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# Income-cum-Consumption Tax Schedules as Stabilization Policy

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Productivity externalities create room for Keynesian-type stabilization to insulate the economy from belief-driven fluctuations. Conventional wisdom indicates that in a Benhabib-Farmer-Guo one-sector model, a progressive tax schedule operates like an automatic stabilizer that mitigates business cycle fluctuations, but in an indeterminate two-sector real business cycle model a regressive, rather than a progressive, tax policy stabilizes the economy against sunspot-driven fluctuations. This paper proposes an alternative policy – an income tax-cum-consumption tax schedule – to stabilize the economy against sunspot fluctuations. We show numerically that the government can suppress belief-driven fluctuations by implementing a tax switch decreasing the income tax and increasing the consumption tax. This result is robust not only in a two-sector model with sector-specific externalities, but also in a one-sector model with aggregate productivity externalities.

Keywords: income tax-cum-consumption tax schedules, tax shifting, stabilization, local indeterminacy, sunspot fluctuations
JEL classification: E32, E63, O41

## 1 Introduction

In the macroeconomics literature, there have been a vast number of articles that have established the existence of indeterminate equilibrium paths.

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Based on the seminal studies of Benhabib and Farmer (1994) and Farmer and Guo (1994), it is well-known that in a one-sector model with increasing returns to scale, an indeterminate steady state can be generated if aggregate returns to scale are sufficiently strong. Indeterminacy potentially indicates that agents' expectations concerning the future can be self-fulfilling and, as a result, the so-called "animal spirits" may generate business cycle fluctuations without any change in economic fundamentals. This creates room for Keynesian-type stabilization to insulate the economy from belief-driven fluctuations. For example, Guo and Lansing (1998), Christiano and Harrison (1999), and Dromel and Pintus (2007) and Dromel and Pintus (2008) propose that, in a Benhabib-Farmer-Guo one-sector model a progressive tax schedule operates like an automatic stabilizer that mitigates business cycle fluctuations. By contrast, in a calibrated two-sector real business cycle (RBC) model with only sector-specific externalities, Guo and Harrison shows that a regressive tax, rather than a progressive tax, policy can stabilize the economy against belief-driven fluctuations.[1]

Along this line of research, this paper attempts to propose an alternative tax policy, rather than the income-dependent (progressive/regressive) tax schedule, to stabilize the economy against sunspot fluctuations in an indeterminate two-sector RBC model.[2] To be specific, we extend the two-sector (consumption and investment sectors) model of Benhabib and Farmer (1996) and Harrison (2001) by considering an income tax-cum-consumption tax schedule. The income tax-cum-consumption tax schedule refers to a combination of consumption tax and income tax. A major tax structure change involving a shift away from a direct income tax towards an indirect consumption tax has been an important concern to most industrialized countries. This kind of tax reform has been adopted by Italy (in 1972), the UK (in 1979), New Zealand (in 1984 and 2010), Japan (in 1987), Australia (in 2000), and the Netherlands (in 2001).[3] Whether the income tax should be replaced by a consumption tax has also become one of the main

[1] By using different models with the good and education sectors, Devereux and Love (1995), Wang and Yip (1995), and Bond, Wang, and Yip (1996) have analyzed the relationship between macroeconomic instability and factor taxes.

[2] Recently, Chang et al. (2015) turn the attention to the interrelations between sectoral composition of public spending and equilibrium (in) determinacy in a two-sector RBC model with positive productive externalities in investment.

[3] See the Tax Policy Studies of the OECD (2004) and Simon and Clinton (2008) for an overview of the tax reforms of industrialized countries.

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questions in the recent U.S. tax debate, spurred by the 2005 report of an Advisory Panel on Tax Reform. In the theoretical literature, a tax switch from a decrease in income tax to an increase in consumption tax has also been an important issue in public finance and macroeconomics over the past three decades. Many studies, such as Atkinson and Stiglitz (1976), Summers (1981), Abel and Blanchard (1983), Auerbach, Kotlikoff, and Skinner (1983), and Chamley (1985), have pointed out that a consumption tax could result in less distortion than an income tax and could eliminate the bias against investment and savings inherent in the income tax system. In this study, we attempt to show that a tax shifting from an income tax to a consumption tax can stabilize the economy against belief-driven fluctuations. Recently, Giannitsarou (2007) and Xue and Yip (2013) have examined the role of consumption taxation in the relationship between balanced budget rules and aggregate instability in a neoclassical growth model and monetary model, respectively. Our study obviously differs from theirs, given that (i) we focus on an income tax-cum-consumption tax schedule, which combines consumption tax and income tax and (ii) our analysis is based on a two-sector model with sector-specific externalities, instead of a one-sector model with balanced budget rules.

Why can such an income tax-cum-consumption tax schedule be an effective tool for establishing macroeconomic stability when the economy is confronted with sector-specific externalities? The main rationale is the following. When agents optimistically expect a higher future rate of return on capital, they will reduce today's consumption for more investment, thus increasing the future capital stock. If there are high enough sectoral externalities, a convex production possibility frontier (PPF) implies that a shift in the resources from the production of the consumption good towards the investment good will lower the present relative price of the investment good. Thus, the real rate of return on capital will rise. Consequently, the agents' optimistic expectations become self-fulfilling and hence the economy suffers from the belief-driven fluctuations. Logically, to suppress sunspot fluctuations, the government's policy has to prevent agents from cutting present consumption for more capital accumulation in the future and to reverse the downward trend in the relative price of investment goods. Our numerical analysis indicates that a tax shifting away from an income tax towards a consumption tax can increase not only output, but consumption as well. Although an increase in the consumption tax gives rise to a negative effect on consumption, a reduction in the income tax gives rise to a

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positive wealth effect which raises output and hence consumption as well.[4] Because the wealth effect dominates, consumption increases following such a tax shift. It turns out that the present consumption is enhanced and the relative price of investment goods rises in response. As a result, the real future return on capital decreases and thus the income tax-cum-consumption tax schedule (tax switch) prohibits agents' optimistic expectations from being self-fulfilling. A particular emphasis is that since tax shifting away from an income tax towards a consumption tax increases both output and consumption, in our model consumption is procyclical in relation to output. This positive consumption-GDP correlation is in accordance with the data on business cycles in most countries.

Our numerical analysis indicates that an effective income tax-cum-consumption tax schedule can insulate the economy from belief-driven fluctuations caused by sectoral externalities.[5] To be more specific, a tax combination, involving a higher consumption tax and a lower income tax, can remove local indeterminacy and suppress belief-driven fluctuations. This potentially indicates that (i) the steady-state equilibrium could be determinate for the economy in which the tax schedule is structured by combining a higher consumption tax with a lower income tax, and (ii) for an indeterminate economy a tax shift away from an income tax towards a consumption tax could stabilize the economy against sunspot fluctuations. Notably, either a single constant income tax rate or a single constant consumption tax rate cannot have a stabilizing effect on the economy, and therefore an income tax-cum-consumption tax schedule is necessary for suppressing sunspot fluctuations. We also point out that the stabilization of the income tax-cum-consumption tax schedule is robust not only in a two-sector model with the sectoral externalities of the investment and consumption sectors, but also in a one-sector model with the aggregate productivity externalities.

The remainder of this paper is organized as follows. Section 2 presents the benchmark framework with the externality in the investment sector and

[4]Given that a consumption tax involves less distortion than an income tax to economic *efficiency*, several studies have argued that, as the result of a strong wealth effect, such a tax switch results in either a higher level of output (Chamley, 1985) or a higher rate of economic growth (Pecorino (1993) and Pecorino (1994) and Turnovsky (2000)).

