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Balanced-budget consumption taxes and aggregate stability in a small open economy

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HIGHLIGHTS

- We study the indeterminacy issue under the balanced-budget consumption taxation in a small open economy.
- We show that for a small open economy facing a perfect world capital market indeterminacy cannot occur.
- This result is in contrast to those obtained in some recent closed economy models.
- The paper demonstrates that unfettered world capital mobility can help stabilize the economy.

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ABSTRACT

In a small open economy facing a perfect world capital market, this paper shows that if the government follows a balanced-budget fiscal policy based on endogenous consumption tax rates, then the steady state is saddle-path stable and hence beliefs-driven aggregate instability can be ruled out. This result is in contrast to those obtained in some closed economy models, and it suggests that unrestricted world capital mobility can help stabilize the economy under the balanced-budget fiscal policy based on consumption taxation.

1. Introduction

A number of recent studies have examine the possibility of indeterminacy induced by balanced-budget fiscal policy rules based on consumption taxation. Giannitsarou (2007) shows that if public spending is financed by consumption tax with an endogenous tax rate then indeterminacy cannot occur. However, Nourry et al. (2013) find that her result is not robust to an alternative preference specification, and Nishimura et al. (2013) further demonstrate that indeterminacy can also arise in a multisector model. Both Nourry et al. (2013) and Nishimura et al. (2013) conclude that consumption taxation can be a source of beliefs-driven aggregate instability for most OECD countries.[1]

To our knowledge, all of the existing studies on this issue, including the articles cited above, use closed-economy frameworks. In this paper we investigate the issue in a neoclassical small open economy model. This is a necessary and realistic extension as most economies (including most OECD countries) are not closed but small and open. Indeed, under the same type of balanced-budget rule considered in the literature, we find that for a small open economy facing a perfect world capital market indeterminacy cannot

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[1] See also Schmitt-Grohé and Uribe (1997) and Guo and Harrison (2004) for a related strand of research on balanced-budget income taxation and aggregate (in)stability.

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occur, independently of both the utility function and the production function. This result is in contrast to those obtained in some recent closed economy models, and it suggests that unfettered international capital mobility can help stabilize the economy under the balanced-budget fiscal policy.

The intuition for our result can be understood by examining the indeterminacy results obtained in closed economy models. For example, in Nourry et al. (2013), indeterminacy arises when the intertemporal elasticity of substitution is sufficiently large and greater than 1. In that model, if the households expect that future tax rates on consumption will increase, their expected labor supply will fall (i.e., leisure will increase) due to the substitution effect, so their expected total income will fall. Because of the effect of the permanent income, households' current labor supply increases and current consumption falls. In the closed economy, the increase in labor supply and the needed increase in investment goods also require a reduction in consumption.[2] If the intertemporal elasticity of substitution in consumption is high, these changes and especially the reduction in consumption will be large enough to match the balanced-budget consumption tax rule, and hence the households' expectations are self-fulfilling. If, however, the intertemporal elasticity is small, the change in consumption will be small and insufficient to match the policy rule, making indeterminacy impossible.

In a small open economy facing a perfect world capital market the situation is very different. Under the same policy, due to the permanent income effect, the increase in current labor supply and the associated increase in capital goods do not require a large drop in consumption, as the households can achieve consumption smoothing by borrowing abroad to finance the needed investment. The curvature of the utility function does not affect investment decisions, and the reduction in consumption if any is not sufficient to match the balanced-budget rule, which prevents households' expectations from becoming self-fulfilling. Thus, in contrast to the policy implications of the results of Nourry et al. (2013) and Nishimura et al. (2013), the balanced-budget fiscal policy based on consumption taxation does not cause beliefs-driven aggregate instability in a small open economy.

The next section describes the model. Section 3 solves the dynamic equilibrium and proves the determinacy result. Section 4 concludes.

2. A small open economy model with endogenous consumption taxation

Firms

The production side of the small open economy consists of two sectors with one producing the traded consumption good (y_{1t}) and the other producing the nontraded investment good (y_{2t}),[3] by means of constant returns to scale neoclassical production functions, which we write in intensive form as

$$y_{1t} = F(k_{1t}, l_{1t}) \equiv f(\eta_t)\, k_{1t}, \tag{1}$$

$$y_{2t} = H(k_{2t}, l_{2t}) \equiv h(\psi_t)\, k_{2t}, \tag{2}$$

where k_{it} and l_{it} ($i = 1, 2$) are the capital and labor inputs utilized in the two sectors, and

$$\eta_t = \frac{l_{1t}}{k_{1t}}, \qquad \psi_t = \frac{l_{2t}}{k_{2t}}. \tag{3}$$

