benchmark equilibrium (dataset).

	Units term		Production exponent (labor)		Production exponent (capital)		Utility exponent	
	Goods ϕ_{n0}	Housing ϕ_{n1}	Goods α_{n0}	Housing α_{n1}	Goods β_{n0}	Housing β_{n1}	Goods δ_{n0}	Housing δ_{n1}
Beijing	3.022394	1.880207	0.484022	0.182645	0.515978	0.817355	0.901035	0.098965
Tianjin	2.284234	1.683536	0.320865	0.152298	0.679135	0.847702	0.903261	0.096739
Hebei	2.051634	1.252880	0.391495	0.056879	0.608505	0.943121	0.916499	0.083501
Shanxi	1.994611	1.283991	0.328134	0.064317	0.671866	0.935683	0.934543	0.065457
Inner Mongolia	2.172615	1.772111	0.412040	0.215230	0.587960	0.784770	0.899866	0.100134
Liaoning	2.160522	1.451172	0.418441	0.110889	0.581559	0.889111	0.905937	0.094063
Jilin	1.996520	1.333703	0.401145	0.082271	0.598855	0.917729	0.943336	0.056664
Heilongjiang	1.932485	1.607593	0.369721	0.182216	0.630279	0.817784	0.921050	0.078950
Shanghai	2.708037	1.617141	0.381516	0.123335	0.618484	0.876665	0.935934	0.064066
Jiangsu	2.265096	1.355879	0.400547	0.078877	0.599453	0.921123	0.874631	0.125369
Zhejiang	2.332279	1.615199	0.428869	0.149736	0.571131	0.850264	0.908011	0.091989
Anhui	2.179558	1.528353	0.474235	0.136748	0.525765	0.863252	0.923955	0.076045
Fujian	2.126301	1.363096	0.442218	0.087341	0.557782	0.912659	0.900162	0.099838
Jiangxi	2.021600	2.022598	0.521655	0.508932	0.478345	0.491068	0.920959	0.079041
Shandong	2.051649	1.794019	0.358908	0.232149	0.641092	0.767851	0.920114	0.079886
Henan	2.026729	1.406783	0.409679	0.103994	0.590321	0.896006	0.924457	0.075543
Hubei	2.143629	2.129722	0.506389	0.597299	0.493611	0.402701	0.930054	0.069946
Hunan	2.056668	1.347549	0.460531	0.085713	0.539469	0.914287	0.935373	0.064627
Guangdong	2.296461	1.559486	0.409961	0.133968	0.590039	0.866032	0.929411	0.070589
Guangxi	2.096860	1.346773	0.478712	0.084330	0.521288	0.915670	0.924,402	0.075598
Hainan	2.076799	1.532714	0.437529	0.143949	0.562471	0.856051	0.861482	0.138518
Chongqing	2.207366	1.803326	0.456027	0.229058	0.543973	0.770942	0.915107	0.084893
Sichuan	2.152272	1.596991	0.468917	0.161519	0.531083	0.838481	0.926420	0.073580
Guizhou	2.068167	1.456342	0.439661	0.118977	0.560339	0.881023	0.958216	0.041784
Yunnan	2.041575	1.302038	0.460852	0.072559	0.539148	0.927441	0.936674	0.063326
Tibet	2.545932	1.503101	0.428451	0.108664	0.571549	0.891336	0.946879	0.053121
Shaanxi	2.131085	1.438869	0.417042	0.108664	0.582958	0.891336	0.903648	0.096352
Gansu	2.042918	1.384395	0.473201	0.097957	0.526799	0.902043	0.941100	0.058900
Qinghai	2.278881	1.500121	0.494364	0.123086	0.505636	0.876914	0.922742	0.077258
Ningxia	2.270440	2.197366	0.450244	0.395991	0.549756	0.604009	0.893535	0.106465
Xinjiang	2.152248	1.672788	0.516261	0.190675	0.483739	0.809325	0.925379	0.074621

Table 3. Benchmark equilibrium (with no property tax rate).

	Production		Labor input		Capital input						Consumption		
	Y_{n0}	Y_{n1}	L_{n0}	L_{n1}	K_{n0}	K_{n1}	Wage rate W_n	Capital return R_n	Welfare	National income I_n	X_{n0}	X_{n1}	Income tax revenue
Beijing	1282.572	128.786	264.245	10.012	661.779	105.264	2.349306	1.000000	942.320	1301.337	1172.551	128.786	77.451
Tianjin	864.077	58.369	149.344	4.788	586.825	49.479	1.856463	1.000000	439.070	603.362	544.993	58.369	8.600
Hebei	1897.024	142.402	654.926	7.143	1154.349	134.302	1.133982	1.000000	1279.612	1705.392	1562.990	142.402	20.007
Shanxi	866.653	53.433	238.595	2.883	582.275	49.996	1.191888	1.000000	641.016	816.299	762.867	53.433	17.513
Inner Mongolia	1086.394	80.806	352.595	13.699	638.756	63.414	1.269551	1.000000	582.842	806.976	726.170	80.806	34.620
Liaoning	1696.100	149.627	571.596	13.363	986.382	133.035	1.241644	1.000000	1164.551	1590.702	1441.075	149.627	52.533
Jilin	801.834	64.924	307.589	5.108	480.182	59.583	1.045718	1.000000	921.645	1145.787	1080.862	64.924	35.782
Heilongjiang	956.067	80.793	353.478	14.722	602.589	66.071	1.000000	1.000000	776.376	1023.347	942.554	80.793	15.494
Shanghai	1592.222	124.376	254.826	6.435	984.765	109.036	2.383811	1.000000	1530.163	1941.357	1816.981	124.376	69.402
Jiangsu	3715.326	427.222	1037.770	23.499	2227.164	393.524	1.434000	1.000000	2336.254	3407.699	2980.478	427.222	50.772
Zhejiang	2525.446	246.785	739.157	25.219	1442.361	209.833	1.465297	1.000000	1973.343	2682.758	2435.973	246.785	48.825
Anhui	1122.739	113.194	442.917	12.876	590.296	97.715	1.202127	1.000000	1137.430	1488.508	1375.314	113.194	12.263
Fujian	1332.932	140.780	505.514	10.545	743.485	128.484	1.166036	1.000000	1019.104	1410.085	1269.306	140.780	54.124
Jiangxi	857.932	87.194	437.635	43.393	410.388	42.818	1.022643	1.000000	836.726	1103.143	1015.949	87.194	20.659
Shandong	3601.929	315.063	1076.039	60.880	2309.169	241.921	1.201406	1.000000	2985.239	3943.902	3628.839	315.063	67.556
Henan	2151.936	157.300	819.990	15.215	1270.333	140.942	1.075140	1.000000	1593.125	2082.242	1924.942	157.300	32.286
Hubei	1476.163	120.598	651.732	62.804	728.650	48.565	1.146962	1.000000	1338.087	1724.161	1603.562	120.598	8.288
Hunan	1492.636	111.160	642.574	8.907	805.231	101.632	1.069767	1.000000	1353.678	1720.026	1608.866	111.160	20.648
Guangdong	4240.360	360.946	1192.471	33.170	2501.980	312.591	1.457797	1.000000	3961.799	5113.364	4752.418	360.946	66.543
Guangxi	875.776	81.209	379.087	6.192	456.531	74.361	1.105931	1.000000	821.774	1074.220	993.011	81.209	23.995
Hainan	175.298	31.152	69.122	4.041	98.600	26.667	1.109609	1.000000	150.409	224.892	193.740	31.152	3.362
Chongqing	718.739	73.819	261.772	13.504	390.975	56.910	1.252100	1.000000	650.294	869.557	795.738	73.819	9.686
Sichuan	1576.990	141.558	629.761	19.472	837.512	118.694	1.174220	1.000000	1479.259	1923.878	1782.320	141.558	39.686
Guizhou	431.050	29.166	172.715	3.162	241.534	25.696	1.097278	1.000000	586.790	698.014	668.848	29.166	7.015
Yunnan	666.160	56.258	291.649	3.878	359.159	52.176	1.052641	1.000000	701.611	888.381	832.124	56.258	16.853
Tibet	44.018	6.728	10.483	0.406	25.159	5.997	1.799099	1.000000	102.907	126.650	119.923	6.728	4.000
Shaanxi	924.688	87.660	320.380	7.914	539.054	78.134	1.203678	1.000000	662.629	909.785	822.125	87.660	25.576
Gansu	379.727	32.348	171.282	3.020	200.040	29.179	1.049072	1.000000	439.015	549.200	516.852	32.348	13.553
Qinghai	125.002	10.041	47.450	0.949	63.206	8.805	1.302362	1.000000	99.011	129.963	119.923	10.041	0.716
Ningxia	151.988	16.977	51.067	5.017	83.556	10.254	1.340040	1.000000	113.606	159.461	142.484	16.977	4.465
Xinjiang	503.470	40.277	225.258	6.656	243.548	32.597	1.153885	1.000000	413.921	539.750	499.473	40.277	9.808
Total	40,133.251	3570.948	13,323.018	448.873	23,245.833	3007.674	1.301724	1.000000	33,033.606	43,704.199	40,133.251	3570.948	872.080

Table 4. Equilibrium with property tax rates 5% in Shanghai and 4% in Chonqing.