[5]Giannitsarou (2007) argues that the economy can be immune from sunspot fluctuations caused by a balanced budget rule, if the government finances its expenditures via an endogenous consumption tax.

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Section 3 analyzes the (in)determinacy properties. Section 4 shows numerically how an income tax-cum-consumption tax schedule can suppress aggregate instability arising from animal spirits. Finally, Section 5 concludes.

## 2 The Model

The model is an extension of Benhabib and Farmer (1996) and Harrison (2001) in which we consider the government's income tax-cum-consumption tax schedules. Consider an economy consisting of households, firms and a government. Households derive utility from consumption and leisure. There are two sectors – the consumption good and investment good sectors. The typical firm in each sector produces with a constant returns-to-scale technology and has access to sector-specific externalities. The externalities may lead the steady-state equilibrium to be indeterminate so that the economy confronts endogenous business cycles. To focus our point, the economy-wide externalities are abstracted from the analysis. The government levies income and consumption taxes to finance its spending. In particular, the government attempts to design an income tax-cum-consumption tax schedule in order to stabilize the economy against sunspot fluctuations.

### 2.1 Firms

Each consumption and investment good is produced by a decentralized competitive sector and by using capital $K_t$ and labor $L_t$ in competitive factor markets. The production technologies of a typical firm in the consumption good and investment good sectors are, respectively:

$$Y_{C,t} = \left(K_{C,t}\right)^a \left(L_{C,t}\right)^b \quad \text{and} \quad Y_{I,t} = B_t \left(K_{I,t}\right)^a \left(L_{I,t}\right)^b, \quad \text{with} \quad a + b = 1, \tag{1}$$

where $K_{C,t}$ and $L_{C,t}$ ($K_{I,t}$ and $L_{I,t}$) denote the capital and labor services in the consumption (investment) sector. The term $B_t$ captures the productive externality in the investment sector, which is given by:

$$B_t = \left(\bar{K}^a_{I,t} \bar{L}^b_{I,t}\right)^{\theta_I}, \tag{2}$$

where the relevant variables with a bar "–" denote the sector-wide average levels and $\theta_I$ represents a measure of sector-specific externalities. We focus only on the sectoral externality of the investment sector, since the specific

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externality of the consumption sector does not play an important role in terms of generating the equilibrium indeterminacy (see Harrison (2001)).[6]

Denote $r_t$, $w_t$, $P_t$ as the interest rate, the wage rate, and the relative price of the investment good to the consumption good, respectively. Thus, the firms' first-order conditions for profit maximization in both sectors are given by:

$$r_t = aY_{C,t}/K_{C,t} \quad \text{and} \quad w_t = bY_{C,t}/L_{C,t}, \tag{3}$$

$$r_t = aP_tY_{I,t}/K_{I,t} \quad \text{and} \quad w_t = bP_tY_{I,t}/L_{I,t}. \tag{4}$$

Since factors can be perfectly mobile across both sectors, the so-called "factor price equalization" indicates that the workforce (capital) will move around until the wage (interest) rates in both sectors are equal. Let $\mu_{K,t}$ and $\mu_{L,t}$, respectively, be the fractions of capital $K_t$ and labor $L_t$ used in the consumption good industry. Hence, $\mu_{K,t} = K_{C,t}/K_t$ and $\mu_{L,t} = L_{C,t}/L_t$ are the relative factor intensities. Since firms use identical technologies and face equal factor prices across the two sectors, factor intensities must be identical across these two sectors, i.e., $\mu_{K,t} = \mu_{L,t} = \mu_t$. Given this and factor price equalization, we can easily see that $P_tY_{I,t} = (1 - \mu_t/\mu_t)Y_{C,t}$. Thus, the PPF can be expressed as follows:

$$Y_t = Y_{C,t} + P_tY_{I,t} = \frac{1}{\mu_t}Y_{C,t} = K_t^aL_t^b. \tag{5}$$

It is follows from (3)-(5) that the slope of the PPF is the relative price $P_t = 1/B_t = [(1 - \mu_t)K_t^aL_t^b]^{-\theta_I}$, which is crucially related to factor intensity $\mu_t$. If there is no externality ($B_t$ is constant), the PPF turns out to be linear, while in the presence of the specific-sector externality the PPF is convex, as shown in Figure 1. As emphasized by Harrison (2001), the relative price $P_t$ (or factor intensity $\mu_t$) plays a key role in terms of determining the dynamics of a competitive equilibrium.

## 2.2 Households

The economy is populated by a unit measure of identical infinitely lived households. A representative household acts to maximize the following dis-

[6]This simplification, on the one hand, makes our exposition more concise and, on the other hand, makes our point more striking. Nonetheless, our results still hold, even though the externality of the consumption sector is taken into account (See Section 4 and Appendix B).

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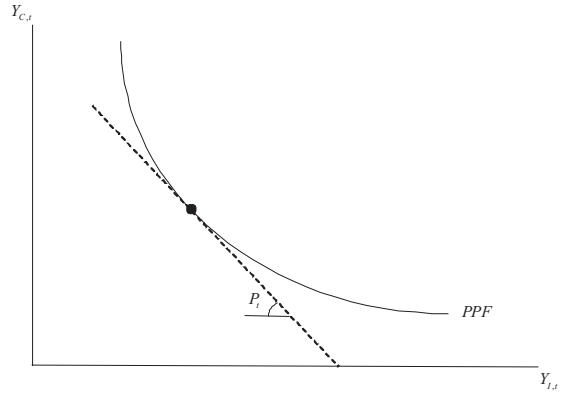



Figure 1: Production possibility frontier

counted present value of a utility function which is separable in consumption $C_t$ and labor $L_t$:

$$\max \int_0^{\infty} \left[ \ln C_t - \frac{L_t^{1+\chi}}{1+\chi} \right] e^{-\rho t} dt, \tag{6}$$

where $\rho$ is the subjective discount rate and $\chi$ is the inverse of the labor supply elasticity. Given that the law of motion for capital is $\dot{K}_t = I_t - \delta K_t$, the budget constraint facing the representative household is:

$$\dot{K}_t = \frac{1}{P_t} \left[ \left(1 - \tau_{Y,t}\right) \left(w_t L_t + r_t K_t\right) - \left(1 + \tau_{C,t}\right) C_t + T_t \right] - \delta K_t, \tag{7}$$

where $\tau_Y$ is the income tax rate, $\tau_C$ is the consumption tax rate, and the $T_t$ are lump-sum transfers from the government. It is easy from (3)-(5) with factor aggregation constraints to show that $Y_t = w_t L_t + r_t K_t$ holds true.

The optimal conditions necessary for the household optimization problem are given by:

$$\frac{1}{C_t} = \frac{\Lambda_t \left(1 + \tau_{C,t}\right)}{P_t}, \tag{8}$$

$$L_t^{\chi} = \frac{b \left(1 - \tau_{Y,t}\right) K_t^a L_t^{b-1}}{C_t \left(1 + \tau_{C,t}\right)}, \tag{9}$$

$$\dot{\Lambda}_t = (\rho + \delta)\Lambda_t - \frac{a \left(1 - \tau_{Y,t}\right) K_t^{a-1} L_t^b}{C_t \left(1 + \tau_{C,t}\right)}, \tag{10}$$

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together with the transversality condition, $\lim_{t\to\infty} \Lambda_t K_t e^{-\rho t} = 0$, where $\Lambda_t$ is the co-state variable which can be interpreted as the shadow value of the capital stock, measured in utility terms. Equations (8) and (9) refer to the optimal conditions for consumption and labor, respectively, and (10) is the Euler equation of the shadow price of wealth.

