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Supply-Side Economics in an Integrated World Economy 1/

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Abstract

The macroeconomic effects of changes in tax and expenditure policies are examined in the context of the competitive equilibrium of a two-country, two-sector model of an integrated world economy. Governments finance purchases and net transfers of tradable and nontradable goods by imposing distortionary taxes on factor incomes and consumption. The model is parameterized and calibrated using data from large industrial economies, including estimates of effective tax rates. Numerical simulations provide estimates of the welfare costs associated with existing distortionary taxes and of the potential gains linked to a more efficient use of these taxes. Welfare gains from tax reforms favoring indirect taxation are substantial. The effects of permanent changes in expenditures depend on their sectoral allocation across tradables and nontradables and on whether they are debt- or tax-financed. Trade in goods and assets is very sensitive to fiscal policy changes, but aggregate consumption patterns and welfare implications are not.

JEL Classification Numbers:
E62, H87, H21

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Summary

This paper examines long-run macroeconomic effects of fiscal policies in the context of a two-country, two-sector dynamic equilibrium model. Numerical simulations quantify the effects of changes in tax and expenditure policies on welfare and macroeconomic aggregates. Some of these simulations aim to examine part of the effects of European debt convergence and tax harmonization envisaged in the Maastricht Treaty and of fiscal consolidation in the United States. The model is calibrated to mimic features of the current stance of fiscal policy in industrial countries such as GDP ratios of government expenditures and tax rates on factor incomes and consumption as well as average growth rates and labor income shares in GDP. This benchmark model reproduces the observed output shares of consumption, investment, net exports, tax revenue, and government transfers.

A comparison of long-run welfare levels shows that in the model the costs associated with the distortions of existing taxes are large, as are potential gains of tax reforms favoring indirect taxes, and that, in contrast, incentives for immigration are small. Although transition costs following a tax reform dramatically reduce the long-run welfare gains, these gains are still larger than existing estimates of those derived from price and output stability, international risk sharing aimed at smoothing consumption, and decreased policy uncertainty.

Consumption taxes generate smaller welfare costs per unit of revenue than factor income taxes. The capital income tax is the least efficient because it distorts savings and lowers the investment rate. These findings imply that proposals to reduce budget deficits partly by shifting the tax system toward heavier capital income taxation may be suboptimal. Although tax policies affect the external balance, a widening fiscal deficit resulting from tax reductions does not always worsen the trade deficit. This is true of the labor income tax but not of capital and consumption taxes.

The effects of changes in government expenditures depend on whether they are uniform across tradable and nontradable sectors and on whether they are financed with distortionary taxes or lump-sum taxes. An expansion of expenditures financed with lump-sum taxes has significant effects when it is uniform across sectors, but not when it is biased toward nontradables. The opposite is true for a consumption tax-financed increase in expenditures.

The model shows that the effects of tax harmonization and public debt convergence on macroeconomic aggregates are small, but the welfare implications are significant. However, tax agreements that focus only on indirect tax harmonization induce incentives for low-tax countries to modify factor income taxes in order to offset welfare losses. Debt convergence results in welfare gains in excess of 4 percent for high-debt countries, with little impact on the performance of low-debt countries.

I. Introduction

This paper examines the long-term implications of fiscal policy in the context of a two-country, two-sector intertemporal general equilibrium model. The model is calibrated to capture some of the basic features that characterize the stance of fiscal policies in the group of seven largest industrialized countries (G-7)--particularly the structure of tax systems and the output shares of government expenditures and transfers. We use the model to study some of the channels by which changes in policies regarding tax rates on factor incomes and consumption, the level and sectoral distribution of public expenditures, and the level of net transfers or the public deficit, affect equilibrium allocations and welfare. In particular, we focus on the effects of fiscal policies on macroeconomic aggregates, the efficiency of the tax system, and the welfare costs resulting from the distortions introduced by government policies. Our goal is to study some of the macroeconomic implications of current fiscal policies in the G-7 and to provide some insights into potential improvements in the design of these policies. To this end, we conduct numerical experiments to study some of the effects that may result from major fiscal policy adjustments, such as the proposed fiscal adjustment package in the United States and the debt-convergence and tax-harmonization envisaged for the European Community in the Maastricht Agreement.

Recently, interest in assessing the effects of these substantial fiscal policy changes has grown with the need to contribute to ongoing political debates on Maastricht, in Europe, and on the design of the package of fiscal austerity in the United States. In contrast with conventional policy simulations based on macroeconometric models or computational static equilibrium models, in this paper we examine the implications of policy changes in the context of an intertemporal general equilibrium framework. Modern macroeconomic theory emphasizes the importance of this framework because it allows agents to react optimally to changes in policy variables, and it provides an explicit characterization of the income and substitution effects by which fiscal policies affect economic activity (see Frenkel and Razin (1992)). Hence, the assessment of the effects of fiscal policy changes that results from quantitative applications of this theory are not affected by the Lucas Critique, which casts doubts on the reliability of standard econometric policy simulations. Lucas (1990) provides a clear illustration of the potential usefulness of this approach for the assessment of fiscal policies.

Following Lucas' quantitative analysis of the effects of distortionary factor income taxation on the long-run equilibrium allocations and the level of welfare of a balanced-growth closed economy, there has been growing interest in using numerical simulations of dynamic equilibrium models to study the stance of fiscal policies and its potential improvements. Notably, Cooley and Hansen (1992), Chari, Christiano, and Kehoe (1993), and Jones, Manuelli, and Rossi (1993) have examined various aspects of the United States fiscal policy framework using closed-economy models. These authors have extended Lucas' work by focusing not only on comparing balanced-growth equilibria for different tax systems, but also by studying transitional dynamics between steady states, by assessing the business cycle effects of fiscal policies, by providing specific solutions to the Ramsey

optimal taxation problem, and by looking at the relationship between the structure of taxation and growth. Razin and Sadka (1992) have conducted similar experiments for the Israeli economy using a model of a small open economy. All these studies have shown that potential benefits of reforms to the tax system are substantial. Although the actual magnitude of welfare gains is sensitive to the costs of transitional dynamics and some parameter values, these gains are much larger than those that have been derived from attaining full price and output stability. Lucas (1990) interprets this result as suggesting that, at least among large industrial countries, emphasis on tax reform, and structural fiscal policies in general, may be potentially more relevant than emphasis on stabilization policies.

We find that our results on the welfare costs of existing distortionary taxes for the case of a two-country model of a fully-integrated world economy where there is free trade in goods, capital, and financial assets, are consistent with those obtained in closed-economy models by Lucas and the other authors mentioned. A reform of the tax system intended to finance current expenditure and transfers patterns using indirect taxation only, could result in welfare gains in excess of 13 percent in the long-run trend level of consumption per-capita in each country. When rough approximations of the costs of transitional dynamics are considered, these welfare gains decline to 1.5 percent, but this still a large figure in equilibrium analysis of economic polices. We also find that changes in tax policies have notable effects on trade in goods and assets, although most of the welfare gains of improved tax efficiency are not due to the openness of the economy.

In addition to examining the efficiency of the tax system, we also study the effects of government expenditures. We find that the effects of changes in expenditures vary depending on their allocation across tradable and nontradable goods, and also depending on whether they are financed with lump sum taxes (which may be interpreted as permanent increases in debt) or with distortionary taxes. Unilateral, debt-financed increases in expenditures that are uniform across sectors induce strong wealth effects on labor supply, which are significantly reduced when the fiscal expansion is biased towards nontradables and agents reallocate labor across sectors. In contrast, unilateral, consumption tax-financed increases in expenditures that are uniform across sectors have minimal aggregate effects as wealth effects are significantly weakened by the agents' desire to substitute labor for leisure given rising rates of indirect taxation. When the consumption tax-financed increase in expenditures is concentrated in nontradable goods, the after-tax wage in the tradables sector falls given that consumption taxes are uniform across all goods, and hence there are significant aggregate effects on labor supply and output. Thus, fiscal policy strategies aimed at reducing the size of government expenditures or the public deficit, both as shares of GDP, should take into account the sectoral allocation of expenditures and transfers.

The results of this analysis, particularly those that favor the implementation of tax reforms in favor of indirect taxation, need to be interpreted with caution. The model abstracts from several important

elements of actual economies so as to maintain tractability and to focus the analysis on a limited set of transmission mechanisms of fiscal policy. Extensions to study the implications of allowing for the existence of heterogeneous agents, with different income levels, as well as to allow for production and consumption benefits of government expenditures, are just two examples of topics that deserve further attention. However, given that it is common practice to disregard these elements in the design of macroeconometric projections of the effects of fiscal policy changes, we view our results as a fair first approximation.

The paper is organized as follows. The next section presents the model and characterizes the allocations that describe world general equilibrium in the long-run, along a path of balanced growth. Section III specifies the structure of exogenous parameters that are used to calibrate the model to the stylized facts of the G-7. We specify a benchmark world economy and provide some estimates of the macroeconomic effects of existing tax and expenditure policies. Section IV examines the implications of unilateral changes in fiscal policies in one country using the benchmark framework, and also studies tax harmonization and debt convergence in an alternative specification of the model. Section V provides some concluding remarks.

II. The Model

Consider a world economy consisting of two countries, Country 1 and Country 2. Households display the same preferences in each country and firms make use of similar production technologies. Each country produces two goods, one tradable good and one that is only for domestic use. The goods are produced using capital and labor services according to constant-returns-to-scale technologies. Preferences and technology are specified to satisfy balanced-growth conditions as in King, Plosser, and Rebelo (1988) and Lucas (1990), so that in the long-run each country grows at a rate that is constant over time and uniform across GDP, consumption, and investment. This requires, in addition to certain restrictions on utility and technology, that we assume labor-augmenting technological change, which can be represented as a time-variant multiplicative factor in the labor input of the production function. This technological change grows at a constant rate γ, and this rate determines the long-run growth rates of macroeconomic aggregates in the model. 1/

There is a large number of identical households and firms in each country that formulate optimal decisions taking all relative prices as given. Hence, the analysis focuses on allocations that characterize the

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1/ If we denote the factor of labor augmenting technological change by X_t, where $X_{t+1}/X_t = \gamma$, the optimization problem that characterizes the model's equilibrium can be re-defined in stationary form by deflating all variables, except leisure and labor supply, by X_t. To keep the notation simple, this adjustment is not explicitly noted in the paper, but it should be kept in mind when interpreting the variables of the model.

competitive equilibrium of the world economy. We also assume that there are no restrictions on international trading of equity and one-period discounted bonds, or on the cross-country mobility of physical capital in the industries that produce tradable goods. In each economy there is also a government which undertakes nonproductive expenditures and makes transfer payments to households in tradable and nontradable goods. Each government finances its expenditures by levying distortionary taxes on labor and capital income, and on private consumption. Households are allowed to claim an allowance for the depreciation of physical capital in their payments of capital income taxes. There are international agreements establishing the residence principle as the rule for tax collection.

Given that preferences and technology in each country are identical, we describe only the choice problems faced by households, firms, and government in Country 1. This simplifies the notation significantly. We then proceed to characterize the general equilibrium of the world economy.