		Price		Production		Labor input		Capital input						Consumption			
	Property tax rate t_n	P_{n0}	P_{n1}	Y_{n0}	Y_{n1}	L_{n0}	L_{n1}	K_{n0}	K_{n1}	Wage rate W_n	Capital return R_n	Welfare	National income I_n	X_{n0}	X_{n1}	PTR_n	ITR_n
Beijing	0.000	1.000	1.000	1287.240	128.813	265.207	10.014	664.188	105.286	2.349306	1.000000	942.512	1301.601	1172.789	128.813	0.000	77.468
Tianjin	0.000	1.000	1.000	873.090	58.379	150.902	4.789	592.946	49.488	1.856463	1.000000	439.148	603.468	545.090	58.379	0.000	8.602
Hebei	0.000	1.000	1.000	1898.563	142.444	655.457	7.145	1155.286	134.342	1.133982	1.000000	1279.990	1705.896	1563.452	142.444	0.000	20.013
Shanxi	0.000	1.000	1.000	871.782	53.445	240.007	2.884	585.721	50.008	1.191888	1.000000	641.168	816.492	763.047	53.445	0.000	17.517
Inner Mongolia	0.000	1.000	1.000	1087.952	80.819	353.101	13.701	639.672	63.424	1.269551	1.000000	582.936	807.106	726.287	80.819	0.000	34.628
Liaoning	0.000	1.000	1.000	1697.248	149.658	571.983	13.366	987.049	133.062	1.241644	1.000000	1164.793	1591.032	1441.375	149.658	0.000	52.546
Jilin	0.000	1.000	1.000	801.502	64.937	307.462	5.109	479.984	59.595	1.045718	1.000000	921.828	1146.014	1081.077	64.937	0.000	35.790
Heilongjiang	0.000	1.000	1.000	956.879	80.812	353.778	14.725	603.101	66.086	1.000000	1.000000	776.553	1023.581	942.769	80.812	0.000	15.497
Shanghai	0.005	1.000	1.005	1600.617	123.782	259.249	6.514	982.687	108.257	2.355499	1.007397	1529.987	1941.753	1817.352	123.782	0.619	69.417
Jiangsu	0.000	1.000	1.000	3719.499	427.338	1038.936	23.506	2229.665	393.631	1.434000	1.000000	2336.894	3408.632	2981.294	427.338	0.000	50.786
Zhejiang	0.000	1.000	1.000	2528.305	246.843	739.994	25.224	1443.994	209.881	1.465297	1.000000	1973.800	2683.381	2436.538	246.843	0.000	48.836
Anhui	0.000	1.000	1.000	1120.745	113.228	442.130	12.880	589.248	97.745	1.202127	1.000000	1137.773	1488.957	1375.728	113.228	0.000	12.266
Fujian	0.000	1.000	1.000	1332.040	140.814	505.175	10.548	742.988	128.515	1.166036	1.000000	1019.352	1410.428	1269.614	140.814	0.000	54.138
Jiangxi	0.000	1.000	1.000	850.562	87.219	433.876	43.406	406.862	42.831	1.022643	1.000000	836.969	1103.463	1016.244	87.219	0.000	20.664
Shandong	0.000	1.000	1.000	3606.607	315.168	1077.437	60.900	2312.168	242.002	1.201406	1.000000	2986.239	3945.223	3630.055	315.168	0.000	67.574
Henan	0.000	1.000	1.000	2151.935	157.350	819.989	15.220	1270.332	140.987	1.075140	1.000000	1593.637	2082.911	1925.561	157.350	0.000	32.295
Hubei	0.000	1.000	1.000	1471.787	120.630	649.800	62.820	726.491	48.578	1.146962	1.000000	1338.442	1724.619	1603.988	120.630	0.000	8.290
Hunan	0.000	1.000	1.000	1489.525	111.185	641.235	8.909	803.552	101.655	1.069767	1.000000	1353.987	1720.418	1609.233	111.185	0.000	20.653
Guangdong	0.000	1.000	1.000	4245.112	361.072	1193.807	33.182	2504.784	312.700	1.457797	1.000000	3963.178	5115.143	4754.072	361.072	0.000	66.565
Guangxi	0.000	1.000	1.000	872.106	81.231	377.499	6.194	454.618	74.380	1.105931	1.000000	821.987	1074.500	993.269	81.231	0.000	24.001
Hainan	0.000	1.000	1.000	173.646	31.155	68.470	4.042	97.671	26.670	1.109609	1.000000	150.423	224.913	193.758	31.155	0.000	3.362
Chongqing	0.004	1.000	1.004	717.755	73.539	263.927	13.637	387.320	56.466	1.240178	1.008053	650.195	869.719	795.886	73.539	0.294	9.688
Sichuan	0.000	1.000	1.000	1575.089	141.604	629.002	19.478	836.502	118.732	1.174220	1.000000	1479.742	1924.505	1782.901	141.604	0.000	39.697
Guizhou	0.000	1.000	1.000	429.259	29.173	171.997	3.163	240.530	25.702	1.097278	1.000000	586.929	698.179	669.007	29.173	0.000	7.016
Yunnan	0.000	1.000	1.000	662.631	56.273	290.104	3.879	357.256	52.190	1.052641	1.000000	701.803	888.625	832.352	56.273	0.000	16.857
Tibet	0.000	1.000	1.000	48.365	6.728	11.518	0.406	27.643	5.997	1.799099	1.000000	102.915	126.660	119.932	6.728	0.000	4.001
Shaanxi	0.000	1.000	1.000	925.375	87.677	320.618	7.915	539.455	78.150	1.203678	1.000000	662.761	909.966	822.289	87.677	0.000	25.582
Gansu	0.000	1.000	1.000	375.352	32.356	169.309	3.021	197.735	29.186	1.049072	1.000000	439.119	549.331	516.975	32.356	0.000	13.556
Qinghai	0.000	1.000	1.000	122.769	10.042	46.602	0.949	62.076	8.806	1.302362	1.000000	99.026	129.983	119.941	10.042	0.000	0.717
Ningxia	0.000	1.000	1.000	152.251	16.978	51.155	5.017	83.701	10.255	1.340040	1.000000	113.614	159.472	142.494	16.978	0.000	4.466
Xinjiang	0.000	1.000	1.000	498.348	40.284	222.967	6.657	241.070	32.603	1.153885	1.000000	414.001	539.854	499.569	40.284	0.000	9.811
Total	0.000	1.000	1.000	40,143.938	3571.890	13,322.691	449.201	23,246.297	3007.211	1.300426	1.000498	33,041.700	43,715.827	40,143.938	3570.977	0.913	872.298

Table 5. Equilibrium per cent changes from benchmark equilibrium to equilibrium with property tax rates 5% in Shanghai and 4% in Chonqing.

		Price		Production		Labor input		Capital input						Consumption			
	Property tax rate t_n	$\dot{P}_{n0}$	$\dot{P}_{n1}$	$\dot{Y}_{n0}$	$\dot{Y}_{n1}$	$\dot{L}_{n0}$	$\dot{L}_{n1}$	$\dot{K}_{n0}$	$\dot{K}_{n1}$	Wage rate $\dot{W}_n$	Capital return $\dot{R}_n$	Welfare	National income $\dot{I}_n$	$\dot{X}_{n0}$	$\dot{X}_{n1}$	$\dot{PTR}_n$	$\dot{ITR}_n$
Beijing	0.000	0.000	0.000	3.640	0.203	3.640	0.203	3.640	0.203	0.000	0.000	0.203	0.203	0.203	0.203	0.000	0.223
Tianjin	0.000	0.000	0.000	10.430	0.176	10.430	0.176	10.430	0.176	−0.000	0.000	0.176	0.176	0.176	0.176	0.000	0.185
Hebei	0.000	0.000	0.000	0.812	0.296	0.812	0.296	0.812	0.296	0.000	0.000	0.296	0.296	0.296	0.296	0.000	0.265
Shanxi	0.000	0.000	0.000	5.917	0.236	5.917	0.236	5.917	0.236	0.000	0.000	0.236	0.236	0.236	0.236	0.000	0.246
Inner Mongolia	0.000	0.000	0.000	1.434	0.161	1.434	0.161	1.434	0.161	0.000	−0.000	0.161	0.161	0.161	0.161	0.000	0.232
Liaoning	0.000	0.000	0.000	0.677	0.208	0.677	0.208	0.677	0.208	0.000	−0.000	0.208	0.208	0.208	0.208	0.000	0.240
Jilin	0.000	0.000	0.000	−0.413	0.199	−0.413	0.199	−0.413	0.199	0.000	0.000	0.199	0.199	0.199	0.199	0.000	0.242
Heilongjiang	0.000	0.000	0.000	0.850	0.228	0.850	0.228	0.850	0.228	−0.000	0.000	0.228	0.228	0.228	0.228	0.000	0.244
Shanghai	0.005	0.000	5.000	5.273	−4.772	17.355	12.226	−2.109	−7.140	−11.877	7.397	−0.115	0.204	0.204	−4.772	0.619	0.207
Jiangsu	0.000	0.000	0.000	1.123	0.274	1.123	0.274	1.123	0.274	0.000	0.000	0.274	0.274	0.274	0.274	0.000	0.265
Zhejiang	0.000	0.000	0.000	1.132	0.232	1.132	0.232	1.132	0.232	0.000	0.000	0.232	0.232	0.232	0.232	0.000	0.241
Anhui	0.000	0.000	0.000	−1.775	0.301	−1.775	0.301	−1.775	0.301	0.000	0.000	0.301	0.301	0.301	0.301	0.000	0.269
Fujian	0.000	0.000	0.000	−0.670	0.243	−0.670	0.243	−0.670	0.243	0.000	0.000	0.243	0.243	0.243	0.243	0.000	0.249
Jiangxi	0.000	0.000	0.000	−8.590	0.291	−8.590	0.291	−8.590	0.291	0.000	−0.000	0.291	0.291	0.291	0.291	0.000	0.256
Shandong	0.000	0.000	0.000	1.299	0.335	1.299	0.335	1.299	0.335	−0.000	0.000	0.335	0.335	0.335	0.335	0.000	0.269
Henan	0.000	0.000	0.000	−0.001	0.321	−0.001	0.321	−0.001	0.321	0.000	0.000	0.321	0.321	0.321	0.321	0.000	0.261
Hubei	0.000	0.000	0.000	−2.964	0.266	−2.964	0.266	−2.964	0.266	0.000	0.000	0.266	0.266	0.266	0.266	0.000	0.261
Hunan	0.000	0.000	0.000	−2.084	0.228	−2.084	0.228	−2.084	0.228	0.000	0.000	0.228	0.228	0.228	0.228	0.000	0.244
Guangdong	0.000	0.000	0.000	1.121	0.348	1.121	0.348	1.121	0.348	0.000	0.000	0.348	0.348	0.348	0.348	0.000	0.328
Guangxi	0.000	0.000	0.000	−4.190	0.260	−4.190	0.260	−4.190	0.260	0.000	0.000	0.260	0.260	0.260	0.260	0.000	0.251
Hainan	0.000	0.000	0.000	−9.423	0.092	−9.423	0.092	−9.423	0.092	0.000	0.000	0.092	0.092	0.092	0.092	0.000	0.192
Chongqing	0.004	0.000	4.000	−1.369	−3.798	8.232	9.802	−9.346	−7.803	−9.522	8.053	−0.152	0.187	0.187	−3.798	0.294	0.223
Sichuan	0.000	0.000	0.000	−1.205	0.326	−1.205	0.326	−1.205	0.326	−0.000	0.000	0.326	0.326	0.326	0.326	0.000	0.266
Guizhou	0.000	0.000	0.000	−4.156	0.237	−4.156	0.237	−4.156	0.237	0.000	0.000	0.237	0.237	0.237	0.237	0.000	0.243
Yunnan	0.000	0.000	0.000	−5.298	0.274	−5.298	0.274	−5.298	0.274	0.000	0.000	0.274	0.274	0.274	0.274	0.000	0.255
Tibet	0.000	0.000	0.000	98.759	0.079	98.759	0.079	98.759	0.079	0.000	0.000	0.079	0.079	0.079	0.079	0.000	0.228
Shaanxi	0.000	0.000	0.000	0.743	0.199	0.743	0.199	0.743	0.199	0.000	0.000	0.199	0.199	0.199	0.199	0.000	0.240
Gansu	0.000	0.000	0.000	−11.521	0.238	−11.521	0.238	−11.521	0.238	0.000	0.000	0.238	0.238	0.238	0.238	0.000	0.248
Qinghai	0.000	0.000	0.000	−17.868	0.154	−17.868	0.154	−17.868	0.154	0.000	0.000	0.154	0.154	0.154	0.154	0.000	0.180
Ningxia	0.000	0.000	0.000	1.729	0.068	1.729	0.068	1.729	0.068	0.000	0.000	0.068	0.068	0.068	0.068	0.000	0.217
Xinjiang	0.000	0.000	0.000	−10.174	0.192	−10.174	0.192	−10.174	0.192	0.000	0.000	0.192	0.192	0.192	0.192	0.000	0.224

Table 6. Equilibrium per cent changes from benchmark equilibrium to equilibrium with property tax rates 5% in Beijing, Tianjin and Shanghai and 4% in Chonqing.