### 2.3 Government

The government collects tax revenues from income and consumption taxes in order to finance lump-sum transfers and government spending $G_t$. Thus, the government budget constraint can be expressed as:

$$\tau_{Y,t} Y_t + \tau_{C,t} C_t = G_t + T_t. \tag{11}$$

In a two-sector model, the government can purchase consumption good $G_{C,t}$ and/or investment good $P_t G_{I,t}$, i.e., $G_t = G_{C,t} + P_t G_{I,t}$. To make our point more striking, the government expenditure is assumed to be wasteful and is not valued by private agents. Instead, the government attempts to design an effective income tax-cum-consumption tax schedule to stabilize the economy against sunspot fluctuations; the stabilization policy involves a tax switch, namely, shifting tax away from an income tax (a decrease in $\tau_{Y,t}$) towards a consumption tax (an increase in $\tau_{C,t}$). To focus on the tax policy, we assume the government expenditures on transfers, the purchase of the consumption good, and the purchase of the investment good are constant, i.e., $T_t = \bar{T}$, $G_{C,t} = \bar{G}_C$, and $G_{I,t} = \bar{G}_I$, in order to isolate the possible distortion caused by the government spending. We simultaneously consider both government spending and lump-sum transfers in order to satisfy the fiscal observation in practice. A particular emphasis is that when the government changes the income tax rate, the consumption tax rate must endogenously adjust in order to meet constraint (11). That is, under the income tax-cum-consumption tax schedule an exogenously-given flat income tax rate $\tau_{Y,t} = \tau_Y$ must be associated with an endogenously-adjusted consumption tax rate $\tau_{C,t}$.

In addition, substituting (11) into (7) yields the following aggregate resource constraint:

$$\dot{K}_t = \frac{1}{P_t}(Y_t - C_t - G_t) - \delta K_t. \tag{12}$$

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## 3 Competitive Equilibrium and Dynamic Analysis

Under aggregate consistency (i.e., $K_{I,t} = \overline{K}_{I,t}$ and $L_{I,t} = \overline{L}_{I,t}$), a competitive equilibrium is defined as a tuple of paths for quantities $\{C_t, K_t, L_t, Y_t\}_{t=0}^{\infty}$, prices $\{P_t, r_t, w_t, \Lambda_t\}_{t=0}^{\infty}$, and tax policy variables $\{\tau_{C,t}, \tau_Y\}_{t=0}^{\infty}$ that satisfy: (i) the firm's profit maximization conditions (3) and (4); (ii) the household's utility maximization conditions (8)–(10); (iii) the government's budget constraint (11); and (iv) the market-clearing conditions for both sectors: $Y_{C,t} = C_t + \bar{G}_C$ and $Y_{I,t} = I_t + \bar{G}_I$ (hence, the aggregate resource constraint (12)).

It follows from (5) and the market-clearing condition of the consumption sector $Y_{C,t} = C_t + \bar{G}_C$ that the factor intensity is given by:

$$\mu_t = \frac{C_t + \bar{G}_C}{Y_t}. \tag{13}$$

By some simple manipulations, (8) and (9) can be rewritten as:

$$\frac{1}{C_t} = \left[(1-\mu_t) K_t^a L_t^b\right]^{\theta_I} \Lambda_t \,(1+\tau_C)\,, \tag{8'}$$

$$L_t^{1+\chi} = \frac{b\,(1-\tau_Y)\,Y_t}{(1+\tau_C)\,C_t}. \tag{9'}$$

Accordingly, from (10) and (7) with (8'), we then have the following two differential equations:

$$\frac{\dot{\Lambda}_t}{\Lambda_t} = (\rho+\delta) - \frac{a\,(1-\tau_Y)\,Y_t}{(1+\tau_C)\,C_t \Lambda_t K_t}, \tag{14}$$

$$\frac{\dot{K}_t}{K_t} = \frac{(1-\tau_Y)\,Y_t - (1+\tau_C)\,C_t + \bar{T}}{(1+\tau_C)\,C_t \Lambda_t K_t} - \delta. \tag{15}$$

In the steady state, the economy is characterized by $\dot{\Lambda}_t = 0$ and $\dot{K}_t = 0$. Let the superscript "$\hat{}$" denote the steady-state value for relevant variables. Recalling $P_t = [(1-\mu_t) K_t^a L_t^b]^{-\theta_I}$, we can solve (11), (12), (13), (8'), (9'), (14), and (15) for seven stationary values of $\{\hat{C}, \hat{K}, \hat{L}, \hat{\Lambda}, \hat{Y}, \hat{\mu}, \hat{\tau}_C\}$.[7] By

[7] To be more specific, from (9'), (14) and (15), we can obtain the steady-state aggregate labor:

$$\hat{L} = \left[\frac{b(\rho+\delta)}{\rho + (1-a)\delta}\right]^{\frac{1}{1+\chi}}.$$

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substituting (11), (12), (13), (8'), (9') into (14) and (15), the economy's dynamical system can be reduced to a $2 \times 2$ one in terms of $\Lambda_t$ and $K_t$.

In line with Benhabib and Farmer (1996), we log-linearize these seven equations around the steady state values. By defining $\lambda_t = \ln \Lambda_t$, $k_t = \ln K_t$, $y_t = \ln Y_t$ and $c_t = \ln C_t$, the resulting equations allow us to construct the following $2 \times 2$ dynamic system in terms of $\lambda_t$ and $k_t$:

$$\dot{\lambda}_t = (\rho + \delta) - \frac{a\,(1 - \tau_Y)\, e^{y_t - c_t - \lambda_t - k_t}}{(1 + \tau_C)}, \tag{16}$$

$$\dot{k}_t = \frac{(1 - \tau_Y)\, e^{y_t - c_t - \lambda_t - k_t}}{(1 + \tau_C)} - e^{-\lambda_t - k_t} + \frac{\bar{T} e^{-c_t - \lambda_t - k_t}}{(1 + \tau_C)} - \delta, \tag{17}$$

where $y_t = \eta(k_t, \lambda_t, \tau_Y, G_I)$, $c_t = \varphi(k_t, \lambda_t, \tau_Y, G_C, G_I)$ and $\tau_{C,t} = \omega(k_t, \lambda_t, \tau_Y, G_C, G_I)$. The exact derivations are relegated to the Appendix A. Given the dynamic system, we can obtain the following trace and determinant of the Jacobian matrix:

$$Tr(J) = \rho - \frac{(\rho + \delta)\Omega}{a\left(1 + \hat{\tau}_C\right)} \gtreqless 0, \tag{18}$$

$$Det(J) = \frac{\left(1 + \hat{\tau}_C\right)(\rho + \delta)^2 \hat{C} \Phi}{a\,(1 - \tau_Y)\,\hat{Y}} \gtreqless 0, \tag{19}$$

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Moreover, by using (8'), (9'), (11), (13), (14), and (15), we can obtain:

$$\hat{\Lambda} = \left[\frac{a}{\rho + (1 - a)\delta}\right] \frac{1}{\hat{K}},$$

$$\hat{K} = \left[\frac{\rho + \delta}{a(1 - \tau_Y)(1 - \hat{\mu})^{\theta_I}} \hat{L}^{-b(1+\theta_I)}\right]^{\frac{1}{a(1+\theta_I)-1}},$$

$$\hat{\mu} = \tau_Y + \frac{b(1 - \tau_Y)}{\hat{L}^{1+\chi}} - (1 - \hat{\mu})^{-\theta_I} \left[\frac{\rho + \delta}{a(1 - \tau_Y)(1 - \hat{\mu})^{\theta_I}}\right]^{\frac{-a(1+\theta_I)}{a(1+\theta_I)-1}}$$
$$\hat{L}^{\frac{b(1+\theta_I)}{a(1+\theta_I)-1}} G_I - T \left[\frac{\rho + \delta}{a(1 - \tau_Y)(1 - \hat{\mu})^{\theta_I}}\right]^{\frac{-a}{a(1+\theta_I)-1}} \hat{L}^{\frac{b}{a(1+\theta_I)-1}}.$$

Accordingly, we can solve the steady-state $\hat{\Lambda}$, $\hat{K}$, and $\hat{\mu}$ from the three equations above. Thus, all other endogenous variables can be easily derived further.

