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OPTIMAL FISCAL POLICY WITH LAND FINANCING IN CHINA

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This paper examines China's optimal fiscal policy in a general equilibrium model, in which the government finances its budget through both a special instrument, an implicit tax on the residential land, and a typical conventional instrument, the value-added tax (VAT). By solving a Ramsey problem, we find that (i) the optimal policy suggests a much lower land tax rate than the existing rate in China, and (ii) a substantial part of debt stabilization should come through an adjustment in the VAT rate, instead of relying on land financing. Switching from the existing policy to the Ramsey policy generates significant welfare gains.

Keywords: Optimal Fiscal Policy, Fiscal Consolidation, Land Market, China

1. INTRODUCTION

In this paper, we examine the Chinese government's use of land financing, that is, obtaining finances through revenues from land sales. As a monopolistic supplier, the Chinese government controls the supply of land. Revenue from land sales is essential for the Chinese government, accounting for about 20–30% of total government revenue in recent years. This paper addresses several policy questions related to land financing, such as what distortions are caused by land financing in China? What is the optimal policy mix of land financing and conventional instruments, such as value-added tax (VAT)? How far is the current policy practice from the optimal, and what are the welfare gains of pursuing the optimal policy? In particular, we are interested in exploring the macroeconomic consequences and welfare implications of resorting to land financing for debt consolidation.

The financial crisis of 2007–2009 led to large increases in global ratios of government debt to gross domestic product (GDP) [IMF (2011)]. A fiscal consolidation is inevitable for many countries in the medium term, calling for government stabilization of debt with various fiscal instruments and the rebuilding of the fiscal spaces that eroded during the crisis. The government debt in China also increased fast, especially after the 4 trillion RMB stimulus package during 2008–2010.

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According to the Ministry of Finance, China's government debt to GDP ratio reached 38.9% by the end of 2015. At first glance, with a relatively stronger fiscal position than advanced economies, fiscal consolidation in China may not seem as urgent as other countries. Concern about the negative impacts of fiscal consolidation on already weak economic growth has also deferred the Chinese government from taking actions. However, as suggested by IMF (2012), short-term caution should not be an excuse to delay efforts of putting public finances on a sounder footing over the medium term, as this remains a key requirement for sustainable growth.

To fulfill our task, we build a general equilibrium model, in which the government finances its budget through revenues from an implicit tax on residential land, in addition to revenues from the conventional VAT used in China. The tax on residential land is implicit, in the sense that the government manipulates land allocation by usage—residential vs. nonresidential—so that the price of residential land is much higher. The economic environment considered in this paper features two inefficiencies. First, firms have market power in the goods market to charge a mark-up over marginal costs, which causes the two production factors, labor and nonresidential land, and the resulting output to be below efficient levels. Second, the government has to use distortionary taxes to finance public spending and debt services.

The calibrated model is then used to study the Ramsey optimal policy under various mixes of instruments. We find that the residential land tax has an advantage in reducing inefficiencies caused by the market power. This advantage, which increases with the degree of market power, derives from the fact that the residential land tax pushes more land into production, thereby promoting more outputs. Both the existence of market power and the low elasticity of demand for residential land could justify relatively higher residential land tax rates than VAT rates. However, even considering this advantage, we find that the existing implicit residential tax rate in China is still higher than the rate suggested by the Ramsey policy. With our baseline calibration, the optimal residential land tax rate suggested by the Ramsey policy is 52.75%, much lower than the 98% rate implied by the ratio of land sales revenues to GDP in China. Meanwhile, the optimal VAT rate suggested by the Ramsey policy is 20.28%, higher than the 17% statutory rate currently applied to most industries in China. We show that switching from the existing tax rates to those recommended by the Ramsey policy could lead to a welfare gain of 0.51% of permanent consumption.

Furthermore, when exploring the macroeconomic consequences of debt consolidation with the two policy instruments, we find that the land tax instrument responds to a positive debt shock by causing a rise in output, a decline in residential land stock and an increase in residential land price in the long run. The VAT instrument dampens output, increases residential land stock and lowers residential land prices. Compared to the scenario with only VAT, the model with land tax generates smaller variations in employment and output, but much greater variations in land allocations and prices. When both instruments are available, the Ramsey optimal

policy requires the VAT bear more of the burden of debt stabilization. This is in stark contrast to the current debt consolidation practice in China, in which the government relies on the implicit residential land tax to stabilize debt. Our calculations indicate that the welfare gain of switching from only land tax to utilizing both instruments in reacting to debt shocks leads to a welfare gain of 0.11% of permanent consumption.

This paper links to the vast literature on optimal taxation pioneered by Ramsey (1927) and then developed by Judd (1985), Chamley (1986), Chari et al. (1994), Chari and Kehoe (1999), and Domeij (2005), among many others. The fundamental question relates to the optimal tax structure in an economy when only distortionary taxes are available. The basic logic behind Ramsey optimal taxation is the smoothing of distortions over time and state of nature. Previous studies have focused on conventional instruments, such as taxes on labor income, capital, and consumption. We enrich the literature by examining optimal taxation with a special policy instrument in China: the implicit tax on residential land.

Our paper also contributes to the literature on fiscal consolidation and sustainability. Leeper and Yang (2008) find that the consequences of a tax cut depend on the fiscal instrument used to maintain budget solvency. Bi et al. (2013) explore the macroeconomic consequences of fiscal consolidations with uncertain timing and composition. One important lesson from these studies is that the macroeconomic consequences of fiscal consolidation greatly depend on the particular fiscal instrument used. Therefore, it is worthwhile to study the implications of the special land financing instrument in China. Meanwhile, this paper abstracts from studying monetary policy to focus on the optimal mix of tax instruments. Benigno and Woodford (2003), Schmitt-Grohe and Uribe (2004a), and Leith and Wren-Lewis (2013) all examine the optimal monetary and fiscal policies in a model with nominal rigidities. They find that in cases of even a modest degree of price stickiness, inflation is not optimal for responding to fiscal stress by more than a tiny fraction. Instead, substantial adjustment should come through a change in the tax rate.

Our paper also relates to a burgeoning strand of literature that explores the macroeconomic implications of land financing. For example, Guo et al. (2015) examine the business cycle implications of land financing in China in an estimated dynamic stochastic general equilibrium (DSGE) model, in which the government finances public investments via land sale revenues. Their paper assumes the government chooses land supply to maximize land sales profit, whereas our paper assumes that the government maximizes the household utility. Wu et al. (2015) develop a simple model to illustrate the transmission mechanism from government budget deficits to housing prices. However, they assume that the government has to close deficits with land sales revenues at each period, therefore accumulating no government debt. In contrast, we realistically assume that the government strives to achieve an intertemporal budget balance, making debt accumulation possible. Chakraborty (2016) finds that taxes on landholdings of households can trigger large land price fluctuations. We also find that land financing can lead to significant

TABLE 1. Structure of tax revenues in China (% of total tax revenues)

	Domestic VAT	Business tax	Excise tax	Corporate income tax	Individual income tax
2014	25.89	14.92	7.45	20.68	6.19
2015	24.90	15.46	7.47	21.72	6.90
2016	31.23	8.82	8.44	22.13	7.74
Average	27.34	13.09	7.79	21.51	6.94

land price changes. However, land financing in China is an implicit tax imposed on land transactions, instead of a property tax imposed on landholdings as in Chakraborty (2016). Finally, none of the above studies consider the optimal fiscal policies utilizing a Ramsey framework with land financing as an instrument.

The rest of the paper is organized as follows. Section 2 provides a brief introduction of institutional fiscal policy in China. Section 3 presents the model in which the government has land market monopoly, and finances its budget through two instruments: an implicit tax on residential land and VAT. In Section 4, we construct an analytical analysis to examine the first best allocations, which serve as criteria to evaluate the two policy instruments. In Section 5, we calibrate the model and perform a number of simulation exercises to explore the optimal mix of fiscal instruments. In Section 6, we explore the welfare gains from switching the existing policy to the Ramsey optimal one. The final section concludes the paper.

2. INSTITUTIONAL BACKGROUNDS

The Chinese government has two major sources of revenues: tax revenues and nontax revenues accrued to the government-managed funds. In 2015, total tax revenues accounted for 18.13% of GDP and nontax revenues accrued to government-managed funds accounted for 6.14% of GDP, of which about 80% came from land sales proceeds.

The two institutional features that motivate our study can be summarized as follows: (i) the Chinese government relies intensively on VAT-style tax revenue as the major source of conventional tax revenue, and (ii) the unconventional revenue based on implicit residential land tax plays a significant role in public finance.