		Price		Production		Labor input		Capital input						Consumption			
	Property tax rate t_n	$\dot{P}_{n0}$	$\dot{P}_{n1}$	$\dot{Y}_{n0}$	$\dot{Y}_{n1}$	$\dot{L}_{n0}$	$\dot{L}_{n1}$	$\dot{K}_{n0}$	$\dot{K}_{n1}$	Wage rate $\dot{W}_n$	Capital return $\dot{R}_n$	Welfare	National income $\dot{I}_n$	$\dot{X}_{n0}$	$\dot{X}_{n1}$	$\dot{PTR}_n$	$\dot{ITR}_n$
Beijing	0.005	0.000	5.000	7.168	−4.549	15.805	9.008	−0.867	−7.553	−8.503	8.042	−0.065	0.428	0.428	−4.549	0.641	0.468
Tianjin	0.005	0.000	5.000	20.552	−4.602	41.266	20.680	10.909	−9.078	−19.894	9.539	−0.108	0.375	0.375	−4.602	0.290	0.393
Hebei	0.000	0.000	0.000	1.671	0.615	1.671	0.615	1.671	0.615	−0.000	0.000	0.615	0.615	0.615	0.615	0.000	0.552
Shanxi	0.000	0.000	0.000	12.028	0.495	12.028	0.495	12.028	0.495	0.000	0.000	0.495	0.495	0.495	0.495	0.000	0.516
Inner Mongolia	0.000	0.000	0.000	2.939	0.344	2.939	0.344	2.939	0.344	0.000	0.000	0.344	0.344	0.344	0.344	0.000	0.487
Liaoning	0.000	0.000	0.000	1.400	0.438	1.400	0.438	1.400	0.438	0.000	−0.000	0.438	0.438	0.438	0.438	0.000	0.504
Jilin	0.000	0.000	0.000	−0.778	0.419	−0.778	0.419	−0.778	0.419	0.000	0.000	0.419	0.419	0.419	0.419	0.000	0.506
Heilongjiang	0.000	0.000	0.000	1.768	0.479	1.768	0.479	1.768	0.479	−0.000	0.000	0.479	0.479	0.479	0.479	0.000	0.510
Shanghai	0.005	0.000	5.000	10.710	−4.547	22.858	12.456	3.288	−6.915	−11.877	7.397	0.111	0.431	0.431	−4.547	0.619	0.437
Jiangsu	0.000	0.000	0.000	2.294	0.571	2.294	0.571	2.294	0.571	0.000	0.000	0.571	0.571	0.571	0.571	0.000	0.553
Zhejiang	0.000	0.000	0.000	2.319	0.487	2.319	0.487	2.319	0.487	0.000	0.000	0.487	0.487	0.487	0.487	0.000	0.504
Anhui	0.000	0.000	0.000	−3.551	0.626	−3.551	0.626	−3.551	0.626	0.000	0.000	0.626	0.626	0.626	0.626	0.000	0.561
Fujian	0.000	0.000	0.000	−1.320	0.509	−1.320	0.509	−1.320	0.509	0.000	0.000	0.509	0.509	0.509	0.509	0.000	0.520
Jiangxi	0.000	0.000	0.000	−17.341	0.605	−17.341	0.605	−17.341	0.605	−0.000	0.000	0.605	0.605	0.605	0.605	0.000	0.535
Shandong	0.000	0.000	0.000	2.653	0.694	2.653	0.694	2.653	0.694	−0.000	0.000	0.694	0.694	0.694	0.694	0.000	0.562
Henan	0.000	0.000	0.000	0.026	0.667	0.026	0.667	0.026	0.667	0.000	0.000	0.667	0.667	0.667	0.667	0.000	0.546
Hubei	0.000	0.000	0.000	−5.966	0.554	−5.966	0.554	−5.966	0.554	−0.000	0.000	0.554	0.554	0.554	0.554	0.000	0.545
Hunan	0.000	0.000	0.000	−4.183	0.479	−4.183	0.479	−4.183	0.479	0.000	0.000	0.479	0.479	0.479	0.479	0.000	0.511
Guangdong	0.000	0.000	0.000	2.293	0.720	2.293	0.720	2.293	0.720	0.000	0.000	0.720	0.720	0.720	0.720	0.000	0.680
Guangxi	0.000	0.000	0.000	−8.434	0.543	−8.434	0.543	−8.434	0.543	0.000	0.000	0.543	0.543	0.543	0.543	0.000	0.525
Hainan	0.000	0.000	0.000	−18.903	0.205	−18.903	0.205	−18.903	0.205	0.000	0.000	0.205	0.205	0.205	0.205	0.000	0.405
Chongqing	0.004	0.000	4.000	−2.715	−3.590	6.872	10.013	−10.682	−7.596	−9.522	8.053	0.056	0.395	0.395	−3.590	0.294	0.468
Sichuan	0.000	0.000	0.000	−2.406	0.676	−2.406	0.676	−2.406	0.676	0.000	0.000	0.676	0.676	0.676	0.676	0.000	0.554
Guizhou	0.000	0.000	0.000	−8.326	0.496	−8.326	0.496	−8.326	0.496	0.000	−0.000	0.496	0.496	0.496	0.496	0.000	0.509
Yunnan	0.000	0.000	0.000	−10.664	0.571	−10.664	0.571	−10.664	0.571	0.000	0.000	0.571	0.571	0.571	0.571	0.000	0.533
Tibet	0.000	0.000	0.000	200.556	0.179	200.556	0.179	200.556	0.179	0.000	0.000	0.179	0.179	0.179	0.179	0.000	0.479
Shaanxi	0.000	0.000	0.000	1.548	0.421	1.548	0.421	1.548	0.421	0.000	0.000	0.421	0.421	0.421	0.421	0.000	0.502
Gansu	0.000	0.000	0.000	−23.230	0.498	−23.230	0.498	−23.230	0.498	0.000	0.000	0.498	0.498	0.498	0.498	0.000	0.520
Qinghai	0.000	0.000	0.000	−35.955	0.329	−35.955	0.329	−35.955	0.329	0.000	0.000	0.329	0.329	0.329	0.329	0.000	0.382
Ningxia	0.000	0.000	0.000	3.688	0.157	3.688	0.157	3.688	0.157	0.000	0.000	0.157	0.157	0.157	0.157	0.000	0.457
Xinjiang	0.000	0.000	0.000	−20.530	0.407	−20.530	0.407	−20.530	0.407	0.000	0.000	0.407	0.407	0.407	0.407	0.000	0.470

Table 7. Equilibrium per cent changes from benchmark equilibrium to equilibrium with property tax rates 5% in Eastern Coastal China.

		Price		Production		Labor input		Capital input						Consumption			
	Property tax rate t_n	$\dot{P}_{n0}$	$\dot{P}_{n1}$	$\dot{Y}_{n0}$	$\dot{Y}_{n1}$	$\dot{L}_{n0}$	$\dot{L}_{n1}$	$\dot{K}_{n0}$	$\dot{K}_{n1}$	Wage rate $\dot{W}_n$	Capital return $\dot{R}_n$	Welfare	National income $\dot{I}_n$	$\dot{X}_{n0}$	$\dot{X}_{n1}$	$\dot{PTR}_n$	$\dot{ITR}_n$
Beijing	0.005	0.000	5.000	47.169	−3.125	56.149	10.451	38.815	−6.134	−8.503	8.042	1.365	1.859	1.859	−3.125	0.642	2.119
Tianjin	0.005	0.000	5.000	136.838	−3.477	159.913	21.833	126.096	−7.958	−19.894	9.539	1.022	1.505	1.505	−3.477	0.291	1.625
Hebei	0.005	0.000	5.000	9.384	−1.904	18.581	12.226	3.511	−2.750	−9.029	5.852	2.669	3.087	3.087	−1.904	0.711	2.677
Shanxi	0.000	0.000	0.000	80.045	2.296	80.045	2.296	80.045	2.296	0.000	0.000	2.296	2.296	2.296	2.296	0.000	2.435
Inner Mongolia	0.000	0.000	0.000	19.592	1.306	19.592	1.306	19.592	1.306	0.000	0.000	1.306	1.306	1.306	1.306	0.000	2.249
Liaoning	0.005	0.000	5.000	7.358	−3.062	16.904	11.416	0.546	−4.854	−9.387	6.809	1.452	1.922	1.922	−3.062	0.746	2.355
Jilin	0.000	0.000	0.000	−5.443	1.801	−5.443	1.801	−5.443	1.801	0.000	0.000	1.801	1.801	1.801	1.801	0.000	2.369
Heilongjiang	0.000	0.000	0.000	11.694	2.193	11.694	2.193	11.694	2.193	−0.000	0.000	2.193	2.193	2.193	2.193	0.000	2.398
Shanghai	0.005	0.000	5.000	70.461	−3.109	83.328	13.917	62.601	−5.482	−11.877	7.397	1.555	1.875	1.875	−3.109	0.620	1.916
Jiangsu	0.005	0.000	5.000	14.027	−2.193	23.496	12.160	7.749	−3.413	−9.252	6.230	2.169	2.796	2.796	−2.193	2.131	2.677
Zhejiang	0.005	0.000	5.000	13.680	−2.743	24.078	12.523	5.942	−5.408	−10.153	7.692	1.784	2.243	2.243	−2.743	1.231	2.359
Anhui	0.000	0.000	0.000	−24.152	3.161	−24.152	3.161	−24.152	3.161	0.000	0.000	3.161	3.161	3.161	3.161	0.000	2.733
Fujian	0.005	0.000	5.000	−10.948	−2.598	−3.165	10.278	−17.076	−3.821	−7.809	6.234	1.890	2.389	2.389	−2.598	0.702	2.465
Jiangxi	0.000	0.000	0.000	−115.496	3.020	−115.496	3.020	−115.496	3.020	−0.000	0.000	3.020	3.020	3.020	3.020	0.000	2.560
Shandong	0.005	0.000	5.000	15.113	−1.382	41.045	29.249	0.879	−10.462	−24.909	14.222	3.211	3.611	3.611	−1.382	1.573	2.739
Henan	0.000	0.000	0.000	−0.337	3.431	−0.337	3.431	−0.337	3.431	0.000	0.000	3.431	3.431	3.431	3.431	0.000	2.634
Hubei	0.000	0.000	0.000	−40.216	2.688	−40.216	2.688	−40.216	2.688	−0.000	0.000	2.688	2.688	2.688	2.688	0.000	2.629
Hunan	0.000	0.000	0.000	−28.324	2.192	−28.324	2.192	−28.324	2.192	0.000	0.000	2.192	2.192	2.192	2.192	0.000	2.402
Guangdong	0.005	0.000	5.000	13.652	−1.212	24.519	14.542	6.171	−3.627	−10.606	7.436	3.429	3.782	3.782	−1.212	1.803	3.519
Guangxi	0.005	0.000	5.000	−58.890	−2.372	−52.665	9.248	−64.570	−3.435	−6.571	6.072	2.238	2.616	2.616	−2.372	0.405	2.499
Hainan	0.005	0.000	5.000	−139.336	−4.590	−131.072	9.992	−145.709	−7.022	−9.510	7.461	−0.304	0.387	0.387	−4.590	0.155	1.708
Chongqing	0.000	0.000	0.000	−14.020	1.642	−14.020	1.642	−14.020	1.642	0.000	0.000	1.642	1.642	1.642	1.642	0.000	2.117
Sichuan	0.000	0.000	0.000	−16.634	3.493	−16.634	3.493	−16.634	3.493	0.000	0.000	3.493	3.493	3.493	3.493	0.000	2.688
Guizhou	0.000	0.000	0.000	−54.986	2.307	−54.986	2.307	−54.986	2.307	0.000	0.000	2.307	2.307	2.307	2.307	0.000	2.390
Yunnan	0.000	0.000	0.000	−70.889	2.799	−70.889	2.799	−70.889	2.799	0.000	0.000	2.799	2.799	2.799	2.799	0.000	2.548
Tibet	0.000	0.000	0.000	1345.498	0.216	1345.498	0.216	1345.498	0.216	0.000	0.000	0.216	0.216	0.216	0.216	0.000	2.193
Shaanxi	0.000	0.000	0.000	10.268	1.808	10.268	1.808	10.268	1.808	0.000	0.000	1.808	1.808	1.808	1.808	0.000	2.346
Gansu	0.000	0.000	0.000	−153.599	2.316	−153.599	2.316	−153.599	2.316	0.000	0.000	2.316	2.316	2.316	2.316	0.000	2.460
Qinghai	0.000	0.000	0.000	−234.197	1.202	−234.197	1.202	−234.197	1.202	0.000	0.000	1.202	1.202	1.202	1.202	0.000	1.556
Ningxia	0.000	0.000	0.000	28.431	0.071	28.431	0.071	28.431	0.071	0.000	−0.000	0.071	0.071	0.071	0.071	0.000	2.045
Xinjiang	0.000	0.000	0.000	−135.935	1.716	−135.935	1.716	−135.935	1.716	0.000	0.000	1.716	1.716	1.716	1.716	0.000	2.134

Table 8. Equilibrium per cent changes from benchmark equilibrium to equilibrium with property tax rates 5% in high per capita GDP provinces.

