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Fiscal policy in a simple two-country dynamic model

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Abstract

This paper analyzes the national and international effects of labor and capital income taxes in a two-country infinite-horizon perfect-foresight neoclassical model with endogenous labor supply and capital accumulation. Two polar regimes of capital income taxation are considered: the source-based and the residence-based. The qualitative effects of labor income taxes are shown to be independent of the taxation regime, whereas the effects of capital income taxes are not.

Key words: International taxation; Labor supply; Dynamics
JEL classification: F36; F42; H87

1. Introduction

The simple infinite-horizon representative-agent maximizing framework has become a standard benchmark model for the analysis of intertemporal macroeconomic problems. However, the literature has been restricted to the closed economy, and open economy applications usually consider the case of a small open economy.[1] This paper extends this standard framework to a two-country setting with integrated capital markets and examines issues of labor and capital income tax disturbances under alternative capital income tax regimes.

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[1] See, e.g., Obstfeld (1981), Brock (1988), Sen and Turnovsky (1989, 1990), Matsuyama (1991), Turnovsky and Sen (1991), Turnovsky (1991), among others.

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Recently, there have been two exceptions to the small open economy case in this class of open economy models: (i) Devereux and Shi (1991) and (ii) Turnovsky and Bianconi (1992). However, in both instances it is assumed that labor is fixed at an exogenous level. The contribution of this paper is to endogenize the labor/leisure choice of the representative agent. This is an important issue both from the point of view of the demand and the supply sides. On the demand side, endogenous labor/leisure choice allows the agent to substitute not only intertemporally, but also intratemporally between consumption and leisure. On the supply side, it allows for the endogenous substitution of capital and labor along the technological frontier.

More specifically, Devereux and Shi (1991) examine the effects of productivity and government expenditures disturbances in a two-country world with integrated capital markets where: (i) labor is fixed; (ii) consumers have a variable subjective rate of time preference; and (iii) the distribution of consumption across countries is exogenously given. On the other hand, Turnovsky and Bianconi (1992) examine the effects of distortionary tax disturbances under alternative capital income tax regimes in a two-country world with integrated capital markets where: (i) labor is fixed; (ii) the dynamic problem of the firm is fully accounted for; (iii) consumers have a given rate of time preference which may or may not be the same across countries; and (iv) the distribution of consumption across countries is endogenously determined.

My paper is a direct extension of this literature to the case where labor is variable and immobile across countries. I examine the effects of distortionary labor and capital income tax disturbances under alternative capital income tax regimes in a two-country world with integrated capital markets, where consumers have a given rate of time preference which may or may not be the same across countries and the distribution of consumption across countries is endogenously determined.

The issue of international taxation under integrated capital markets has been the subject of other recent studies by Gordon (1992). Christensen and Nielsen (1992), Ihori (1991), Frenkel, Razin, and Sadka (1991), Giovannini (1990), and others. However, in this set of studies none of these authors apply the simple representative-agent infinite-horizon two-country dynamic framework with endogenously supplied labor as is done in this paper.[2]

Aside from the main theoretical interest, there is also some real world motivation to study the issues outlined above. First, in the last decade or so, there has been a large increase in the volume of international capital movement

[2]Gordon (1992), Frenkel, Razin, and Sadka (1991), and Giovannini (1990) use a simple two-period model, while Christensen and Nielsen (1992) and Ihori (1991) use versions of the heterogeneous-agent overlapping-generations model. More recently, Baxter (1993) and Kollmann (1993) have focused on quantitative aspects of the relationship between fiscal policy and trade deficits.

and economic integration in the western world, not only within regions but also across countries. Second, there is empirical evidence showing that disturbances to marginal physical product schedules impact on labor supply decisions.[3] Thus, the analysis of the international repercussions of taxes on capital and labor in a two-country world with perfect capital mobility and endogenously supplied labor deserves some attention.

The main results obtained are as follows. First, it is shown that the effects of labor tax disturbances are independent of the system of capital income taxation. Second, in the case of source-based tax regime, a domestic labor tax disturbance has a long-run effect on both labor and the capital stock in the domestic and foreign economies. However, the long-run capital/labor ratio is unchanged in both economies, and capital and labor are disturbed proportionally. On the other hand, a domestic capital income tax disturbance has a long-run effect on both labor and the capital stock in the foreign economy and it does affect the long-run capital/labor ratio domestically, but not abroad. Third, in the case of residence-based taxation, a capital income tax disturbance does not have short- and long-run effects in both economies, and it does not affect the long-run capital/labor ratios domestically and abroad.

The paper is organized as follows: Section 2 presents the basic two-country model; Section 3 solves for the equilibrium with particular attention to the issue of the restrictions that arbitrage under integrated capital markets impose on the equilibrium; Section 4 considers tax disturbances under source-based taxation while Section 5 considers the alternative case of residence-based taxation; Section 6 compares the results with the current literature; and Section 7 concludes.

2. Two-country macroeconomic structure

Consider a continuous-time perfect-foresight two-country one-good model of a decentralized economy inhabited by households, firms, and their respective governments. Both countries accumulate capital gradually over time, with the world market for capital being perfectly integrated. Labor supply is endogenously determined and assumed to be immobile across international borders. The economy is a real one, abstracting from money and other nominal assets. The model is based on the standard infinite-horizon representative-agent framework extended to a two-country setting. In effect, it is a two-country version of earlier contributions by Brock and Turnovsky (1981) and Turnovsky (1982) along the lines of Devereux and Shi (1991) and Turnovsky and Bianconi (1992). In outlining the model, I shall focus primarily on the domestic economy. Variables

[3] See, e.g., Hall (1988) for a critical survey of this evidence.

pertaining to the domestic economy are unstarred, while the ones pertaining to the foreign economy are starred. The superscript d refers to holdings of domestic residents, while f refers to holdings of foreign residents.[4]

2.1. Households

The representative household in the domestic country faces the intertemporal problem

$$\max_{\{c,l,k^d,k^{*d}\}} \int_0^\infty U(c,l)\,(\exp-\beta t)\mathrm{d}t, \tag{1}$$

subject to the budget constraint

$$c + \dot{k}^d + \dot{k}^{*d} = wl(1-\tau_w) + rk^d(1-\tau_{c1}) + r^*k^{*d}(1-\tau_{c3}^*-\tau_{c2}) + T, \tag{1a}$$

and given initial holdings

$$k_o^d > 0, \quad k_o^{*d} > 0, \tag{1b}$$

where c is domestic real consumption, l is real labor, $\beta > 0$ is the domestic rate of time preference, k^d is the domestic capital stock owned by domestic residents, k^{*d} is the foreign capital stock owned by domestic residents, r is the rental rate of domestic capital, r^* is the rental rate of foreign capital, w is the real wage rate, and T is a lump-sum tax rebate. In addition, agents in both countries face a set of distortionary effective tax rates defined as follows: τ_w is the domestic labor income tax, τ_{c1} is the domestic tax on domestic capital income received by the domestic residents, τ_{c2} is the domestic tax on foreign capital income received by the domestic residents, and τ_{c3}^* is the foreign tax on foreign capital income received by domestic residents.