Factor markets are perfectly competitive, and the first-order conditions for profit maximization imply that the wage rate w_t and the rental rate r_t satisfy, respectively,

$$w_t = f'(\eta_t) = p_t h'(\psi_t), \tag{4}$$

$$r_t = f(\eta_t) - \eta_t f'(\eta_t) = p_t \left(h(\psi_t) - \psi_t h'(\psi_t)\right). \tag{5}$$

Households

The economy is inhabited by a large number of households. The representative household maximizes the present discounted value of its lifetime utility

$$\int_0^\infty u(c_t, l_t)\, e^{-\int_0^t \rho(\bar{c}_s, \bar{l}_s) ds} dt, \tag{6}$$

where l_t is the household's labor supply. The utility function $u(c_t, l_t)$ is concave, $u_c > 0$, $u_l < 0$, and consumption and leisure are normal goods. For the subjective discount rate, assume that it depends on the consumption average ($\overline{c_t}$) and the labor input average ($\overline{l_t}$), i.e.,

$$\rho = \rho\left(\overline{c_t}, \overline{l_t}\right), \quad \rho_{\bar{c}} \geq 0,\ \rho_{\bar{l}} \leq 0,\ \rho_{\bar{c}}^2 + \rho_{\bar{l}}^2 \neq 0. \tag{7}$$

As is well known in the literature on small open economy RBC models, the system would have a zero eigenvalue and hence be non-stationary if the discount rate were assumed to be a constant. Various approaches have been introduced in the literature to resolve this problem; see, in particular, Schmitt-Grohé and Uribe (2003).[4] Our specification here follows Schmitt-Grohé and Uribe (2003), but it is more general than that used in their paper.[5]

Capital mobility is assumed to be perfect in the sense that domestic households can borrow and lend freely in the world capital market at an exogenously given and constant real interest rate. Specifically, the household has net foreign debt d_t, denominated in units of the tradable consumption good, that pays a constant interest rate θ. The household's budget constraint is given by

$$\dot{d}_t = \theta d_t - w_t l_t - r_t k_t + p_t i_t + (1 + \tau_t)\, c_t, \tag{8}$$

where p_t is the relative price of investment goods in consumption goods, i_t is the capital good investment, and τ_t is the consumption tax rate, which we explain further below. The household's total capital stock, denoted by k_t, evolves according to the law of motion

$$\dot{k}_t = i_t - \delta k_t. \tag{9}$$

In addition, the market-clearing conditions for capital and labor inputs imply that

$$l_t = l_{1t} + l_{2t}, \qquad k_t = k_{1t} + k_{2t}. \tag{10}$$

[2] As is noted in Wen (2001), it has been found difficult to provide a rigorous intuition for indeterminacy, and his paper presents an explanation based on the permanent income. Giannitsarou (2007) gives a very intuitive explanation on taxation issues, which relies on large and dominating *intratemporal*income effects to rule out indeterminacy; but this cannot explain why determinacy can still arise with small or even no *intratemporal*income effect, as the results of Nourry et al. (2013) suggest. In contrast, the income effect that we refer to here is *intertemporal* and based on Wen (2001).

[3] Weder (2001) and Meng and Velasco (2004) use the same production structure in their small open economy models. The model here can also be extended to the case with both traded and nontraded capital goods.

[4] The zero root problem in continuous time models corresponds to the unit root problem in discrete time setups which are used in the literature on small open economy RBC models.

[5] Specifying a discount rate that depends on the average levels of some variables instead of the individual variables can considerably simplify the analysis. As $\rho_{\bar{c}} \geq 0$ ($\rho_{\bar{l}} \leq 0$) implies that average consumption (leisure) reduces the household's lifetime utility, it represents one kind of specification of the so-called "jealousy" effects. See also Drugeon (1996) and Bian and Meng (2004) for models using similar specifications.