1. Optimal plans in Country 1

a. Households

The optimization problem faced by the representative agent in Country 1 is to choose optimal consumption plans so as to maximize the following time-separable utility function:

$$\sum_{t=0}^{\infty} \beta^t U(C_t^T, C_t^N, L_t) \tag{1}$$

where:

$$U(C_t^T, C_t^N, L_t) = \left(\frac{1}{1-\sigma}\right) \left\{ \left[(C_t^T)^{-\mu} + (C_t^N)^{-\mu} \right]^{-\frac{1}{\mu}} L_t^a \right\}^{1-\sigma} \tag{2}$$

Households take as given all relative prices of goods and factors of production in the world economy, as well as the rates of taxation and the amount of net transfers set by the Government. They are also assumed to own the firms, and hence they make capital-accumulation decisions and allocate capital to firms. Thus, households maximize utility subject to the following budget constraint:

$$
\begin{aligned}
& p_t^N(1+\tau_c)C_t^N + (1+\tau_c)C_t^T = (1-\tau_k)\left[r_t^T K_t^H + r_t^{T*} K_t^F + p_t^N r_t^N K_t^N\right] \\
& -\gamma[k_{t+1}^H + K_{t+1}^F + p_t^N K^N] + (1-\delta)\left[K_t^H + K_t^F + p_t^N K_t^N\right] \\
& +\delta\tau_k\left[K_{t+1}^H + K_t^F + p_t^N K_t^N\right] + (1-\tau_n)\left[\omega_t^T N_t^T + p_t^N \omega_t^N N_t^N\right] \\
& -\gamma(1+\tau_b)R_t B_{t+1} + B_t + T_t^T + p_t^N T_t^N
\end{aligned}
\tag{3}
$$

and the time constraint,

$$
L_t + N_t^N + N_t^T = 1 \tag{4}
$$

In this optimization problem, parameters and variables are defined as follows:

1) C^T consumption of tradables.

2) C^N consumption of nontradables.

3) L time devoted to leisure activities.

4) σ coefficient of relative risk aversion ($1/\sigma$ is the intertemporal elasticity of substitution in consumption).

5) μ tradables-nontradables consumption substitution factor ($1/(1+\mu)$ is the elasticity of substitution between consumption of tradables and nontradables).

6) a exponent governing the real-wage elasticity of labor supply.

7) β subjective discount factor modified to produce balanced growth. 1/

8) p^N relative price of nontradable goods in terms of tradable goods (i.e. the real exchange rate).

9) τ_c tax rate on private consumption.

1/ As in King, Plosser and Rebelo (1988), we interpret $\beta=B\gamma^{1-\sigma}$, where $1/B-1$ is the rate of time preference.

10) τ_k tax rate on capital income.

11) r^T rental price of capital in the tradables industry of Country 1.

12) K^H capital stock allocated to the tradables industry of Country 1 and owned by residents of Country 1.

13) r^{T*} rental price of capital in the tradable industry of Country 2. 1/

14) K^F capital stock allocated to the tradables industry of Country 2 and owned by residents of Country 1.

15) r^N rental price of capital in the nontradables industry.

16) K^N capital stock allocated to the nontradables industry (it is assumed that only residents of Country 1 can own shares in the country's nontradables industry).

17) γ percentage change in the rate of labor-augmented technological change.

18) δ depreciation rate of physical capital.

19) τ_n tax rate on labor income.

20) w^T real wage in the tradables industry.

21) N^T labor services supplied to the tradables industry.

22) w^N real wage in the nontradables industry.

23) N^N labor services supplied to the nontradables industry.

24) τ_b tax rate on purchases of international bonds.

25) R inverse of the gross rate of return on one-period international bonds.

26) B net holdings of international bonds.

1/ All variables pertaining to Country 2 are identified by an asterisk.

27) T^T net transfers from government in units of tradable goods.

28) T^N net transfers from government in units of nontradable goods.

The first-order conditions that characterize the households' optimal plans are the following:

$$\frac{U_2(t)}{U_1(t)} = p_t^N \tag{5}$$

$$\frac{U_3(t)}{U_1(t)} = \frac{(1-\tau_n)}{(1+\tau_c)}\,\omega_t^T \tag{6}$$

$$\frac{U_3(t)}{U_2(t)} = \frac{(1-\tau_n)}{(1+\tau_c)}\,\omega_t^N \tag{7}$$

$$\gamma(1+\tau_b)\,R_t\,U_1(t) = \beta U_1(t+1) \tag{8}$$

$$\gamma U_1(t) = \beta U_1(t+1)\left[(1-\tau_k)r_{t+1}^T + 1-\delta(1-\tau_k)\right] \tag{9}$$

$$\gamma U_1(t) = \beta U_1(t+1)\left[(1-\tau_k)r_{t+1}^{T*} + 1-\delta(1-\tau_k)\right] \tag{10}$$

$$\gamma p_t^N U_1(t) = \beta p_{t+1}^N U_1(t+1)\left[(1-\tau_k)r_{t+1}^N + 1-\delta(1-\tau_k)\right] \tag{11}$$

These conditions have the standard interpretation. (5) equates the marginal rate of substitution between tradables and nontradables consumption with the corresponding relative price. Equations (6) and (7) set the marginal rates of substitution between leisure and consumption of tradables and nontradables equal to the corresponding post-tax real wage in each industry. Labor income and consumption taxes introduce distortions that reduce the effective relative price of leisure, and hence induce substitution effects that motivate agents to reduce labor supply. Equations (8)-(11) are Euler conditions governing the optimal allocation of savings in each of the four available investment vehicles--each condition equates the marginal costs and benefits, in terms of lifetime utility, resulting from reallocating consumption of tradables from the present to the future, taking into account the marginal rates of return of investments in international bonds, (8), the domestic tradables industry, (9), the foreign tradables industry, (10), and

the domestic nontradables industry, (11). The role of the tax on capital income as a tax on savings is clearly illustrated in these equations. An increase in the capital income tax reduces the marginal return on savings, and hence induces a substitution effect in favor of current consumption. The constraints (3) and (4) are also part of the set of optimality conditions.

Equations (8)-(11) produce two important implications of the assumption of perfect international capital mobility, under a regime of residence-based taxation. First, households undertake investments up to the point where they equate the real, pre-tax rates of return on capital in the domestic tradables, foreign tradables, and on international one-period bonds ($r^T=r^{T*}=R^{-1}-1$). Thus, under residence-based taxation, capital income taxes do not distort the optimality conditions governing the allocation of capital across industries and across countries, as explained in Frenkel, Razin, and Sadka (1991). The second implication is that, given exogenous growth driven by labor-augmenting technological change, countries cannot have independent capital income tax policies along the balanced-growth path. If marginal utility is to grow at a constant rate in each country, equation (9) and its Country 2 counterpart imply that, given one country's capital income tax rate, there is only one value of the other country's capital income tax rate that supports the steady-state, balanced-growth equilibrium. 1/

Therefore, unless the model is modified to incorporate a theory relating taxation and growth, as in Lucas (1990), this basic neoclassical framework predicts that, if countries follow paths of balanced growth, the elimination of barriers to capital mobility implies that countries give up their independence in setting taxes on capital income. 2/

b. Firms

There are two industries in Country 1, each containing a large number of identical firms, producing tradable and nontradable goods. The representative firms in each sector maximize profits subject to a cost constraint, taking the pre-tax prices of productive factors as given. Goods are produced in each sector according to Cobb-Douglas technologies:

$$F(K_t^T, N_t^T) = (N_t^T)^{\alpha T} (K_t^N)^{1-\alpha T} \qquad (12)$$

1/ A similar result is presented in Frenkel, Razin, and Sadka (1992).

2/ Using a model of endogenous growth based on human capital accumulation, Razin and Yuen (1993) examine how cross-country differences in capital income tax rates may explain why there is convergence or divergence in growth across countries.

$$F(K_t^N, N_t^N) = (N_t^N)^{\alpha N}(K_t^N)^{1-\alpha N} \tag{13}$$

Where αT is the labor's share on income in the tradables industry and αN is the labor's share on income in the nontradables industry. The input of capital in the tradables industry is the sum of the capital stocks owned by residents of Country 1 and Country 2 (i.e. $K^T=K^H+K^{H*}$).

Profit maximization under constant returns to scale and perfect competition implies that there are zero profits in equilibrium, and total output equals payments to each input, where unit input costs are measured by the corresponding marginal products. Optimal plans of firms are therefore characterized by the following zero-profit conditions:

$$F(K_t^T, N_t^T) = r_T^T K_t^T + \omega_t^T N_t^T \tag{14}$$

$$F(K_t^N, N_t^N) = r_t^N K_t^N + \omega_t^N N_t^N \tag{15}$$

Where the rental prices of capital and labor services are given by:

$$r_t^T = F_1(K_t^T, N_t^T) \tag{16}$$

$$\omega_t^T = F_2(K_t^T, N_t^T) \tag{17}$$

$$r_t^N = F_1(K_t^N, N_t^N) \tag{18}$$

$$\omega_t^N = F_2(K_t^N, N_t^N) \tag{19}$$

c. Government

In addition to setting taxes and transfers, the government undertakes unproductive expenditures in the tradables and nontradables sectors, denoted G^T and G^N respectively. The government's budget constraint:

$$
\begin{aligned}
G_t^T + p_t^N\, G^N + T_t^T + p_t^N T^N &= \tau_n\left[r_t^T\, K_t^H + r_t^{T*}\, K_t^F + p_t^N\, r_t^N\, K_t^N\right] \\
&+ \tau_n\left[\omega_t^T\, N_t^T + p_t^N\, \omega_t^N\, N_t^N\right] + \tau_c\left[C_t^T + p_t^N\, C_t^N\right] \\
&- \tau_{k\delta}\left[k_t^H + K_t^F + p_t^N\, K_t^N\right] + \tau_b \gamma\, R_t\, B_{t+1}
\end{aligned}
\tag{20}
$$

Where, to ensure that capital income is taxed uniformly, the tax on foreign bond purchases is set as:

$$
\begin{aligned}
(1+\tau_b) R_t &\equiv \left[1 + r_t(1-\tau_k)\right]^{-1} \\
R_t &\equiv (1+r_t)^{-1}
\end{aligned}
\tag{21}
$$

Borrowing and lending by the government is not explicitly modelled. For the purposes of the long-run, balanced-growth analysis undertaken here this is an innocuous assumption, since government debt can be easily priced in the model (i.e. in equilibrium it must yield the same return as physical capital and the international bond), and because in the steady state it can be treated as having identical effects as changes in the level of transfers (see Razin and Sadka (1992), Cooley and Hansen (1992) and Lucas (1990)).