The instantaneous utility function $U(.,.)$ is a concave function with partials $U_c > 0$, $U_{cc} < 0$, $U_l < 0$, $U_{ll} < 0$. The sign of the cross-partial $U_{cl} = U_{lc}$, depends on the elasticity of intertemporal substitution. In order to simplify the analysis, I am going to assume throughout the paper that the utility function is additively separable in its two arguments, c and l. This implies the convenient property that the cross partial is zero, i.e., $U_{cl} = U_{lc} = 0$.[5]

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[4] I suppressed time subscripts where time dependence in more obvious, assumed the convention that a dot over a variable indicates its derivative with respect to time, a tilde over a variable indicates its steady state value, and (exp.) indicates the exponential operator.

[5] This assumption, which is equivalent to assuming the intertemporal elasticity of substitution to the unitary, gives me analytical tractability. For example, the instantaneous utility function may be parameterized by the constant elasticity of substitution form $U(c,l) = \{[c^\xi(1-l)^{(1-\xi)}]^{(1-\sigma)} - 1\}/$

Problem (1) is standard. The domestic household budget constraint is expressed in real flow terms and consists of after-tax labor and capital income on domestic and foreign capital holdings plus transfers (right-hand side), to be spent on consumption or additions to the stock of domestic and/or foreign capital (left-hand side). Tax rates are assumed linear with holding of foreign capital being taxed possibly by the domestic and foreign governments.

The first-order conditions to this problem are

$$U_c(c, l) = \alpha, \tag{2a}$$

$$U_l(c, l) = -\alpha w(l - \tau_w), \tag{2b}$$

$$(1 - \tau_{c1})r = \theta, \tag{2c}$$

$$(1 - \tau_{c2} - \tau_{c3}^*)r^* = \theta, \tag{2d}$$

$$\theta = \beta - (\dot{\alpha}/\alpha), \tag{2e}$$

together with the transversality conditions

$$\lim_{t\to\infty} \alpha k^d (\exp - \beta t) = 0, \qquad \lim_{t\to\infty} \alpha k^{*d} (\exp - \beta t) = 0, \tag{2f}$$

where α, the Lagrange multiplier associated with the accumulation equation (1a), is the marginal utility of wealth of the domestic resident. Eqs. (2c) and (2d) are arbitrage conditions stating that the domestic consumer must be indifferent between the after-tax rates of return on domestic and foreign capital. The rate of return on consumption is defined in (2e).

The problem facing the foreign household is symmetric, with the corresponding first-order conditions given by

$$U_c^*(c^*, l^*) = \alpha^*, \tag{3a}$$

$$U_l^*(c^*, l^*) = -\alpha^* w^*(l - \tau_w^*), \tag{3b}$$

$$(1 - \tau_{c1}^*)r^* = \theta^*, \tag{3c}$$

$$(1 - \tau_{c2}^* - \tau_{c3})r = \theta^*, \tag{3d}$$

$$\theta^* = \beta^* - (\dot{\alpha}^*/\alpha^*), \tag{3e}$$

$(1 - \sigma)$ where $0 < \xi < 1$ is the share of consumption in instantaneous utility, $(1 - l)$ is leisure, and $\sigma > 0$ is the inverse of the elasticity of intertemporal substitution $(1/\sigma)$. In the case where $\sigma = 1$, the function above reduces to the logrithmic utility function which is separable in its arguments.

and the transversality conditions

$$\lim_{t\to\infty} \alpha^* k^{*f} (\exp - \beta^* t) = 0, \qquad \lim_{t\to\infty} \alpha^* k^f (\exp - \beta^* t) = 0, \tag{3f}$$

where α^* is the marginal utility of wealth of the foreign resident.

2.2. Firms

The firms rent capital and hire labor is spot markets. The domestic representative firm is assumed to face perfect competition and constant returns to scale technology such that profits and factor returns are given by

$$\pi = f(k, l) - wl - rk, \tag{4a}$$

$$r = f_k(k, l), \tag{4b}$$

$$w = f_l(k, l), \tag{4c}$$

where π is profits and $f(.,.)$ is the usual constant returns to scale production function, with positive, but diminishing marginal physical products. In particular, $f_k > 0$, $f_{kk} < 0$, $f_l > 0$, $f_{ll} < 0$, and $f_{kk} f_{ll} - f_{kl}^2 = 0$. Symmetrically for the foreign economy,

$$\pi^* = f^*(k^*, l^*) - w^* l^* - r^* k^*, \tag{5a}$$

$$r^* = f_k^*(k^*, l^*), \tag{5b}$$

$$w^* = f_l^*(k^*, l^*). \tag{5c}$$

2.3. Governments

I assume that all revenues received by each government in each country are rebated to its own residents in a lump-sum fashion.[6] The tax-rebate schemes are

$$T = wl\tau_w + rk^d\tau_{cl} + r^* k^{*d}\tau_{c2} + rk^f\tau_{c3}, \tag{6}$$

$$T^* = w^* l^* \tau_w^* + r^* k^{*f}\tau_{c1}^* + rk^f\tau_{c2}^* + r^* k^{*d}\tau_{c3}^* - g^*. \tag{7}$$

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[6]These transfer schemes involve an international redistribution of tax revenues to the extent that domestic (foreign) capital owned by foreign (domestic) residents is taxed. g^* is foreign government consumption (saving) such that $g^* \neq 0 \to N \neq 0$.

These depend upon the tax regimes adopted in each country. The tax regimes considered here are: (i) the source-based and (ii) the residence-based, which are well known in the literature; see, e.g., Giovannini (1990), Frenkel, Razin, and Sadka (1991), and Turnovsky and Bianconi (1992). The source-based regime means that the tax liabilities depend on the source of income, implying that

$$\begin{aligned} \tau_{c1} &= \tau_{c3} = \tau_c, \qquad \tau_{c2} = 0, \\ \tau_{c1}^* &= \tau_{c3}^* = \tau_c^*, \qquad \tau_{c2}^* = 0. \end{aligned} \tag{8}$$

In the residence-based regime agents will be liable for taxes according to the place of residence, implying that

$$\begin{aligned} \tau_{c1} &= \tau_{c2} = \tau_c, \qquad \tau_{c3} = 0, \\ \tau_{c1}^* &= \tau_{c2}^* = \tau_c^*, \qquad \tau_{c3}^* = 0. \end{aligned} \tag{9}$$

2.4. World goods market equilibrium

In a one-good world, good market equilibrium is described by

$$f(k, l) + f^*(k^*, l^*) = c + c^* + \dot{k} + \dot{k}^* + g^*, \tag{10}$$

which states that the sum consumption and investment must equal total world output.