Government

The only source of government revenue is the consumption tax. As in Nourry et al. (2013) and Nishimura et al. (2013) we assume a general balanced-budget consumption taxation rule with government expenditure depending on consumption c_t, i.e.,

$$G_t \equiv G(c_t) = \tau_t c_t \Longleftrightarrow \tau_t = \tau(c_t) = G(c_t)/c_t, \tag{11}$$

which endogenously determines the consumption tax rate. The government spending can be pro-cyclical, constant, or counter-cyclical if $\epsilon \equiv G'(c_t)\, c_t / G(c_t)$ is positive, zero or negative, respectively.[6]

3. Equilibrium and dynamics

The representative household maximizes its lifetime utility (6) subject to constraints (8) and (9), and conditions (3)–(5) and (10). The present-value Hamiltonian is given by

$$\begin{aligned}\mathcal{H} = {} & u(c_t, l_t)\, e^{-\int_0^t \rho(\bar{c}_s, \bar{l}_s) ds} + \mu_t(\theta d_t - w_t l_t - r_t k_t \\ & + p_t i_t + (1 + \tau(c_t))\, c_t) + \nu_t(i_t - \delta k_t),\end{aligned} \tag{12}$$

where μ_t and ν_t are the co-state variables. The household takes the consumption tax rate $\tau(c_t)$ as given. Define $\lambda_t = \mu_t e^{\int_0^t \rho(\bar{c}_s, \bar{l}_s) ds}$. The first-order conditions are

$$u_c = \lambda_t (1 + \tau(c_t)), \tag{13}$$

$$-u_l = \lambda_t w_t, \tag{14}$$

$$\dot{\lambda}_t = \lambda_t [\rho(c_t, l_t) - \theta], \tag{15}$$

$$\dot{p}_t = p_t \left[\theta + \delta - p_t^{-1} r_t\right], \tag{16}$$

together with the transversality conditions. Note that in equilibrium $\bar{c}_t = c_t$ and $\bar{l}_t = l_t$. From Eqs. (4) and (5), η_t and ψ_t can be expressed as functions of p_t. In addition,

$$\eta_p \equiv \frac{d\eta_t}{dp_t} = \frac{1 - \pi_\eta}{(\pi_\eta - \pi_\psi)\, \varepsilon_\eta} \frac{\eta_t}{p_t},$$

$$\psi_p \equiv \frac{d\psi_t}{dp_t} = \frac{1 - \pi_\psi}{(\pi_\eta - \pi_\psi)\, \varepsilon_\psi} \frac{\psi_t}{p_t},$$

where $\varepsilon_\psi = -\frac{h''\psi}{h'} > 0$, $\varepsilon_\eta = -\frac{f''\eta}{f'} > 0$, $\pi_\eta = \frac{\eta f'}{f}$ and $\pi_\psi = \frac{\psi h'}{h}$. As η_t and ψ_t are functions of p_t, $c_t = c(\lambda_t, p_t)$ and $l_t = l(\lambda_t, p_t)$ can be solved from Eqs. (11), (13) and (14). In addition, we have

$$c_\lambda \equiv \frac{\partial c}{\partial \lambda} = \frac{\delta_{ll} - \delta_{cl}}{\Delta} \frac{c}{\lambda}, \qquad l_\lambda \equiv \frac{\partial l}{\partial \lambda} = \frac{\delta_{cc} - \delta_{lc} - \frac{\tau}{1+\tau}\xi}{\Delta} \frac{l}{\lambda},$$

$$c_p \equiv \frac{\partial c}{\partial p} = \frac{1 - \pi_\eta}{\pi_\eta - \pi_\psi} \frac{\delta_{cl}}{\Delta} \frac{c}{p},$$

$$l_p \equiv \frac{\partial l}{\partial p} = -\frac{1 - \pi_\eta}{\pi_\eta - \pi_\psi} \frac{\delta_{cc} - \frac{\tau}{1+\tau}\xi}{\Delta} \frac{l}{p},$$

where $\xi = c\tau'(c)/\tau(c)$, $\delta_{11} = u_{cc}c/u_c$, $\delta_{12} = u_{cl}l/u_c$, $\delta_{21} = u_{cl}c/u_l$, $\delta_{22} = u_{ll}l/u_l$, and

$$\Delta = \delta_{cc}\delta_{ll} - \delta_{cl}\delta_{lc} - \delta_{ll}\frac{\tau}{1+\tau}\xi.$$

It is also easy to obtain the following equation

$$k_{2t} = \frac{\eta_t k_t - l_t}{\eta_t - \psi_t}.$$

As ψ_t, η_t, l_t are all independent of k_t, we have

$$\frac{\partial k_{2t}}{\partial k_t} = \frac{\eta_t}{\eta_t - \psi_t} = \frac{(1 - \pi_\psi)\, \pi_\eta}{\pi_\eta - \pi_\psi}.$$