2.1. Tax Structure in China

The Chinese government relies predominately on VAT as the conventional tax instrument. Table 1 presents the main domestic sources of tax revenues over the recent 3 years, from 2014 to 2016. Column 2 shows that traditional VAT revenues, primarily from industrial production, account for an average of 27.34% of total tax revenues. Meanwhile, due to difficulties in calculating the value-added in service sectors, the government has imposed sales taxes (business taxes) in those sectors to practically replace the VAT. Column 3 shows that this kind of tax revenue

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typically accounted for 15%, as in 2014 and 2015. However, the government has been working to formally restore VAT in the service sectors, introducing a fully fledged reform in mid-2016, which can be seen from the sudden decrease in the share of business tax revenues and the increase of domestic VAT.

Therefore, in the context of China, the combination of domestic VAT and business tax, about 40% of total tax revenue, is a more appropriate representation of VAT's true position in the tax structure, even though they are currently reported under separate categories. Moreover, there is also a consumption tax on certain types of goods, such as tobacco, alcohol, cars, and jewelery, shown in Column 4 of Table 1. Considering this, we argue that the role of VAT-style tax is further strengthened. In contrast, traditional corporate tax, and especially individual income tax, accounts for a much smaller share of total tax revenues. With these stylized facts, this paper mainly focuses on VAT as the conventional tax instrument when we later study the optimal fiscal policy.

2.2. Land Financing and Implicit Residential Land Tax

In China, the government has the monopolistic power in land supply. On one hand, urban land is completely owned by the state, and users do not own the property. Instead, they are granted land-use rights for a fixed period of time, with the terms of rights varying depending on land use purpose. For instance, a land buyer can use the land for residential purposes for 70 years, business purposes for 40 years, and industrial purposes for 50 years. Buyers are required to pay up-front land use prices that are actually a lump sum of land rent for the specified leasing period. Furthermore, land markets are segmented according to type of land usage, and the government strictly restricts changes in usage functions of land. In particular, without government allowance, it is unlawful to switch the usage of land from nonresidential to residential.

On the other hand, even though rural land is officially owned by individual local collective economic organizations, these owners are not allowed to transfer their land rights to urban use. Almost all land used for urban purposes has to be acquired by the government first. The government transforms the raw land into processed land with basic infrastructure, and then grants land-use rights through public auctions. Besides requisitions from farmland, the government can also acquire land from urban redevelopment, such as reallocating industrial firms from urban to suburban areas. Land requisition is highly profitable for the government, since the compensation for acquired land is usually much lower than the price of land use rights that the government sells to the land users [Ding and Lichtenberg (2011)].

The allocation of land operates under various government objectives, including promoting economic growth, preserving farmland, and especially managing public finances. Since the government is the only land market supplier, it can manipulate price of different land types through reallocation. Particularly, to promote business investments, the government may sacrifice land sale revenue by granting land-use

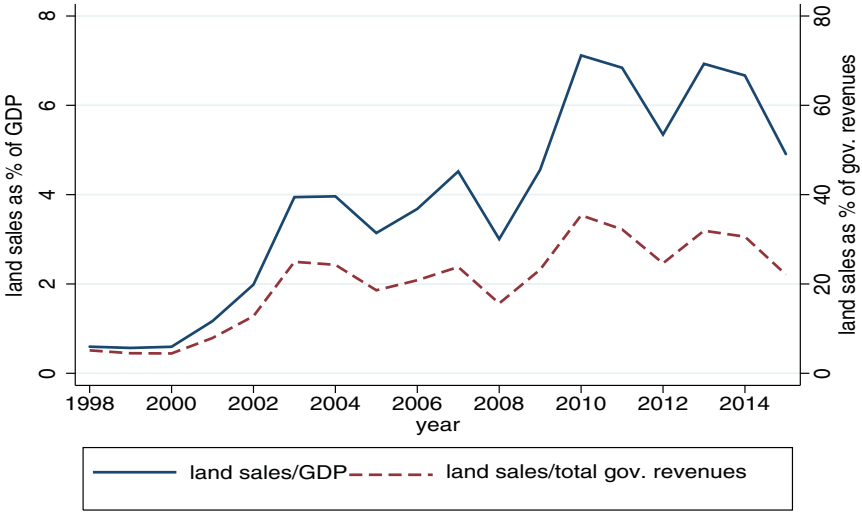

FIGURE 1. Revenues from land sales.

rights to firms at very low prices [Ding (2007)]. The government can also collect more revenues from the sale of residential land, by charging a higher price.

Therefore, the wedge between residential and nonresidential land prices can be considered an implicit tax, imposed on the residential land. The land tax is implicit in the sense that the government generates a land price wedge by manipulating land allocation among different types of usage, instead of imposing a tax explicitly. Given a fixed amount of land, the lower the supply of residential land, the higher the price of residential land relative to nonresidential land, and therefore the higher the implicit tax on residential land.

Figure 1 demonstrates that the scale of land sales is increasing, and land financing has become one of the major sources of government revenue in China. In particular, the proceeds from land sales as a percentage of GDP rose from 0.59% in 1998 to the peak of 7.1% in 2010, and has fluctuated between 5% and 7% since. Meanwhile, the proceeds from land sales as a percentage of total government on-budget revenue rose from 5.1% in 1998 to the peak of 35.4% in 2010, fluctuating between 20% and 30% since.

Besides its monopolistic power in land sales, there is another feature of China's public finance that motivates increasing government reliance on land financing, especially for sub-national governments. China has a multitiered structure of governments, which share the overall national fiscal revenues and expenditures. The central government sets the legislation governing taxation and tax rates, whereas the subnational governments have no discretionary power to adjust tax rates. The central government assigns various portions of tax revenues to the subnational governments, which are responsible for many expenditures, such as infrastructure, public service delivery, and other social spending.

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However, there is a severe vertical fiscal imbalance between the central and subnational governments. Following the 1994 intergovernmental fiscal reform, the total share of sub-national fiscal revenue decreased from 78% in 1993 to around 55% in 2015, whereas its share of total government expenditures increased from 72% to about 85% over the same period (China Statistical Yearbook, 1994–2016). Lack of tax revenue resources and little discretion over tax policies make subnational governments increasingly reliant on other sources of public finance. For instance, they try to maintain their budget through all kinds of borrowing. In fact, subnational government liabilities accounted for about 60% of all government debt by the end of 2015. Meanwhile, these governments may respond by selling more land to finance expenditures, and more importantly, repay the accumulated debt.

3. THE MODEL

The model economy is composed of households, producers, and the government. The representative household's utility depends on consumption goods, residential land holdings, and leisure. The monopolistically competitive producers produce goods using labor and nonresidential land. Based on the institutional background discussed in the preceding section, we assume that the government is the monopolistic supplier of land and the land market is segmented so that land sold to households for residential purposes cannot be used in production, and vice versa. The government finances its budget through implicit land tax and VAT.

3.1. Households

The representative household maximizes the expected present value of lifetime utility, as given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\ln C_t + \varphi \frac{H_t^{1-\chi}}{1-\chi} - \gamma \frac{N_t^{1+\sigma}}{1+\sigma} \right), \tag{1}$$

where C_t denotes consumption, H_t denotes residential land holding, and N_t denotes labor hours. The parameter β is the discount factor; φ indicates the household's taste for land services; the parameter γ determines the steady-state labor supply; χ determines the elasticity of land demand; and σ determines the elasticity of labor supply.

Following Coleman (2000), we model the VAT as a tax on the consumption. The household budget constraint is given by

$$\begin{aligned}(1+\tau_t^c)C_t + q_t^h[H_t - (1-\delta)H_{t-1}] + q_t^l[L_t - (1-\delta)L_{t-1}] + B_t \\ = w_t N_t + r_t L_{t-1} + R_{t-1}B_{t-1} + \Pi_t + \Omega_t - T,\end{aligned} \tag{2}$$

where τ_t^c is the VAT rate, L_t is the nonresidential land held by the household, q_t^h and q_t^l denote the price of residential land and nonresidential land in consumption units,

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respectively, and δ is the rate at which the land is expropriated by the government for each period.[1] B_t denotes the bonds holding, w_t is the wage rate, R_t is the interest rate of bonds, and r_t is the rental rate of nonresidential land. In addition to the wage income, the household also receives income by renting nonresidential land to producers, bonds investments, profits from goods producers Π_t, and a lump-sum transfer Ω_t from the government to compensate for land expropriation. T denotes a time invariant lump-sum tax, which represents taxes other than VAT. For expenditures, the household allocates its income among consumption goods, residential land, nonresidential land, and bonds.