2.5. Wealth and accumulation of net foreign assets

Aggregate wealth in each country is defined as

$$W = k^d + k^{*d}, \tag{11}$$

$$W^* = k^{*f} + k^f, \tag{12}$$

where k^d and k^{*d} denote the stocks of domestic and foreign capital owned by domestic residents, and k^{*f} and k^f the stock of foreign and domestic capital owned by foreign residents. Therefore, world aggregate wealth is

$$W + W^* = k + k^* = k^d + k^f + k^{*d} + k^{*f}. \tag{13}$$

The net foreign asset position of the domestic economy, N, is defined as

$$N = k^{*d} - k^f. \tag{14}$$

Thus domestic and foreign wealth can be expressed as $W = k + N$ and $W^* = k^* - N$. Taking the time derivative of (14) and using (i) the domestic household budget constraint, (ii) the equilibrium conditions for firms, and (iii) the tax rebate scheme (6), one obtains a formula for the change in the net foreign asset position, or the current account balance, $\dot{N}$, given by

$$\dot{N} = \{[f(k, l) - c] + f_k(k, l)N + k^{*d}[\tau_{c2} f_k^*(k^*, l^*) - \tau_{c1} f_k(k, l)] + f_k(k, l)k^f \tau_{c3}\} - \dot{k}, \tag{15}$$

for a given N_o and $k_o > 0$. This equation describes the rate of accumulation of net foreign assets depending upon output less domestic absorption plus the net international flow of earnings of assets. Note that given the tax structure, $\dot{N}$ depends on the distribution of the capital stock, i.e., k^{*d} and k^f.

3. Short-run equilibrium, viability of general equilibrium, and dynamics

The short-run equilibrium for aggregate consumption and labor supply, in each country, is given from (2a), (2b), (3a), and (3b) by

$$c = c(\alpha, k, \tau_w), \qquad c_\alpha < 0, \quad c_k = 0, \quad c_\tau = 0, \tag{16a}$$

$$l = l(\alpha, k, \tau_w), \qquad l_\alpha > 0, \quad l_k > 0, \quad l_\tau < 0, \tag{16b}$$

$$c^* = c^*(\alpha^*, k^*, \tau_w^*), \quad c_\alpha^* < 0, \quad c_k^* = 0, \quad c_\tau^* = 0, \tag{17a}$$

$$l^* = l^*(\alpha^*, k^*, \tau_w^*), \quad l_\alpha^* > 0, \quad l_k^* > 0, \quad l_\tau^* < 0, \tag{17b}$$

where the signs of the partial derivatives of these functions were obtained under the assumption of additively separable preferences.

In a world of perfectly integrated capital markets, the arbitrage opportunities (2c), (2d), (3c), and (3d) yield restrictions for an equilibrium to be viable, or alternatively for the equilibrium to be an interior one, as

$$(1 - \tau_{c1}) f_k(k, l) = (1 - \tau_{c2} - \tau_{c3}^*) f_k^*(k^*, l^*) = \theta, \tag{18a}$$

$$(1 - \tau_{c2}^* - \tau_{c3}) f_k(k, l) = (1 - \tau_{c1}^*) f_k^*(k^*, l^*) = \theta^*, \tag{18b}$$

which imply

$$[(1 - \tau_{c1})/(1 - \tau_{c2}^* - \tau_{c3})] = [(1 - \tau_{c2} - \tau_{c3}^*)/(1 - \tau_{c1}^*)] = (\theta/\theta^*), \tag{18c}$$

where from (2e) and (3e), in steady state, $\theta = \beta$ is the rate of return on domestic consumption and $\theta^* = \beta^*$ is the rate of return on foreign consumption.[7]

In the source-based case, (8), the viability conditions reduce to

$$(1 - \tau_c) f_k(k, l) = (1 - \tau_c^*) f_k^*(k^*, l^*), \tag{19}$$

which implies $\theta = \theta^*$ and, in steady state, $\beta = \beta^*$. This means that the after-tax marginal physical products are equalized in the short and long run. The rates of return on consumption must be equalized in the short and long run as well.

In the residence-based case, (9), the viability conditions reduce to

$$f_k(k, l) = f_k^*(k^*, l^*), \tag{20}$$

which implies $[\theta/(1 - \tau_c)] = [\theta^*/(1 - \tau_c^*)]$ and, in steady state, $[\beta/(1 - \tau_c)] = [\beta^*/(1 - \tau_c^*)]$. In this case, it requires gross (before-tax) marginal physical products of capital to the equalized in the short and long run, and the rates of return on consumption, capitalized by the respective capital income tax factor, to be equalized in the short and long run.

As it is apparent from (19) and (20), the viability conditions impose important restrictions on the rates of return on consumption and assets across countries. This is the 'corner solution problem' which has been emphasized by Slemrod (1988), among others. In Slemrod's article only certain combinations of capital income taxes allow both domestic and foreign residents to hold domestic and foreign capital. In the general-equilibrium infinite-horizon representative-agent dynamic framework of this paper, there is one further implication: one must distinguish between the short and long run because the rates of return on consumption include capital gains or losses in the short run, i.e., $-(\dot{\alpha}/\alpha)$ and $-(\dot{\alpha}^*/\alpha^*)$, and in the long run the rates of return on consumption reduce to the rates of time preference, i.e., β and β^*.

In the source-based case, (19), a combination of capital income taxes allows the after-tax marginal physical products to be equalized in the short and long run. In addition, the rates of return on consumption must be equalized in the short and long run. Since this paper does not consider consumption taxes, it imposes a direct restriction on the rates of time preference to be equalized in the long run, such that they cannot be chosen independently across countries.

In the residence-based cases, (20), the gross returns on capital must be equalized in the short and long run. In this case, a certain combination of capital income taxes allows the rates of return on consumption to be equalized in the short and long run. On the other hand, given the tax rates, the rates of time

[7] Authors such as Slemrod (1988), Frenkel, Razin, and Sadka (1991), and Turnovsky and Bianconi (1992) also discuss these arbitrage restrictions under alternative tax regimes.

preference also cannot be chosen independently in order to guarantee the long-run viability condition.

In summary, in this paper only certain combinations of either the tax rates or the rates of time preference are consistent with both domestic and foreign residents holding domestic and foreign capital in the short and long run. For example, in the source-based case, (19), if in steady state $\beta < \beta^*$, then the country which the lower rate of time preference, or alternatively the 'more patient' country, will asymptotically accumulate all the wealth in the world economy.[8]

Finally, the dynamic evolution of the world economy may be represented by the following set of equations:

$$\dot{\alpha}/\alpha = \beta - \theta, \tag{21a}$$

$$\dot{\alpha}^*/\alpha^* = \beta^* - \theta^*, \tag{21b}$$

$$\dot{k} + \dot{k}^* = f(k, l) + f^*(k^*, l^*) - c - c^* - g^*, \tag{21c}$$

$$\dot{N} = f(k, l) - c - \dot{k} + \theta' f_k(k, l)N, \tag{21d}$$

given $k_o > 0$, $k_o^* > 0$, and N_o, where θ and θ^* are given by (2c), (2d), (3c), and (3d), are given by (16a) and (17a), and from (15), (8), and (9):

(i) $\theta' \equiv (1 - \tau_c)$ for the source-based regime;
(ii) $\theta' \equiv 1$ for the residence-based regime.