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with

$$\Omega = \left\{ \left(1+\hat{\tau}_C\right)\left[a\left(\eta_\lambda - \varphi_\lambda\right) - \left(\eta_k - \varphi_k\right)\right] - a\omega_\lambda + \omega_k \right.$$
$$\left. + \frac{\bar{T}}{\hat{Y}}\frac{\left(1+\hat{\tau}_C\right)}{\left(1-\tau_Y\right)}\left[\varphi_k + \frac{\omega_k}{\left(1+\hat{\tau}_C\right)}\right]\right\},$$
$$\Phi = \varphi_\lambda - \varphi_k + \frac{\omega_\lambda - \omega_k}{\left(1+\hat{\tau}_C\right)} + \left[\frac{\bar{T}}{\hat{C}}\frac{1}{\left(1+\hat{\tau}_C\right)} - 1\right]\left(\eta_\lambda - \eta_k\right)$$
$$+ \frac{\bar{T}}{\hat{C}}\frac{1}{\left(1+\hat{\tau}_C\right)}\left(\eta_\lambda\varphi_k - \eta_k\varphi_\lambda\right) + \frac{\bar{T}}{\hat{C}}\frac{1}{\left(1+\hat{\tau}_C\right)^2}\left(\eta_\lambda\omega_k - \eta_k\omega_\lambda\right),$$

where

$$\eta_k \equiv \frac{\partial y_t}{\partial k_t},\ \eta_\lambda \equiv \frac{\partial y_t}{\partial \lambda_t},\ \varphi_k \equiv \frac{\partial c_t}{\partial k_t},\ \varphi_\lambda \equiv \frac{\partial c_t}{\partial \lambda_t},$$
$$\omega_k \equiv \frac{\partial \tau_{C,t}}{\partial k_t}, \quad \text{and} \quad \omega_\lambda \equiv \frac{\partial \tau_{C,t}}{\partial \lambda_t}.^{8}$$

In this model there is a jump variable $\lambda_t$ and a predetermined variable $k_t$. Local determinacy requires the system to exhibit saddle-point stability in that the two characteristic roots are of opposite signs, i.e., $Det(J) < 0$. However, the equilibrium exhibits indeterminacy if the economy has two roots with negative real parts, i.e., $Det(J) > 0$ and $Tr(J) < 0$.[9] It is clear from (19) that $\Phi > 0$ is a necessary (but not sufficient) condition for the steady state to be indeterminate. This condition can nest that in the Benhabib and Farmer (1996) model. If we ignore the government's role ($\tau_{C,t} = \tau_Y = G_t = \bar{T} = 0$), the necessary condition is reduced to: $[(\theta_I)/(1+\chi)(1-\hat{\mu})][b + (\hat{C}/\hat{Y})(1+\chi-b)] - (1+\chi-b/1+\chi) > 0$. Under such a situation, the steady-state equilibrium is indeterminate when $\theta_I$ is high enough, as indicated by Benhabib and Farmer (1996) and Harrison (2001).[10] In the presence of the government sector, if a tax shifting away from an income tax towards a consumption tax can reverse the sign of

[8] Analytically, the steady-state variables $\{\hat{C}, \hat{K}, \hat{L}, \hat{\Lambda}, \hat{Y}, \hat{\mu}, \hat{\tau}_C\}$ in equation (18) and (19) can be obtained from (11), (12), (13), (8'), (9'), (14), and (15). See Footnote 7 for details.

[9] The equilibrium exhibits a source if the system has two roots with positive real parts.

[10] It is easy to show that the stabilizing effect of the income tax-cum-consumption tax schedule is still robust by setting $G_t = 0$. Because if $G_t > 0$, the households are aware

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Table 1: Benchmark parameter values

| Definition | Parameter | Value |
|---|---|---|
| Capital share | $a$ | 0.3 |
| Labor share | $b$ | 0.7 |
| Sector-specific externality | $\theta_I$ | 0.108 |
| Time preference rate | $\rho$ | 0.082 |
| Depreciation rate of capital | $\delta$ | 0.1324 |
| Inverse of the labor supply elasticity | $\chi$ | 1.05 |
| Income tax rate | $\tau_Y$ | 0.31 |

$\Phi$, the income tax-cum-consumption tax schedule can remove indeterminacy caused by sectoral externalities and hence stabilize the economy against sunspot fluctuations. Apparently, the model is too complicated (if not rendering it impossible) to analytically examine the conditions for local (in) determinacy. We then conduct a numerical analysis to which we now turn.

## 4 Equilibrium Indeterminacy and Income Tax-Cum-Consumption Tax Schedules

This section will perform a simple numerical analysis in order to derive the policy implication of an effective income tax-cum-consumption tax schedule for endogenous business cycle fluctuations.

### 4.1 Benchmark parameterizations

All benchmark parameterizations are summarized in Table 1. By following Benhabib and Farmer (1996), we set the capital and labor shares as $a = 0.3$ and $b = 0.7$, respectively. In conformity with the estimate of Harrison (1997), the parameter of the sector-specific externality in the investment good sector is given by $\theta_I = 0.108$. In addition, we follow Giannitsarou (2007) and set the income tax rate as $\tau_Y = 0.31$, which is

that today's investment will be crowded out by the government's purchases. Due to this crowding-out effect, government spending gives rise to an additional effect which prohibits agents' optimistic expectations from being self-fulfilling and, as a result, stabilizes the economy against sunspot fluctuations.

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consistent with the US data. Moreover, we use the time preference rate of the USA, $\rho = 0.082$, estimated by Galí, Gertler, and López-Salido (2001), as a benchmark value. In the benchmark, we also specify that $\hat{P}\bar{G}_I/\hat{G}(= \bar{G}_C/\hat{G}) = 0.5$, which roughly satisfies the observation in the OECD countries during 2001–2010.[11] In addition, we set the capital depreciation rate $\delta = 0.132$ and the inverse of the labor supply elasticity $\chi = 1.05$. Both parameters fall in empirically plausible ranges, for example, the value of $\chi$ is in conformity with the estimate studied by Chetty et al. (2011) from the US micro data. With these parameterizations, we can calculate that the consumption-output ratio is $\hat{C}/\hat{Y} = 0.6154$, the investment-output ratio is $\hat{P}\hat{I}/\hat{Y} = 0.1949$, the government-output ratio is $\hat{G}/\hat{Y} = 0.1897$, the output-labor ratio $\hat{Y}/\hat{L} = 1.11$, and the endogenous consumption tax rate is $\hat{\tau}_C = 0.06$.