2. World general equilibrium

Optimal decisions by agents in Country 2 can be characterized by conditions that are identical to those presented in equations (1)-(21), except that the functions representing utility, production, and budget constraints are evaluated for the values of the variables that correspond to that economy, which are identified by an asterisk. The allocations that characterize the world general equilibrium of the model are given by a set of sequences of macroeconomic aggregates, $\{C_t^T, C_t^N, L_t, N_t^T, N_t^N, K_{t+1}^T, K_{t+1}^N, B_{t+1}, C_t^{T*}, C_t^{N*}, L_t^*, N_t^{T*}, N_t^{N*}, K_{t+1}^{T*}, K_{t+1}^{N*}, B_{t+1}^*\}_{t=0}^{\infty}$, and a set of sequences of relative prices, $\{p_t^N, r_t^T, r_t^N, w_t^T, w_t^N, p_t^{N*}, r_t^{T*}, r_t^{N*}, w_t^{T*}, w_t^{N*}, R_t\}_{t=0}^{\infty}$ that, given initial conditions on capital stocks and bond holdings, the tax rates, and the levels of government expenditures and transfers, satisfy the optimality conditions of households and firms in Country 1 and Country 2, the two government budget constraints, the market-clearing conditions for nontradables in each country, and the world market-clearing conditions in the markets of tradable goods and bonds. These market-clearing conditions are:

$$
F(K_t^N, N_t^N) = C_t^N + \gamma K_{t+1}^N - (1-\delta) K_t^N + G_t^N \tag{22}
$$

$$F(K_t^{N*}, N_t^{N*}) = C_t^{N*} + \gamma^* K_{t+1}^{N} - (1-\delta)K_t^{N*} + G_t^{N*} \tag{23}$$

$$F(K_t^{T}, N_t^{T}) + F(k_t^{T*}, N_t^{T*}) = C_t^{T} + C_t^{T*} + \gamma K_{t+1}^{T} - (1-\delta)K_t^{T} + \gamma^* K_{t+1}^{T*} - (1-\delta)K_t^{T*} + G_t^{T} + G_t^{T*} \tag{24}$$

$$B_t + B_t^* = 0 \tag{25}$$

Note that the market-clearing condition in world trade can be derived from combining the households' budget constraints, the government budget constraints, the zero-profit conditions, the nontradables market clearing conditions, and the condition of market clearing in the bond market. Thus, Walras' Law holds.

a. Steady-state, balanced-growth equilibrium

A closed-form solution for the general equilibrium allocations in a model of this kind usually does not exist, even under conditions of perfect foresight. For purposes of business cycle analysis (i.e. random, short-term fluctuations around long-term trends) the model can be solved using a linear approximation method that applies first-order Taylor approximations around the steady state (see Mendoza and Tesar (1993)). For purposes of examining the long-run implications of the model, as we intend to do here, one can focus on a solution to the model's general equilibrium in the stationary state. 1/ In particular, we restrict our analysis to world equilibrium allocations along a path of long-run growth that is constant over time and uniform across sectors. As illustrated next, this restricts our analysis to equilibria in which Country 1 and Country 2 grow at the same rate and impose the same rate of taxation on the income derived from capital.

After simple, but lengthy, algebraic manipulation, one can show that along the balanced-growth path, and given the functional forms adopted for preferences and technology, the general equilibrium system is characterized as follows:

$$skt = \frac{\beta(1-\tau_k)(1-\alpha T)}{\gamma - \beta[1-\delta(1-\tau_k)]} \tag{26}$$

1/ Recall that the model does not have a steady state in levels of the variables, but it does have a stationary equilibrium for variables deflated by the factor of labor-augmenting technological change.

$$skt^{*} = \frac{\beta(1-\tau_k^{*})(1-\alpha T^{*})}{\gamma^{*}-\beta[1-\delta(1-\tau_k^{*})]} \tag{27}$$

$$skn = \frac{(1-\alpha N)}{(1-\alpha T)} skt \tag{28}$$

$$\eta^{T} = \frac{\psi}{(\frac{\alpha N}{\alpha T})+\psi} \tag{29}$$

$$\psi = (\frac{scn}{sct})^{1+\mu} \left[\frac{skn^{\frac{1-\alpha N}{\alpha N}}(1-\eta^{T})}{skt^{\frac{1-\alpha T}{\alpha T}}\eta^{T}}\right]^{\mu} \tag{30}$$

$$\Omega = \frac{\psi sct}{\psi sct + scn} \tag{31}$$

$$N = \frac{\left[\frac{(1-\tau_n)}{(1+\tau_c)}\alpha T\Omega\right]}{asct\eta^{T}} \Bigg/ 1+\left[\frac{\left[\frac{(1-\tau_n)}{(1+\tau_c)}\alpha T\Omega\right]}{asct\eta^{T}}\right] \tag{32}$$

$$scn = 1-[\gamma-(1-\delta)]skn - sgn \tag{33}$$

$$sct = \phi^{T}\left[(1-\alpha T)+(1-\alpha T)\left(\frac{yt^{*}}{yt}\right)-(\gamma-(1-\delta)\left(skt+skt^{*}(\frac{yt^{*}}{yt})\right)\right] +\alpha T-\left[\frac{\beta}{(1+\tau_b)}-1\right]sb-sgt \tag{34}$$

$$(1+\tau_b) = \frac{(1-\delta)skt + (1-\alpha T)}{(1-\tau_k)[(1-\alpha T)-\delta skt]+skt} \tag{35}$$

$$\phi^{T} = \frac{\left[\frac{(1-\tau_k)(1-\alpha T) + \tau_n \alpha T}{(1-\tau_k^*)(1-\alpha T^*) + \tau_n^* \alpha T^*}\right]\left[\frac{yt}{yt^*}\right]}{1+\left[\frac{(1-\tau_k)(1-\alpha T) + \tau_n \alpha T}{(1-\tau_k^*)(1-\alpha T^*) + \tau_n^* \alpha T^*}\right]\left[\frac{yt}{yt^*}\right]} \tag{36}$$

$$\left[\frac{yt}{yt^*}\right] = \frac{skt^{\frac{1-\alpha T}{\alpha T}} \eta^{T} N}{skt^{*\frac{1-\alpha T^*}{\alpha T^*}} \eta^{T*} N^*} \tag{37}$$

$$skt^* = \frac{(1-\alpha T^*)}{(1-\alpha T)} skt \tag{38}$$

$$skn^* = \frac{(1-\alpha N^*)}{(1-\alpha T)} skt \tag{39}$$

$$\eta^{T*} = \frac{\psi^*}{\left(\frac{\alpha N^*}{\alpha T^*}\right) + \psi^*} \tag{40}$$

$$\psi^* = \left(\frac{scn^*}{sct^*}\right)^{1+\mu} \left[\frac{skn^{*\frac{1-\alpha N^*}{\alpha N^*}} (1-\eta^{T*})}{skt^{\frac{1-\alpha T^*}{\alpha T^*}} \eta^{T*}}\right]^{\mu} \tag{41}$$

$$\Omega^* = \frac{\psi^* sct^*}{\psi^* sct^* + scn^*} \tag{42}$$

$$N^* = \frac{\left[\frac{(1-\tau_n^*)}{(1+\tau_c^*)}\alpha T^*\Omega^*\right]}{a^* sct^* \eta^{t*}} \Bigg/ 1+\left[\frac{\left[\frac{(1-\tau_n^*)}{(1+\tau_c^*)}\alpha T^*\Omega^*\right]}{a^* sct^* \eta^{T*}}\right] \tag{43}$$

$$scn^* = 1-[\gamma^*-(1-\delta)]skn^*-sgn^* \tag{44}$$

$$sct+sct^*\left(\frac{y_t^*}{yt}\right)+sgt+sgt^*\left(\frac{y_t^*}{yt}\right)+\left(skt+skt\left(\frac{y_t^*}{yt}\right)\right)\left[\phi^T\gamma+(1-\phi^T)\gamma^*-(1-\delta)\right] +sb(\gamma-\gamma^*)\left(\frac{skt}{skt+(1-\alpha T)}\right) = 1+\left(\frac{y_t^*}{yt}\right) \tag{45}$$

$$(1+\tau_b^*) = \frac{(1-\delta)skt^*+(1-\alpha T^*)}{(1-\tau_k^*)[(1-\alpha T^*)-\delta skt^*]+skt^*} \tag{46}$$

Where the following definitions were adopted:

$$skt \equiv K^T/Y^T \tag{47}$$

$$skn \equiv K^N/Y^N \tag{48}$$

$$\eta^T \equiv N^T/N \tag{49}$$

$$\psi \equiv Y^T/p^N Y^N \tag{50}$$

$$sct \equiv C^T/Y^T \tag{51}$$

$$scn \equiv C^N/Y^N \tag{52}$$

$$sgt \equiv G^T/Y^T \tag{53}$$

$$sgn \equiv G^N/Y^N \tag{54}$$

$$sb \equiv B/Y^T \tag{55}$$

This simultaneous equation system determines the sets of output shares (sct, scn, skt, skn) and (sct*, scn*, skt*, skn*), the ratio of domestic to foreign output of tradables, yt/yt*, the fraction of the world capital stock allocated to tradables industries and owned by residents of Country 1, ϕ^T, the ratios of tradables to non-tradables output in each country, (yt/yn, yt*/yn*), the optimal allocations of time spent on leisure and labor activities, (N, N^T/N) and (N*, N^{T*}/N^*), the foreign capital income tax rate, τ_k^*, the taxes on bond purchases, t_b and t_b^*, and the ratios of tradables to nontradables consumption, (Ω and Ω^*). 1/ The exogenous variables and parameters in the system are given by the set (αT, αN, αT^*, αN^*, δ, β, μ, a, a^*, τ_k, τ_c, τ_n, τ_c^*, τ_n^*, sgt, sgn, sgt*, sgn*, sb, γ and γ^*).

The system in (26)-(46) provides the information needed to understand how changes in fiscal policies affect the world general equilibrium along a path of balanced growth. For instance, equations (26) and (27) illustrate how increases in the rate of capital income taxes, which represent a tax on the marginal return on savings, induce lower capital-output ratios and lower investment rates. Given γ, equation (26) determines the value of skt that results from different values of τ_k. If there is an increase in τ_k, the decline in the marginal return on savings induced by the tax increase is completely offset by an increase in the marginal product of capital, which is induced by a fall in the capital-output ratio. The perfect capital mobility condition, (38), determines skt*, and then, as noted before, from (27) it follows that there is only one value of τ_k^* that is consistent with the predetermined value of γ^* in the long-run growth equilibrium.

Note that, with trade in equity as described in the model, balanced growth with stationary expenditure shares also requires that $\gamma=\gamma^*$. If countries do not grow at the same rate, it is straightforward to show that the ratio of net exports to output is not stationary. This is because the balance of payments in the model implies that the output share of net exports in any of the two countries is equal to the negative of the sum of net payments to foreign capital, net foreign interest income, and net foreign direct investment, weighted by the ratio of foreign to domestic output. This ratio would grow over time at the rate γ/γ^*, unless γ and γ^*

1/ We focus on a particular steady-state solution to the households' portfolio allocation problem, which is in general indeterminate, by imposing the condition that the ratio of Country 1 to Country 2 wealth is equal to the ratio of post-tax factor incomes.

are equal. Thus, balanced growth requires $\gamma=\gamma^*$, and hence it follows that $\tau_k=\tau_k^*$.

The sectoral equilibrium output shares computed in (26)-(46) can be combined to produce the shares of *aggregate* consumption, investment (I), government expenditure, tax revenue (R), transfers (T), net exports (NX), and savings (S) in terms of *aggregate* output. These are denoted sc, si, sg, sr, snx and ss respectively. In general, the share of variable x in aggregate output--where x can be C, G, I, R, NX, or S--is obtained by computing the weighted sum of the shares of x^T in the output of tradables and x^N in the output of nontradables using $\psi/1+\psi$ and $1/1+\psi$ as the corresponding weights.