The evolution of the net foreign asset position is subject to the usual condition that prevents either economy from running up infinite debt, i.e.,

$$\lim_{t \to \infty} N(t)\left[\exp - \int_0^t \theta' f_k(k, l)\mathrm{d}s\right] = 0. \tag{22}$$

4. Tax disturbances with source-based regime

The consistency condition (19) and the dynamic equations (21a) and (21b) imply that the rate of change of the marginal utilities of wealth in the two

[8] This result regarding the interdependence of rates of time preference is well-known in the literature which deals with heterogeneous agents in closed economy versions of the infinite-horizon model, and is a function of the implicit time-separability assumption of preferences; see, e.g., Becker (1980). There are ways to relax this restriction on the rates of time preference: (i) by adopting the overlapping-generations framework of Buiter (1981) as in Ihori (1991) or as in Christensen and Nielsen (1992), (ii) to assume variable discount rates in the framework of Uzawa preferences as in Devereux and Shi (1991), (iii) to assume the long-run growth framework of Jones and Manuelli (1990), (iv) to introduce uncertainty.

countries are proportional, independently of the tax structure. Thus, we have that

$$\alpha^* = \bar{\mu}\alpha, \tag{23}$$

where $\bar{\mu}$ is a constant which endogenously determines the distribution of consumption among the two countries.[9]

In analyzing the dynamics, I assume that total aggregate wealth, $W_o + W_o^*$, is instantaneously predetermined. However, k_o and k_o^* may jump subject to $\mathrm{d}k_o + \mathrm{d}k_o^* = 0$. This assumption implies that, even though world wealth is instantaneously given, 'physical' capital is taken to be fully mobile internationally. In turn, the capital stocks are interchangeable and instantaneously respond to exogenous disturbances. This assumption, which has been widely used in the static trade literature, abstracts from transportation costs and allows the possibility of an instantaneous reshuffling of physical capital between the two countries.[10] Then, from (11), (12), and (14) I obtain the condition that either country can augment or diminish its stock of capital instantaneously by entering the world capital market, or

$$-\mathrm{d}k_o = \mathrm{d}k_o^* = \mathrm{d}N_o. \tag{24}$$

4.1. Dynamic adjustment

The domestic consumer arbitrage conditions, under the source-based regime, imply that along the adjustment path the evolution of capital stocks and employment are related by

$$\begin{aligned}&(1-\tau_c)[f_{kk}(k,l)\dot{k} + f_{kl}(k,l)\dot{l}]\\ &= (1-\tau_c^*)[f_{kk}^*(k^*,l^*)\dot{k}^* + f_{kl}^*(k^*,l^*)\dot{l}^*].\end{aligned} \tag{25}$$

Taking time derivatives of the short-run equilibrium conditions (16) and (17) and using (23), one obtains the relationships

$$\dot{l} = l_\alpha \dot{\alpha} + l_k \dot{k}, \tag{26a}$$

$$\dot{l}^* = l_\alpha^* \bar{\mu}\dot{\alpha} + l_k^* \dot{k}^*. \tag{26b}$$

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[9] Note that in this model the distribution of consumption is endogenously determined by explicitly taking into account the initial capital stocks and net asset position that satisfy the transversality condition (22), as in Turnovsky and Bianconi (1992).

[10] Devereux and Shi (1991), Turnovsky and Bianconi (1992), and Christensen and Nielsen (1992) all make a similar assumption in their analyses of alternative disturbances.

Then, substituting (26) into (25), one obtains

$$\phi_1 \dot{k} - \phi_2 \dot{k}^* - \phi_3 \dot{\alpha} = 0, \tag{27}$$

where

$$\phi_1 \equiv (1 - \tau_c)[f_{kk} + f_{kl} l_k] < 0,$$

$$\phi_2 \equiv (1 - \tau_c^*)[f_{kk}^* + f_{kl}^* l_k^*] < 0,$$

$$\phi_3 \equiv [(1 - \tau_c^*)\bar{\mu} f_{kl}^* l_\alpha^* - (1 - \tau_c) f_{kl} l_\alpha].$$

It is useful to bear in mind that evaluating these expressions at: (i) identical preferences, (ii) identical technologies, and (iii) an initial equilibrium of zero taxes across countries; it yields $\phi_1 = \phi_2$ and $\phi_3 = 0$. Next, solving (27) for $\dot{k}^*$ as a function of $\dot{k}$, substituting into the world goods market equilibrium (21c), and using (23). I may represent the linearized dynamic evolution of the world economy by the second-order differential system

$$\dot{D} = AD, \tag{28}$$

where $D' = \{(k - \tilde{k}), (\alpha - \tilde{\alpha})\}$ is a row vector and A is a 2×2 matrix of coefficients which, upon evaluation at (i) identical preferences, (ii) identical technologies, and (iii) an initial equilibrium of zero taxes across countries, are given by

$$a_{11} = (f_k + f_l l_k) > 0, \quad a_{12} = (f_l l_\alpha - c_\alpha) > 0,$$

$$a_{21} = (-\tilde{\alpha}\phi_1) > 0, \quad a_{22} = (-\tilde{\alpha} f_{kl} l_\alpha) < 0.$$

The characteristic equation of (28) defines a saddlepath with the stable solution for k and α, for every time t, given by

$$k(t) = k + [k_o - \tilde{k}](\exp \lambda t), \tag{29a}$$

$$\alpha(t) = \alpha + (a_{21}/\lambda - a_{22})[k_o - \tilde{k}](\exp \lambda t), \tag{29b}$$

where $\lambda < 0$ is the stable root of the characteristic equation of (28).[11]

[11] λ is a measure of convergence to the long-run equilibrium, the subject of the recent study by Barro and Sala-i-Martin (1992). It is possible to show in this model that $d\lambda/d\sigma > 0$ (evaluated at $\sigma = 1$) meaning that the higher the intertemporal elasticity of substitution, i.e., the lower σ, the higher the speed of convergence to the long-run equilibrium, i.e., the higher λ in absolute value. Chamley (1981, p. 476) shows a similar result in a related closed economy model.

The solution for the net foreign asset position of the domestic economy, N, is recovered by applying a procedure discussed in Sen and Turnovsky (1990) and Turnovsky (1991). First, linearizing (21d) and using (29a) one obtains

$$N(t) = \tilde{N} + [\Omega/(\lambda - \beta)][k_o - \tilde{k}](\exp \lambda t)$$

$$+ \{[N_o - \tilde{N} - [\Omega/(\lambda - \beta)][k_o - \tilde{k}]](\exp \beta t)\}, \tag{29c'}$$

where $\Omega \equiv [(\lambda - a_{11})\lambda\tilde{N}\phi_1/a_{12}a_{21}] < 0$ when evaluated at identical preferences and technologies, zero taxes across countries, and assuming $\tilde{N} > 0$, i.e., the domestic country is a net creditor. The expression for Ω describes the instantaneous effect of an increase in the domestic capital stock (relative to its steady state equilibrium) on the current account balance. Note also that the sign of Ω is negatively related to the sign of $\tilde{N}$. If, in equilibrium, the country is a net creditor, then $\Omega < 0$, implying that as it accumulates capital, it acquires foreign assets. On the other case where the country is a net debtor, then $\Omega > 0$, and the reverse holds.