### 4.2 Numerical analysis: Stabilization and tax combination

Figure 2 indicates that the equilibrium indeterminacy occurs in the shaded area for positive values of $(\theta_I, \tau_Y)$. This implies that a higher degree of the sector-specific externalities $\theta_I$ is more likely to generate indeterminacy, while a higher rate of consumption tax $\tau_C$ is more likely to generate determinacy. The former confirms the result of Harrison (2001). The latter indicates that an income tax-cum-consumption tax schedule which involves a higher consumption tax (which is associated with a lower income tax) could stabilize the economy against sunspot fluctuations.[12] Figure 3 provides a clearer graphical approach to our understanding of the stabilizing effect of a tax combination. To have the stabilizing effect, the combination of $(\tau_C, \tau_Y)$ must be located in the area to the south-east of the $Det(J) = 0$ line (the area of determinacy).[13] This potentially indicates that (i) the steady-state

[11] By following the classification of Kneller, Bleaney, and Gemmell (1999), we aggregate the OECD's functional classifications of fiscal data (OECD stat.) into two main categories, namely government investment and government consumption. The former includes general public services, defence, housing, educational and health expenditures, while the latter includes public order and safety, economic affairs, environmental protection, social protection, and recreational expenditures.

[12] By substituting the steady-state $\hat{C}$ and $\hat{Y}$ into (11), it is easy to show the negative relationship between the consumption tax and the income tax.

[13] We have checked that in the $(\tau_C, \tau_Y)$ space given $\theta_I = 0.108$ (the benchmark value) $Tr(J) < 0$ always holds true under empirically possible values of income and consumption

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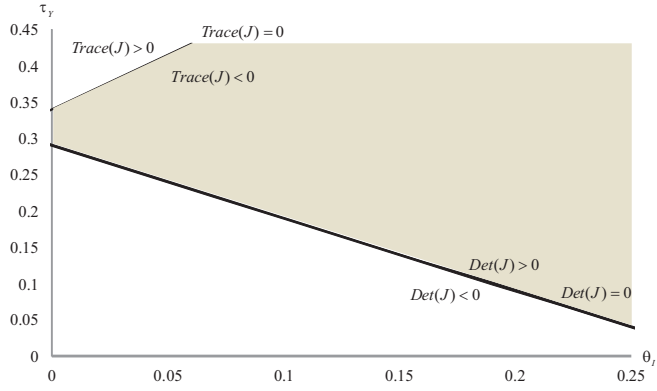



Figure 2: (In) Determinacy in the $(\tau_Y, \theta_I)$ space

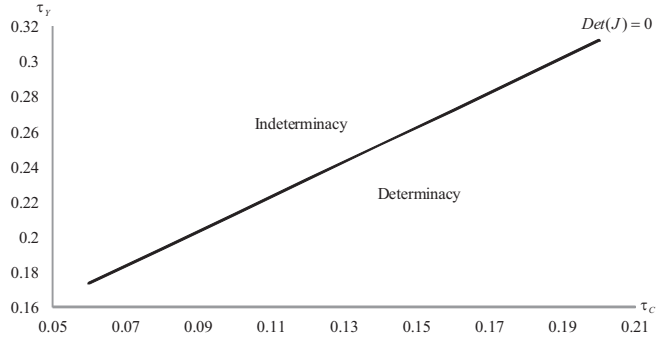



Figure 3: (In) Determinacy in the $(\tau_C, \tau_Y)$ space

equilibrium is determinate for the economy in which the tax schedule exhibits a higher consumption tax and a lower income tax, and (ii) for an indeterminate economy a tax shift away from an income tax towards a consumption tax could remove local indeterminacy and stabilize the economy against sunspot fluctuations.

taxes, say, $\tau_Y \leq 0.6$ and $\tau_C \leq 0.6$. Thus, we only show $Det\,(J)$ in Figure 3 and hence after.

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In order to glean the intuition for the stabilizing effect of the tax switch, we derive the following Euler equation in a discrete-time manner for ease of illustration:

$$\frac{\Lambda_{t+1}}{\Lambda_t} = \frac{1}{\beta \cdot \mathrm{ATRK}_{t+1}} = \frac{1}{\beta} \cdot \frac{1}{\frac{[(1-\tau_Y)r_{t+1}+(1-\delta)P_{t+1}]}{P_t}}, \tag{20}$$

where $\beta = 1/(1+\rho)$ is the discount factor and $\mathrm{ATRK}_{t+1} = \{[(1-\tau_Y)r_{t+1}+(1-\delta)P_{t+1}]\}/(P_t)$ is the real after-tax return on capital in period $t+1$. As regards $\mathrm{ATRK}_{t+1}$, the first term $[(1-\tau_Y)r_{t+1}]/(P_t)$ presents the after-tax real interest rate, discounted by the current price $P_t$, and the second term $((1-\delta)P_{t+1})/(P_t)$ can be viewed as the real capital gain or loss, due to the change in the relative price. The latter plays a crucial role in our analysis, as we will see later.

The economy starts from the steady-state equilibrium in period $t$. For the sake of exposition, we first consider the economy without the government sector ($\tau_{C,t} = \tau_Y = G_t = \bar{T} = 0$). Suppose that agents are optimistic about the future returns on capital, say, the next period's return on capital $\mathrm{ATRK}_{t+1}$. In acting upon this belief, the household will sacrifice consumption today $C_t$ for more investment $I_t$, implying that today's shadow price $\Lambda_t$ is increased above its steady-state level. Today's investment accumulates more capital stock (say, $K_{t+1}$) and hence increases output (say, $Y_{t+1}$) in the future. Consequently, the future consumption $C_{t+1}$ increases, referring to a lower shadow price of wealth in the future $\Lambda_{t+1}$ and, accordingly, the value of the LHS of (20) decreases. In order to remain in equilibrium, the RHS of (20) must also decrease. Benhabib and Farmer (1996) and Harrison (2001) indicate that if investment sector externalities $\theta_I$ are high enough, the PPF is convex, as shown in Figure 1. A convex PPF implies that a shift in the resources towards the production of a good will lower the relative price of that good. It turns out that today's relative price of capital $P_t$ decreases as today's consumption $C_t$ decreases, and tomorrow's relative price of capital $P_{t+1}$ increases as resources are shifted towards the consumption good sector $C_{t+1}$. Due to a lower $P_t$ and a higher $P_{t+1}$, the real capital gain $((1-\delta)P_{t+1})/(P_t)$ increases. Thus, the RHS of (20) decreases, even though the interest rate may fall because of the diminishing marginal productivity of capital. Since the agents' optimistic expectation becomes self-fulfilling, the steady-state equilibrium is indeterminate and the sunspot fluctuations occur.

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We now consider the government's tax policy. Intuitively, in order to avoid the situation where the agents' optimistic expectation becomes self-fulfilling, the tax policy has to prevent the agents from cutting today's consumption and, accordingly, reverse the downward trend in the relative price of the investment goods $P_t$. Our numerical analysis shows that tax shifting away from an income tax towards a consumption tax can increase not only output, but consumption as well. An increase in $\tau_{C,t}$ gives rise to a negative effect on consumption, but a reduction in $\tau_Y$ gives rise to the wealth effect which raises output and hence consumption as well. Since a consumption tax involves less distortion than an income tax on economic efficiency, the wealth effect dominates and hence consumption increases followed by such a tax shift.[14] Of importance, given that the tax shifting away from an income tax towards a consumption tax increases both output and consumption, in our calibrated economy consumption is procyclical in relation to output. This is in accordance with the data on business cycles in most countries.

On the one hand, the tax switch motivates agents to increase consumption today, as mentioned above. On the other hand, in the presence of government spending, households are aware that today's investment could be crowded out by the government's purchases. Since the trend of shifting resources towards investment is reversed, the present relative price of capital $P_t$ will increase, rather than decrease, provided that the PPF is convex. As a result, we can see from (20) that a decrease in the future returns on capital $\text{ATRK}_{t+1}$ (an increase in the RHS of (20)) contradicts the intertemporal Euler equation and this contradiction invalidates the initial rise in the expected return on capital. Given that a combination associating a higher consumption tax with a lower income tax can prohibit agents' optimistic expectations from being self-fulfilling, the steady-state equilibrium turns out to be determinate. This tax policy therefore stabilizes the economy against the belief-driven fluctuations.