III. World General Equilibrium in the Benchmark Model

In order to use the long-run, balanced-growth equilibrium system to examine the effects of fiscal policy changes, we start by specifying values for exogenous variables and parameters. We consider first a benchmark case in which Country 1 is set to mimic roughly stylized facts of the United States and Country 2 is set to represent an average of large European economies (i.e France, Germany, Italy, and the United Kingdom). Preference and technology parameters are also set to mimic some basic stylized facts observed in the data of these countries. The structure of the model is very similar to the one used by Stockman and Tesar (1990) in their study of international business cycles, so we adopt many parameter values from their work.

The rate of growth γ is set to replicate the quarterly equivalent of an annual rate of growth of about 3 percent--roughly the G-7 average annual per-capita GDP growth for the period 1965-1990. The depreciation rate δ is set at the quarterly equivalent of an annual depreciation rate of 10 percent. The coefficient of relative risk aversion σ is set at 2, which implies an elasticity of intertemporal substitution in terms of aggregate consumption of 1/2. The subjective discount factor is set to represent a steady-state real interest rate of about 7 percent, which implies setting β to 0.98 (given that balanced growth requires $\beta=B\gamma^{1-\sigma}$, where B is the subjective discount factor). The 7 percent real interest rate is consistent with some estimates of the historical average real rate of return on risky assets for the United States provided by Mehra and Prescott (1985) and Danthine, Donaldson, and Mehra (1992). The value of μ is set at 1.27 (i.e. an elasticity of substitution between tradables and nontradables of $(1/1+\mu)=0.44$), which is an estimate that Stockman and Tesar (1990) obtained using data on relative expenditures and relative prices for tradables and nontradables in several countries taken from Kravis, Heston, and Summers (1982).

The parameters of the production functions are set by computing the shares of total compensation of employees in GDP using data from the OECD

Quarterly National Accounts for the period 1968-1991. 1/ This average is 0.6 for the United States, while the averages for three of the four large European economies range between 0.53 and 0.58 (see Table 1). We then followed Stockman and Tesar and set the share of labor income in total income of the tradables industry to exceed that in the nontradables industry by 5 percent. Using this information we set $\alpha T=0.61$, $\alpha N=0.56$, $\alpha T^*=0.55$, and $\alpha N^*=0.5$. The elasticity parameters of leisure in the utility functions, a and a^*, are set so as to ensure that households in Country 1 allocate 20 percent of their time to provide labor services, while Country 2 households allocate 14 percent of their time to labor supply. The 20 percent figure is consistent with what is used in some real business cycle models (see Stockman and Tesar (1990)), while the allocation of labor supply in Country 2 is consistent with cross-country evidence on hours worked in manufacturing (see Mendoza, Razin, and Tesar (1993)). The net foreign asset position of Country 1 is set at 1 percent of tradables output, which results in 2 percent of total output.

We also need to specify values for the various parameters that define the stance of fiscal policy in each country. Values for the tax rates and the output shares of government expenditures are set so as to mimic the discrepancies observed between the United States and the large European economies. The tax rates are obtained from the work of Mendoza, Razin and Tesar (1993), keeping in mind that in the benchmark model capital income taxes must be identical in the two countries. Thus, the tax rates are set as follows: $\tau_k=\tau_k^*=0.4$, $\tau_c=0.055$, $\tau_n=0.26$, $\tau_c^*=0.15$, $\tau_n^*=0.28$. The shares of government expenditures in tradables and nontradables are set so as to produce aggregate ratios of government expenditure to total output of 18 percent in Country 1, and 20 percent in Country 2. These figures approximate the actual average shares of government expenditures in output listed in Table 1, taking into account the fact that the United States share includes public investment. A list of all parameter values used to simulate the benchmark model appears in Table 2.

Table 3 reports the outcome of the model's numerical simulation using the parameters of the benchmark case. The table lists the output shares of various macroeconomic aggregates, the ratio that defines the world distribution of ownership of capital in the tradables industries, the size of GDP in Country 1 relative to Country 2, the size of the tradables sector relative to the nontradables sector in each country, the real exchange rates (i.e. the equilibrium relative prices of nontradables), the taxes on bond purchases, the elasticities of labor supply, and three welfare comparisons that examine a) relative welfare across countries, b) the welfare costs of

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1/ This may actually underestimate the value of α because it does not include proprietor's income.

Table 1. Macroeconomic Aggregates of G-7 Countries in Percent of Output

(Averages for the period 1968-1991) 1/

	Private Consumption	Private Investment	Government Expenditure	Net Exports	Tax Revenue	Government transfers 3/	Compensation of Employees
United States	0.65	0.16	0.19 2/	-0.01	0.28	0.14	0.60
Canada	0.57	0.19	0.19	0.01	0.33	0.18	0.55
Germany	0.56	0.18	0.19	0.03	0.37	0.22	0.56
France	0.59	0.19	0.18	0.00	0.40	0.25	0.53
United Kingdom	0.62	0.15	0.20	-0.00	0.36	0.21 4/	0.58
Italy	0.62	--	0.15	-0.01	0.30	0.28 4/	--
Japan	0.57	0.23	0.09	0.01	0.25	0.14	0.53

1/ Source of all data, except tax revenue and government transfers, is OECD Quarterly National Accounts. Tax revenue and government transfer are averages of annual data obtained from OECD National Accounts (1970-1988) and OECD Revenue Statistics (1970-1988).

2/ Includes government investment.

3/ Subsidies and other current transfers.

4/ 1980-1988.

Table 2. Parameters of the Benchmark Model

Preferences:			
	σ = 2		
	β = 0.983		
	μ = 1.27		
	N = 0.2		
	N^* = 0.14		
Technology:			
	γ = γ^* = 1.0074		
	δ = 0.026		
	αT = 0.61	αT^* =	0.55
	αN = 0.56	αN^* =	0.50
Fiscal Policy:			
	τ_k = τ_k^* = 0.4		
	τ_c = 0.055	τ_c^* =	0.15
	τ_n = 0.26	τ_n^* =	0.28
	sgt = 0.18	sgt^* =	0.20
	sgn = 0.18	sgn^* =	0.20
	sb = 0.01		

Table 3. The World General Equilibrium in the Benchmark Model

Variable	Country 1			Country 2		
	Tradables	Nontradables	Aggregate	Tradables	Nontradables	Aggregate
Output shares (in percent):						
Consumption	67.9	63.5	65.8	59.1	59.0	59.1
Capital stock	489.5	552.3	519.8	564.8	627.6	593.3
Investment	16.4	18.5	17.4	18.9	20.9	19.8
Savings	14.1	18.5	16.3	20.9	20.9	20.9
Net exports	-2.3	--	-1.1	2.0	--	1.1
Government expenditure	18.0	18.0	18.0	20.0	20.0	20.0
Tax revenue	31.1	29.9	30.5	35.4	36.3	35.8
Transfers	13.1	11.9	12.5	15.4	16.3	15.8
Other ratios:						
Ownership of world capital			0.48			0.52
Domestic to foreign output			0.95			1.05
Tradables-nontradables output			1.07			1.20
Real exchange rate			0.79			0.72
Memorandum:						
Tax on bond purchases			0.0208			0.0208
Labor supply elasticity			2.499			3.433
Consumption changes needed to: 1/						
Equalize welfare			1.67			-1.64
Offset all tax distortions			20.48			31.93
Offset income tax distortions			13.40			20.22

1/ Consumption changes computed as percent changes in steady-state aggregate consumption needed for the benchmark model to produce the same welfare of the experiments listed (i.e. to give the two economies the same lifetime utility, to generate the Pareto Optimum welfare level using lump-sum taxes, or to generate the same welfare of an economy where $\tau_k = \tau_n = \tau_n^* = 0$ and τ_c and τ_c^* are set to finance the same government expenditure and transfers of the benchmark model).

distortionary taxation (i.e. the excess burden of taxation), and c) the welfare costs of distortionary factor income taxation. 1/

Consider the output shares reported in the first part of the table. Only the shares of government expenditure are set exogenously to match observed shares. Along the balanced growth equilibrium path, the model mimics closely the observed output shares of consumption, investment, savings, net exports, and government transfers. In particular, the model matches observed cross-country differences indicating that in European countries investment rates are higher and consumption-output ratios are lower than in the United States. The model is also consistent with the facts in predicting that net exports are a very small fraction of output, and in showing that transfers-output ratios, which in the model are set to balance the budget, tend to be higher in European countries by about 2 to 3 percent in terms of GDP.

The ratios listed in the middle part of Table 3 show that each country owns about 1/2 of the world capital stock allocated to tradables industries. Aggregate output in Country 1 is roughly the same size as that of Country 2. The tradables sector in Country 1 is about 7 percent larger than the nontradables sector, while in Country 2 the tradables sector is almost 1/5 larger than the nontradables sector. There is no direct evidence on the cross-country structure of capital ownership against which to match our estimate, but there is some data on GDP per capita in purchasing power parity (PPP) units and on the size of tradables and nontradables sectors against which to compare the other ratios. Kravis, Heston, and Summers (1982) constructed detailed measures of GDP per capita in PPP units and of the size of tradables and nontradables sectors for many countries as of 1975. In their data, as predicted by our model, tradables sectors are typically larger than nontradables sectors (see their Tables 6-11 and 6-12), although the ratios we obtained underestimate theirs by a factor of about 1.25. 2/ Their data also shows that GDP per capita in PPP units in the United States exceeds the combined GDP per capita of France, Germany, Italy, and the United Kingdom by about 1/3 (see their Table 1-2). This suggests that the model's prediction that GDP per capita in Country 1 should be roughly the same as that in Country 2 is biased upwards. Nevertheless, the data from Kravis, Heston, and Summers are only for 1975, and hence it is difficult to make any inference with regard to the long-run averages that one should use to evaluate the model's predictions.

1/ The equilibrium relative price of nontradables in the model is the one that equates the marginal rate of substitution in consumption of tradables and nontradables with the ratio of the real wages paid in each industry. Along the balanced-growth path, this equilibrium relative price can be expressed in reduced form as a function of the labor shares and the capital output ratio in the tradables industry.

2/ For France, Germany, and Italy, they obtained ratios of tradables to nontradables output between 1.14 and 1.27, and for the United States they obtained a ratio of 1.35.

The measures of welfare costs reported at the bottom of Table 3 are of particular interest for the analysis of fiscal policies. These measures of welfare costs have been constructed as compensating variations in the trend level of aggregate consumption that would be needed for the benchmark economy to produce the same level of lifetime utility as that of an alternative version of the model representing different policy environments. Thus, if under policy Z the lifetime utility that the model produces for Country 1 is V(Z), we compute the percent change π in the trend level of consumption needed to produce that level of welfare under the benchmark model as:

$$V(Z) = \frac{\left\{\left[\left(C^T(B)(1+\pi)\right)^{-\mu} + \left(C^N(B)(1+\pi)\right)^{-\mu}\right]^{-\frac{1}{\mu}} L(B)^a\right\}^{1-\gamma}}{1-\gamma} \left\{\frac{1}{1-\beta}\right\} \qquad (56)$$

where $C^T(B)$, $C^N(B)$, and $L(B)$, are the arguments of the utility function evaluated at the levels obtained in the benchmark economy.