Then, applying condition (22) to (29c') implies that

$$N_o - \tilde{N} = [\Omega/(\lambda - \beta)][k_o - \tilde{k}] \tag{30}$$

for a given N_o and $k_o > 0$. Thus, the stable solution for N, for every t, is

$$N(t) = \tilde{N} + [\Omega/(\lambda - \beta)][k_o - \tilde{k}](\exp \lambda t). \tag{29c}$$

The system (29a), (29b), and (29c) is the solution for the dynamics of the domestic capital stock, marginal utility of wealth, and the current account deficit along the equilibrium path. The solutions for the foreign capital stock, domestic and foreign labor supplies, and the foreign marginal utility of wealth are readily obtained from (25), (26), (21a), and (21b).

4.2. *Steady state*

The steady state consists of the following set of equations

$$U_c(\tilde{c}, \tilde{l}) = \tilde{\alpha}, \tag{31a}$$

$$U_l(\tilde{c}, \tilde{l}) = -\tilde{\alpha}(1 - \tau_w)f_l(\tilde{k}, \tilde{l}), \tag{31b}$$

$$U_c^*(\tilde{c}^*, \tilde{l}^*) = \tilde{\alpha}^*, \tag{31c}$$

$$U_l^*(\tilde{c}^*, \tilde{l}) = -\tilde{\alpha}^*(1-\tau_w^*) f_l^*(\tilde{k}^*, \tilde{l}^*), \tag{31d}$$

$$\tilde{\alpha}^* = \bar{\mu}\tilde{\alpha}, \tag{31e}$$

$$(1-\tau_c) f_k(\tilde{k}, \tilde{l}) = \beta, \tag{31f}$$

$$(1-\tau_c^*) f_k^*(\tilde{k}^*, \tilde{l}^*) = \beta, \tag{31g}$$

$$f(\tilde{k}, \tilde{l}) + f^*(\tilde{k}^*, \tilde{l}^*) = \tilde{c} + \tilde{c}^* + g^*, \tag{31h}$$

$$\beta \tilde{N} = \tilde{c} - f(\tilde{k}, \tilde{l}), \tag{31i}$$

$$N_o - \tilde{N} = [\Omega/(\lambda - \beta)]\,[k_o - \tilde{k}]. \tag{31j}$$

These are ten equations in the unknowns $\tilde{k}, \tilde{k}^*$, $\tilde{c}, \tilde{c}^*$, $\tilde{l}, \tilde{l}^*$, $\tilde{\alpha}, \tilde{\alpha}^*$, $\tilde{N}$, and $\bar{\mu}$, given $N_o, k_o > 0$, and the tax rates. The first four equations denote the marginal utilities of wealth and labor, while (31e) is the distributional equation. Eqs. (31f) and (31g) are the steady state arbitrage conditions, where the after-tax rate of return on capital domestically and abroad equals the rate of time preference which is also equated. Eq. (31h) is the steady state goods market equilibrium, and (31i) is the net asset position given by the capitalized value of the domestic country dissaving. Finally, Eq. (31j) denotes the adjustment of the steady state domestic capital stock and the net foreign asset position to the initial conditions.[12]

4.3. Comparative dynamics of changes in domestic taxes

Table 1 summarizes the short-run and long-run effects of an unanticipated permanent increase in the domestic labor tax rate, $d\tau_w > 0$. The analysis is carried under the source-based system of taxation. In computing these

[12] Eq. (31j) indicates that temporary tax disturbances do have permanent effects on the endogenous variables. This hysteresis result has been discussed in the context of a small open economy in Sen and Turnovsky (1990) and Turnovsky (1991). In the present context, for instance, it means that a temporary tax shock will have permanent effects on world aggregate consumption and wealth. However, if labor was not endogenous, as in Turnovsky and Bianconi (1992), then temporary changes would not have a permanent effect on aggregate consumption and wealth, although it would affect the distribution across countries. In the case of endogenous labor, it is the capital/labor ratio that is determined by production conditions alone such that aggregate consumption and wealth are affected by permanent changes in the capital stock induced by temporary shocks.

effects, I shall assume (i) identical preferences across countries, (ii) identical technologies across countries, (iii) the initial equilibrium is one of zero taxes, (iv) the domestic economy is a net creditor in the neighborhood of the equilibrium, i.e., $\tilde{N} > 0$.

4.3.1. *Increase in the domestic labor tax rate*

Suppose the world economy is initially in steady state equilibrium. Consider an unanticipated permanent increase in the domestic labor tax rate, $d\tau_w > 0$. The introduction of the labor tax immediately increases the price of domestic labor reducing the demand for labor and consequently the demand for domestic

Table 1
Change in domestic labor income tax under source-based tax regime $-d\tau_w > 0$

Short run	
k_o	$f_{kl}[l_\alpha(P_2^* - \bar{\mu}P_2) - l_\tau]/[2\phi_1 - f_{kl}l_\alpha(P_1^* - \bar{\mu}P_1)] < 0$
k_o^*	$-f_{kl}[l_\alpha(P_2^* - \bar{\mu}P_2) - l_\tau]/[2\phi_1 - f_{kl}l_\alpha(P_1^* - \bar{\mu}P_1] > 0$
N_o	$-f_{kl}[l_\alpha(P_2^* - \bar{\mu}P_2) - l_\tau]/[2\phi_1 - f_{kl}l_\alpha(P_1^* - \bar{\mu}P_1)] > 0$
$c(0)$	$(1/U_{cc})[d\alpha(0)/d\tau_w] < 0$
$c^*(0)$	$(1/U_{cc})[d\alpha^*(0)/d\tau_w] > 0$
$\alpha(0)$	$((d\tilde{\alpha}/d\tau_w) + [(\lambda - a_{11})/a_{12}][(dk_o/d\tau_w) - (d\tilde{k}/d\tau_w)]) > 0$
$\alpha^*(0)$	$[(d\tilde{\alpha}^*/d\tau_w) + \bar{\mu}[(d\alpha(0)/d\tau_w) - (d\tilde{\alpha}/d\tau_w)]) < 0$
$l(0)$	$(l_\alpha[d_\alpha(0)/d\tau_w] + l_k(dk_o/d\tau_w) + l_\tau)$
$l^*(0)$	$[l_\alpha^*[d\alpha^*(0)/d\tau_w] + l_k^*(dk_o^*/d\tau_w)]$
$k_o/l(0)$	$[\tilde{l}(dk_o/d\tau_w) - \tilde{k}[dl(0)/d\tau_w])/\tilde{l}^2$
$k_o^*/l^*(0)$	$[\tilde{l}^*(dk_0^*/d\tau_w) - \tilde{k}^*[dl^*(0)/d\tau_w]/\tilde{l}^{*2}$
$\bar{\mu}$	$(1/\tilde{\alpha})[(d\tilde{\alpha}^*/d\tau_w) - \bar{\mu}(d\tilde{\alpha}/d\tau_w)] < 0$

where $P_1 = \{(-\beta U_{cc}f_{kk}U_{ll}/f_{kl})[1 + (\Omega/\lambda - \beta)]\}/Det > 0$

$P_2 = \{-U_{cc}\tilde{\alpha}f_1(\beta[1 + (\Omega/\lambda - \beta)] - (f_1f_{kk}/f_{kl}))\}/Det > 0$