The system can be reduced to the following four dynamic equations:

$$\dot{p}_t = p_t \left[\theta + \delta - \left(h(\psi_t) - \psi_t h'(\psi_t)\right)\right], \tag{17}$$

$$\dot{\lambda}_t = \lambda_t [\rho(c_t, l_t) - \theta], \tag{18}$$

$$\dot{k}_t = h(\psi_t)\, k_2(\lambda_t, p_t, k_t) - \delta k_t, \tag{19}$$

$$\dot{d}_t = \theta d_t - y_{1t} + [1 + \tau(c(\lambda_t))]\, c(\lambda_t). \tag{20}$$

Linearizing the system at the steady-state by using the partial derivatives derived above, we have (using x^* to denote the steady-state value of a variable x_t):

$$\begin{pmatrix} \dot{p}_t \\ \dot{\lambda}_t \\ \dot{k}_t \\ \dot{d}_t \end{pmatrix} = \begin{pmatrix} \mu_1 & 0 & 0 & 0 \\ * & \mu_2 & 0 & 0 \\ * & * & \mu_3 & 0 \\ * & * & * & \mu_4 \end{pmatrix} \begin{pmatrix} p_t - p^* \\ \lambda_t - \lambda^* \\ k_t - k^* \\ d_t - d^* \end{pmatrix}. \tag{21}$$

The four eigenvalues of the Jacobian are $\mu_1 = -\frac{1-\pi_\psi^*}{\pi_\eta^* - \pi_\psi^*}\psi^* h'$, $\mu_2 = \frac{\rho_c c^*(\delta_{ll} - \delta_{cl}) + \rho_l l^*\left(\delta_{cc} - \delta_{lc} - \frac{\tau^*}{1+\tau^*}\xi^*\right)}{\Delta}$, $\mu_3 = \frac{\delta}{\pi_\eta^* - \pi_\psi^*}\left[\left(1 - \pi_\psi^*\right)\pi_\eta^* \frac{k_1^*}{k_2^*} + \pi_\psi^*\left(1 - \pi_\eta^*\right)\right]$, and $\mu_4 = \theta > 0$. Notice that μ_1 and μ_3 always have opposite signs. As there are two predetermined variables and two jump variables, indeterminacy cannot happen. The system exhibits saddle-path stability and equilibrium determinacy if $\mu_2 < 0$. It has no equilibrium solution that converges to the steady state if $\mu_2 > 0$.

The intuition for the determinacy result is as follows. In expectation of future hikes in consumption tax rates, because of the income effect the households increase their current labor supply and the associated investment in capital goods. However, this does not require a large drop in consumption, as the households can achieve consumption smoothing by borrowing abroad to finance the needed investment. Thus, the reduction in consumption is insufficient to match the balanced-budget consumption taxation rule, which prevents households' expectations from becoming self-fulfilling.

The above determinacy result is in contrast to those obtained in the closed economy models of Nourry et al. (2013) and Nishimura et al. (2013) under the same balanced-budget fiscal policy, in which, when expecting higher tax rates, to invest more, the households may have to reduce their consumption by such a large magnitude that it matches the balanced-budget rule, causing beliefs-driven aggregate fluctuations. Thus, indeterminacy can happen in a closed economy as the households are unable to borrow abroad to achieve consumption smoothing.[7]

Note that the assumption of a perfect world capital market plays a crucial role in the determinacy result in the small open economy. In the intermediate case in which the small open economy faces an imperfect world capital market (e.g., if the real interest rate is not a constant but increases with the country's debt level), it can be shown that indeterminacy can still arise if the capital market

[6] Thus consumption c_t is assumed to be a proxy of the measure of the business cycle. This specification is more general than that used in Giannitsarou (2007), who assumes that government spending is pre-fixed (i.e., $\epsilon = 0$).

[7] The result obtained in this paper is also in contrast to those of Weder (2001) and Meng and Velasco (2003, 2004). They show, to the contrary, that in models with external effects in production because of the households' ability to smooth consumption, indeterminacy can occur more easily in a small open economy than in a closed economy. In their models, there is no government and indeterminacy happens because of the external effects on the real return on capital.

imperfections are strong and hence the cost of consumption smoothing is high.[8]

4. Conclusion

In this paper we show that for a small open economy facing a perfect capital market, indeterminacy cannot occur under the balanced budget fiscal policy based on consumption taxation. This result is in contrast to those obtained in some recent closed economy models, and it suggests that if the government relies on changes in consumption tax rates to achieve a balanced budget then an integrated world capital market can help stabilize the economy.

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[8] The determinacy result of this paper may be most relevant to developed small open economies which are highly integrated in the world capital markets.