In a calibrated two-sector RBC model with only sector-specific externalities, Guo and Harrison (2001) quantitatively show that a progressive tax no longer serves as an automatic stabilizer, removing sunspot fluctuations and that, by contrast, a regressive tax policy stabilizes the economy against sunspot-driven fluctuations. However, the required regressive tax policy that Guo and Harrison (2001) propose is rarely observed in the actual data (see,

[14] As mentioned in the Introduction, this strong wealth effect of a tax switch is supported by the studies which focus on the efficiency of tax switching (e.g., Chamley (1985)).

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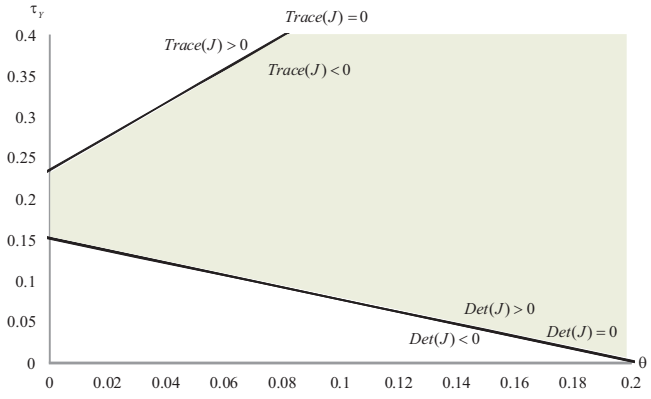



Figure 4: (In) Determinacy in the $(\tau_Y, \theta)$ space

for example, Wagstaff et al. (1999)). Under such a situation, the present study serves as an important complement to the relevant literature. We propose an alternative stabilization tax policy that is more plausible empirically. To stabilize the economy, a relevant combination of income and consumption taxes is necessary; either a single constant income tax rate or a single constant tax consumption tax rate cannot have a stabilizing effect to suppress sunspot fluctuations.

Before the end of this section, two extensions worth further discussions. First, it is important to check whether our results above are robust when we consider the productivity externalities not only in the investment good sector, but also in the consumption good sector. To do so, we follow Benhabib and Farmer (1996) and specify the productive externalities in the consumption and investment sectors, respectively, as follows:

$$A_t = \left(\bar{K}_{C,t}^{a} \bar{L}_{C,t}^{b}\right)^{\theta_C} \quad \text{and} \quad B_t = \left(\bar{K}_{I,t}^{a} \bar{L}_{I,t}^{b}\right)^{\theta_I}, \tag{21}$$

Based on this modification, we can rederive the trace and determinant of the Jacobian matrix, which is relegated to Appendix B. As shown in Figure 4, given $\theta_C = \theta_I = \theta = 0.108$, relative to the benchmark model (Figure 2), we now need a tax combination with a higher consumption tax rate and a lower income tax rate in order to overturn the indeterminate economy to a determinate one. Specifically, in the benchmark with $\theta_I = 0.108$

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the thresholds of the tax combination are $\tau_Y = 0.172$ and $\tau_C = 0.067$ so that the economy is determinate. However, in the model with both externalities in the consumption and investment sectors $\theta_I = \theta_C = 0.108$, the thresholds turn out to become $\tau_Y = 0.087$ and $\tau_C = 0.171$. That is, an effective consumption tax-cum-income tax schedule can still stabilize the economy against belief-driven fluctuations. Second, it is easy to show that the stabilization of the income tax-cum-consumption tax schedule is also robust in a one-sector model with the aggregate productivity externalities. In line with Benhabib and Farmer (1994), the production function is given by: $Y_t = Z_t K_t^a L_t^b$, with aggregate production externalities $Z_t = (\bar{K}_t^a \bar{L}_t^b)^\theta$, where $\theta$ measures the extent of the production externalities. Meanwhile, the government budget constraint is modified as: $\tau_Y Y_t + \tau_{C,t} C_t = \bar{G} + \bar{T}$. Accordingly, we can show easily that to overturn this condition of $Det(J) < 0$, the income tax-cum-consumption tax schedule must satisfy:

$$\tau_Y < \tau_Y' = \frac{b(1+\theta)\hat{K}[\rho + \delta(1-a)]}{a\hat{Y}\{[1-a(1+\theta)](1+\chi) - b(1+\theta)\}} + \frac{\hat{C} + \bar{G} + \bar{T}}{\bar{Y}}.$$

Notice that the condition of $Tr(J) < 0$ is automatically held, if we assume the Benhabib and Farmer (1994) condition $b(1+\theta) > (1+\chi)$ is valid. Under such a situation, a tax shifting away from an income tax towards a consumption tax can remove indeterminacy caused by aggregate production externalities in the one-sector model, provided that the threshold of $\tau_Y' > 0$.

## 5 Concluding Remarks

By extending the analysis of Benhabib and Farmer (1996) and Harrison (2001), this paper has revisited the issue of aggregate instability arising from animal spirits. In a calibrated two-sector RBC model with only sector-specific externalities, Guo and Harrison (2001) have quantitatively shown that a progressive tax cannot serves as an automatic stabilizer, removing sunspot fluctuations, while a regressive tax policy can stabilize the economy against sunspot-driven fluctuations. However, the required regressive tax policy that Guo and Harrison (2001) propose is rarely observed in practice. To fix the problem, this paper has proposed an alternative policy rule that can remove sunspot fluctuations. It has been shown numerically that an income tax-cum-consumption tax schedule which involves a tax switch away from an income tax towards a consumption tax can stabilize the econ-

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omy against sunspot fluctuations. This result is robust not only in a two-sector model with both the specific externalities of the consumption and investment sector and in an one-sector model with aggregate productivity externalities.

Weder (2001), Meng and Velasco (2003) and Meng and Velasco (2004) show that in a two-sector small open economy, the condition for local indeterminacy can be satisfied more easily than in a closed economy. In other words, a small open economy is more likely to confront aggregate instability arising from animal spirits. Thus, it is also interesting to extend our model to a small open economy one. The extended analysis will enable us to examine whether a tax switch away from an income tax towards a consumption tax is still robust, being capable of insulating the small open economy from belief-driven fluctuations.