		Price		Production		Labor input		Capital input						Consumption			
	Property tax rate t_n	$\dot{P}_{n0}$	$\dot{P}_{n1}$	$\dot{Y}_{n0}$	$\dot{Y}_{n1}$	$\dot{L}_{n0}$	$\dot{L}_{n1}$	$\dot{K}_{n0}$	$\dot{K}_{n1}$	Wage rate $\dot{W}_n$	Capital return $\dot{R}_n$	.Welfare	National income $\dot{I}_n$	$\dot{X}_{n0}$	$\dot{X}_{n1}$	$\dot{PTR}_n$	$\dot{ITR}_n$
Beijing	0.005	0.000	5.000	45.523	−3.170	54.489	10.405	37.182	−6.179	−8.503	8.042	1.319	1.814	1.814	−3.170	0.642	2.065
Tianjin	0.005	0.000	5.000	132.141	−3.510	155.120	21.799	121.443	−7.990	−19.894	9.539	0.989	1.472	1.472	−3.510	0.291	1.588
Hebei	0.000	0.000	0.000	10.310	2.998	10.310	2.998	10.310	2.998	0.000	0.000	2.998	2.998	2.998	2.998	0.000	2.602
Shanxi	0.000	0.000	0.000	77.245	2.236	77.245	2.236	77.245	2.236	0.000	0.000	2.236	2.236	2.236	2.236	0.000	2.369
Inner Mongolia	0.005	0.000	5.000	15.200	−3.701	30.440	16.311	4.654	−9.121	−14.790	10.497	0.780	1.280	1.280	−3.701	0.403	2.189
Liaoning	0.005	0.000	5.000	7.057	−3.110	16.600	11.368	0.247	−4.901	−9.387	6.809	1.405	1.874	1.874	−3.110	0.746	2.292
Jilin	0.000	0.000	0.000	−5.388	1.757	−5.388	1.757	−5.388	1.757	0.000	0.000	1.757	1.757	1.757	1.757	0.000	2.306
Heilongjiang	0.000	0.000	0.000	11.192	2.135	11.192	2.135	11.192	2.135	−0.000	0.000	2.135	2.135	2.135	2.135	0.000	2.333
Shanghai	0.005	0.000	5.000	68.055	−3.155	80.892	13.870	60.212	−5.528	−11.877	7.397	1.509	1.829	1.829	−3.155	0.620	1.868
Jiangsu	0.005	0.000	5.000	13.539	−2.271	23.004	12.081	7.264	−3.491	−9.252	6.230	2.091	2.718	2.718	−2.271	2.131	2.603
Zhejiang	0.005	0.000	5.000	13.193	−2.802	23.585	12.464	5.458	−5.466	−10.153	7.692	1.725	2.184	2.184	−2.802	1.230	2.296
Anhui	0.000	0.000	0.000	−23.430	3.069	−23.430	3.069	−23.430	3.069	0.000	0.000	3.069	3.069	3.069	3.069	0.000	2.657
Fujian	0.005	0.000	5.000	−10.655	−2.662	−2.869	10.213	−16.785	−3.885	−7.809	6.234	1.826	2.325	2.325	−2.662	0.702	2.399
Jiangxi	0.000	0.000	0.000	−111.756	2.934	−111.756	2.934	−111.756	2.934	−0.000	0.000	2.934	2.934	2.934	2.934	0.000	2.490
Shandong	0.005	0.000	5.000	14.589	−1.488	40.507	29.140	0.362	−10.568	−24.909	14.222	3.104	3.504	3.504	−1.488	1.573	2.662
Henan	0.000	0.000	0.000	−0.368	3.330	−0.368	3.330	−0.368	3.330	0.000	0.000	3.330	3.330	3.330	3.330	0.000	2.562
Hubei	0.000	0.000	0.000	−38.934	2.614	−38.934	2.614	−38.934	2.614	−0.000	0.000	2.614	2.614	2.614	2.614	0.000	2.557
Hunan	0.000	0.000	0.000	−27.440	2.134	−27.440	2.134	−27.440	2.134	0.000	0.000	2.134	2.134	2.134	2.134	0.000	2.338
Guangdong	0.005	0.000	5.000	13.184	−1.324	24.045	14.428	5.706	−3.739	−10.606	7.436	3.316	3.669	3.669	−1.324	1.802	3.416
Guangxi	0.000	0.000	0.000	−54.516	2.544	−54.516	2.544	−54.516	2.544	0.000	0.000	2.544	2.544	2.544	2.544	0.000	2.431
Hainan	0.000	0.000	0.000	−118.663	0.393	−118.663	0.393	−118.663	0.393	0.000	−0.000	0.393	0.393	0.393	0.393	0.000	1.667
Chongqing	0.000	0.000	0.000	−13.694	1.604	−13.694	1.604	−13.694	1.604	0.000	0.000	1.604	1.604	1.604	1.604	0.000	2.063
Sichuan	0.000	0.000	0.000	−16.136	3.391	−16.136	3.391	−16.136	3.391	−0.000	0.000	3.391	3.391	3.391	3.391	0.000	2.613
Guizhou	0.000	0.000	0.000	−53.399	2.245	−53.399	2.245	−53.399	2.245	0.000	0.000	2.245	2.245	2.245	2.245	0.000	2.326
Yunnan	0.000	0.000	0.000	−68.679	2.720	−68.679	2.720	−68.679	2.720	0.000	0.000	2.720	2.720	2.720	2.720	0.000	2.478
Tibet	0.000	0.000	0.000	1298.008	0.228	1298.008	0.228	1298.008	0.228	0.000	0.000	0.228	0.228	0.228	0.228	0.000	2.136
Shaanxi	0.000	0.000	0.000	9.812	1.765	9.812	1.765	9.812	1.765	0.000	0.000	1.765	1.765	1.765	1.765	0.000	2.283
Gansu	0.000	0.000	0.000	−148.756	2.255	−148.756	2.255	−148.756	2.255	0.000	0.000	2.255	2.255	2.255	2.255	0.000	2.394
Qinghai	0.000	0.000	0.000	−227.269	1.179	−227.269	1.179	−227.269	1.179	0.000	0.000	1.179	1.179	1.179	1.179	0.000	1.521
Ningxia	0.000	0.000	0.000	26.739	0.088	26.739	0.088	26.739	0.088	0.000	−0.000	0.088	0.088	0.088	0.088	0.000	1.993
Xinjiang	0.000	0.000	0.000	−131.605	1.675	−131.605	1.675	−131.605	1.675	0.000	0.000	1.675	1.675	1.675	1.675	0.000	2.079

Table 9. Equilibrium per cent changes from benchmark equilibrium to equilibrium with unified property tax rate of 5%.

		Price		Production		Labor input		Capital input						Consumption			
	Property tax rate t_n	$\dot{P}_{n0}$	$\dot{P}_{n1}$	$\dot{Y}_{n0}$	$\dot{Y}_{n1}$	$\dot{L}_{n0}$	$\dot{L}_{n1}$	$\dot{K}_{n0}$	$\dot{K}_{n1}$	Wage rate $\dot{W}_n$	Capital return $\dot{R}_n$	Welfare	National income $\dot{I}_n$	$\dot{X}_{n0}$	$\dot{X}_{n1}$	$\dot{PTR}_n$	$\dot{ITR}_n$
Beijing	0.005	0.000	5.000	90.913	−2.358	100.268	11.228	82.210	−5.369	−8.503	8.042	2.135	2.630	2.630	−2.358	0.642	3.155
Tianjin	0.005	0.000	5.000	258.792	−3.070	284.342	22.251	246.898	−7.552	−19.894	9.539	1.431	1.915	1.915	−3.070	0.291	2.157
Hebei	0.005	0.000	5.000	20.848	0.109	30.149	14.267	14.908	−0.738	−9.029	5.852	4.691	5.110	5.110	0.109	0.712	4.281
Shanxi	0.005	0.000	5.000	148.994	−1.480	163.681	16.341	141.888	−2.693	−12.622	6.223	3.185	3.513	3.513	−1.480	0.267	3.793
Inner Mongolia	0.005	0.000	5.000	35.377	−3.470	50.919	16.547	24.621	−8.891	−14.790	10.497	1.012	1.512	1.512	−3.470	0.403	3.416
Liaoning	0.005	0.000	5.000	17.310	−2.232	26.950	12.259	10.431	−4.024	−9.387	6.809	2.287	2.757	2.757	−2.232	0.746	3.632
Jilin	0.005	0.000	5.000	−7.638	−2.476	1.701	11.946	−13.845	−3.759	−9.323	6.294	2.228	2.512	2.512	−2.476	0.324	3.660
Heilongjiang	0.005	0.000	5.000	19.900	−1.688	37.143	20.266	9.919	−6.515	−16.625	9.883	2.908	3.303	3.303	−1.688	0.403	3.718
Shanghai	0.005	0.000	5.000	132.643	−2.327	146.257	14.713	124.326	−4.701	−11.877	7.397	2.341	2.661	2.661	−2.327	0.620	2.744
Jiangsu	0.005	0.000	5.000	27.225	−0.475	36.818	13.903	20.866	−1.697	−9.252	6.230	3.895	4.522	4.522	−0.475	2.135	4.282
Zhejiang	0.005	0.000	5.000	27.295	−1.587	37.832	13.698	19.453	−4.254	−10.153	7.692	2.945	3.406	3.406	−1.587	1.232	3.639
Anhui	0.005	0.000	5.000	−42.334	0.258	−34.864	13.101	−49.023	−1.761	−7.740	7.033	4.878	5.259	5.259	0.258	0.566	4.395
Fujian	0.005	0.000	5.000	−14.970	−1.293	−7.218	11.600	−21.073	−2.518	−7.809	6.234	3.201	3.701	3.701	−1.293	0.703	3.854
Jiangxi	0.005	0.000	5.000	−366.988	−0.024	−236.426	212.257	−484.060	−180.888	−170.988	226.910	4.580	4.976	4.976	−0.024	0.436	4.046
Shandong	0.005	0.000	5.000	29.394	1.164	55.691	31.873	14.959	−7.939	−24.909	14.222	5.769	6.170	6.170	1.164	1.577	4.407
Henan	0.005	0.000	5.000	0.115	0.801	9.794	15.540	−6.548	−0.895	−9.585	6.707	5.426	5.805	5.805	0.801	0.787	4.196
Hubei	0.005	0.000	5.000	−57.216	−0.691	−82.405	−22.527	−30.657	32.598	27.451	−27.399	3.955	4.305	4.305	−0.691	0.603	4.185
Hunan	0.005	0.000	5.000	−50.470	−1.690	−43.629	10.530	−56.271	−2.828	−7.153	6.147	2.978	3.301	3.301	−1.690	0.555	3.727
Guangdong	0.005	0.000	5.000	26.296	1.507	37.298	17.304	18.721	−0.914	−10.606	7.436	6.161	6.515	6.515	1.507	1.807	5.984
Guangxi	0.005	0.000	5.000	−99.865	−0.837	−93.911	10.801	−105.298	−1.902	−6.571	6.072	3.781	4.159	4.159	−0.837	0.406	3.922
Hainan	0.005	0.000	5.000	−212.350	−5.319	−204.787	9.252	−218.182	−7.749	−9.510	7.461	−1.036	−0.346	−0.346	−5.319	0.155	2.323
Chongqing	0.005	0.000	5.000	−25.496	−2.795	−13.777	14.242	−35.212	−7.802	−11.882	10.071	1.767	2.191	2.191	−2.795	0.368	3.151
Sichuan	0.005	0.000	5.000	−29.478	0.927	−21.080	14.637	−36.834	−1.693	−8.580	7.637	5.563	5.932	5.932	0.927	0.708	4.304
Guizhou	0.005	0.000	5.000	−95.704	−1.459	−87.789	12.318	−101.867	−3.305	−8.677	6.861	3.325	3.534	3.534	−1.459	0.146	3.702
Yunnan	0.005	0.000	5.000	−125.501	−0.470	−119.424	11.509	−130.663	−1.401	−6.901	5.937	4.211	4.528	4.528	−0.470	0.281	4.022
Tibet	0.005	0.000	5.000	2536.688	−5.663	2568.356	8.257	2513.134	−7.347	−8.875	6.705	−0.956	−0.691	−0.691	−5.663	0.033	3.305
Shaanxi	0.005	0.000	5.000	21.023	−2.461	30.695	12.024	14.159	−4.212	−9.384	6.768	2.045	2.527	2.527	−2.461	0.437	3.613
Gansu	0.005	0.000	5.000	−273.866	−1.440	−268.764	10.605	−278.419	−2.739	−6.977	6.309	3.258	3.553	3.553	−1.440	0.162	3.844
Qinghai	0.005	0.000	5.000	−403.422	−3.680	−399.356	8.126	−407.371	−5.326	−6.769	6.663	0.916	1.302	1.302	−3.680	0.050	2.016
Ningxia	0.005	0.000	5.000	−78.363	−5.954	−30.586	50.805	−115.733	−41.491	−49.284	42.261	−1.514	−0.983	−0.983	−5.954	0.084	3.005
Xinjiang	0.005	0.000	5.000	−244.751	−2.647	−239.134	9.794	−250.700	−5.556	−7.383	7.940	1.966	2.339	2.339	−2.647	0.201	3.185

Table 10. Per capita income and per capita income rank under different policies.