The experiment where we consider the consumption change needed to equalize welfare across countries is one in which $V(Z)=V(B^*)$, where $V(B^*)$ is the lifetime utility of agents living in Country 2 under the benchmark specification. The experiment measuring the excess burden of distortionary taxation is one where V(Z) corresponds to the level of lifetime utility that the model produces if tax rates on factor incomes and consumption are set to zero in both countries and only lump-sum taxes are used to finance government expenditures and transfers. The experiment measuring the welfare costs of income tax distortions is one in which V(Z) corresponds to the level of lifetime utility obtained by setting factor income taxes to zero, transfers and government expenditures to the levels of the benchmark case, and consumption taxes are used to balance the budget in each country. Note, however, that all of these experiments ignore the welfare effects of transitional dynamics as the economy moves from one long-run equilibrium to another. This issue is discussed in more detail later.

The results of these welfare comparisons are interesting. First, agents in the benchmark world economy do not have strong incentives to migrate; Country 2 agents would suffer a welfare loss so they would not move, while Country 1 agents stand to gain about 1.7 percent in the trend of consumption, which is about 2.9 percent of GDP. This means that, if GDP per capita in the United States is about $7,000 in PPP units, the gain is only about $200 in PPP units of consumption a year. With a 7 percent real interest rate, it would suffice that costs of migration exceed $3,000 to offset the present value of the welfare gain of moving for Country 1 residents.

In contrast with the modest welfare gains of immigration, the gains to be obtained from the design of a more efficient tax system are substantial. If it were possible to implement lump-sum taxation, Country 1 would make a gain of 20.5 percent in the trend of consumption, while Country 2 would gain

almost 32 percent. Thus the excess burden attributed to distortionary taxation seems quite large. These estimates of the excess burden are consistent with some of the estimates that exist in the literature regarding the welfare costs of distortionary taxes in closed economies (see Cooley and Hansen (1992), Browning (1976), and Stuart (1984)). If only distortionary taxes are available, still a system based on eliminating taxes to capital and labor, and hence using indirect taxation only to cover the benchmark output shares of government expenditures and transfers, could yield long-run welfare gains of 13 percent for Country 1 and 20 percent for Country 2. 1/ These estimates are similar to those obtained by solving the Ramsey problem for the Israeli economy in a open-economy setting by Razin and Sadka (1992). However, in their optimal solution consumption and capital are not taxed and labor income is the only tax base. This policy in our model would cause Country 2 to suffer a welfare loss of 11 percent, and hence cannot be a solution to the Ramsey problem.

Our estimates of welfare gains under a system of pure indirect taxation are much larger than those obtained by Lucas (1990) for a similar experiment in a closed economy where labor taxes are used to fully replace capital taxes, without explicitly solving the Ramsey problem. To examine the source of this discrepancy we first studied welfare gains of our model in a closed economy, one-good setup, and found that they remained at about 10 percent. Thus, only about 3 percentage points of the welfare gains are attributed to the international transmission mechanisms of fiscal policy to be examined later. Then we identified two important differences in the structure of Lucas' model and ours that account for most of the difference in welfare gains. First, he bases most of his analysis on a CES production technology--when he examines the case of Cobb-Douglas he does find a welfare gain of about 10 percent, which is in line with our findings. Second, he assumes that the labor's share in income is 0.76, while in our analysis it is about 0.6. Increasing the labor's share to 0.76 in the closed economy version of our model reduces the welfare gain of indirect taxation from 10.6 percent to 3.1 percent. There are other significant parameter differences between this framework and Lucas', such as the elasticity parameter on labor supply which he set at 1/2 and we set larger than 2, but these do not cause large quantitative differences in welfare gains.

While long-run welfare gains of the order of 13 to 20 percent are enormous, the fact that these represent comparisons between steady states must be kept in mind. The transition from one steady state to another involves a period in which significant capital accumulation needs to be undertaken and hence consumption must be kept low to sustain large investment rates. Most estimates of the costs of these transitional dynamics indicate that they may be significant (see Lucas (1990), Cooley and Hansen (1992), and Chari, Christiano, and Kehoe (1993)). In our model the

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1/ Note that while this policy is an improvement over the benchmark equilibrium that does not require lump-sum taxation and is designed to satisfy the government's budget constraint, is not necessarily a solution to the Ramsey optimal taxation problem (see Lucas (1990)).

issue is complicated further by the fact that countries may access world markets to finance capital accumulation without sacrificing consumption, so that transitional dynamics may differ from those obtained in closed economy models. Still, if net of transitional costs, welfare gains were only 1 or 2 percent, as Lucas (1990) argues, such gains are much larger than the welfare gains of reducing inflation, smoothing business cycles, opening trade in financial assets, and eliminating policy-credibility problems (see Lucas (1987), Calvo (1987), Cole and Obstfeld (1991), and Mendoza (1991)).

A rough first approximation to the computation of transitional dynamics can be undertaken by following Lucas (1990) in making use of an approximation derived by Bernheim (1981). Bernheim's approximation measures the overall welfare gain of a tax reform as a weighted sum of the initial consumption fall, which contributes the savings needed to finance the expansion of the capital stock, and the long-run increase in consumption that is attainable once the higher steady-state capital stock is reached. The weights are determined by the growth-adjusted discount factor and the speed of adjustment towards the new steady state. For stable dynamic systems, this approximation is accurate if the distortions involved are small and labor is supplied inelastically. In our model, we introduced large distortions and elastic labor supply but still approximated the costs of transitional dynamics using a modified version of the Bernheim formula. This may not be a bad approximation because, as numerical results obtained by Cooley and Hansen (1992) show, in a model with elastic labor supply and relatively large distortions the transition follows a simple concave path--which can be approximated using Bernheim's formula--and, on impact, the response of labor supply is almost identical in magnitude and opposite in sign to that of consumption. 1/ Thus, we modified Bernheim's approximation to account for an initial expansion in hours worked, and hence output, proportional to the initial fall in consumption. This reduces the need for consumption to contribute all of the initial expansion of savings. We also made changes to aggregate adjustments in tradables and nontradables sectors.

Table 4 reports results for these rough estimates of welfare gains of tax reforms adjusted for transitional dynamics in Country 1. The tax reform in question is the case in which factor income taxes are replaced with a consumption tax, subject to the constraint of financing the level of government expenditures and transfers of the benchmark economy. Both the speed of adjustment and the proportion of the initial change in labor supply relative to consumption are exogenous, and hence the table reports results for various combinations of these variables. Only welfare gains in which transitional dynamics are feasible, in the sense that the initial decline in

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1/ We found that with a speed of adjustment of about 0.1, the Bernheim formula reproduces the costs of transitional dynamics that Cooley and Hansen (1992) obtained.

Table 4. Welfare Gains of Tax Reform in Country 1
Under Alternative Transition Scenarios 1/

Speed of Adjustment	Initial Increase in Labor Supply 2/					
	0.5	1.0	1.03	1.05	2.0	∞
0.05	0.30	0.92	0.94	0.96	1.47	2.34
0.07	0.54	1.28	1.31	1.33	1.90	2.78
0.09	0.80	1.64	1.67	1.69	2.31	3.15
0.10	0.93	1.81	1.85	1.87	2.51	3.32
0.15	1.59	2.66	2.70	2.73	3.43	4.11
0.25	n.f.	4.22	4.27	4.30	5.05	5.45
0.30	n.f.	4.93	4.98	5.00	5.77	6.05
0.50	n.f.	n.f.	n.f.	n.f.	n.f.	8.14

1/ The welfare gains pertain to an experiment in which tax policies are reoriented to finance the benchmark model's levels of government expenditures and transfers using only a consumption tax (this implies setting τ_c=0.52, τ_k=0 and τ_n=0). The gains are measured as percentage changes in stationary consumption paths that equate lifetime utility between the benchmark economy and the economy with the proposed policy and each corresponding transition scenario. "n.f." denotes that the implicit initial decline in consumption is not feasible.

2/ Measured as a proportion of the initial percentage fall in consumption.

consumption does not violate the non-negativity constraint, are listed. Assuming that the dynamics of the model are similar to those of the Cooley-Hansen model, the initial increase in labor supply would be about 1.03 of the initial fall in consumption, and the speed of adjustment in the capital stock would be about 0.1--which is close to the 0.09 estimate provided by Chamley (1981) and used by Lucas (1990). In this scenario, the welfare gain of the tax reform falls from 13.4 percent to 1.85 percent; thus, transitional dynamics involve a welfare cost in excess of 11.5 percentage points. Depending on the speed of adjustment and the initial surge in labor supply, the net welfare gain can range between 0.3 percent and 8.1 percent. But, given the elasticity of labor supply, which implies that the initial surge in hours worked is likely to exceed the initial decline in consumption, and the fact that adjustment factors in excess of 0.25 start to violate the feasibility constraint, we would expect more accurate measures of the net welfare gain to be around the 1 to 2 percent range. However, further work to compute more accurately the transitional dynamics of the model is needed to justify this inference.

IV. Macroeconomic Effects of Fiscal Policies in the Benchmark Model

In this section we study the interaction between fiscal policies and macroeconomic aggregates in the model by exploring the quantitative implications of adjusting each fiscal policy instrument given the parameter structure of the benchmark case. The analysis focuses first on the effects of unilateral changes in the fiscal policies of Country 1. Later in this section we examine the implications of European debt convergence and tax harmonization using an alternative parameterization of the model.

1. Capital income taxes

Figures 1-4 summarize the macroeconomic effects that result from changes in the rate of capital income taxation in the two economies considered in the model. The other tax rates and the output share of government expenditures are maintained at the values set in the benchmark model. Transfers are rising with tax revenues so as to balance the governments' budgets; thus, the exercise is one in which the tax increase is used as a deficit-reduction tool, rather than one in which the aim is to alter the efficiency of the tax system as in a Ramsey problem. It is important to recall that because of the balanced growth and perfect capital mobility assumptions, the taxes on capital income in the two countries must always move together.