The household chooses contingent sequences, $\{C_t, H_t, L_t, N_t, B_t\}_{t=0}^{\infty}$, to maximize equation (1) subject to equation (2). The first-order conditions are

$$\gamma N_t^{\sigma} = \frac{w_t}{C_t(1+\tau_t^c)}; \tag{3}$$

$$\frac{q_t^h}{C_t(1+\tau_t^c)} = \varphi H_t^{-\chi} + \beta E_t\left[\frac{q_{t+1}^h(1-\delta)}{C_{t+1}(1+\tau_{t+1}^c)}\right]; \tag{4}$$

$$\frac{q_t^l}{C_t(1+\tau_t^c)} = \beta E_t\left[\frac{r_{t+1}+q_{t+1}^l(1-\delta)}{C_{t+1}(1+\tau_{t+1}^c)}\right]; \tag{5}$$

$$R_t = \frac{E_t\left[C_{t+1}(1+\tau_{t+1}^c)\right]}{\beta C_t(1+\tau_t^c)}, \tag{6}$$

where equation (3) governs the labor-leisure choice. Equations (4) and (5) characterize the optimal accumulation of residential and nonresidential land, respectively, balancing the benefits of an additional unit of land with its cost in foregone consumption. Equation (6) governs the accumulation of bonds.

3.2. Producers

Perfectly competitive final goods producers purchase intermediate goods, $Y_t(i)$, to assemble final goods using the technology

$$Y_t = \left[\int_0^1 Y_t(i)^{(\varepsilon-1)/\varepsilon} di\right]^{\varepsilon/(\varepsilon-1)}, \tag{7}$$

where ε is the elasticity of substitution between differentiated intermediate goods.

There exists a continuum of monopolistically competitive intermediate goods producers indexed by $i \in [0, 1]$. Each firm has access to a technology that uses labor and nonresidential land:

$$Y_t(i) = A_t N(i)_t^{\alpha} L(i)_{t-1}^{1-\alpha}, \tag{8}$$

where A_t is the total factor productivity, L_t is the nonresidential land rented from households, and α is the labor share of income. Given the wage rate w_t and

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the land rental rate r_t, intermediate goods producers choose labor demand and nonresidential land to minimize costs. The first-order conditions are

$$mc_t \alpha A_t N(i)_t^{\alpha-1} L(i)_{t-1}^{1-\alpha} = w_t; \tag{9}$$

$$mc_t (1-\alpha) A_t N(i)_t^{\alpha} L(i)_{t-1}^{-\alpha} = r_t, \tag{10}$$

where mc_t denotes the firm's real marginal cost. Monopolistic competition implies that firms can charge a price higher than their marginal costs. Normalizing prices to 1, the markup over the marginal cost $\mu = 1/mc_t = \varepsilon/(\varepsilon - 1)$.

3.3. The Government

The government is a monopolistic supplier of land. The total land stock is assumed to be fixed at $\overline{L}$. Each period, the government expropriates δ percent of total land and reallocates between residential and nonresidential usage. Assuming that the land sold to households is I_t^h, and the land sold to firms is I_t^l, $I_t^h + I_t^l = \delta\overline{L}$. The stock of residential/nonresidential land evolves as follows:

$$H_t = (1-\delta) H_{t-1} + I_t^h; \tag{11}$$

$$L_t = (1-\delta) L_{t-1} + I_t^l. \tag{12}$$

We assume that the price of residential land, q_t^h, is set higher than that of nonresidential land, q_t^l, to reflect the Chinese government's promotion of business investments through low land prices. The wedge between residential and nonresidential land prices is defined as an implicit land tax, τ_t^h, imposed on residential land, which implies $q_t^h \equiv q_t^l \left(1 + \tau_t^h\right)$. Note that the land tax is implicit in the sense that the government generates the price wedge by manipulating land allocation, instead of imposing a tax explicitly. We further assume that the government compensates households for expropriating their land by a lump-sum transfer $\Omega_t = q_t^l \delta \overline{L}$. This implies that the government makes zero profit from nonresidential land sales and positive profit from residential land sales when the implicit residential land tax is positive. The total land sale revenue net of compensation is therefore equal to $\tau_t^h q_t^l I_t^h$.

We assume that the government finances its expenditures by levying VAT and the implicit residential land tax. In addition, the government issues one-period, noncontingent bonds. The government's budget constraint is as follows[2]:

$$\tau_t^c C_t + \tau_t^h q_t^l I_t^h + B_t + T = G + R_{t-1} B_{t-1}, \tag{13}$$

where G denotes government consumption and T denotes a lump-sum tax, representing revenues from taxes other than VAT, both of which are exogenously determined and time invariant. We assume that $G > T$ so that the government has to resort to distortionary taxes to balance the budget. Note that we introduced government consumption G into the model to reflect that the tax base of VAT, C_t, is just part of the total output Y_t; otherwise, the tax base of VAT would be

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exaggerated. The only reason for adding the lump-sum tax T is to balance the government budget when other variables in equation (13) are calibrated.

3.4. Aggregation and Equilibrium

In a symmetric equilibrium $N_t(i) = N_t$, $L_t(i) = L_t$, and $Y_t(i) = Y_t$. Hence, the aggregate production function is

$$Y_t = A_t N_t^{\alpha} L_{t-1}^{1-\alpha}. \tag{14}$$

A decentralized equilibrium consists of prices, $\left\{w_t, r_t, R_t, q_t^h, q_t^l\right\}_{t=1}^{\infty}$, and private sector allocations, $\{C_t, Y_t, H_t, L_t, N_t, B_t\}_{t=1}^{\infty}$ that satisfy optimality conditions equations (3)–(6) and equations (9), (10), the government budget equation (13), the goods market clearing condition $Y_t = C_t + G$, and the land market clearing condition $H_t + L_t = \bar{L}$, given government policies, $\left\{\tau_t^c, \tau_t^h\right\}_{t=1}^{\infty}$ and the initial level of debt B_0, and nonresidential land, L_0.

3.5. Ramsey-Optimal Policy

We assume that government has two policy instruments: VAT rate τ_t^c and the implicit residential land tax rate, τ_t^h. Note that the resource allocations under the Ramsey policy remain the same if we choose land supply I_t^h or I_t^l as the policy instrument instead of implicit land tax rate. The optimal policy is the process $\left\{\tau_t^c, \tau_t^h\right\}$ associated with the competitive equilibrium that yields the highest utility level for the representative household, that is, that maximizes equation (1). The resulting first-order conditions, along with the equations characterizing firm and household optimization and market clearing conditions, give the solution of the model under the Ramsey-optimal policy.

4. ANALYTICAL RESULTS

There are two features in the model that could distort the economy from efficient resource allocation. The first is the existence of monopolistic power of differentiated goods producers, and the second is the requirement of the government budget to satisfy the constraint in equation (13). As a starting point, we ignore the government budget constraint and explore the ability of the two policy instruments to restore efficient resource allocation by curbing monopolistic power. We first consider the social planner's problem, which characterizes the efficient equilibrium without the impact of distortions, then explore the conditions under which the Ramsey optimal policy could obtain the first best allocation. Then, given a positive level of government debt, we show that such an efficient allocation can never be obtained with these two policy instruments.

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4.1. The Social Planner's Problem

The social planner maximizes the representative household's utility, equation (1), subject to the technology, equation (14), and the resource constraints for goods and land. This yields the following first-order conditions:

$$\frac{\beta(1-\alpha)Y_{t+1}^*}{L_t^* C_{t+1}^*} = \varphi H_t^{*-\chi}; \tag{15}$$

$$\gamma N_t^{*\sigma+1} = \alpha Y_t^*/C_t^*, \tag{16}$$

where the "$*$" superscript denotes the efficient level of that variable. Note that equation (15) determines the efficient allocation of land between residential and nonresidential usage, which balances the marginal utility gain from holding residential land for housing services and nonresidential land for production. A benevolent government with no intention of financing its budget with land sales would endeavor to allocate the land based on equation (15), and any deviation from this efficient land allocation would generate a welfare loss. In addition, equation (16) determines efficient labor hours. The efficient output is then given by $Y_t^* = A_t N_t^{*\alpha} L_{t-1}^{*1-\alpha}$.