	Income per capita						Income per capita Rank					
	Benchmark	P1	P2	P3	P4	P5	Benchmark	P1	P2	P3	P4	P5
Beijing	66,327.067	66,340.538	66,355.480	66,450.391	66,447.366	66,501.492	2	2	2	2	2	2
Tianjin	46,448.193	46,456.388	46,465.595	46,518.118	46,516.575	46,537.126	5	5	5	5	5	5
Hebei	23,705.758	23,712.765	23,720.329	23,778.927	23,776.828	23,826.886	24	24	24	24	24	24
Shanxi	22,839.936	22,845.327	22,851.235	22,892.386	22,890.995	22,920.173	27	27	27	27	27	27
Inner Mongolia	32,644.641	32,649.911	32,655.885	32,687.285	32,686.428	32,694.008	12	12	12	12	12	12
Liaoning	36,358.898	36,366.455	36,374.821	36,428.791	36,427.053	36,459.140	11	11	11	11	11	11
Jilin	41,710.468	41,718.756	41,727.965	41,785.581	41,783.764	41,815.225	8	8	8	8	8	8
Heilongjiang	26,698.336	26,704.429	26,711.124	26,756.877	26,755.348	26,786.532	15	15	15	15	15	15
Shanghai	84,296.859	84,314.079	84,333.170	84,454.915	84,451.024	84,521.208	1	1	1	1	1	1
Jiangsu	43,305.369	43,317.220	43,330.077	43,426.450	43,423.056	43,501.216	6	6	6	6	6	6
Zhejiang	49,252.034	49,263.462	49,276.003	49,362.519	49,359.611	49,419.765	3	3	3	3	3	3
Anhui	24,987.552	24,995.077	25,003.191	25,066.527	25,064.250	25,118.967	19	19	19	19	19	19
Fujian	38,182.646	38,191.926	38,202.074	38,273.873	38,271.424	38,323.942	10	10	10	10	10	10
Jiangxi	24,723.052	24,730.236	24,738.000	24,797.725	24,795.593	24,846.071	20	20	20	20	20	20
Shandong	41,133.727	41,147.510	41,162.286	41,282.267	41,277.870	41,387.509	9	9	9	9	9	9
Henan	22,139.732	22,146.849	22,154.497	22,215.689	22,213.462	22,268.259	28	28	28	28	28	28
Hubei	30,100.573	30,108.567	30,117.256	30,181.498	30,179.252	30,230.164	14	14	14	14	14	13
Hunan	26,179.994	26,185.967	26,192.530	26,237.374	26,235.875	26,266.426	16	16	16	16	16	16
Guangdong	48,973.894	48,990.935	49,009.166	49,159.111	49,153.583	49,292.951	4	4	4	4	4	4
Guangxi	23,301.955	23,308.017	23,314.614	23,362.918	23,361.238	23,398.873	25	25	25	25	25	25
Hainan	25,879.417	25,881.802	25,884.718	25,889.424	25,889.578	25,870.463	17	17	17	17	17	17
Chongqing	30,140.615	30,146.243	30,152.532	30,190.108	30,188.963	30,206.646	13	13	13	13	13	14
Sichuan	23,913.956	23,921.757	23,930.132	23,997.497	23,995.040	24,055.808	23	23	23	23	23	23
Guizhou	20,063.644	20,068.396	20,073.602	20,109.926	20,108.697	20,134.546	30	30	30	30	30	30
Yunnan	19,304.247	19,309.534	19,315.269	19,358.275	19,356.760	19,391.659	31	31	31	31	31	31
Tibet	42,216.795	42,220.143	42,224.349	42,225.910	42,226.412	42,187.618	7	7	7	7	7	7
Shaanxi	24,358.367	24,363.221	24,368.613	24402.418	24,401.350	24,419.919	22	22	22	22	22	22
Gansu	21,453.138	21,458.234	21,463.817	21,502.831	21,501.510	21,529.366	29	29	29	29	29	29
Qinghai	23,084.066	23,087.612	23,091.652	23,111.815	23,111.293	23,114.112	26	26	26	26	26	26
Ningxia	25,191.293	25,193.016	25,195.247	25,193.088	25,193.515	25,166.518	18	18	18	18	18	18
Xinjiang	24,702.519	24,707.269	24,712.562	24,744.899	24,743.896	24,760.306	21	21	21	21	21	21

Policies P0, P1, P2, P3, P4 and P5 indicate no property tax, property tax rate as 5% in Shanghai and 4% in Chongqing, property tax rate as 5% in Beijing, Tianjin and Shanghai and 4% in Chongqing, property tax rate as 5% in Eastern Coastal China, property tax rate as 5% in high GDP per capita provinces and property tax rate as 5% in the whole country, respectively.

response. This allows us to assess the implications of alternative property tax policy changes in China capturing taxation behavioural response using the formulation. We can also compare the results we generate to a comparable competitive case by also calibrating a simple competitive model with benchmark equilibrium and general equilibrium with property tax rate as zero using the same datasets. In each experiment we perform, we first calibrate the relevant model to the 2010 benchmark dataset in Table 1, and then vary the property tax rate in each province and compute the relevant new equilibria. We also change the individual income tax rate under varied property tax policy and compute the relevant new equilibria.

Substituting the data in Table 1 and the calibrated parameters in Table 2 into the model and running GAMS software of the equilibrium program, we have benchmark equilibrium in Table 3. In the benchmark equilibrium, the property tax rate is $t_n = 0\%$, the capital return is $R_n = 1$ and average wage rate is $W = 1.267124$. We assume that net trade is not changed. As the property tax rate was introduced in January 2011, we examine general equilibrium under the policy with property tax rate as 5% in Shanghai and 4% in Chongqing.

IV. Policy analysis on property tax

We next consider five equilibria with property tax rate as 5% in Shanghai and 4% in Chongqing (Policy P1), with property tax rate as 5% in Beijing, Tianjin and Shanghai and 4% in Chongqing (Policy P2), with property tax rate as 5% in Eastern Coastal China[1] (Policy P3), with property tax rate as 5% in all provinces whose GDP per capita is above average (Policy P4) and with property tax rate as 5% in all provinces (Policy P5) based on the benchmark equilibrium as follows. Table 4 reports the Policy 1 equilibrium (with property tax rate as 5% in Shanghai and

[1]Eastern Coastal China includes 12 provinces: Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Guangxi and Hainan.

Table 11. Equilibrium changes from property tax rates 5% in Shanghai and 4% in Chonqing to 10% in Shanghai and Chonqing.

			Price		Production		Labor input		Capital input						Consumption			
	Property tax rate t_n	Income tax rate (%) $\dot{t}_n$	$\dot{P}_{n0}$	$\dot{P}_{n1}$	$\dot{Y}_{n0}$	$\dot{Y}_{n1}$	$\dot{L}_{n0}$	$\dot{L}_{n1}$	$\dot{K}_{n0}$	$\dot{K}_{n1}$	Wage rate $\dot{W}_n$	Capital return $\dot{R}_n$	Welfare	National income $\dot{I}_n$	$\dot{X}_{n0}$	$\dot{X}_{n1}$	$\dot{PTR}_n$	$\dot{ITR}_n$
Beijing	0.000	10.000	0.000	0.000	−1.267	−2.532	−1.267	−2.532	−1.267	−2.532	0.000	0.000	−2.532	−2.532	−2.532	−2.532		99.947
Tianjin	0.000	10.000	0.000	0.000	1.993	−1.754	1.993	−1.754	1.993	−1.754	0.000	0.000	−1.754	−1.754	−1.754	−1.754		99.938
Hebei	0.000	10.000	0.000	0.000	0.335	0.199	0.335	0.199	0.335	0.199	−0.000	0.000	0.199	0.199	0.199	0.199		99.956
Shanxi	0.000	10.000	0.000	0.000	2.406	0.787	2.406	0.787	2.406	0.787	−0.000	0.000	0.787	0.787	0.787	0.787		99.952
Inner Mongolia	0.000	10.000	0.000	0.000	1.857	2.183	1.857	2.183	1.857	2.183	−0.000	0.000	2.183	2.183	2.183	2.183		99.949
Liaoning	0.000	10.000	0.000	0.000	1.378	1.445	1.378	1.445	1.378	1.445	−0.000	0.000	1.445	1.445	1.445	1.445		99.951
Jilin	0.000	10.000	0.000	0.000	2.256	1.825	2.256	1.825	2.256	1.825	−0.000	0.000	1.825	1.825	1.825	1.825		99.951
Heilongjiang	0.000	10.000	0.000	0.000	0.571	0.388	0.571	0.388	0.571	0.388	0.000	0.000	0.388	0.388	0.388	0.388		99.952
Shanghai	0.005	10.000	0.000	0.000	−3.924	−4.791	−3.924	−4.791	−3.924	−4.791	0.000	0.000	−4.791	−4.791	−4.791	−4.791	−4.791	99.943
Jiangsu	0.000	10.000	0.000	0.000	−0.413	−0.856	−0.413	−0.856	−0.413	−0.856	0.000	0.000	−0.856	−0.856	−0.856	−0.856		99.956
Zhejiang	0.000	10.000	0.000	0.000	−0.246	−0.540	−0.246	−0.540	−0.246	−0.540	−0.000	0.000	−0.540	−0.540	−0.540	−0.540		99.951
Anhui	0.000	10.000	0.000	0.000	−0.612	0.031	−0.612	0.031	−0.612	0.031	−0.000	0.000	0.031	0.031	0.031	0.031		99.957
Fujian	0.000	10.000	0.000	0.000	1.872	2.251	1.872	2.251	1.872	2.251	0.000	0.000	2.251	2.251	2.251	2.251		99.953
Jiangxi	0.000	10.000	0.000	0.000	−1.338	1.161	−1.338	1.161	−1.338	1.161	−0.000	0.000	1.161	1.161	1.161	1.161		99.954
Shandong	0.000	10.000	0.000	0.000	1.018	0.723	1.018	0.723	1.018	0.723	0.000	−0.000	0.723	0.723	0.723	0.723		99.958
Henan	0.000	10.000	0.000	0.000	0.722	0.904	0.722	0.904	0.722	0.904	0.000	0.000	0.904	0.904	0.904	0.904		99.956
Hubei	0.000	10.000	0.000	0.000	−1.441	−0.417	−1.441	−0.417	−1.441	−0.417	0.000	0.000	−0.417	−0.417	−0.417	−0.417		99.956
Hunan	0.000	10.000	0.000	0.000	−0.333	0.345	−0.333	0.345	−0.333	0.345	0.000	0.000	0.345	0.345	0.345	0.345		99.952
Guangdong	0.000	10.000	0.000	0.000	−1.248	−1.311	−1.248	−1.311	−1.248	−1.311	−0.000	0.000	−1.311	−1.311	−1.311	−1.311		99.971
Guangxi	0.000	10.000	0.000	0.000	0.297	1.456	0.297	1.456	0.297	1.456	0.000	0.000	1.456	1.456	1.456	1.456		99.953
Hainan	0.000	10.000	0.000	0.000	−2.849	0.052	−2.849	0.052	−2.849	0.052	0.000	0.000	0.052	0.052	0.052	0.052		99.939
Chongqing	0.004	10.000	0.000	0.000	−0.634	−0.141	−0.634	−0.141	−0.634	−0.141	−0.000	0.000	−0.141	−0.141	−0.141	−0.141	−0.141	99.947
Sichuan	0.000	10.000	0.000	0.000	0.654	0.999	0.654	0.999	0.654	0.999	0.000	0.000	0.999	0.999	0.999	0.999		99.957
Guizhou	0.000	10.000	0.000	0.000	−1.913	−0.347	−1.913	−0.347	−1.913	−0.347	0.000	0.000	−0.347	−0.347	−0.347	−0.347		99.951
Yunnan	0.000	10.000	0.000	0.000	−0.626	0.866	−0.626	0.866	−0.626	0.866	0.000	0.000	0.866	0.866	0.866	0.866		99.954
Tibet	0.000	10.000	0.000	0.000	32.333	2.106	32.333	2.106	32.333	2.106	0.000	−0.000	2.106	2.106	2.106	2.106		99.948
Shaanxi	0.000	10.000	0.000	0.000	1.400	1.383	1.400	1.383	1.400	1.383	0.000	−0.000	1.383	1.383	1.383	1.383		99.951
Gansu	0.000	10.000	0.000	0.000	−1.315	1.676	−1.315	1.676	−1.315	1.676	0.000	0.000	1.676	1.676	1.676	1.676		99.953
Qinghai	0.000	10.000	0.000	0.000	−6.045	−0.508	−6.045	−0.508	−6.045	−0.508	−0.000	0.000	−0.508	−0.508	−0.508	−0.508		99.937
Ningxia	0.000	10.000	0.000	0.000	1.889	1.483	1.889	1.483	1.889	1.483	0.000	−0.000	1.483	1.483	1.483	1.483		99.945
Xinjiang	0.000	10.000	0.000	0.000	−3.442	−0.274	−3.442	−0.274	−3.442	−0.274	0.000	−0.000	−0.274	−0.274	−0.274	−0.274		99.947

Table 12. Equilibrium per cent changes from equilibrium with property tax rates 5% in Shanghai and 4% in Chonqing to sum of the third power of excess demands.