Figure 1 is a picture of the Laffer curves relating total tax revenue in the tradables industry of each country to the capital income tax rate. In both countries, an increase in the capital income tax rate has the effect of reducing the capital-output ratio, and this in turn reduces the size of the tax base in the new equilibrium path--as illustrated in Figure 3, the increase in τ_k reduces K^T, C^T, and N^T in the steady state, although the effects on the capital stock are much stronger. At low levels of the tax

FIGURE 1. STEADY STATE TAX REVENUE FROM TRADABLES AND WORLD CAPITAL INCOME TAX

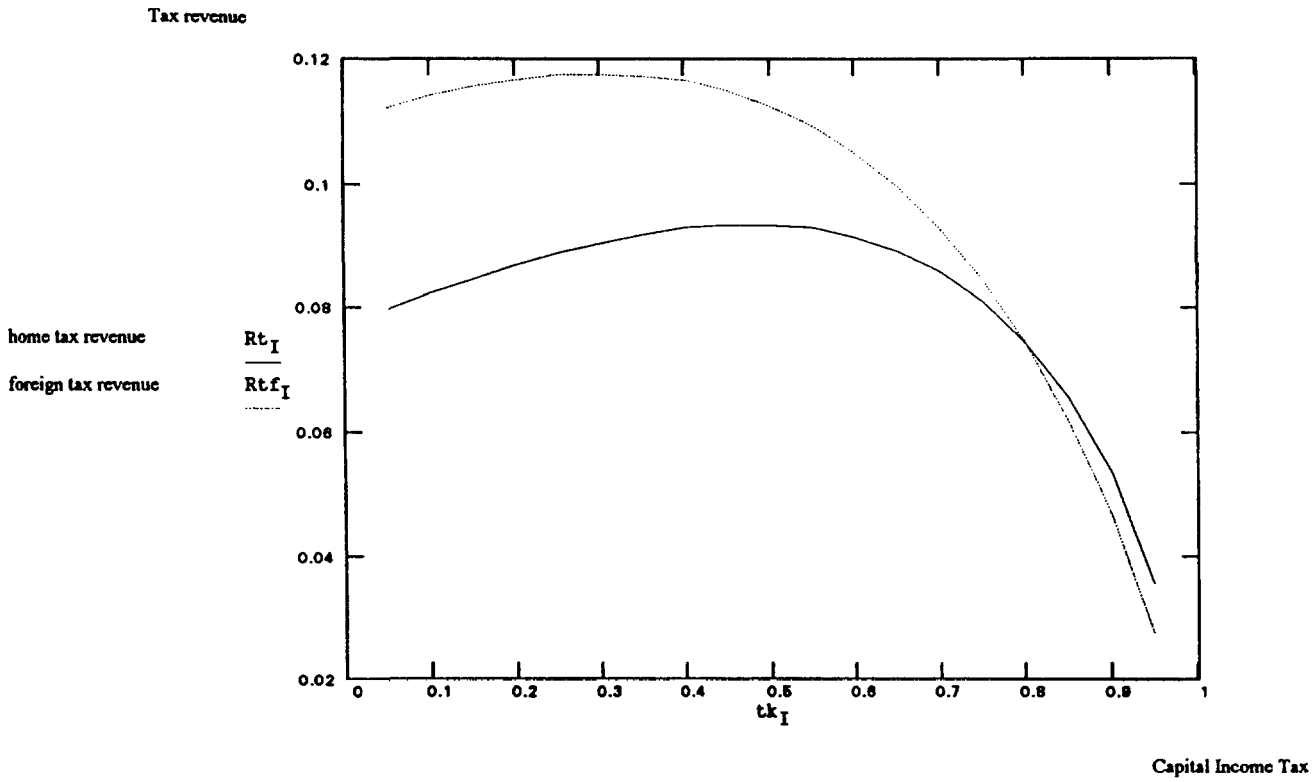


FIGURE 2. STEADY STATE WELFARE LOSS AND WORLD CAPITAL INCOME TAX

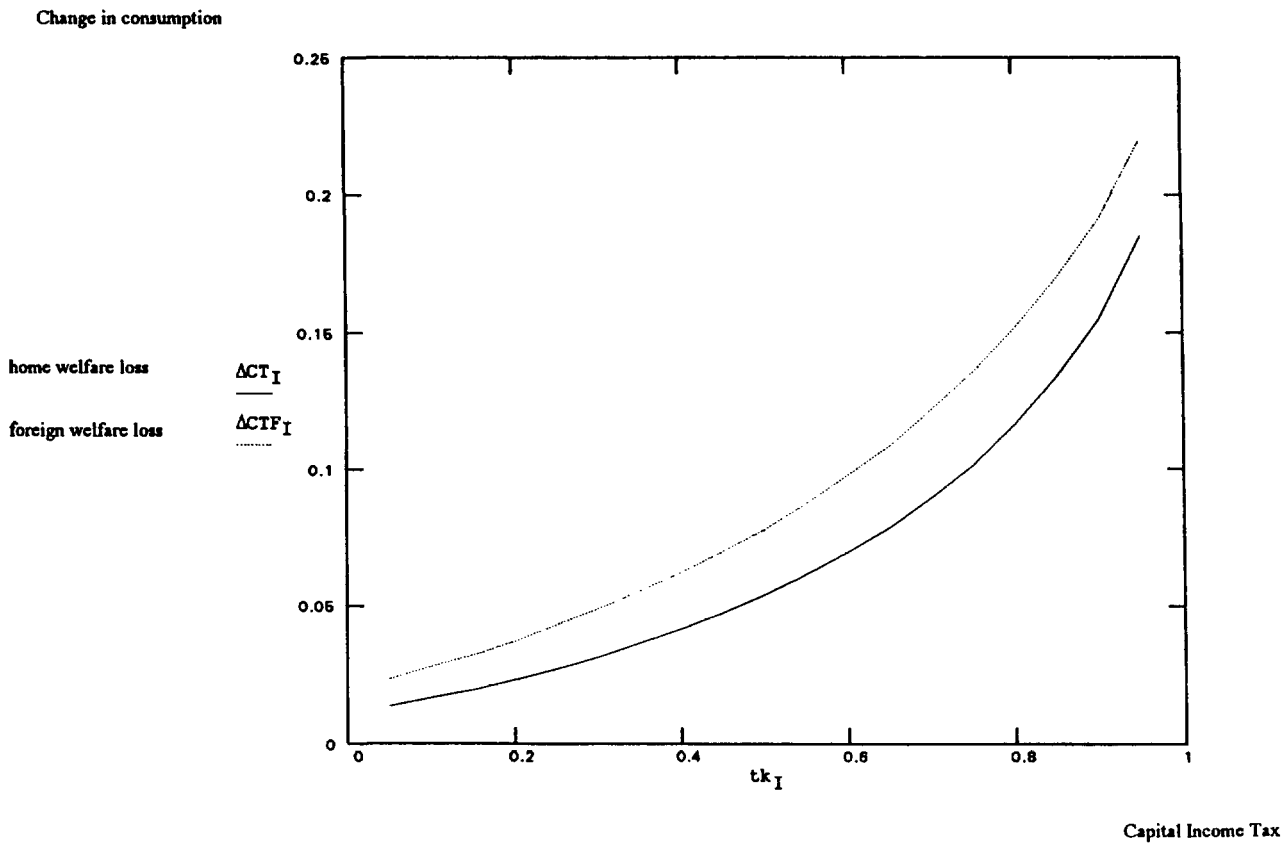


FIGURE 3. HOME ECONOMY STEADY STATE EQUILIBRIA UNDER DIFFERENT CAPITAL INCOME TAX RATES

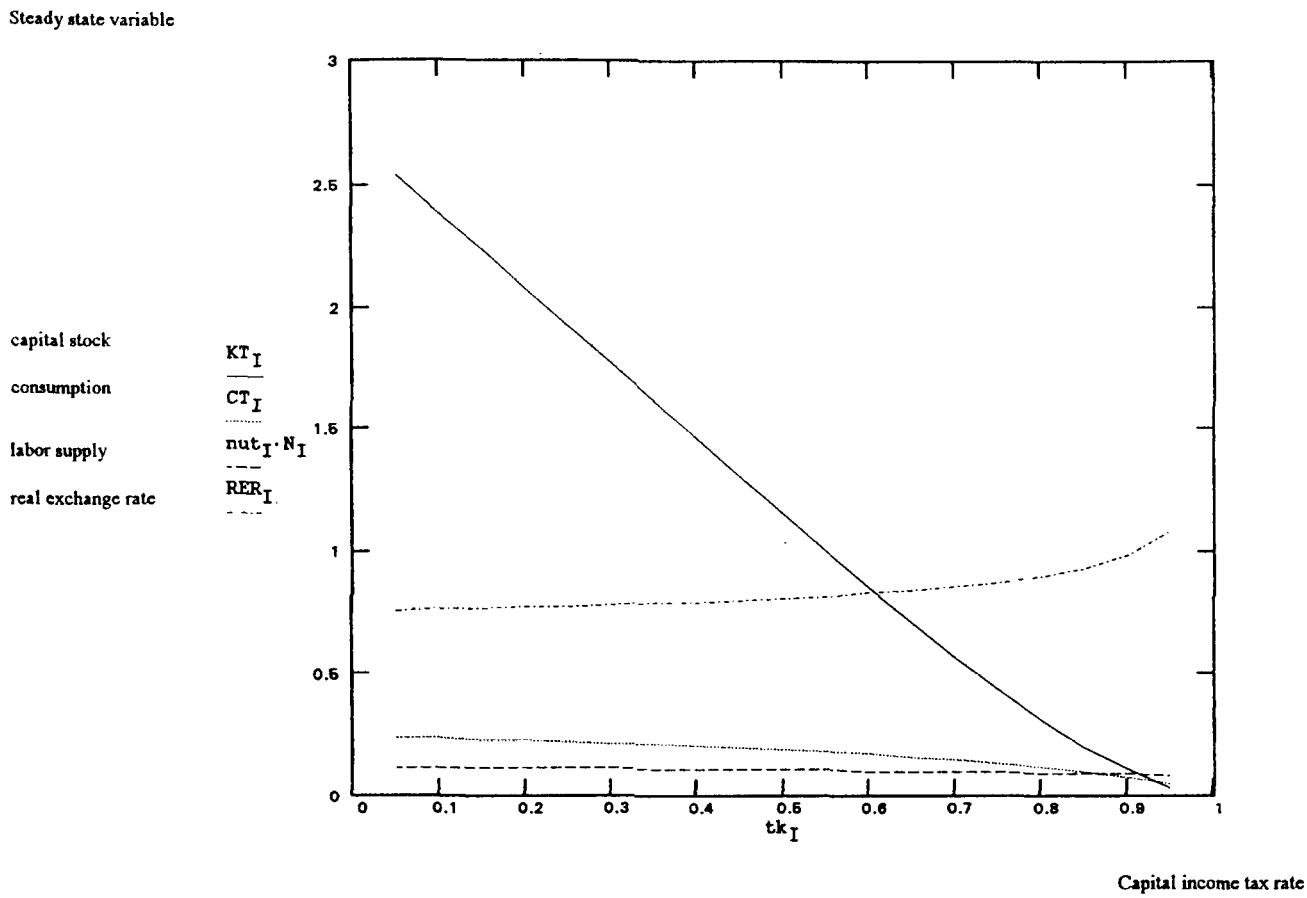
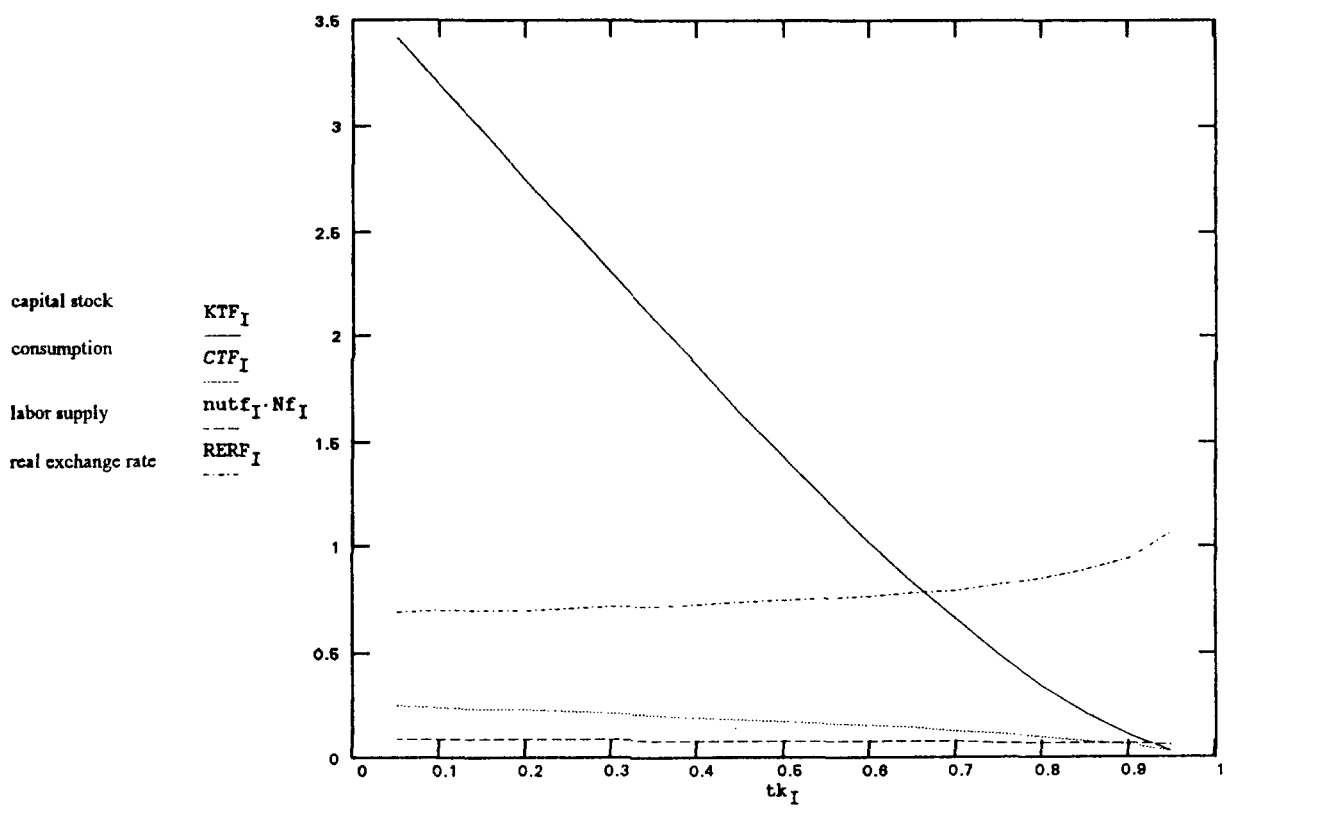