4.2. The Decentralized Equilibrium

Next, we examine whether the decentralized equilibrium under the Ramsey policy can obtain the first best allocation characterized by equations (15) and (16). Combining equations (3) and (9) yields

$$\gamma N_t^{\sigma+1} = \frac{(\varepsilon-1)\alpha Y_t}{\varepsilon C_t(1+\tau_t^c)}. \tag{17}$$

A contrast between equations (16) and (17) shows that the Ramsey policy needs to set the VAT rate $\tau_t^c = -1/\varepsilon$, so that employment under the decentralized equilibrium is identical to the optimal level of employment chosen by the social planner. Meanwhile, the implicit land tax rate, τ_t^h, should be set to zero so that the land allocations are the same as those chosen by the social planner. When $\tau_t^h = 0$, the prices of residential land and nonresidential land are identical, and therefore combining equations (4), (5), and (10) yields

$$\frac{(\varepsilon-1)\beta(1-\alpha)Y_{t+1}}{\varepsilon L_t C_{t+1}(1+\tau_{t+1}^c)} = \varphi H_t^{-\chi}. \tag{18}$$

A comparison between equations (15) and (18) suggests that the first best allocation of land can be achieved as long as the VAT rate $\tau_t^c = -1/\varepsilon$.

In summary, without considering the government budget constraint, the optimal Ramsey policy is characterized by a negative VAT rate and a zero land tax rate. The reason that this is an optimal tax policy is as follows. The market power of producers generates an inefficiently low level of output, which is reflected by

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the low equilibrium levels of labor and nonresidential land. The negative VAT fully eliminates the market power distortion by subsidizing consumptions, and therefore boosting the demand for goods and production. Once the market power distortion disappears, any nonzero land tax rate will distort the efficient land and labor allocations.

In other words, the VAT instrument itself is enough to restore efficient resource allocations. On the other hand, without VAT, the land tax instrument itself can never achieve this outcome. According to equations (16) and (17), as long as the VAT rate is zero, there is no way for land tax to restore efficient allocation of labor.

Now, we reconsider a balanced government budget as in equation (13). Recall that, the elimination of market power distortion requires a negative VAT and a zero land tax. When the lump-sum tax, T, is not enough to cover government consumption G, equation (13) implies a negative government debt (a positive government asset). In other words, the Ramsey policy cannot obtain the first best allocation with a generic level of debt. In the sections hereafter, we will focus on situations where government debt is positive, and hence at least one tax rate has to be positive to finance government expenditures.

5. NUMERICAL ANALYSIS

In this section, we first calibrate the model and then explore the Ramsey steady state, comparing welfare under various mixes of policy instruments. We then investigate impulse responses to a debt shock under the Ramsey policy. Through the examination of impulse responses, we analyze how the burden of debt stabilization is borne by various policy instruments and compare the economic and fiscal consequences of fiscal consolidation.

5.1. Parameter Calibration

The parameter values are either borrowed from the relevant literature or calibrated to Chinese data at quarterly frequency. The value of γ is chosen so that the steady-state fraction of time spent on working is 1/3. Following Bai et al. (2006) and Song et al. (2011), the parameter determining share of labor income, α, is set to be 0.5. As in Chang et al. (2015), the discount factor, β, is set to be 0.995; the parameter σ is set to be 2, so that the elasticity of labor supply is 0.5; the elasticity of demand for intermediate goods ε, is set to be 10, so that the steady-state markup of final goods price over intermediate goods price is about 11%.

We set δ, the annual land expropriation rate, to 0.005 so that households can keep land use rights for 50 years. The parameter measuring the importance of land holding relative to consumption, φ, is chosen so that the ratio of residential land supply to total land supply is 20%, which is consistent with the average ratio observed in China over the period of 2007–2015. Furthermore, according to data released by the Ministry of Finance, China's government debt to GDP ratio was about 38.9% at the end of 2015, so we set the steady-state ratio of debt to output in

our model accordingly. The VAT rate, τ^c, is set to 17%, the statutory rate applied to most industries in China. The government consumption G is calibrated to target a G/Y ratio equal to 22.2%, the average ratio observed in China from 2007 to 2015.

Since the implicit residential land tax rate is unobservable, we derive it from implicit land tax revenues. In our model, the steady-state ratio of land tax revenues to output can be calculated as $\tau^h \beta(1-\alpha)\delta H/L$, where the land tax rate τ^h is the only parameter left to be calibrated. We therefore set the implicit residential land tax rate, τ^h, to 98% so that the implicit land tax revenues account for 5.5% of output, corresponding to the average in China from 2007 to 2015.

We are left with one important parameter χ, which determines the elasticity of demand for residential land. The value of this parameter is important, since it determines how residential land demand and land tax revenues change with the implicit residential land tax rate. However, we have little knowledge about the value of this parameter. We set this parameter to 2 in the benchmark case, and then examine how our results change with alternative values.

5.2. Ramsey Steady State

The analysis in Section 4 indicates that the Ramsey policy can obtain the first best allocation only when the government holds asset and subsidizes consumption with a negative VAT rate. When the debt is positive and the lump-sum tax, T, is not enough to cover government consumption G, the government has to impose a positive tax on either consumption or residential land, or both, to finance government expenditures, including government consumption and debt services.

To compare the distortions in resource allocations and welfare under different policy instruments, we first calculate the Ramsey steady state of the model with either VAT or residential land tax as the only policy instrument. As shown in Figure 2, the lines with circles demonstrate the land tax rates required to finance various levels of government expenditures not covered by the lump-sum tax, and distortions caused by the tax expressed as the percentage deviation from the first best allocation. The lines with stars show the scenario in which VAT is the only policy instrument.

Several observations are worth discussion. First, even when the government expenditure not covered by the lump-sum tax is zero, and therefore the required tax rate is zero, the steady-state levels of employment, nonresidential land, consumption and output are below the first best allocations due to the market power, while the residential land is above the first best level. Second, when the government expenditure not covered by the lump-sum tax is relatively small and the required tax rate is low, a positive residential land tax can increase welfare by discouraging residential land demand, therefore narrowing market power distortions. However, when the government expenditure grows and the required residential land tax rate increases, the level of residential land starts to fall short of the first best level, whereas the nonresidential land surpasses. By contrast, a positive VAT always

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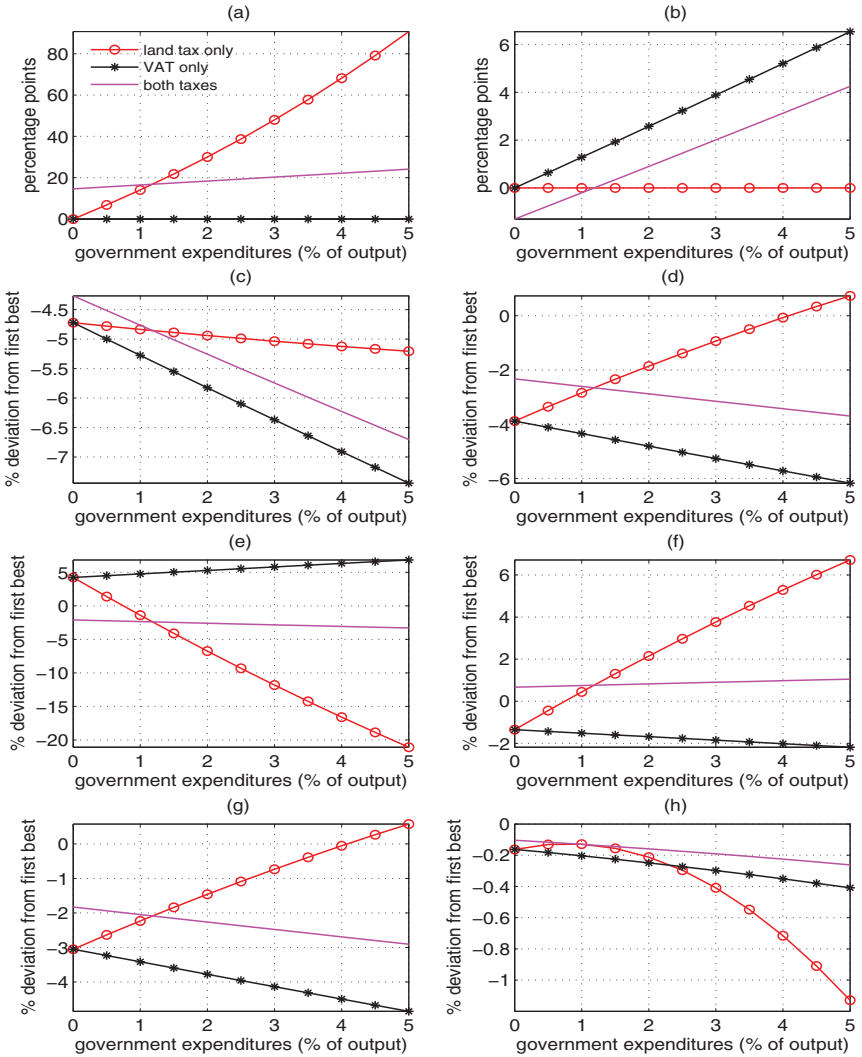

FIGURE 2. Ramsey steady state and welfare under different policy instruments. The tax rates are measured in percentage points, whereas the other variables are measured in percentage deviations from the first best allocations. (a) Land tax rate, (b) VAT rate, (c) labor, (d) consumption, (e) residential land, (f) nonresidential land, (g) output, and (h) welfare.

exacerbates distortions. Hence, as shown in Figure 2(h), the welfare gap with land tax, measured by the percentage deviation from the first best welfare, first narrows when the tax rate is low and then widens when the tax rate rises, while the welfare gap with VAT always expands with the tax rate. Last, the residential land tax rate increases much faster than the VAT rate when the government expenditure rises,

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which can be explained by the relatively small residential land tax base. Note that the tax base of land tax is $q^l I^h$, and the tax base of VAT is simply C. Thus, the ratio of tax base, $q^l I^h / C$, evaluated at the calibrated values of parameters, is 0.072. When the government expenditures increase, the faster rise in the residential land tax rate required to finance the budget quickly enlarges land allocation distortions, and the welfare declines drastically, finally dropping below the welfare with the VAT.