			Price		Production		Labor input		Capital input						Consumption			
	Property tax rate t_n	Income tax rate (%) $\dot{\tau}_n$	$\dot{P}_{n0}$	$\dot{P}_{n1}$	$\dot{Y}_{n0}$	$\dot{Y}_{n1}$	$\dot{L}_{n0}$	$\dot{L}_{n1}$	$\dot{K}_{n0}$	$\dot{K}_{n1}$	Wage rate $\dot{W}_n$	Capital return $\dot{R}_n$	Welfare	National income $\dot{I}_n$	$\dot{X}_{n0}$	$\dot{X}_{n1}$	$\dot{PTR}_n$	$\dot{ITR}_n$
Beijing	0.000	0.000	0.000	0.000	0.303	−0.003	0.303	−0.003	0.303	−0.003	0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.002
Tianjin	0.000	0.000	0.000	0.000	−2.444	−0.003	−2.444	−0.003	−2.444	−0.003	0.000	−0.000	−0.003	−0.003	−0.003	−0.003		−0.003
Hebei	0.000	0.000	0.000	0.000	0.749	−0.002	0.749	−0.002	0.749	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Shanxi	0.000	0.000	0.000	0.000	0.159	−0.002	0.159	−0.002	0.159	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Inner Mongolia	0.000	0.000	0.000	0.000	1.290	−0.003	1.290	−0.003	1.290	−0.003	−0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.002
Liaoning	0.000	0.000	0.000	0.000	0.828	−0.003	0.828	−0.003	0.828	−0.003	−0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.002
Jilin	0.000	0.000	0.000	0.000	−1.076	−0.003	−1.076	−0.003	−1.076	−0.003	0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.002
Heilongjiang	0.000	0.000	0.000	0.000	1.417	−0.002	1.417	−0.002	1.417	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Shanghai	0.005	0.000	0.000	0.000	−0.992	−0.003	−0.992	−0.003	−0.992	−0.003	−0.000	0.000	−0.003	−0.003	−0.003	−0.003	−0.003	−0.003
Jiangsu	0.000	0.000	0.000	0.000	0.231	−0.002	0.231	−0.002	0.231	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Zhejiang	0.000	0.000	0.000	0.000	0.485	−0.002	0.485	−0.002	0.485	−0.002	−0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Anhui	0.000	0.000	0.000	0.000	−0.869	−0.002	−0.869	−0.002	−0.869	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Fujian	0.000	0.000	0.000	0.000	−0.829	−0.002	−0.829	−0.002	−0.829	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Jiangxi	0.000	0.000	0.000	0.000	1.754	−0.002	1.754	−0.002	1.754	−0.002	−0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Shandong	0.000	0.000	0.000	0.000	0.227	−0.001	0.227	−0.001	0.227	−0.001	0.000	−0.000	−0.001	−0.001	−0.001	−0.001		−0.002
Henan	0.000	0.000	0.000	0.000	−0.426	−0.002	−0.426	−0.002	−0.426	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Hubei	0.000	0.000	0.000	0.000	−0.038	−0.002	−0.038	−0.002	−0.038	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Hunan	0.000	0.000	0.000	0.000	−0.423	−0.002	−0.423	−0.002	−0.423	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Guangdong	0.000	0.000	0.000	0.000	0.226	−0.001	0.226	−0.001	0.226	−0.001	0.000	0.000	−0.001	−0.001	−0.001	−0.001		−0.001
Guangxi	0.000	0.000	0.000	0.000	−0.514	−0.002	−0.514	−0.002	−0.514	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Hainan	0.000	0.000	0.000	0.000	−6.343	−0.004	−6.343	−0.004	−6.343	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.003
Chongqing	0.004	0.000	0.000	0.000	−1.525	−0.003	−1.525	−0.003	−1.525	−0.003	−0.000	0.000	−0.003	−0.003	−0.003	−0.003	−0.003	−0.002
Sichuan	0.000	0.000	0.000	0.000	−0.606	−0.002	−0.606	−0.002	−0.606	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Guizhou	0.000	0.000	0.000	0.000	−2.487	−0.002	−2.487	−0.002	−2.487	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Yunnan	0.000	0.000	0.000	0.000	−0.782	−0.002	−0.782	−0.002	−0.782	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Tibet	0.000	0.000	0.000	0.000	9.022	−0.004	9.022	−0.004	9.022	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.002
Shaanxi	0.000	0.000	0.000	0.000	1.439	−0.003	1.439	−0.003	1.439	−0.003	0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.002
Gansu	0.000	0.000	0.000	0.000	−0.523	−0.002	−0.523	−0.002	−0.523	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Qinghai	0.000	0.000	0.000	0.000	−8.216	−0.003	−8.216	−0.003	−8.216	−0.003	−0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.003
Ningxia	0.000	0.000	0.000	0.000	7.801	−0.004	7.801	−0.004	7.801	−0.004	0.000	−0.000	−0.004	−0.004	−0.004	−0.004		−0.003
Xinjiang	0.000	0.000	0.000	0.000	0.301	−0.003	0.301	−0.003	0.301	−0.003	0.000	−0.000	−0.003	−0.003	−0.003	−0.003		−0.002

Table 13. Equilibrium per cent changes from equilibrium with property tax rates 5% in Shanghai and 4% in Chonqing to sum of the fourth power of excess demands.

			Price		Production		Labor input		Capital input						Consumption			
	Property tax rate t_n	Income tax rate (%) τ_n	$\dot{P}_{n0}$	$\dot{P}_{n1}$	$\dot{Y}_{n0}$	$\dot{Y}_{n1}$	$\dot{L}_{n0}$	$\dot{L}_{n1}$	$\dot{K}_{n0}$	$\dot{K}_{n1}$	Wage rate $\dot{W}_n$	Capital return $\dot{R}_n$	Welfare	National income $\dot{I}_n$	$\dot{X}_{n0}$	$\dot{X}_{n1}$	$\dot{PTR}_n$	$\dot{ITR}_n$
Beijing	0.000	0.000	0.000	0.000	0.329	−0.004	0.329	−0.004	0.329	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Tianjin	0.000	0.000	0.000	0.000	−3.249	−0.004	−3.249	−0.004	−3.249	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Hebei	0.000	0.000	0.000	0.000	1.106	−0.003	1.106	−0.003	1.106	−0.003	0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.003
Shanxi	0.000	0.000	0.000	0.000	0.093	−0.004	0.093	−0.004	0.093	−0.004	−0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.003
Inner Mongolia	0.000	0.000	0.000	0.000	1.846	−0.005	1.846	−0.005	1.846	−0.005	−0.000	0.000	−0.005	−0.005	−0.005	−0.005		−0.004
Liaoning	0.000	0.000	0.000	0.000	1.255	−0.004	1.255	−0.004	1.255	−0.004	−0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Jilin	0.000	0.000	0.000	0.000	−1.790	−0.004	−1.790	−0.004	−1.790	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Heilongjiang	0.000	0.000	0.000	0.000	2.228	−0.004	2.228	−0.004	2.228	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Shanghai	0.005	0.000	0.000	0.000	−1.345	−0.004	−1.345	−0.004	−1.345	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004	−0.004	−0.004
Jiangsu	0.000	0.000	0.000	0.000	0.292	−0.003	0.292	−0.003	0.292	−0.003	0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.003
Zhejiang	0.000	0.000	0.000	0.000	0.656	−0.004	0.656	−0.004	0.656	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Anhui	0.000	0.000	0.000	0.000	−1.217	−0.003	−1.217	−0.003	−1.217	−0.003	0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.003
Fujian	0.000	0.000	0.000	0.000	−1.262	−0.004	−1.262	−0.004	−1.262	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.003
Jiangxi	0.000	0.000	0.000	0.000	2.336	−0.003	2.336	−0.003	2.336	−0.003	−0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.003
Shandong	0.000	0.000	0.000	0.000	0.284	−0.002	0.284	−0.002	0.284	−0.002	0.000	−0.000	−0.002	−0.002	−0.002	−0.002		−0.003
Henan	0.000	0.000	0.000	0.000	−0.700	−0.002	−0.700	−0.002	−0.700	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.003
Hubei	0.000	0.000	0.000	0.000	−0.020	−0.003	−0.020	−0.003	−0.020	−0.003	−0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.003
Hunan	0.000	0.000	0.000	0.000	−0.560	−0.004	−0.560	−0.004	−0.560	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Guangdong	0.000	0.000	0.000	0.000	0.291	−0.002	0.291	−0.002	0.291	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.002
Guangxi	0.000	0.000	0.000	0.000	−0.655	−0.003	−0.655	−0.003	−0.655	−0.003	0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.003
Hainan	0.000	0.000	0.000	0.000	−9.290	−0.006	−9.290	−0.006	−9.290	−0.006	0.000	0.000	−0.006	−0.006	−0.006	−0.006		−0.004
Chongqing	0.004	0.000	0.000	0.000	−2.339	−0.004	−2.339	−0.004	−2.339	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004	−0.004	−0.004
Sichuan	0.000	0.000	0.000	0.000	−0.846	−0.002	−0.846	−0.002	−0.846	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.003
Guizhou	0.000	0.000	0.000	0.000	−3.576	−0.004	−3.576	−0.004	−3.576	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Yunnan	0.000	0.000	0.000	0.000	−1.013	−0.003	−1.013	−0.003	−1.013	−0.003	0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.003
Tibet	0.000	0.000	0.000	0.000	10.081	−0.006	10.081	−0.006	10.081	−0.006	0.000	0.000	−0.006	−0.006	−0.006	−0.006		−0.004
Shaanxi	0.000	0.000	0.000	0.000	2.293	−0.004	2.293	−0.004	2.293	−0.004	0.000	−0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Gansu	0.000	0.000	0.000	0.000	−0.587	−0.004	−0.587	−0.004	−0.587	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.003
Qinghai	0.000	0.000	0.000	0.000	−11.603	−0.005	−11.603	−0.005	−11.603	−0.005	−0.000	0.000	−0.005	−0.005	−0.005	−0.005		−0.004
Ningxia	0.000	0.000	0.000	0.000	13.344	−0.006	13.344	−0.006	13.344	−0.006	0.000	−0.000	−0.006	−0.006	−0.006	−0.006		−0.004
Xinjiang	0.000	0.000	0.000	0.000	0.498	−0.004	0.498	−0.004	0.498	−0.004	0.000	−0.000	−0.004	−0.004	−0.004	−0.004		−0.004

Table 14. Equilibrium per cent changes from equilibrium with property tax rates 5% in Shanghai and 4% in Chonqing to sum of the fifth power of excess demands.