## Appendix A

The exact derivations are given by:

$$\frac{\partial y_t}{\partial k_t} = \frac{a}{\Delta}\frac{\hat{C}}{\left(1+\hat{\tau}_C\right)}\left[-\frac{\theta_I}{\left(1-\hat{\mu}\right)}\frac{\hat{C}\left(1+\hat{\tau}_C\right)-\hat{P}G_I}{\hat{Y}}+1\right],$$

$$\frac{\partial y_t}{\partial \lambda_t} = \frac{1}{\Delta}\frac{b}{1+\chi}\frac{\hat{C}}{\left(1+\hat{\tau}_C\right)}\left[1+\frac{\hat{P}G_I}{\hat{Y}}\frac{\theta_I}{\left(1-\hat{\mu}\right)}\right],$$

$$\frac{\partial y_t}{\partial \tau_Y} = \frac{b\hat{C}}{(1+\chi)\left(1+\hat{\tau}_C\right)\Delta}\left\{\frac{1}{(1-\tau_Y)}\right.$$
$$\left.\left[-1+\frac{\theta_I}{(1-\hat{\mu})}\frac{\hat{C}\left(1+\hat{\tau}_C\right)-\hat{P}G_I}{\hat{Y}}\right]-\frac{\theta_I}{(1-\hat{\mu})}\right\},$$

$$\frac{\partial y_t}{\partial \bar{G}_I} = \frac{\hat{C}\hat{P}b}{\Delta\hat{Y}(1+\chi)\left(1+\hat{\tau}_C\right)}\frac{\theta_I}{(1-\hat{\mu})},$$

$$\frac{\partial c_t}{\partial k_t} = \frac{-a\hat{Y}}{\Delta\left(1+\hat{\tau}_C\right)}\left[\frac{\hat{C}\left(1+\hat{\tau}_C\right)-\hat{P}G_I}{\hat{Y}}\frac{\theta_I}{(1-\hat{\mu})}-\tau_Y\right],$$

$$\frac{\partial c_t}{\partial \lambda_t} = \frac{\hat{Y}}{\Delta\left(1+\hat{\tau}_C\right)}\left[-\left(1-\frac{b}{1+\chi}\right)\left(1+\hat{\tau}_C\right)\frac{\hat{C}}{\hat{Y}}+\tau_Y\frac{b}{1+\chi}\right.$$

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$$+\frac{b\theta_I \hat{P} G_I}{(1+\chi)\left(1-\hat{\mu}\right)\hat{Y}}\Bigg],$$

$$\frac{\partial c_t}{\partial \tau_Y} = \frac{\hat{Y}}{\Delta\left(1+\hat{\tau}_C\right)}\left[\frac{\hat{C}\left(1+\hat{\tau}_C\right)-\hat{P}G_I}{\hat{Y}}\frac{b\theta_I}{(1-\tau_Y)(1+\chi)(1-\hat{\mu})}\right.$$
$$\left.+1-\frac{b}{1+\chi}\left(\frac{1}{1-\tau_Y}+\frac{\theta_I}{1-\hat{\mu}}\right)\right],$$

$$\frac{\partial c_t}{\partial \bar{G}_C} = \frac{1}{\Delta\left(1+\hat{\tau}_C\right)}\left\{\left(1-\frac{b}{1+\chi}\right)\frac{\theta_I}{(1-\hat{\mu})\hat{Y}}\left[\hat{C}\left(1+\hat{\tau}_C\right)-\hat{P}G_I\right]\right.$$
$$\left.-1+\frac{b}{1+\chi}\left[1+\frac{\theta_I(1-\tau_Y)}{1-\hat{\mu}}\right]\right\},$$

$$\frac{\partial c_t}{\partial \bar{G}_I} = \frac{-\hat{P}}{\Delta\left(1+\hat{\tau}_C\right)}\left[1-\frac{b}{1+\chi}\left(1+\frac{\theta_I}{1-\hat{\mu}}\right)\right],$$

$$\frac{\partial \tau_{C,t}}{\partial k_t} = \frac{a\hat{Y}}{\Delta}\left[\left(\frac{\hat{\tau}_C\hat{C}-\hat{P}G_I}{\hat{Y}}\right)\frac{\theta_I}{1-\hat{\mu}}-\tau_Y\left(1-\frac{\hat{C}\theta_I}{\hat{Y}(1-\hat{\mu})}\right)\right],$$

$$\frac{\partial \tau_{C,t}}{\partial \lambda_t} = \frac{\hat{Y}}{\Delta}\left\{\frac{\hat{P}G_I}{\hat{Y}}\left[\left(1-\frac{b}{1+\chi}\right)\left(1-\frac{\theta_I}{1-\hat{\mu}}\frac{\hat{C}}{\hat{Y}}\right)-\frac{b\theta_I}{(1+\chi)(1-\hat{\mu})}\right]\right.$$
$$\left.+\left(1-\frac{b}{1+\chi}\right)\frac{\hat{\tau}_C\hat{C}-\hat{P}G_I}{\hat{Y}}-\frac{b\tau_Y}{1+\chi}\right\},$$

$$\frac{\partial \tau_{C,t}}{\partial \tau_Y} = \frac{\hat{Y}}{\Delta}\left\{\frac{b\theta_I}{(1+\chi)(1-\hat{\mu})}-\frac{\hat{\tau}_C\hat{C}-\hat{P}G_I}{\hat{Y}}\frac{b\theta_I}{(1+\chi)(1-\tau_Y)(1-\hat{\mu})}\right.$$
$$\left.+\left(1-\frac{\theta_I}{1-\hat{\mu}}\frac{\hat{C}}{\hat{Y}}\right)\left[\frac{b}{(1+\chi)(1-\tau_Y)}-1\right]\right\},$$

$$\frac{\partial \tau_{C,t}}{\partial \bar{G}_C} = \frac{1}{\Delta}\left\{\left(1-\frac{b}{1+\chi}\right)\left[1-\frac{\theta_I\hat{C}\left(1+\hat{\tau}_C\right)}{(1-\hat{\mu})\hat{Y}}+\frac{\theta_I\hat{P}G_I}{(1-\hat{\mu})\hat{Y}}\right]\right.$$
$$\left.-\frac{b\theta_I(1-\tau_Y)}{(1+\chi)(1-\hat{\mu})}\right\},$$

$$\frac{\partial \tau_{C,t}}{\partial \bar{G}_I} = \frac{\hat{P}}{\Delta}\left\{\left(1-\frac{b}{1+\chi}\right)\left[1-\frac{\theta_I\hat{C}}{(1-\hat{\mu})\hat{Y}}\right]-\frac{b\theta_I}{(1+\chi)(1-\hat{\mu})}\right\}.$$

where

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$$\Delta = \frac{\hat{C}}{\left(1+\hat{\tau}_C\right)}\left\{1-\frac{b}{1+\chi}-\frac{\theta_I\left[\left(1+\hat{\tau}_C\right)\hat{C}-\hat{P}G_I\right]}{(1-\hat{\mu})\hat{Y}} + \frac{b\theta_I}{(1+\chi)(1-\hat{\mu})}\frac{\hat{C}-\hat{Y}+T+G_C}{\hat{Y}}\right\}.$$

## Appendix B

Based on (21), the trace and determinant of the Jacobian matrix are given by:

$$Tr(J) = \rho - \frac{(\rho+\delta)\Theta}{a\left(1+\hat{\tau}_C\right)} \gtreqless 0,$$

$$Det(J) = \frac{\left(1+\hat{\tau}_C\right)(\rho+\delta)^2\hat{C}\Psi}{a\left(1-\tau_Y\right)\hat{Y}} \gtreqless 0,$$

where

$$\Theta = \left\{\left(1+\hat{\tau}_C\right)\left[a\left(\eta_\lambda-\varphi_\lambda\right)-\left(\eta_k-\varphi_k\right)\right]-a\omega_\lambda + \omega_k+\frac{\bar{T}}{\hat{Y}}\frac{\left(1+\hat{\tau}_C\right)}{\left(1-\tau_Y\right)}\left[\varphi_k+\frac{\omega_k}{\left(1+\hat{\tau}_C\right)}\right]\right\},$$

$$\Psi = \varphi_\lambda-\varphi_k+\frac{\omega_\lambda-\omega_k}{\left(1+\hat{\tau}_C\right)}+\left[\frac{\bar{T}}{\hat{C}}\frac{1}{\left(1+\hat{\tau}_C\right)}-1\right]\left(\eta_\lambda-\eta_k\right) + \frac{\bar{T}}{\hat{C}}\frac{1}{\left(1+\hat{\tau}_C\right)}\left(\eta_\lambda\varphi_k-\eta_k\varphi_\lambda\right)+\frac{\bar{T}}{\hat{C}}\frac{1}{\left(1+\hat{\tau}_C\right)^2}\left(\eta_\lambda\omega_k-\eta_k\omega_\lambda\right),$$