FIGURE 4. FOREIGN ECONOMY STEADY STATE EQUILIBRIA UNDER DIFFERENT CAPITAL INCOME TAX RATES



rate the direct positive effect of the tax increase on revenues dominates the negative effect of the shrinking tax base, but as the tax rate rises the second effect dominates and hence the nonmonotonic appearance of the Laffer curves. It is interesting to note that revenues tend to increase at a very slow and stable rate in the upward sloping part of the Laffer curves, while they decline at an increasingly fast rate once the maximum revenue point is passed. Moreover, at the current level of 40 percent in capital income tax rates, countries would appear to have reached near-maximum revenue levels. Figure 1 also shows that the Laffer curves intersect. This is because, given that the capital's share in income is lower in Country 1 than in Country 2, and that taxes on labor and consumption are higher in Country 2 than in Country 1, tax revenues are higher in Country 2 at low levels of τ_k but they become lower than Country 1 tax revenues at high levels of τ_k.

Figure 2 plots the relationship between the magnitude of the welfare *costs induced by distortionary taxation and the level of the capital income* tax. The chart shows that welfare loss curves are increasing and convex. Thus, welfare costs grow at a faster rate as the tax rate is increased and tax distortions are magnified. Moreover, welfare costs in Country 2 are always higher than in Country 1, reflecting the fact that, given the foreign country's larger share of capital income in total income, the impact effects of a given tax increase on the foreign capital-output ratio and on foreign levels of output and consumption are stronger than in the domestic economy.

Figures 3 and 4 plot the responses of the capital stock, consumption, and labor supply in the tradables industry, and the real exchange rate to changes in the level of capital income tax rates. The increase in τ_k reduces the after-tax return on savings and thus reduces the capital-output ratio of Country 1 (see equation (26)). Under perfect capital mobility, the capital-output ratio of Country 2 is proportional to that of Country 1 (see equation (38)), and thus it also falls as the tax rate rises--it actually falls more than in Country 1 because $1-\alpha T^*$ is greater than $1-\alpha T$. Higher capital income taxes also induce a fall in labor supply because as capital-output ratios fall, investment and savings rates also fall, and the resulting rise in consumption-output ratios motivate households in both countries to work less (see equations (32) and (43)). With the Cobb-Douglas production technologies it is straightforward to show that the combined effect of a lower capital-output ratio and lower labor supply is a decline in the level of output. The fall in both the capital-output ratio and in the level of output produce the sharp decline in the level of each country's capital stock, while the fall in consumption is much weaker because the output decline is partially offset by the decline in the savings rate--i.e. in the new equilibrium the consumption-output ratio rises.

The rise in the capital income tax rate also induces appreciations of the real exchange rate in both countries, as shown in Figures 3-4. This is because in the model the equilibrium price of nontradables can be expressed as the ratio of the marginal products of labor in tradables and nontradables industries, and hence can be characterized as a log-linear function of the labor shares and the capital-output ratio in the tradables industry. With fixed labor shares, the real exchange rate is affected by tax policy only to

the extent that it distorts savings plans, and hence affects capital-output ratios. When the tax on capital rises, the resulting decline in the capital output ratio may induce a real appreciation or a depreciation depending on which of the tradables and nontradables sector has a larger share of output allocated to labor income. Since in the benchmark case αT is greater than αN in both countries, the increase in the tax induces real appreciations. This model, therefore, produces the classic results of the Balassa-Samuelson model of real exchange rates as an outcome of a balanced growth, long-run general equilibrium framework (for an empirical assessment of this result see Asea and Mendoza (1993)).

2. Labor income taxes

Figures 5-8 show the model's predictions regarding the effects of a change in τ_n keeping τ_n^* unchanged at 28 percent and all other taxes fixed at benchmark levels. Figure 5 plots the Laffer curves. The Laffer curve of the foreign country is almost flat showing that a change in the domestic economy's labor income tax does not affect tax revenues abroad. This is not an obvious result in the open economy framework that we examine because a change in τ_n not only motivates agents to substitute labor for leisure in the home country, but also induces a re-distribution of wealth in favor of the foreign country as the share of the world capital stock owned by Country 2 residents increases (see equations (32) and (36)). This redistribution of wealth results from the fact that increases in the home labor tax reduce disposable income in Country 1 relative to Country 2, both because of the direct effect of higher taxation and because of the decline in pre-tax output resulting from the substitution effect on leisure. The wealth effect affects labor supply, capital accumulation, and consumption decisions in both countries, as shown in Figures 7-8, despite the fact that labor income taxes do not distort the intertemporal relative price of consumption, and hence do not affect the capital-output ratio and the investment rate. The stock of capital and the supply of labor fall in both countries, although more sharply in the country where taxes are rising because of the leisure-labor substitution effect, and consumption falls in Country 1 while it increases in Country 2. These changes affect the tax base, and hence should affect tax revenues. Figure 5 indicates, however, that the combined effects on tax revenue in Country 2 tend to cancel out. In contrast, the Laffer curve for the home country shows the familiar inverted-U shape. At low labor income tax rates, tax revenue rises with the tax because the positive revenue effect of the tax hike is stronger than the negative effect on the tax base. At about the 50 percent tax rate, revenues peak, and after that the negative effect on the tax base dominates and revenues decline with increases in the tax. This Laffer curve is also much steeper than the Laffer curve for capital income taxes in the upward-sloping region.

Figure 5 shows the welfare costs in the two countries that result from unilateral labor income tax increases in Country 1. The figure shows that in Country 1 the welfare loss reaches about 14 percent when labor income is completely taxed away. The welfare cost curve is convex, as in the case of