In sum, the advantage of residential land tax is that it is able to alleviate the market power distortions on land allocation when the tax rate is low. However, if its tax base is small, like in our calibration case, this advantage is overwhelmed by the disadvantage that the tax rate requires drastic change as the government budget increases.

We then turn to the case where both fiscal instruments are employed. The solid lines in Figure 2(a) and (b) shows the optimal mix of the taxes with various levels of government expenditures not covered by lump-sum tax. As the government expenditure not covered by the lump-sum tax is relatively small, the optimal land tax is positive, whereas the VAT rate is negative. This policy strategy can be rationalized by the Ramsey planner's intention to partially correct the distortions caused by market power. Both the positive land tax and negative VAT are capable of narrowing distortions, however, under slightly different working channels. The positive land tax has more influence on correcting the under-supply of nonresidential land, whereas the negative VAT primarily corrects the under-supply of labor. A negative VAT rate is possible because land tax revenues can be used to subsidize the consumption. When the government expenditure is large enough, both of the tax rates must be positive to finance the budget. Figure 2(h) indicates that the welfare gap relative to the first best under both taxes is always smaller than the one with only one fiscal instrument, except for a special case in which only land tax is used.

With our baseline calibration, the government expenditure not covered by the lump-sum tax accounts for 18.73% of output. Correspondingly, the optimal residential land tax rate suggested by the Ramsey policy is 52.75%, much lower than the 98% rate implied by the ratio of land sales revenues to GDP in China. Meanwhile, the optimal VAT rate suggested by the Ramsey policy is 20.28%, higher than 17% the statutory rate applied to most industries in China.[3]

5.3. Ramsey Dynamics

We now turn our attention to the optimal policy in a stochastic setting. To this end, we perturb the model with a positive debt shock, that is, an unexpected 1% rise in the initial debt level. To avoid interactions between the two fiscal instruments, we first focus on cases in which only one policy instrument reacts to the debt shock while keeping the other fixed at the Ramsey steady state. This assumption facilitates the comparison of the dynamic efficiency of debt stabilization with different policy mixes, because the initial steady states are the same.

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First, we investigate the government's optimal reaction to a sudden rise in debt by plotting impulse responses. Figure 3 shows responses to a 1% unexpected increase in debt under the optimal policy when only the land tax reacts to the shock. The left panel shows responses within 10 quarters after the shock, while the right panel presents responses from the 11th to the 1,000th quarters after the shock.[4] Immediately after the debt shock, the government reacts by raising the residential land tax rate, leading to an increase in the residential land price. It is interesting to note that the stock of residential land jumps up at the period of impact, despite the rising land price. This observation can be explained by a combination of equations (4) and (6), which suggests that current household's residential land holding is not only affected by the current residential land price, but also governed by the interest rate and expected future land price. At the initial period, the rising land tax is not able to affect consumption, but it can still reduce the interest rate in that period by dampening next period consumption, according to equation (6). Note that Figure 3(i) shows that the impact on the interest rate lasts primarily for one period only. The expected land price appreciation and decline in interest rate reduce the user cost of holding the residential land, and therefore help boost the short-term demand for the residential land. A small jump in the residential land stock requires a large increase in new residential land investment on which the residential land tax is imposed, increasing the revenue from land tax by about 5.5% at impact period. From the second period, the stock of residential land starts to decline and therefore new residential land investment slumps, reducing the revenue from land tax. In the long run, the residential land tax and price rise gradually and finally converge to steady states above their respective initial levels. Correspondingly, the residential land stock gradually drops to a level below pre-shock value. During this adjustment process, the revenue from land tax rebounds due to the rising land tax rate, which finally curbs the ever-increasing debt. Meanwhile, the output and consumption converge to steady states above their respective initial levels, due to land reallocation from residential to nonresidential usages.

The impulse responses in Figure 3 demonstrate that the government stabilizes the debt by adjusting the residential land tax. Alternatively, we can assume that the residential land supply is the policy instrument of the government: as shown in Figure 3(g) and (p), the government raises the land supply immediately after the debt shock to obtain additional revenue, but generates an undersupply of land in the long term, causing a rise in land price and revenue.

Figure 4 demonstrates the responses to a 1% unexpected increase in debt under the optimal policy when only the VAT is imposed. Immediately after the debt shock, the government reacts by raising the VAT rate, boosting the price of consumption and lowering the purchasing power of wage, therefore causing an immediate decline in consumption and labor. The rise in the VAT also lowers the opportunity costs of investing in bonds, which drives up the demand for bonds and therefore lowers the interest rates, according to equation (6). A drop in the interest rate at period 1 helps to lower debt services and dampen government debt at period 2. Similarly, the rise in VAT also lowers the opportunity costs of investing in both

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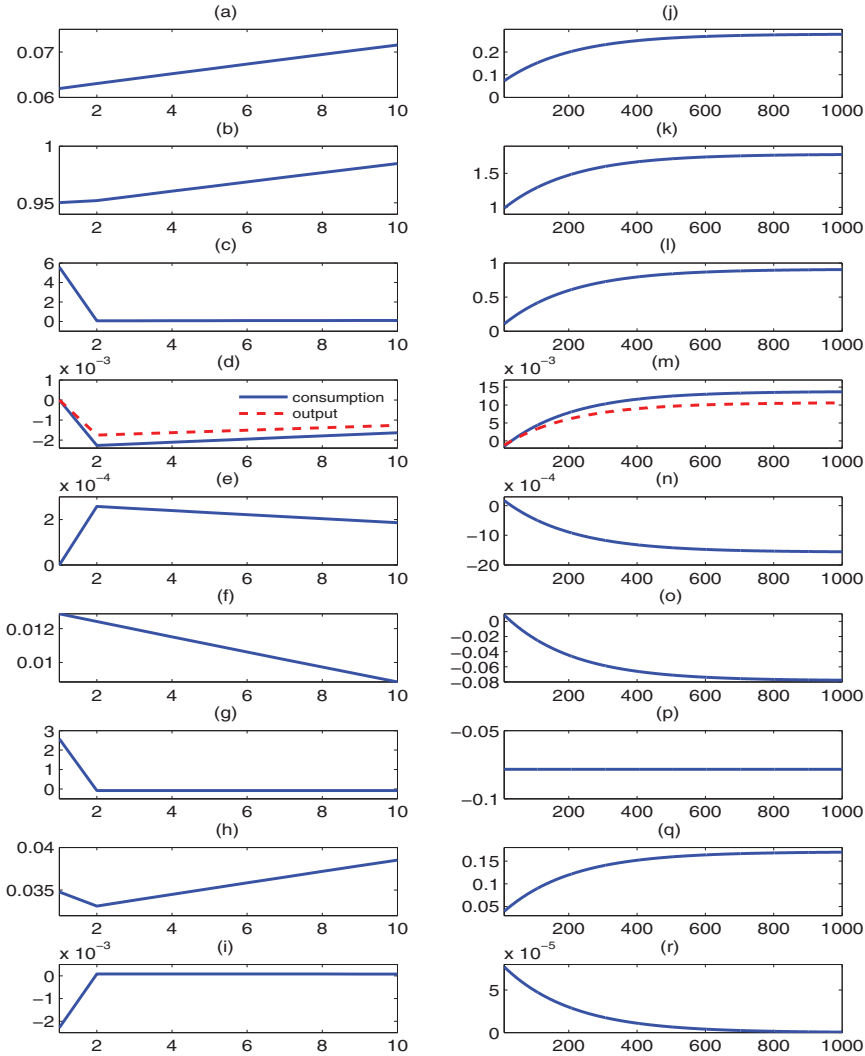

FIGURE 3. Responses of selected variables to a debt shock when the land tax is the only policy instrument. The tax rates and the interest rate are measured in percentage points, whereas the other variables are measured in percentage deviations from their preshock steady state. (a) Land tax rate, (b) government debt, (c) government revenues, (d) consumption/output, (e) labor, (f) residential land stock, (g) residential land supply, (h) residential land price, (i) interest rate, (j) land tax rate, (k) government debt, (l) government revenues, (m) consumption/output, (n) labor, (o) residential land stock, (p) residential land supply, (q) residential land price, and (r) interest rate.