$P_1^* = \{\beta U_{cc}f_{kk}U_{ll}[1 + (\Omega/\lambda - \beta)][1 + (\beta U_{cc}f_1[1 + \Omega/\lambda - \beta)]/Det)]\}/Det^*$

$P_2^* = \{\tilde{\alpha}f_1\beta U_{cc}f_{kk}U_{ll}(\Omega/\lambda - \beta)\}/Det^* < 0$

Assume: (1) identical preferences, (ii) identical technologies, (iii) zero initial taxes

Table 1 (continued)

Long run	
$\tilde{k}$	$-\{\tilde{\alpha}f_l + U_{cc}f_l\beta[1 + (\Omega/\lambda - \beta)](dk_o/d\tau_w)\}/Det < 0$
$\tilde{k}^*$	$-U_{cc}f_l\beta(d\tilde{N}/d\tau_w)/Det^*$
$\tilde{N}$	$\{-(dk_o/d\tau_w)[1 + (\Omega/\lambda - \beta)] + (\Omega/\lambda - \beta)(d\tilde{k}/d\tau_w)\}$
$\tilde{c}$	$(1/U_{cc})[d\tilde{\alpha}/dr_w] < 0$
$\tilde{c}^*$	$(1/U_{cc})[d\tilde{\alpha}^*/d\tau_w]$
$\tilde{\alpha}$	$P_1(dk_o/d\tau_w) + P_2 > 0$
$\tilde{\alpha}^*$	$P_1^*(dk_o/d\tau_w) + P_2^*$
$\tilde{l}$	$-(f_{kk}/f_{kl})(d\tilde{k}/d\tau_w) < 0$
$\tilde{l}^*$	$-(f_{kk}/f_{kl})(d\tilde{k}^*/d\tau_w)$
$\tilde{k}/\tilde{l}$	0
$\tilde{k}^*/\tilde{l}^*$	0
$\tilde{\mu}$	$(1/\tilde{\alpha})[(d\tilde{\alpha}^*/dr_w) - \tilde{\mu}(d\tilde{\alpha}/dr_w)] < 0$

where $Det = \{(f_{kk}/f_{kl})(U_{ll} + U_{cc}f_l^2) - \beta U_{cc}f_l[1 + (\Omega/\lambda - \beta)]\} > 0$

$Det^* = \{(f_{kk}/f_{kl})(U_{ll} + U_{cc}f_l^2) - \beta U_{cc}f_l\} > 0$

Assume: (i) identical preferences, (ii) identical technologies, (iii) zero initial taxes

capital.[13] Since the world capital stock is predetermined, there is an instantaneous increase in the capital stock abroad along with an increase in the net foreign asset holdings of domestic residents. The initial trade in capital lowers the marginal physical product of capital abroad along with the after-tax world rate of return on capital, θ. The initial effect on the domestic and foreign labor supplies is ambiguous. This is because the tax and capital stock effects are countered by the initial effect on the domestic marginal utility of consumption which, being a forward-looking variable, depends on the long-run responses of $\tilde{\alpha}$ and $\tilde{k}$.

In the long run, given the higher domestic labor tax, the labor supply of the domestic resident decreases. However, the after-tax return on capital in the two economies must equal the common rate of time preference. Therefore, in both economies the after-tax marginal physical product of capital is restored to its

[13] Sufficient conditions to sign the initial effects in Table 1 are $P_1^* > \tilde{\mu}P_1$ and $P_2^* > [(l_*/l_n) + \tilde{\mu}P_2]$.

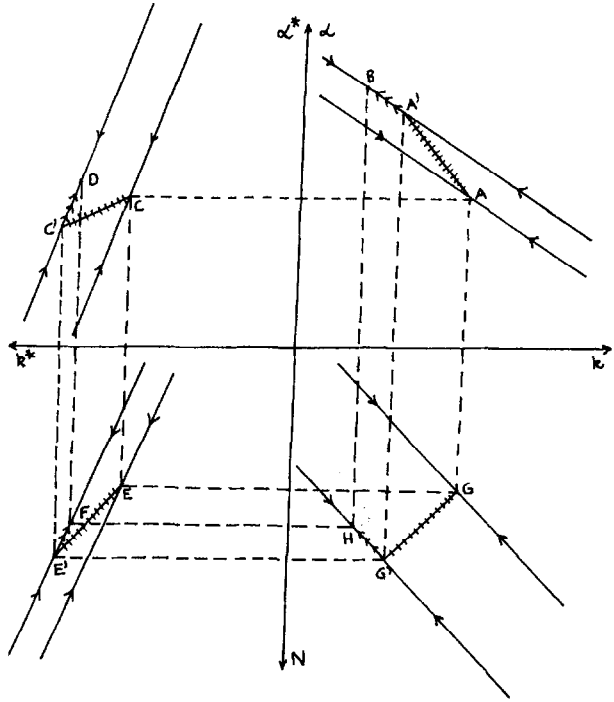
original level. This implies that the long-run domestic capital stock decreases exactly by the same amount as the domestic labor supply and the domestic capital/labor ratio is unchanged.[14] The same phenomenon happens in the foreign economy. Foreign long-run labor and capital move in the same direction exactly by the same amount such that the foreign long-run capital/labor ratio is unchanged.

However, the long-run effect on capital and labor abroad depend critically upon the long-run response of the net foreign asset position, $\tilde{N}$. On the one hand, the initial sale of capital abroad raises the initial stock of net foreign assets, N_o. On the other hand, since the domestic economy is assumed to be a net creditor, the subsequent decline in the domestic capital stock is associated with a current account deficit, i.e., foreign assets are decumulated. The net effect on the long-run net asset position depends upon the relative magnitudes of these two opposite effects. Long-run domestic consumption declines and the long-run domestic marginal utility rises because agents perfectly foresee the long-run disincentive to supply labor and to accumulate domestic capital. But the effects on foreign consumption and marginal utility are unclear.

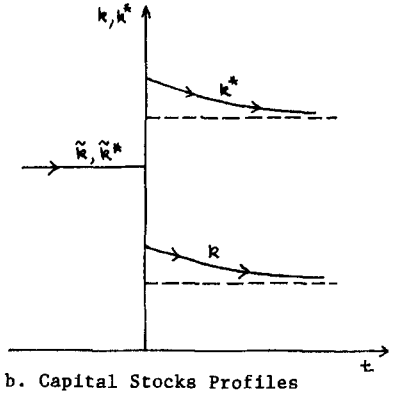
Consider a specific example where the effect on the long-run net foreign asset position is positive, i.e., $d\tilde{N}/d\tau_w > 0$. This is a case where the initial increase in foreign assets exceeds the subsequent accumulation of current account deficits by the domestic economy. The long-run capital stock and labor abroad increase by exactly the same amount; foreign consumption decreases and the foreign marginal utility of wealth increases. Fig. 1 depicts these adjustments.