			Price		Production		Labor input		Capital input						Consumption			
	Property tax rate t_n	Income tax rate (%) τ_n	$\dot{P}_{n0}$	$\dot{P}_{n1}$	$\dot{Y}_{n0}$	$\dot{Y}_{n1}$	$\dot{L}_{n0}$	$\dot{L}_{n1}$	$\dot{K}_{n0}$	$\dot{K}_{n1}$	Wage rate $\dot{W}_n$	Capital return $\dot{R}_n$	Welfare	National income $\dot{I}_n$	$\dot{X}_{n0}$	$\dot{X}_{n1}$	$\dot{PTR}_n$	$\dot{ITR}_n$
Beijing	0.000	0.000	0.000	0.000	0.325	−0.005	0.325	−0.005	0.325	−0.005	0.000	0.000	−0.005	−0.005	−0.005	−0.005		−0.005
Tianjin	0.000	0.000	0.000	0.000	−3.650	−0.005	−3.650	−0.005	−3.650	−0.005	0.000	−0.000	−0.005	−0.005	−0.005	−0.005		−0.005
Hebei	0.000	0.000	0.000	0.000	1.315	−0.003	1.315	−0.003	1.315	−0.003	−0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.004
Shanxi	0.000	0.000	0.000	0.000	0.033	−0.004	0.033	−0.004	0.033	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Inner Mongolia	0.000	0.000	0.000	0.000	2.148	−0.006	2.148	−0.006	2.148	−0.006	−0.000	0.000	−0.006	−0.006	−0.006	−0.006		−0.004
Liaoning	0.000	0.000	0.000	0.000	1.514	−0.005	1.514	−0.005	1.514	−0.005	−0.000	0.000	−0.005	−0.005	−0.005	−0.005		−0.004
Jilin	0.000	0.000	0.000	0.000	−2.207	−0.005	−2.207	−0.005	−2.207	−0.005	0.000	0.000	−0.005	−0.005	−0.005	−0.005		−0.004
Heilongjiang	0.000	0.000	0.000	0.000	2.720	−0.004	2.720	−0.004	2.720	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Shanghai	0.005	0.000	0.000	0.000	−1.522	−0.005	−1.522	−0.005	−1.522	−0.005	−0.000	0.000	−0.005	−0.005	−0.005	−0.005	−0.005	−0.005
Jiangsu	0.000	0.000	0.000	0.000	0.317	−0.004	0.317	−0.004	0.317	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Zhejiang	0.000	0.000	0.000	0.000	0.742	−0.004	0.742	−0.004	0.742	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Anhui	0.000	0.000	0.000	0.000	−1.407	−0.003	−1.407	−0.003	−1.407	−0.003	0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.004
Fujian	0.000	0.000	0.000	0.000	−1.518	−0.004	−1.518	−0.004	−1.518	−0.004	0.000	−0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Jiangxi	0.000	0.000	0.000	0.000	2.621	−0.003	2.621	−0.003	2.621	−0.003	−0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.004
Shandong	0.000	0.000	0.000	0.000	0.308	−0.003	0.308	−0.003	0.308	−0.003	0.000	−0.000	−0.003	−0.003	−0.003	−0.003		−0.004
Henan	0.000	0.000	0.000	0.000	−0.900	−0.003	−0.900	−0.003	−0.900	−0.003	0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.004
Hubei	0.000	0.000	0.000	0.000	−0.002	−0.004	−0.002	−0.004	−0.002	−0.004	−0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Hunan	0.000	0.000	0.000	0.000	−0.625	−0.004	−0.625	−0.004	−0.625	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Guangdong	0.000	0.000	0.000	0.000	0.323	−0.002	0.323	−0.002	0.323	−0.002	0.000	0.000	−0.002	−0.002	−0.002	−0.002		−0.003
Guangxi	0.000	0.000	0.000	0.000	−0.715	−0.004	−0.715	−0.004	−0.715	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Hainan	0.000	0.000	0.000	0.000	−10.934	−0.007	−10.934	−0.007	−10.934	−0.007	0.000	0.000	−0.007	−0.007	−0.007	−0.007		−0.005
Chongqing	0.004	0.000	0.000	0.000	−2.822	−0.005	−2.822	−0.005	−2.822	−0.005	−0.000	0.000	−0.005	−0.005	−0.005	−0.005	−0.005	−0.005
Sichuan	0.000	0.000	0.000	0.000	−0.971	−0.003	−0.971	−0.003	−0.971	−0.003	0.000	0.000	−0.003	−0.003	−0.003	−0.003		−0.004
Guizhou	0.000	0.000	0.000	0.000	−4.165	−0.004	−4.165	−0.004	−4.165	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Yunnan	0.000	0.000	0.000	0.000	−1.116	−0.004	−1.116	−0.004	−1.116	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Tibet	0.000	0.000	0.000	0.000	10.121	−0.007	10.121	−0.007	10.121	−0.007	0.000	0.000	−0.007	−0.007	−0.007	−0.007		−0.004
Shaanxi	0.000	0.000	0.000	0.000	2.801	−0.005	2.801	−0.005	2.801	−0.005	0.000	0.000	−0.005	−0.005	−0.005	−0.005		−0.004
Gansu	0.000	0.000	0.000	0.000	−0.590	−0.004	−0.590	−0.004	−0.590	−0.004	0.000	0.000	−0.004	−0.004	−0.004	−0.004		−0.004
Qinghai	0.000	0.000	0.000	0.000	−13.432	−0.006	−13.432	−0.006	−13.432	−0.006	−0.000	0.000	−0.006	−0.006	−0.006	−0.006		−0.005
Ningxia	0.000	0.000	0.000	0.000	16.872	−0.007	16.872	−0.007	16.872	−0.007	0.000	−0.000	−0.007	−0.007	−0.007	−0.007		−0.005
Xinjiang	0.000	0.000	0.000	0.000	0.634	−0.005	0.634	−0.005	0.634	−0.005	0.000	−0.000	−0.005	−0.005	−0.005	−0.005		−0.005

4% in Chongqing) and Table 5 shows the permillage difference between benchmark equilibrium (Policy P0 with no property tax) and the Policy 1 equilibrium. Next, we list the result in permillage changes from benchmark equilibrium with no property tax to Policy 2 equilibria (with property tax rate as 5% in Beijing, Tianjin and Shanghai and 4% in Chongqing), Policy 3 equilibrium (with property tax rate as 5% in Eastern Coastal China), Policy 4 equilibrium (with property tax rate as 5% in high GDP per capita provinces) and Policy 5 equilibrium (with property tax rate as 5% in the whole country) in Tables 6–9, respectively. We explore the effects of all these policies on income distribution. Table 10 shows that the property tax policy is not able to change the situation of income disparity.

Comparison between benchmark equilibrium and equilibrium with property tax rate as 5% in Shanghai and 4% in Chongqing

Policy P1, with property tax on housing in Shanghai (tax rate is 5%) and Chongqing (tax rate is 4%), reduces the housing production in the two provinces (municipalities), while other provinces nearly do not change in housing supply. And the changes in goods production are subtle in all provinces. In the whole economy, resources take a slight shift from housing to non-housing industry, resulting in a subtle decrease from 8.170721% to 8.170701% in the proportion of housing production to GDP.

After being taxed, consumption demand on housing is decreased by 4.772% in Shanghai and 3.798% in Chongqing. Due to the immobility of housing, the supply of housing in Shanghai and Chongqing is reduced by the same permillage. When we set the property tax rate on housing as 5% in Shanghai and 4% in Chongqing, compared with the situation with no property tax on all provinces, capital return in Shanghai and Chongqing increases 7.397% and 8.053% and wage rate falls 11.877% and 9.522%, respectively. The equilibrium capital price of housing increases in these areas, leading to a decrease in capital input in Shanghai (7.140%) and Chongqing (7.803%). In addition, due to the relative lower cost of labour, housing industry would choose labour as substitution and thus labour input boosts in the housing of Shanghai and Chongqing, increasing 12.226% and 9.802%, respectively.

Property tax that is imposed in Shanghai (tax rate is 5%) and Chongqing (tax rate is 4%) slightly reduces the welfare in the two cities by 0.115% and 0.152%, respectively, while it increases the welfare in other provinces. The gross income grows in each province.

After being taxed, the price of housing in Shanghai and Chongqing is distorted. The distorted price leads to the drop in consumption of housing, but the increase in consumption of goods cannot offset the fall in house. Hence, the welfare declines in these two provinces (municipalities). While in other provinces, due to the increase in their income and undistorted price, the consumption in both goods and housing grows and, thereby, welfare increases.

Comparison between benchmark equilibrium and equilibrium with property tax rate as 5% in Beijing, Tianjin and Shanghai and 4% in Chongqing

The effects of Policy P2, with property tax on housing in Beijing, Tianjin, Shanghai (tax rate is 5) and Chongqing (tax rate is 4%), on the production are almost the same as Policy P1, with property tax on housing in Shanghai (tax rate is 5%) and Chongqing (tax rate is 4%). Policy P2 also reduces the housing production in the four taxed provinces (municipalities directly under the central government), while other provinces nearly do not change in housing supply. And the changes in goods production are subtle in all provinces. In the whole economy, resources take a slight shift from housing to non-housing industry, resulting in a continuous decrease from 8.170701% to 8.170681% in the proportion of housing production to GDP compared with Policy P1. After being taxed, consumption demand on housing is decreased by 4.549% in Beijing, 4.602% in Tianjin, 4.547% in Shanghai and 3.590% in Chongqing. Due to the immobility of housing, the supply of housing in these four cities is reduced by the same permillage. Capital return in Beijing, Tianjin, Shanghai and Chongqing increases 8.042%, 9.539%, 7.397% and 8.053% and the wage rate falls 8.503%, 19.894%, 11.877% and 9.522%, respectively. The equilibrium capital price of housing increases in these areas, leading to a decrease in capital input in Beijing (7.553%), Tianjin (9.078%), Shanghai (6.915%) and Chongqing (7.596%). In addition, due to the relative lower cost of labour, housing industry would choose labor as substitution and thus labour input boosts in the housing

of Beijing, Tianjin, Shanghai and Chongqing, increasing by 9.008%, 20.680%, 12.456% and 10.013%.

Compared with Policy P1, Policy P2 is better off in terms of social welfare. The welfare increases in most provinces except Beijing and Tianjin under Policy P2. The gross income still grows in each province.

Comparison between benchmark equilibrium and equilibrium with property tax rate as 5% in Eastern Coastal China

Policy P3, with property tax on housing in eastern coastal provinces (tax rate is 5%), also effectively reduced housing production in the taxed area. And the changes in goods production are subtle in each province. In the whole economy, resources take a slight shift from housing to non-housing industry, resulting in a continuous decrease from 8.170701% to 8.170457% in the proportion of housing production to GDP compared with Policy P1.

After being taxed, consumption demand on housing is decreased in all eastern coastal provinces. Capital return increases and the wage rate falls. The equilibrium capital price of housing increases in taxed area, leading to a decrease in the capital input. In addition, due to the relative lower cost of labour, the housing industry would choose labour as substitution and thus labour input boosts in eastern coastal provinces.

After expanding the taxed region, Policy P3 almost increases welfare in all provinces, excluding Hainan, which reduces welfare by 0.304%. Compared with other provinces in eastern coastal provinces, the development of Hainan is largely dependent on the housing industry. As a result, the increase in consumption of goods cannot offset the fall in house. Hence, the welfare declines in Hainan.

And for robustness test, when we change the property tax rate from 1% to 5%, the outcomes are in the same direction and with little change.

Comparison between benchmark equilibrium and equilibrium with property tax rate as 5% in high GDP per capita provinces

Policy P4, with property tax on housing in provinces (tax rate is 5%) whose GDP per capita is above average, also reduces the housing production in these provinces. And the changes in goods production are subtle in each province. In the whole economy, resources take a slight shift from housing to non-housing industry, resulting in a decrease from 8.170701% to 8.170466% in the proportion of housing production to GDP compared with Policy P1.