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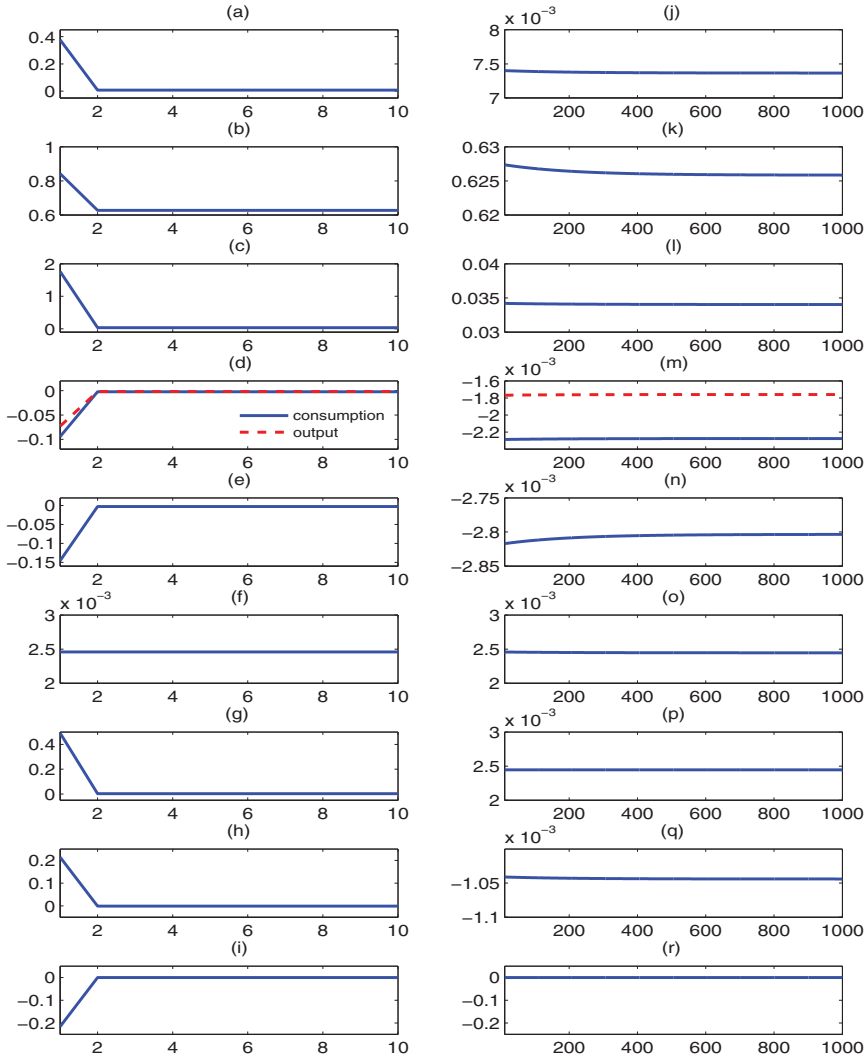

FIGURE 4. Responses of selected variables to a debt shock when the VAT is the only policy instrument. The tax rates and the interest rate are measured in percentage points, whereas the other variables are measured in percentage deviations from their preshock steady state. (a) VAT rate, (b) government debt, (c) government revenues, (d) consumption/output, (e) labor, (f) residential land stock, (g) residential land supply, (h) residential land price, (i) interest rate, (j) VAT rate, (k) government debt, (l) government revenues, (m) consumption/output, (n) labor, (o) residential land stock, (p) residential land supply, (q) residential land price, and (r) interest rate.

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residential and nonresidential land. The competition of lands leads to a rise in land price.

A comparison of Figures 3 and 4 clearly shows the differences in the process of debt stabilization, and the economic and fiscal consequences under the two policy instruments. Most of the adjustments for debt stabilization are done within two periods after the shock when the VAT serves as the policy instrument, whereas debt stabilization with land tax takes a much longer time to reach a new steady state. The tendency for the VAT to rely on short-run adjustments is due to its advantage of being able to directly reduce the government's borrowing cost, the interest rate, and therefore lower the debt burden, besides the channel through affecting consumption. This is obviously shown by equation (6). On the other hand, the land tax instrument has little impact on interest rates, given the limit that it only works through the channel of reducing consumption. The very reason that this adjustment channel is not intensively used is as follows. Suppose the land tax instrument is used to greatly reduce current interest rate R_t by reducing consumption C_{t+1}, according to equation (6). As a by-product, the reduced consumption appears in the denominator of next period interest rate, R_{t+1}, causing it to rise, and ruining the initial benefit of reducing R_t. It is interesting to note that a debt consolidation with land tax is able to boost the long-run output, whereas using VAT as instrument dampens the output. In particular, the 1% debt shock leads to a 0.011% increase in the steady-state output when the land tax serves as the policy instrument, whereas the same shock generates a 0.0018% decline when the VAT is employed. The difference is caused by the fact that the land tax generates more nonresidential land for production in the long run, while the VAT generates less nonresidential land, even though both instruments reduce labor supply in the long run. A 1% debt shock causes a 0.078% decline in residential land stock and a 0.17% rise in residential land price when land tax is the policy instrument. In contrast, the same shock leads to a 0.0024% increase in residential land stock and a 0.001% decline in residential land price when the VAT is the policy instrument. Overall, the government debt finally reaches a new steady state, which is about 1.78% higher than the initial level with the land tax as the instrument, much higher than 0.63% level with the VAT.

The above analysis helps us to understand the responses to a positive debt shock in the model in which both policy instruments react to the shock. As shown in Figure 5, the Ramsey optimal policy requires that the burden of debt adjustment be shared by both policy instruments. A comparison between Figures 3 and 5 indicates that land tax incurs much less adjustments in the model with both policy instruments reacting to the debt shock. In particular, the new steady state of the land tax is only 0.013 percentage points above the preshock level in the model with two policy instruments, whereas it converges to 0.28 percentage points above the preshock level in the model with land tax alone. By contrast, the adjustment of the VAT in the model with both policy instruments is only slightly smaller than the one in the model with VAT only. Figure 5(d) and (m) demonstrates that the revenue from VAT reacts to the debt shock more drastically than the revenue from

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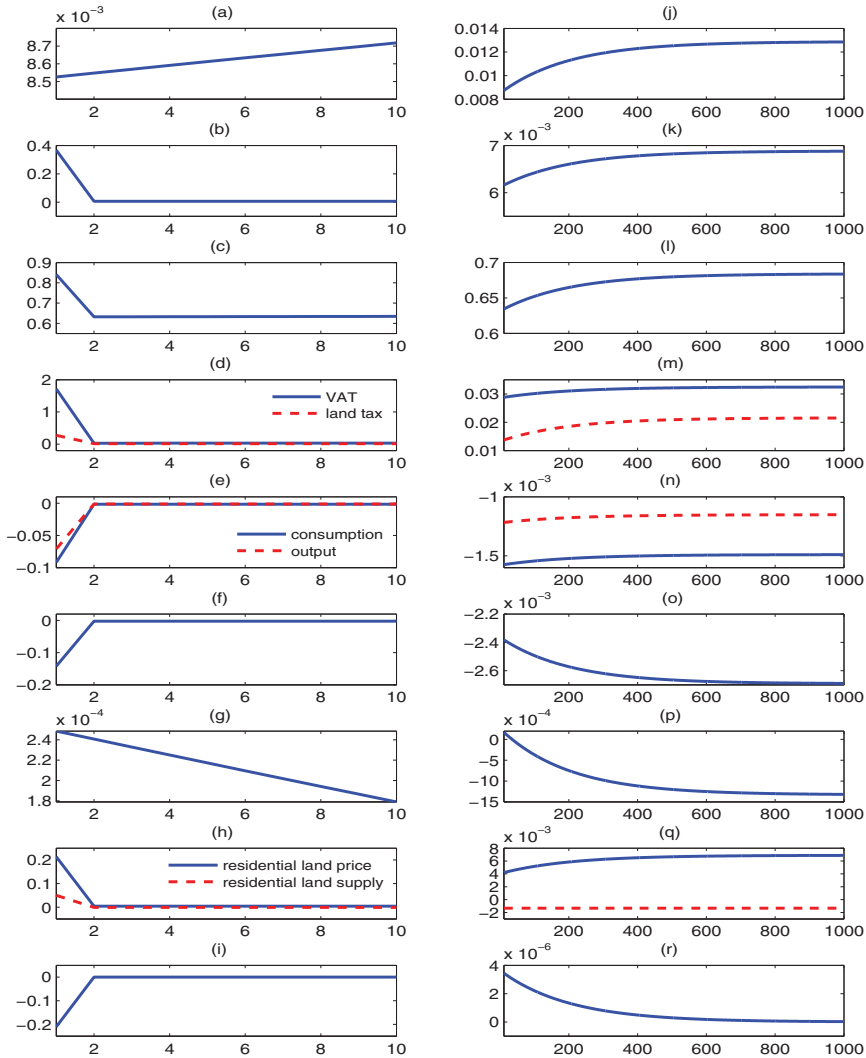