$$\eta_k \equiv \frac{\partial y_t}{\partial k_t} = \frac{a}{\nabla}\left\{(1+\theta_C)\left[1-\frac{\hat{C}}{\hat{Y}}\left(\frac{\theta_C}{\hat{\mu}}+\frac{\theta_I}{1-\hat{\mu}}\right)+\frac{b\left(\theta_C-\theta_I\right)}{1+\chi}\right]\left(\hat{C}-\frac{\hat{P}G_I}{1+\hat{\tau}_C}\right)-\frac{\left(\hat{\tau}_C\hat{C}-\hat{P}G_I\right)(1+\theta_C)}{1+\hat{\tau}_C}-\left(\theta_C-\theta_I\right)\left[\frac{b\left(1+\theta_C\right)}{1+\chi}-\frac{\theta_C}{\hat{\mu}}\frac{\hat{C}}{\hat{Y}}\right]\left(\hat{C}-\frac{\hat{P}G_I}{1+\hat{\tau}_C}\right)\right\},$$

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$$\eta_\lambda \equiv \frac{\partial y_t}{\partial \lambda_t} = \frac{\hat{C}}{\nabla}\left\{\frac{b}{1+\chi}\frac{(1+\theta_C)}{(1+\hat{\tau}_C)} - \frac{\theta_C}{\hat{\mu}}\frac{\hat{C}}{\hat{Y}} + \frac{b\hat{P}G_I\left[\theta_C\theta_I + \theta_C(1-\hat{\mu}) + \theta_I\hat{\mu}\right]}{(1+\chi)\left(1+\hat{\tau}_C\right)(1-\hat{\mu})\hat{\mu}\hat{Y}}\right\},$$

$$\varphi_k \equiv \frac{\partial c_t}{\partial k_t} = \frac{-a\,(1+\theta_C)}{\nabla}\left[\left(\hat{C} - \frac{\hat{P}G_I}{1+\hat{\tau}_C}\right)\frac{\theta_I}{(1-\hat{\mu})} - \frac{\tau_Y\hat{Y}}{1+\hat{\tau}_C}\right],$$

$$\varphi_\lambda \equiv \frac{\partial c_t}{\partial \lambda_t} = \frac{(1+\theta_C)}{\nabla}\left[-\hat{C}\left(1 - \frac{b}{1+\chi}\right) + \frac{\tau_Y\hat{Y}b}{(1+\chi)(1+\hat{\tau}_C)} + \frac{b\theta_I\hat{P}G_I}{(1+\chi)\left(1+\hat{\tau}_C\right)(1-\hat{\mu})}\right],$$

$$\omega_k \equiv \frac{\partial \tau_{C,t}}{\partial k_t} = \frac{a\,(1+\theta_C)}{\nabla}\left\{\frac{\theta_I\left(\hat{\tau}_C\hat{C} - \hat{P}G_I\right)}{(1-\hat{\mu})} - \tau_Y\hat{Y}\left[1 - \frac{\hat{C}}{\hat{Y}}\left(\frac{\theta_C}{\hat{\mu}} + \frac{\theta_I}{1-\hat{\mu}}\right) + \frac{(\theta_C-\theta_I)\,\theta_C\hat{C}}{\hat{\mu}\hat{Y}\,(1+\theta_C)}\right]\right\},$$

$$\omega_\lambda \equiv \frac{\partial \tau_{C,t}}{\partial \lambda_t} = \frac{1}{\nabla}\left\{\frac{\hat{\tau}_C\hat{C}(1+\chi-b)\,(1+\theta_C)}{1+\chi} - \tau_Y\hat{Y}\left[\frac{b\,(1+\theta_C)}{(1+\chi)} - \frac{\theta_C}{\hat{\mu}}\frac{\hat{C}}{\hat{Y}}\right] + \hat{P}G_I\left[-\frac{\hat{C}}{\hat{Y}}\frac{\theta_C(1+\chi-b)}{\hat{\mu}(1+\chi)} - \frac{\hat{C}}{\hat{Y}}\frac{\theta_I}{(1-\hat{\mu})}\frac{1+\chi-b\,(1+\theta_C)}{1+\chi} - \frac{b\theta_I}{1+\chi}\left(\frac{1+\theta_C}{1-\hat{\mu}} - \frac{\theta_C\hat{C}}{\hat{\mu}\hat{Y}}\right)\right]\right\}.$$

and

$$\nabla = (1+\theta_C)\frac{\hat{C}}{\left(1+\hat{\tau}_C\right)}\left\{\left[1 - \frac{\hat{C}}{\hat{Y}}\left(\frac{\theta_C}{\hat{\mu}} + \frac{\theta_I}{1-\hat{\mu}}\right)\right]\left(\hat{C} - \frac{\hat{P}G_I}{1+\hat{\tau}_C}\right) - \left(\hat{C}\hat{\tau}_C - \hat{P}G_I\right)\frac{1+\hat{\tau}_C + b\,(\theta_C-\theta_I)}{1+\hat{\tau}_C}\right\} + \frac{\theta_C}{\hat{\mu}}\frac{\hat{C}}{\hat{Y}}\left\{\left(\hat{C} - \frac{\hat{P}G_I}{1+\hat{\tau}_C}\right)\left[\hat{\mu}\left(\frac{\theta_C}{\hat{\mu}} + \frac{\theta_I}{1-\hat{\mu}}\right) - \frac{b\,(\theta_C-\theta_I)}{1+\chi}\right] - \frac{\hat{\tau}_Y\hat{Y}}{1+\hat{\tau}_C}\right\} - \frac{b\,(1+\theta_C)}{1+\chi}$$

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$$\left[\left(\hat{C}-\frac{\hat{P}G_I}{1+\hat{\tau}_C}\right)\hat{\mu}\left(\frac{\theta_C}{\hat{\mu}}+\frac{\theta_I}{1-\hat{\mu}}\right)\right]+\frac{b\,(1+\theta_C)}{(1+\chi)\left(1+\hat{\tau}_C\right)}$$
$$\left\{\hat{\mu}\left(\frac{\theta_C}{\hat{\mu}}+\frac{\theta_I}{1-\hat{\mu}}\right)\left(\hat{C}\hat{\tau}_C-\hat{P}G_I\right)+\hat{\tau}_Y\hat{C}\left(\frac{\theta_C}{\hat{\mu}}+\frac{\theta_I}{1-\hat{\mu}}\right)\right\}.$$

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# 穩定政策之所得稅與消費稅組合

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生產外部性的存在將產生信念自我實現的景氣波動, 而這個現象賦予穩定政策一個討論的空間。在一個傳統的 Benhabib-Farmer-Guo 單部門模型, 累進稅被視爲一項自動安定機制, 可以消除景氣循環的波動; 然而, 在一個實質景氣循環的兩部門模型底下, 反而是累退稅才能使經濟體系達到安定。本文試圖提供另一項政策 — 所得稅與消費稅組合 — 以穩定自我信念驅動所造成的景氣波動。透過數值分析, 我們顯示政府可以透過降低所得稅並提高消費稅的方式穩定經濟體系。這樣的結論不僅適用於兩部門具有部門特定外部性的情況, 且在存在總合外部性的單部門模型也依然適用。

**關鍵詞**: 局部不確定性, 所得稅與消費稅組合, 稅制移轉, 穩定政策
**JEL 分類代號**: E32, E63, O41

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