After being taxed, consumption demand on housing is decreased in these provinces. Due to the immobility of housing, the supply of housing in these provinces is reduced by the same permillage. Capital return increases and wage rate falls. The equilibrium capital price of housing increases in these areas, leading a decrease in the capital input. In addition, due to the relative lower cost of labour, the housing industry would choose labour as substitution, and thus, labour input boosts in these provinces.

In welfare analysis, Policy P4 improves the welfare in all provinces. Thus, from Policy P1 to Policy P4, when we expand the taxed region, the social welfare becomes better off. Besides, the tax policy improves the total welfare if it is imposed in more developed regions.

When we change the property tax rate from 1% to 5%, the outcomes are in the same direction and change little.

Comparison between benchmark equilibrium and equilibrium with property tax rate as 5% in the whole China

Policy P5, with property tax on housing in all provinces (tax rate is 5%), reduces the housing production in nearly all provinces, and only slightly increases the housing production in a few provinces. The changes in goods production are subtle in each province. In the whole economy, resources take a slight shift from housing to non-housing industry, resulting in a decrease from 8.170701% to 8.170466% in the proportion of housing production to GDP compared with Policy P1.

Except Hubei, other provinces all have a decrease in capital input and an increase in labour input for housing. Hubei input more capital due to the relatively low cost of capital.

Property tax on housing in all provinces (tax rate is 5%) reduces the welfare and individual income in Hainan, Tibet and Ningxia, while it

increases the welfare and invidul income in other provinces. Hainan is highly dependent on the housing industry and, as a result, property tax policy would highly affect its development. As to Tibet and Ningxia, capital and housing production are limited in these areas, and when being taxed, the social welfare would be reduced.

Compared with Policy P5, we can find that a unified property tax policy may not be efficient. Actually, since we tax all regions at the same rate, the distortion of price will mostly affect the area which is underdeveloped in goods production as the negative effects cannot be offset by increasing consumption in goods. As a result, this globally unified property tax policy will decrease the welfare in less developed regions, which goes against the initial purpose of the government when they put forward such tax policy.

Property tax policy on income distribution

We compute income per capita and income per capita rank under five different policies we have mentioned above. Results are presented in Table 10. It shows that property tax policy has little effect on changing income distribution.

In the benchmark equilibrium, GDP per capita varies widely among 31 provinces. Shanghai ranks first with GDP per capita as 84,296.859, followed by Beijing with 66,327.067. Then comes Zhejiang, Guangdong, Tianjin, Jiangsu, Tibet, Jilin and Shandong with GDP per capita above 40,000 ranging from 49,252.034 (Zhejiang) to 41,133.727 (Shandong). The 10th place is Fujian with 38,182.646, followed by Liaoning (36,358.898), Inner Mongolia (32,644.641), Chongqing (30,140.615) and Hubei (30,100.573). The GDPs per capita of the left 17 provinces are all below 30,000, including Heilongjiang, Hunan, Hainan, Ningxia, Anhui, Jiangxi, Xinjiang, Shaanxi, Sichuan, Hebei, Guangxi, Qinghai, Shanxi, Henan, Gansu, Guizhou and Yunnan. Yunnan ranks the last place with GDP per capita as 19,304.247, less than a quarter of that in Shanghai.

After the introduction of property tax, all provinces have the same rank as in the benchmark equilibrium, except Hubei and Chongqing change in Policy P5.

V. Policy analysis on income tax

On the basis of Policy P1, we increase the income tax rate in each province by 10%. Compared with policy P1, the housing production, welfare and national income all decrease in Beijing, Tianjin, Shanghai, Jiangsu, Zhejiang, Hubei, Guangdong, Chongqing, Guizhou, Qinghai and Xinjiang. Table 11 shows the changes from Policy P1 equilibrium to the new equilibrium.

According to the China Statistical Yearbook in 2010 and 2011, these provinces are among the high GDP per capita coastal provinces. Owing to higher GDP per capita in these regions, when the income tax rate increases, their incomes decrease more than other provinces do. As a result, the welfare in these provinces is reduced.

When we increase the income tax rate from 10% to 50%, all the results are in the same direction. Even with varied property tax policies we have examined above, increasing income tax rate will not change the outcomes we mentioned above. Figures 1 and 2 present the changes in housing production and welfare with income tax rate increasing by 10% under these five policies.

VI. Sensitivity analysis

We compute equilibria with varied property tax policies and income tax policies by minimizing the difference between net trade of goods under new equilibrium and that in dataset. Different measures of the dispersion in net trade would affect the equilibrium results. Adopting the similar analysis steps of Section 4, we list the results in Table 12 – concerning the sensitivity effect of the measure of dispersion for net trade upon equilibrium outcomes. We choose Policy P1 with property tax rate 5% in Shanghai and 4% in Chongqing as the benchmark equilibrium.

In our benchmark equilibrium (Table 4), we choose to minimize the sum of squares of the difference between net trade of goods under new equilibrium and that in dataset, that is:

$$\min_{X_{n0},Y_{n0}} \sum_{n=1}^{31} \left(X_{n0} - Y_{n0} - Z_{n0}\right)^k \tag{1}$$

where Z_{i0} is the net trade of goods in dataset and $k = 2$.

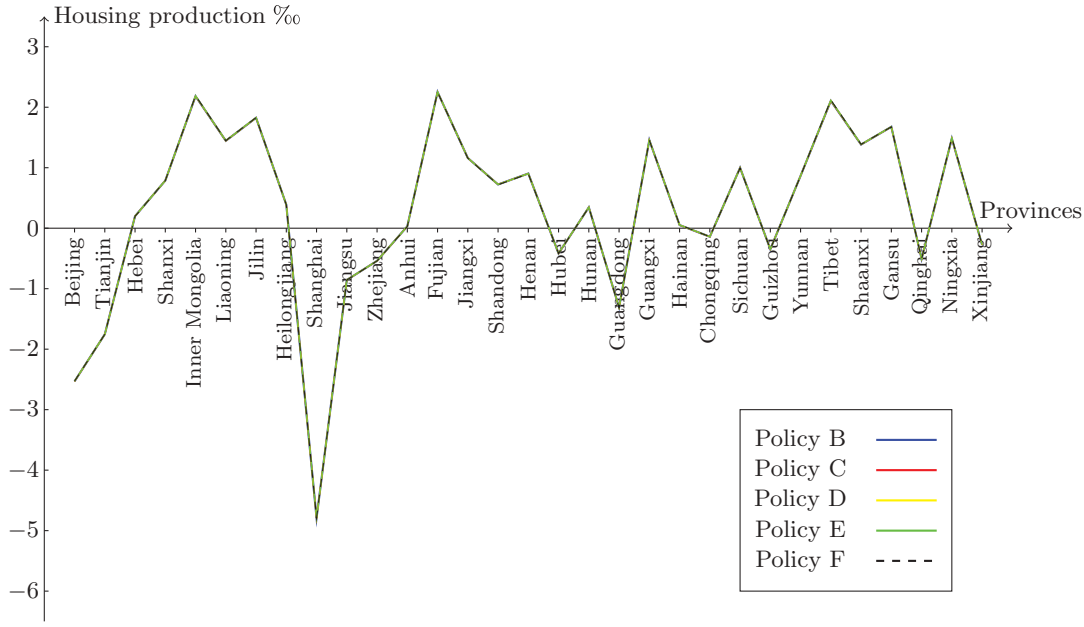

Figure 1. Housing production per cent changes after increasing the income tax rate (10%).

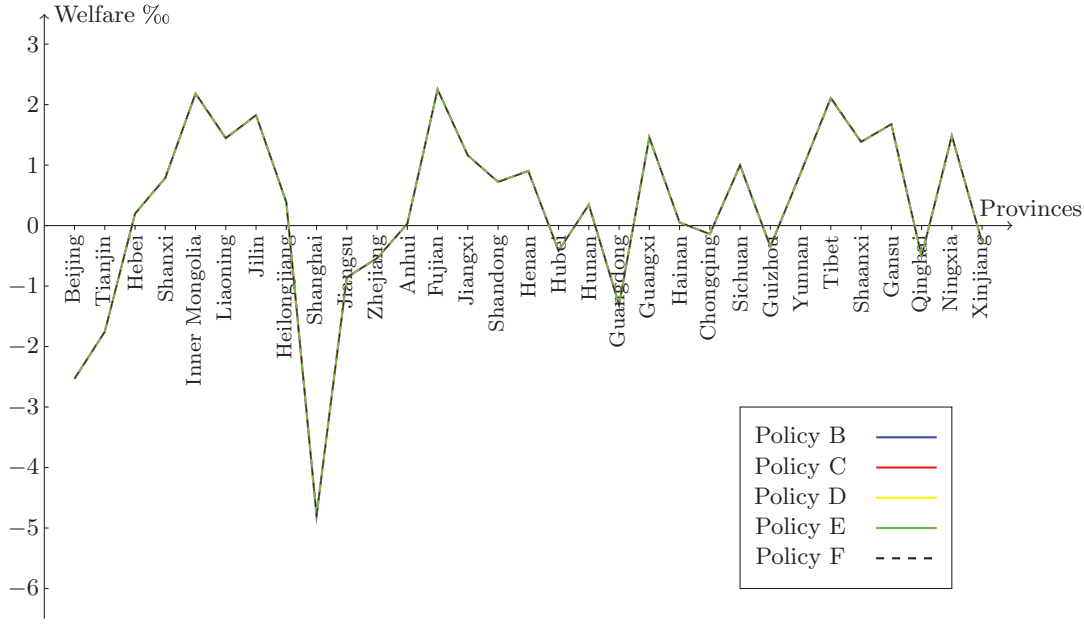

Figure 2. Welfare per cent changes after increasing the income tax rate (10%).

Tables 12, 13 and 14 show the changes from benchmark equilibrium to new equilibrium under alternative measures of dispersion, when we choose $k = 3, 4, 5$.

From the results presented by Tables 12–14, we can address that the results among the four equilibria are almost the same. Thereby, no matter what measure of dispersion in net trade of goods we choose, the outcomes we have discussed before are robust and reliable.

VII. Conclusions

This article has employed a general equilibrium model to examine the effects of introducing property tax on production, consumption and welfare of different provinces in China. We investigate five property tax policy alternatives and make a comparison between the new equilibrium with the benchmark equilibrium. We also explore the effects of increasing income tax on the income distribution and welfare.

Results indicate that the introduction of property tax in certain regions can substantially reduce the production and consumption in the housing of taxed area, whereas a unified property tax cannot. If we only have one representative in our economy, the introduction of a unified property tax will distort the relevant price between goods and housing and definitely decrease the housing supply and demand. However, after considering the heterogeneity of agents with different preferences and endowments, the effects of a unified property tax may change according to the numerical simulation in the present article. These findings may be conducive to the central government when introducing a unified property tax.

In addition, another finding addressed by the present study shows that there exists a Pareto improvement when we include more regions that have higher GDP per capita into the taxed area. When only Shanghai and Chongqing are taxed, welfare declines in both of the cities. However, when introducing Policy E, with property tax on all provinces whose GDP per capita is higher than average, all provinces share an increase in the welfare. Noticeably, Chongqing is not in the list of higher GDP per capita provinces. This may help to explain the recent research by Bai, Li and Ouyang (2014). They found that property tax experiment has different effects in Shanghai and Chonqing, which they called a tale of two. In effect, the average home price in Shanghai is lowered, whereas the price in Chongqing is raised. Our results suggest that a discriminative taxation based on the level of development may be more desirable.

Despite the effectiveness of property tax on the reduction of supply and demand in housing, this policy may not be able to change the income distribution largely. We rank the income per capita before and after the introduction of varied property tax policies and find no change in the rank. However, increasing income tax rate will reduce the income and welfare in provinces with high GDP per capita. The present study offers a suggestion that the income tax policy could be perceived as a useful complement to narrow the income gap.

The results above are complemented by completing a sensitivity analysis on the optimal condition of equilibrium. Replacing the standard in benchmark equilibrium with other measures of dispersion, we find that changing the power in the measure would not alter our results. Thereby, the reliability of our outcomes is strengthened.

Disclosure statement

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