Panel a of Fig. 1 presents the phase diagram of the labor tax shock. The northeast quadrant portrays the negatively-sloped stable manifold between k and α. The northwest quadrant portrays the corresponding relationship abroad. The lower quadrants depict the positive relationship between the two capital stocks and the net asset position. The dynamics are as follows. The initial world equilibrium is represented by points A, C, E, and G. When the domestic labor tax is introduced, the equilibrium instantaneously moves to points A', C', E', and G'. These are represented in the upper quadrants by an initial decline in k_o, an initial increase in $\alpha(0)$, and initial increase in k_o^* equal to $-dk_o$, and an initial decline in $\alpha^*(0)$. The net asset position also increases by $-dk_o$. Thereafter, the two capital stocks decline monotonically to its long-run equilibrium as shown in panel b of Fig. 1. The domestic and foreign marginal utilities of wealth rise, while domestic and foreign consumption decline steadily to its long-run equilibrium as shown in panel c. The net foreign asset position of the domestic economy decreases (the net asset position abroad increases) monotonically. The

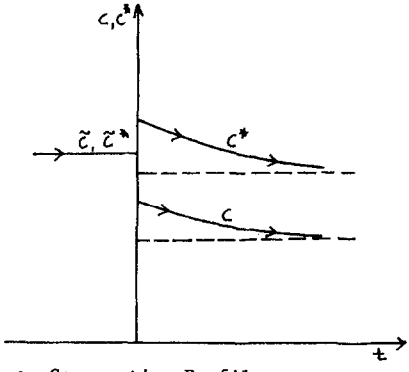
[14] See, e.g., Sen and Turnovsky (1989, p. 239) for a similar result with respect to terms of trade shocks in a small open economy.



a. Phase Diagram



b. Capital Stocks Profiles



c. Consumption Profiles

Fig. 1

final equilibrium is at points B, D, F, and H. In the final equilibrium, $\tilde{\alpha}$ increases by more than $\tilde{\alpha}^*$ reflecting the fact that domestic consumption is more adversely affected than its foreign counterpart and consequently the ratio $\bar{\mu}$ falls.

4.3.2. Increase in the domestic capital income tax rate

Consider an unanticipated permanent increase in the domestic interest income tax rate, τ_c. The qualitative effects on the economies is identical to the case of an increase in the domestic labor tax, as in Table 1 and Fig. 1. In this case, the impact effect on the domestic capital stock is given by [15]

$$dk_o/d\tau_c = \beta[1 + l_\alpha(P_2^* - \bar{\mu}P_2')]/[2\phi_1 - \beta l_\alpha(P_1^* - \bar{\mu}P_1)] < 0.$$

There are two main differences here that are worth noting: (i) The operating channel of the capital income tax disturbance is through its direct effect on the domestic after-tax marginal physical product of capital, i.e., the introduction of the tax immediately reduces the domestic after-tax marginal physical product of capital below the required rate of return and the rate of return on capital abroad. (ii) The long-run capital/labor ratio in the domestic country falls by

$$d(\tilde{k}/\tilde{l})/dc = \beta/f_{kk} < 0,$$

but in the foreign country it remains constant. Intuitively, the higher the domestic interest income tax, the lower the productivity of domestic capital relative to foreign capital which triggers an instantaneous increase in the capital stock abroad. In this case, the tax disturbance resembles a productivity shock.[16]

5. Tax disturbances with residence-based regime

In this case, the viability condition (20) and the dynamic equations (21a) and (21b) imply that the rate of change of the marginal utilities of wealth in the two countries are proportional, but now it depends on the tax structure, that is

$$\alpha^* = \bar{\mu}\alpha^{\psi}, \tag{33a}$$

[15] $P_2' \equiv \{(U_{cc}/f_{kl}^2)[(\beta U_{ll} f_{kk} f_l/Det) + (\tilde{\alpha} f_{ll} + \beta U_{ll})(f_{kl}\beta[1 + (\Omega/\lambda - \beta)] - f_l f_{kk})]\} < 0$ in the formula below. Sufficient conditions to sign the initial effect are $P_1^* > \bar{\mu}P_1$ and $P_2^* > [(-1/l_\alpha) + \bar{\mu}P_2']$.

[16] See, e.g., Abel and Blanchard (1983) for an early analysis that discusses the issue of the equivalence between a tax and a productivity disturbance.

where $\psi \equiv [(1-\tau_c^*)/(1-\tau_c)]$. As discussed above, the steady state equilibrium requires that the rates of time preference satisfy

$$\beta^* = \psi\beta. \tag{33b}$$

In general, there are many possible solutions for (33b). For instance, for a given set of tax rates it implies that the rates of time preference cannot be chosen independently. Here, I am going to focus on one possible case: the two countries peg to a world discount rate, $\beta' > 0$, adjusting it to its own interest income tax factor, that is,

$$\beta = (1-\tau_c)\beta', \tag{44}$$

$$\beta^* = (1-\tau_c^*)\beta'. \tag{45}$$

This scheme, which has been used by Turnovsky and Bianconi (1992), is compatible with the assumption of a small open economy that takes the world rate of time preference as given. It still implies (33a) and satisfies (33b).[17]

5.1. Dynamic adjustment

The dynamic relationship between capital stocks and employments is now

$$[f_{kk}(k,l)\dot{k} + f_{kl}(k,l)\dot{l}] = [f_{k\bar{k}}^*(k^*,l^*)\dot{k}^* + f_{kl}^*(k^*,l^*)\dot{l}^*]. \tag{46}$$

The evolution of domestic labor is still given by (26a), but for foreign labor it is

$$\dot{l}^* = l_\alpha^*\bar{\mu}\psi\alpha^{(\psi-1)}\dot{\alpha} + l_k^*\dot{k}^*, \tag{26b'}$$

and the counterpart of (27) is

$$\phi_1'\dot{k} - \phi_2'\dot{k}^* - \phi_3'\dot{\alpha} = 0, \tag{27'}$$

where

$$\phi_1' \equiv [f_{kk} + f_{kl}l_k] < 0,$$

$$\phi_2' \equiv [f_{k\bar{k}}^* + f_{kl}^* l_k^*] < 0,$$

$$\phi_3' \equiv [\bar{\mu}\psi\tilde{\alpha}^{(\psi-1)}f_{kl}^* l_\alpha^* - f_{kl}l_\alpha].$$

[17] The framework of tax adjusted discount rates in arbitrary but a plausible one; the reader is referred to Sick (1990) where tax-adjusted discount rates are discussed in detail.