FIGURE 5. Responses of selected variables to a debt shock when both policy instruments are used. The tax rates and the interest rate are measured in percentage points, whereas the other variables are measured in percentage deviations from their preshock steady state. (a) Land tax rate, (b) VAT rate, (c) government debt, (d) government revenues, (e) consumption/output, (f) labor, (g) residential land stock, (h) residential land supply/price, (i) interest rate, (j) land tax rate, (k) VAT rate, (l) government debt, (m) government revenues, (n) consumption/output, (o) labor, (p) residential land stock, (p) residential land supply/price, and (r) interest rate.

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land tax, both in the short and in the long run. As shown in Figure 5, a rise in land tax boosts the residential land price and lowers the residential land stock; however, the fluctuations are much smaller than those in the land tax only case. The decline in the output and consumption is smaller than the VAT only case, since the negative impact of VAT is partially offset by the positive impact of land tax.

Moreover, Figure 5 inherits the patterns that VAT induces more short-run adjustments, whereas adjustments in land tax take a much longer time. For instance, Figure 5(c) shows that the government debt adjustment is more like Figure 4(b) in the short run, rather than Figure 3(b). On the other hand, in the long run, Figure 5(l) is more like Figure 3(k) than Figure 4(k). The same patterns can also be observed for the adjustment of labor and other variables.

5.4. Contribution of Policy Instruments to Debt Stabilization

It is interesting to examine the contribution of each policy instrument on debt stabilization under the Ramsey policy. To do this, we explore how an increase in debt can be stabilized by investigating the government's intertemporal budget balance. Note that the government's budget constraint equation (13) can be solved forward to obtain

$$B_{t-1} = \sum_{i=0}^{\infty} \left[\left(\tau_t^c C_t + \tau_t^h q_t^l I_t^h + T - G \right) \prod_{s=0}^{i} \frac{1}{R_{t+s-1}} \right] + \lim_{i \to \infty} B_{t+i} \prod_{s=0}^{i} \frac{1}{R_{t+s-1}}. \tag{19}$$

The debt can be stabilized only if the last term in equation (19) equals zero. When there is a sudden rise in initial debt B_{t-1}, there is an increase in the discounted present value of all future revenues from land tax and VAT. We already show that the VAT can stabilize the debt not only through raising the tax revenue directly, but also through lowering the interest rate. To distinguish these two channels, we calculate the contribution of VAT revenue and interest rate adjustments separately. The contribution of each policy instrument in debt stabilization is calculated by allowing only one policy instrument variable to adjust while keeping the others fixed at their initial steady state. For example, the relative contribution of revenues from land tax can be calculate as follows:

$$\frac{\sum_{i=0}^{\infty} \left[\left(\tau^c C + \tau_t^h q_t^l I_t^h - T - G \right) \prod_{s=0}^{i} \frac{1}{R} \right] - B}{B_{t-1} - B}, \tag{20}$$

where all variables without subscript denote the steady state, and $B_{t-1} - B$ measures all of the adjustments in policy instruments needed to stabilize the debt.

Table 2 shows the contribution of land tax revenues, VAT revenues, and interest rate adjustment in stabilizing the debt for various values of χ, the parameter governing the elasticity of demand for residential land. With the parameters setting

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TABLE 2. Contribution of policy instruments to debt stabilization

	Land tax revenues	VAT revenues	Interest rate adjustment
$\chi = 1$	7.43	71.33	21.10
$\chi = 2$	7.60	71.48	20.79
$\chi = 4$	10.37	69.57	19.94
$\chi = 6$	14.81	66.13	18.93
$\chi = 8$	20.64	61.44	17.80
$\chi = 10$	27.38	55.88	16.62

at the baseline case ($\chi = 2$), land tax revenues only accounts for 7.6% of the total debt stabilization, whereas the relative contributions of VAT revenues and interest rate adjustments are about 71.5% and 20.8%, respectively. Note that the ratio of contribution of land tax revenue to VAT revenue is about 0.106, actually higher than the tax base ratio of 0.072.

As shown in Table 2, the contribution of land tax revenue in debt stabilization increases with the value of parameter χ. As χ increases, the elasticity of demand for residential land declines. The underlying reasoning is straightforward: the smaller the elasticity of demand for residential land, the less land allocation distortion generated by land tax. However, even with the value of χ as high as 10, land tax revenues still only bear about 27.4% of total burden of debt stabilization. Once again, this result rests more on the empirically realistic setting of China, that land tax base is relatively small, not on shortage in the theoretical ability of the land tax instrument in a comparison with the VAT instrument.

6. WELFARE ANALYSIS

From the above analysis based on the model calibrated to Chinese data, we obtain two salient results: first, the existing implicit residential land tax in China is much higher than the steady-state optimal rate suggested by the Ramsey policy; second, the Ramsey optimal policy requires the VAT to bear more of the debt stabilization burden. However, in reality, the government relies more heavily on revenues from the implicit residential land tax to stabilize debt, due to the fiscal institution described in Section 2. It would be interesting to examine whether significant welfare gains exist if China were to switch its current fiscal practice to the optimal Ramsey policy.

Table 3 demonstrates the optimal mix suggested by the Ramsey policy, and the corresponding percentage changes in steady states and welfare gains when the existing tax rates are switched to the Ramsey suggestions. The welfare gains are reported as the permanent percentage change in consumption that would make households indifferent between remaining with the existing tax rates and switching to the Ramsey policy. With our baseline calibration, switching to a Ramsey tax policy implies an increase in the VAT rate from 17% to 20.28% and

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TABLE 3. Ramsey tax policies and welfare

	τ^c	τ^h	ΔY	ΔC	ΔN	ΔH	ΔL	Δq^h	$\Delta Welfare$
Baseline	20.28	52.75	−2.18	−2.80	−1.06	13.17	−3.29	−21.98	0.51
$\chi = 0.5$	21.37	39.55	−7.37	−9.48	−0.68	54.45	−13.61	−24.44	2.23
$\chi = 1$	21.02	43.53	−4.32	−5.55	−1.03	29.97	−7.49	−25.03	1.18
$\chi = 4$	18.69	74.50	−0.72	−0.92	−0.61	3.31	−0.83	−11.78	0.13
$\chi = 5$	17.80	86.76	−0.30	−0.39	−0.30	1.23	−0.31	−5.68	0.05
$\varepsilon = 4$	18.54	89.72	−1.09	−1.40	−0.49	6.73	−1.68	−12.30	0.20
$\varepsilon = 6$	19.47	67.56	−1.69	−2.17	−0.80	10.29	−2.57	−17.87	0.36
$\varepsilon = 8$	19.97	58.04	−2.00	−2.56	−0.96	12.08	−3.02	−20.47	0.45
$\varepsilon = 20$	20.93	42.98	−2.56	−3.29	−1.27	15.35	−3.84	−24.88	0.64

a reduction in the land tax rate from 98% to 52.75%. This leads to a 1.1% decline in employment, 2.2% decline in output, 3.3% decline in nonresidential land, 13.2% increase in residential land, and 22% drop in residential land price. The welfare gain of implementing the Ramsey optimal tax is about 0.51% of permanent consumption.

It is worthwhile to note that two parameters could significantly change the optimal mix of tax rates: one is χ, governing the elasticity of demand for residential land, and the other is ε, measuring the market power. As shown in Table 3, when the value of χ increases, that is, the elasticity of demand for residential land decreases, the optimal land tax rate suggested by the Ramsey policy rises drastically. The intuition is straightforward: a relatively small elasticity of demand for residential land means that a high land tax only leads to very small land-allocation distortions. Table 3 also illustrates that the optimal land tax rate increases when the parameter ε declines, that is, the degree of market power rises. The advantage of residential land tax is that distortions in land allocations are generated only after the tax rate exceeds a certain threshold value, and a stronger market power pushes up this threshold value and therefore rationalizes a higher land tax.