Evaluating these expressions at identical preferences, and technologies, and zero taxes across countries yields: $\phi_1' = \phi_2'$ and $\phi_3' = 0$. The dynamics are still given by (28), (29), (30), substituting ϕ_1 for ϕ_1', and the dynamic equation for the domestic marginal utility of wealth, (21a), for

$$\dot{\alpha}/\alpha = (1 - \tau_c)[\beta' - f_k(k, l)]. \tag{21a'}$$

5.2. Steady state

In this case, the steady state consists of Eqs. (31a)–(31d), (33a), (31h), (31j), and

$$f_k(\tilde{k}, \tilde{l}) = \beta', \tag{31f'}$$

$$f_k^*(\tilde{k}^*, \tilde{l}^*) = \beta', \tag{31g'}$$

$$\beta' \tilde{N} = \tilde{c} - f(\tilde{k}, \tilde{l}), \tag{31i'}$$

solving for the unknowns $\tilde{k}$, $\tilde{k}^*$, $\tilde{c}$, $\tilde{c}^*$, $\tilde{l}$, $\tilde{l}^*$, $\tilde{\alpha}$, $\tilde{\alpha}^*$, $\tilde{N}$ and $\tilde{\mu}$, given N_o, $k_o > 0$, $k_o^* > 0$, and the tax rates. The main difference is that the domestic and foreign capital/labor ratios are independent of capital income taxes. In effect, (31f') and (31g') denote the open economy version of the production efficiency theorem of Diamond and Mirrlees (1971). In the infinite horizon model this means that the capital/labor ratios follow the modified golden rule.[18]

5.3. Comparative dynamics of changes in domestic taxes

5.3.1. Increase in the domestic labor tax rate

Consider an unanticipated permanent increase in the domestic labor tax rate, $d\tau_w > 0$. It can be shown that in this case the qualitative response of the economies is identical to the source-based case as in Table 1 and Fig. 1. The main reason for this result is that the way the labor income tax impacts on the household labor supply decision in Eqs. (2b) and (3b) is rather insensitive to the system of capital income taxation. Moreover, the only determinant of international borders in this paper is the fact that labor is assumed immobile. If labor was assumed mobile, then the system of labor income taxation could well parallel the system of capital income taxation inducing differentiated impacts.[19]

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[18] For a discussion of this result in a related model see Turnovsky and Bianconi (1992), and in alternative models see Gordon (1992), Frenkel, Razin, and Sadka (1991), and Giovannini (1990).

[19] Note that this result does not depend on the fact that the tax change is computed from an initial equilibrium of zero capital income taxes. For any given set of existing capital income taxes, the qualitative effects are identical even though their relative magnitudes may not be the same.

5.3.2. Increase in the domestic capital income tax rate

Consider an unanticipated permanent increase in the domestic interest income tax rate, $d\tau_c > 0$. In this case, there are neither short- nor long-run effects in any of the relevant endogenous variables. Only the domestic discount rate becomes lower relative to the foreign discount rate, i.e., $d\beta/d\tau_c = -\beta' < 0$, and the parameter $\bar{\mu}$ changes by $d\bar{\mu}/d\tau_c = -\bar{\mu}(\log \tilde{\alpha})$, according to (33a). The residence-based scheme of capital income taxation with tax-adjusted discount rates in this framework insulates both the domestic and foreign economies from changes in capital income taxation.

6. Contrast with other results in the literature

The results obtained in this paper are closely related to the previous results obtained by Turnovsky and Bianconi (1992) and should be interpreted as complementary to that paper. As stated before, the main contribution here is to endogenize the labor supply of households.[20] The main distinctive features of the present model, when compared to Turnovsky and Bianconi (1992) are:

(i) In the case of source-based tax regime, when labor is endogenously supplied, an increase in the domestic capital income tax has a long-run international transmission effect on the capital stock abroad. If labor is held constant, the long-run capital stock abroad is determined entirely by production conditions abroad and therefore unchanged. With variable capital and labor, it is the long-run capital/labor ratio that is determined entirely by production conditions abroad. Thus, the domestic tax increase has a long-run positive spillover effect on the capital stock and employment in the foreign economy, exactly by the same amount.

(ii) In the alternative case of residence-based regime, a capital income tax disturbance does not have short- and long-run effects on the domestic and foreign capital stocks, or alternatively there are no international transmission effects. It is shown here that whether or not labor is variable does not influence the outcome of capital income tax disturbances when the residence-based scheme is coupled with tax-adjusted discount rates. In this case, a capital income tax disturbance does not affect the allocation of resources. This result is shared by Turnovsky and Bianconi (1992) where the appropriate rate of time preference adjusts and everything else remains constant.

The results obtained in my infinite-horizon representative-agent model differ from the results in the alternative overlapping-generations model. Christensen

[20] For example, Solow (1957) among others has pointed out the importance of labor supply effects on capital accumulation.

and Nielsen (1992) and Ihori (1991) analyze tax disturbances under alternative taxation schemes in two-country versions of the overlapping generations model where labor is assumed fixed.

In the article by Christensen and Nielsen (1992), an increase in the domestic capital income tax under the residence-based regime generates no initial effects in all endogenous variables (except for consumption), but it does generate long-run effects in all endogenous variables. In my model there are no short- and long-run effects in all the endogenous variables. However, in my model, capital income tax disturbances generate a positive correlation between consumption across countries along the transitional path in the source-based scheme, a fact shared with real world data.[21] In the Christensen and Nielsen framework, capital income tax shocks always generate a negative correlation between consumption across countries in the alternative taxation schemes. The difference in consumption responses derives from the fact that, in the overlapping-generations model, domestic residents not only trade with foreigners but also with other domestic residents from different generations. In contrast, the representative-agent framework allows for trade to occur only between domestic and foreign residents, and since the distribution of consumption is endogenously determined in steady state, after the initial impact effects the consumption profiles are always positively correlated along the transitional paths.

Finally, Ihori (1991) finds that, given a capital income tax change, there is a negative correlation between capital accumulation across countries in the source-based case. In my model, I find that, given a capital income tax change, there is a positive correlation between capital accumulation across countries in the source-based case along the transitional path. The reason for the contrast here is that my model allows for the instantaneous adjustment of capital stocks across countries given an exogenous disturbance [recall Eq. (24)], whereas in Ihori's (1991) model [and in Buiter (1981) as well] preexisting capital stocks cannot be instantaneously relocated.

7. Conclusions

In this paper, I have extended the two-country framework available in the literature to include endogenously supplied labor. It is shown that the qualitative effect of domestic labor income taxes are insensitive to the system of capital income taxation, while the effects of capital income tax disturbances are sensitive to the particular tax regime.

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[21] See, e.g., the stylized facts in Backus, Kehoe, and Kydland (1992) and Devereux, Gregory, and Smith (1992). Obviously, in my model given that preferences are identical and homothetic, the consumptions of the two agents are prefectly correlated along the transitional path; see for example Townsend (1987).

Two caveats of the model presented are: (i) with endogenously supplied labor, some of the qualitative effects obtained are ambiguous and require some restrictions upon preferences and technologies in order to be signed, and (ii) the arbitrage conditions that insure an interior equilibrium induce restrictions on the parameters of the model.

There are three extensions that could be readily assessed from the present analysis: (i) government expenditure disturbances, as in Devereaux and Shi (1991), and its international repercussions may be readily analyzed in this framework and the results compared to other papers in the literature; (ii) welfare effects may be computed with the available analytical methods in the literature, as in Turnovsky and Sen (1991) and Turnovsky and Bianconi (1992); and (iii) temporary tax shocks may be analyzed using the methods presented in Sen and Turnovsky (1990). The introduction of long-run growth, along the lines of Jones and Manuelli (1990), is also a promising extension of the model.

One more ambitious project is the analytical solution of these models for the case of uncertainty along the lines of Grinols and Turnovsky (1991). As first noted by Slemrod (1988), the arbitrage conditions for an interior equilibrium are very restrictive, basically imposing some interdependence in the parameters of the model. Once uncertainty and risk aversion enter the picture, it will be possible for domestic and foreign residents to hold assets with different rates of return and risk characteristics.

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