In sum, the results in Table 3 reveal that the existing residential land tax is higher than the one suggested by the Ramsey policy while the VAT is lower, and this result is robust to the changes in parameter values within the reasonable range. Switching from the existing tax rates to the Ramsey policy would lead to a decline in employment, consumption and output due to the rise of VAT, meanwhile the residential land price would decrease with the residential land tax, leading to a reallocation of land from nonresidential to residential usages. Most importantly, switching to the Ramsey optimal tax rates by cutting the land tax rate and raising the VAT rate could achieve a significant welfare gain.

Next, we focus on the dynamic efficiency of debt stabilization under different mixes of policy instruments. We consider three cases: the baseline case in which only the land tax is allowed to react to the debt shock, an alternative case in which only the VAT is allowed to respond to the debt shock and the other alternative case

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TABLE 4. Macroeconomic stability and welfare under alternative mix of policy instruments

	Land tax alone	VAT alone	Both instruments
σ_y	0.0348	0.0745	0.0551
σ_n	0.0002	0.0063	0.0052
σ_h	1.6204	0.4330	0.1210
σ_q	0.2615	0.0769	0.0735
Welfare gains($\chi = 2$)	–	0.1056	0.1131
Welfare gains($\chi = 1$)	–	0.2278	0.2373
Welfare gains($\chi = 4$)	–	0.0439	0.0523
Welfare gains($\chi = 6$)	–	0.0245	0.0345
Welfare gains($\chi = 8$)	–	0.0145	0.0265
Welfare gains($\chi = 10$)	–	0.0090	0.0230

in which both policy instruments react to the shock. Note that the steady states of variables are the same in these three cases and we assume that at time zero all state variables of the economy are equal to their respective Ramsey steady-state values. Since distortions in our model exert both short-run and steady-state effects, we resort to a second-order approximation of policy functions of the Ramsey problem, so that alternative policies could be correctly ranked, following the approach taken by Schmitt-Grohe and Uribe (2004b).

Table 4 reports the standard deviations of output (σ_y), labor (σ_n), stock of residential land (σ_h), price of residential land (σ_q), and welfare gains under the alternative mixes of policy instruments, relative to the baseline case. The results in Table 4 unravel that relying on land tax alone to stabilize debt leads to smaller volatilities in output and employment, but much greater volatilities in the stock and price of residential land. Stabilizing the debt with VAT alone generates the highest volatilities in output and employment among three cases. Note that volatility in the stock of residential land in the case of both instruments is the smallest because the two taxes have opposite effects on residential land holdings. Our calculation indicates that the welfare gain of switching from the land tax alone case to the VAT alone case would be 0.1056% of permanent consumption, and switching from the land tax alone case to the case with both instruments would lead to a welfare gain of 0.1131% of permanent consumption. This result is consistent with the results in Table 2, which shows that the Ramsey policy requires more VAT tax contribution in stabilizing debt. Table 4 also shows that our results remain valid for different values of χ: switching from the policy with land tax reacting to debt shock alone to a policy with VAT responding to debt shock alone, or to a policy with both policy instruments, always leads to welfare improvements. As χ increases, with the decline of land demand elasticity, the land tax generates much less distortions in land allocations, and therefore the welfare gains from switching decrease.

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7. CONCLUSION

In this paper, we explore optimal fiscal policies in China where the government finances its budget primarily through an implicit tax on residential land and VAT. Both the existence of market power and the low elasticity of demand for residential land could justify a relatively higher residential land tax rate than VAT rate. However, even considering these advantages, we find that the existing implicit residential tax rate in China is still higher than the one suggested by the Ramsey policy. Furthermore, constrained by the institutional fiscal structure, the Chinese government in reality relies more on revenues from land sales to stabilize debt, whereas our model finds that the Ramsey optimal policy requires VAT to bear more of the debt stabilization burden.

We then conduct a counterfactual welfare analysis to show that there are significant welfare gains of switching from the current fiscal practice to the optimal Ramsey policy mix. The proposed reforms involve two parts: first, the government should raise the VAT rate, but lower the implicit tax on residential land by supplying more residential land and thereby reducing its relative price; second, the government should rely more on adjusting VAT rates to stabilize debt instead of using implicit land tax alone.

NOTES

1. In China, land buyers do not really own land property; instead, they are granted land-use rights for a fixed period of time. We can adjust the value of parameter δ so that households can only keep the land for $1/\delta$ periods.

2. Note that this budget constraint already combines the budgets of the central and subnational governments. We assume that revenues collected from different levels of government are pooled together to finance all government expenditures and debt services.

3. This optimal mix of tax rates is not shown in Figure 2. To show local details, we only plot the optimal mix of tax rates for the scenarios in which government expenditures not covered by the lump-sum tax are within 5% of the output.

4. Note that it takes a long time for some variables to converge to the steady state. We depict the short-run and long-run responses separately to show convergeneces to the steady state while maintaining the details of short-run responses.

REFERENCES

Bai, Chong-En, Chang-Tai Hsieh, and Yingyi Qian (2006) The return to capital in China. *Brookings Papers on Economic Activity* 37, 61–102.

Benigno, Pierpaolo and Michael Woodford (2003) Optimal Monetary and Fiscal Policy: A Linear Quadratic Approach. NBER working papers 9905, National Bureau of Economic Research.

Bi, Huixin, Eric M. Leeper, and Campbell Leith (2013) Uncertain fiscal consolidations. *Economic Journal* 123, 31–63.

Chakraborty, Suparna (2016) Real estate cycles, asset redistribution, and the dynamics of a crisis. *Macroeconomic Dynamics* 20, 1873–1905.

Chamley, Christophe (1986) Optimal taxation of capital income in general equilibrium with infinite lives. *Econometrica* 54, 607–622.

Chang, Chun, Zheng Liu, and Mark M. Spiegel (2015) Capital controls and optimal Chinese monetary policy. *Journal of Monetary Economics* 74, 1–15.

Chari, V. V., Lawrence J. Christiano, and Patrick J. Kehoe (1994) Optimal fiscal policy in a business cycle model. *Journal of Political Economy* 102, 617–652.

Chari, V. V. and Patrick J. Kehoe (1999) Optimal fiscal and monetary policy. In John B. Taylor and Michael Woodford (eds.), *Handbook of Macroeconomics*, pp. 1671–1745. Amsterdam: North Holland.

Coleman, Wilbur J. (2000) Welfare and optimum dynamic taxation of consumption and income. *Journal of Public Economics* 76, 1–39.

Ding, Chengri (2007) Policy and praxis of land acquisition in China. *Land Use Policy* 24, 1–13.

Ding, Chengri and Erik Lichtenberg (2011) Land and urban economic growth in China. *Journal of Regional Science* 51, 299–317.

Domeij, David and Paul Klein (2005) Preannounced optimal tax reform. *Macroeconomic Dynamics* 9, 150–169.

Guo, Shen, Lezheng Liu, and Yan Zhao (2015) The business cycle implications of land financing in China. *Economic Modelling* 46, 225–237.

IMF (2011) Shifting gears: Tackling challenges on the road to fiscal adjustment. In *Fiscal Monitor*. Washington, DC: International Monetary Fund.

IMF (2012) Balancing fiscal risks. In *Fiscal Monitor*. Washington, DC: International Monetary Fund.

Judd, Kenneth L. (1985) Redistributive taxation in a simple perfect foresight model. *Journal of Public Economics* 28, 59–83.

Leeper, Eric M. and Shu-Chun S. Yang (2008) Dynamic scoring: Alternative financing schemes. *Journal of Public Economics* 92, 159–182.

Leith, Campbell and Simon Wren-Lewis (2013) Fiscal sustainability in a new Keynesian model. *Journal of Money, Credit and Banking* 45, 1477–1516.

Ramsey, Frank P. (1927) A contribution to the theory of taxation. *Economic Journal* 37, 47–61.

Schmitt-Grohe, Stephanie and Martin Uribe (2004a) Optimal fiscal and monetary policy under sticky prices. *Journal of Economic Theory* 114, 198–230.

Schmitt-Grohe, Stephanie and Martin Uribe (2004b) Solving dynamic general equilibrium models using a second-order approximation to the policy function. *Journal of Economic Dynamics and Control* 28, 755–775.

Song, Zheng, Kjetil Storesletten, and Fabrizio Zilibotti (2011) Growing like China. *American Economic Review* 101, 196–233.

Wu, Guiying L., Qu Feng, and Pei Li (2015) Does local governments' budget deficit push up housing prices in China? *China Economic Review* 35, 183–196.