FIGURE 5. STEADY STATE TAX REVENUE FROM TRADABLES AND HOME LABOR INCOME TAX

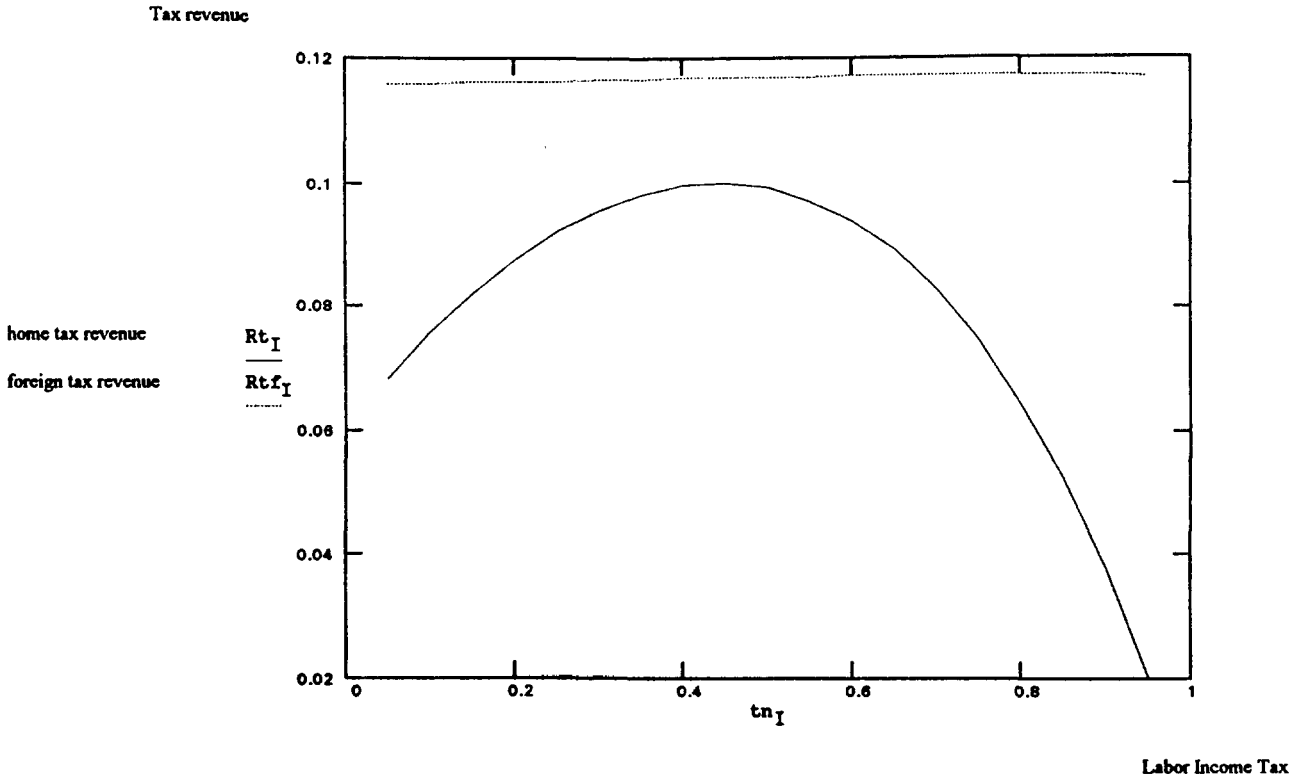


FIGURE 6. STEADY STATE WELFARE LOSS AND HOME LABOR INCOME TAX

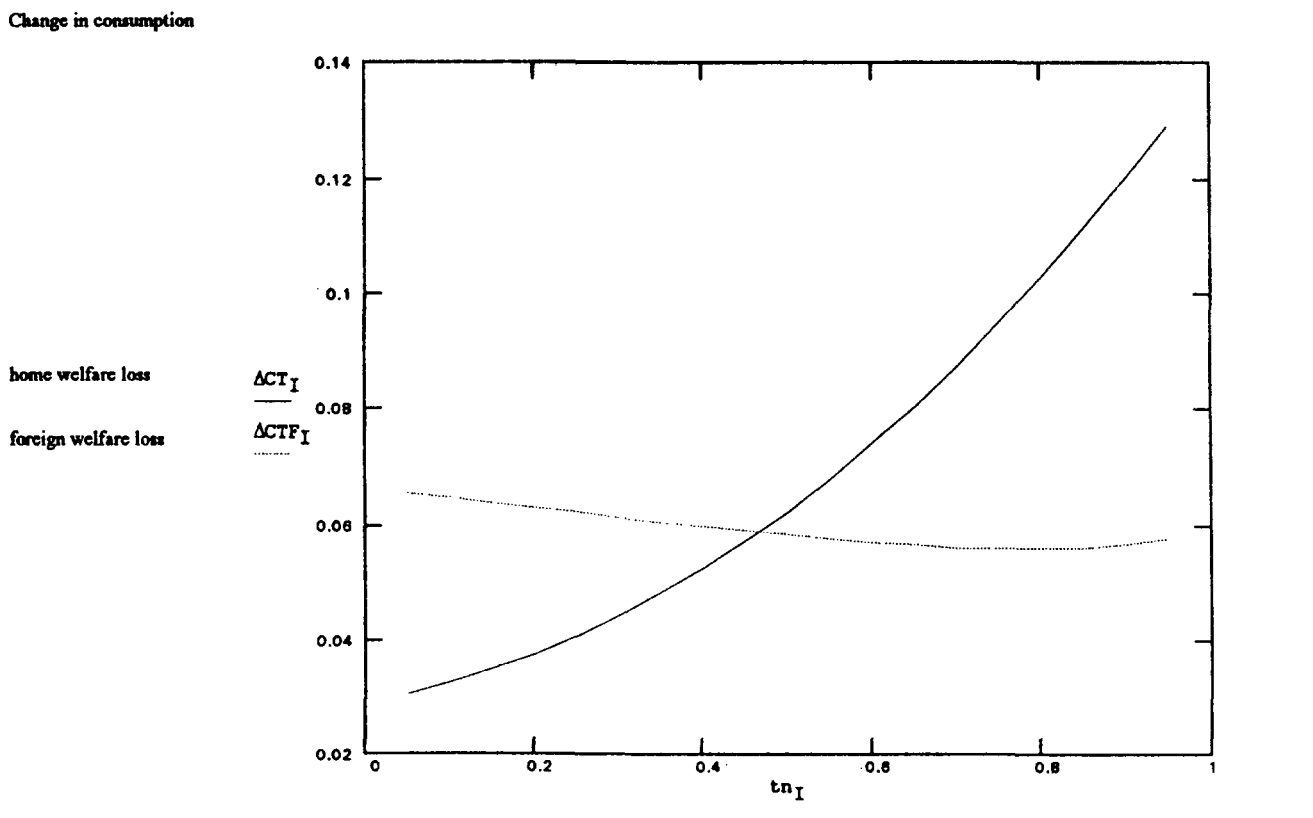


FIGURE 7. HOME ECONOMY STEADY STATE EQUILIBRIA UNDER DIFFERENT HOME LABOR INCOME TAX RATES

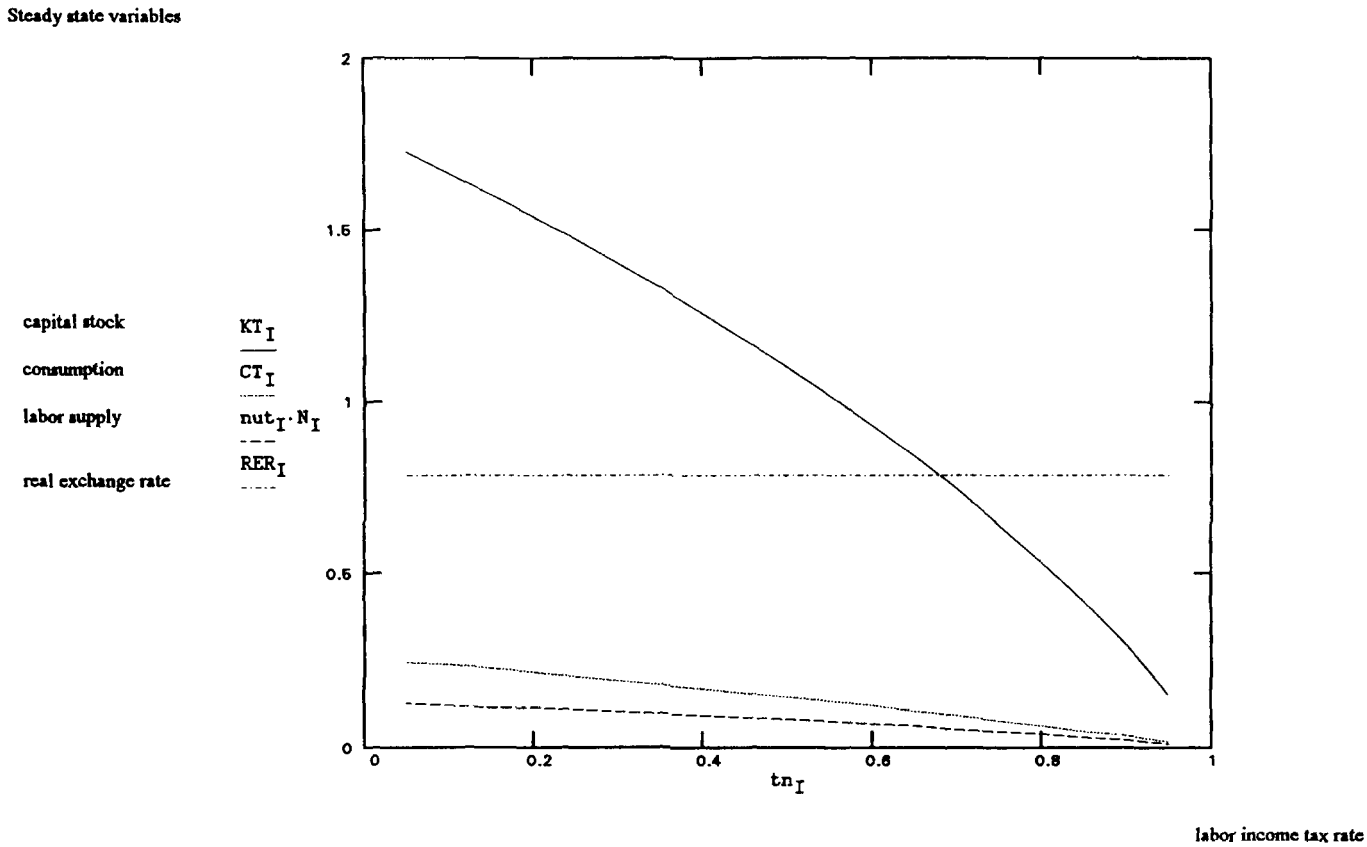
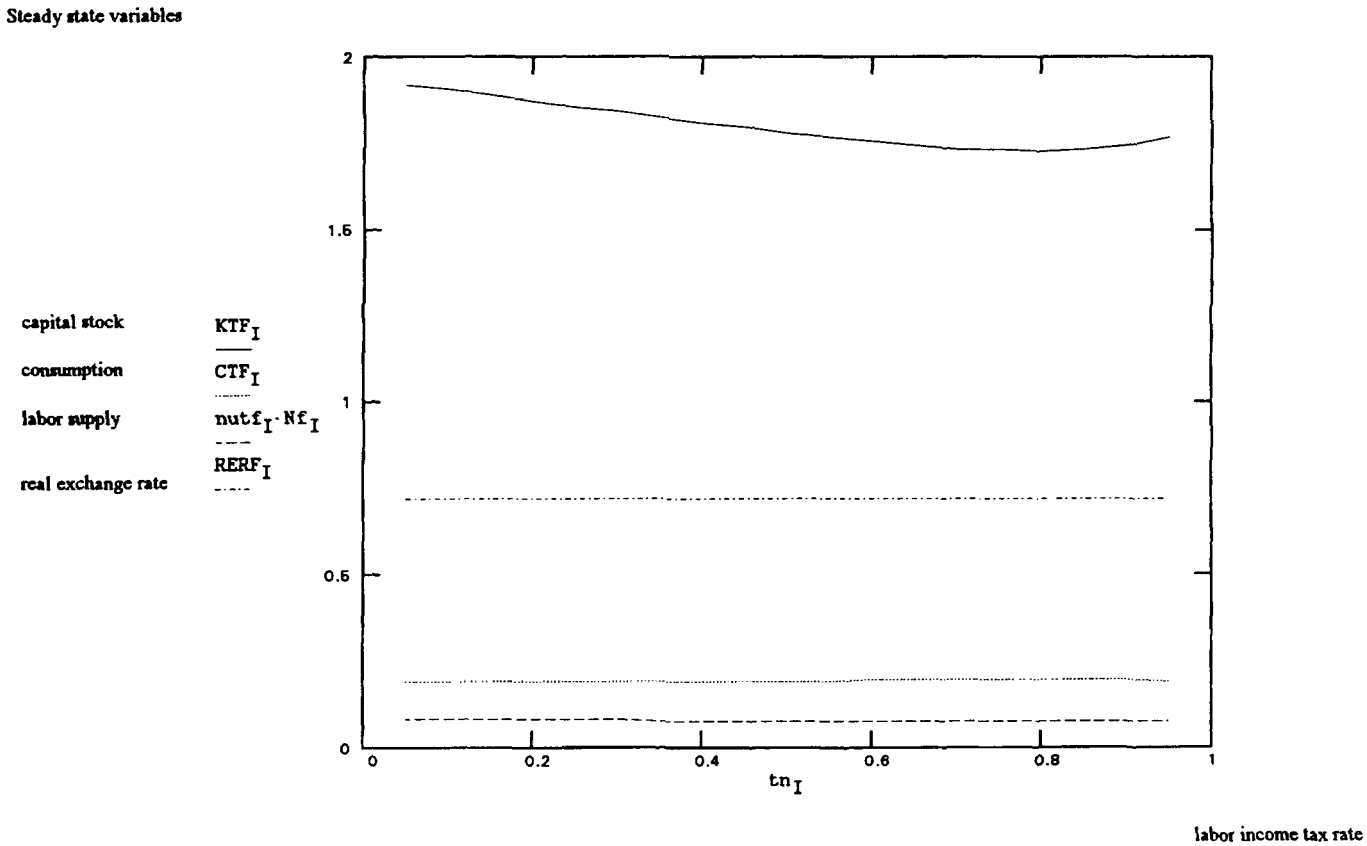


FIGURE 8. FOREIGN ECONOMY STEADY STATE EQUILIBRIA UNDER DIFFERENT HOME LABOR INCOME TAX RATES



the capital income tax, but is much less steep. In contrast, the welfare curve for Country 2 shows that welfare actually improves slightly in that economy as the home labor income tax rises. This result is another implication of the redistribution of wealth across countries that follows the increase in the labor tax rate. The supply of labor falls and consumption increases in Country 2, even tough output and the stock of capital are falling as a result of the contraction in hours worked (Figure 8). Since capital-output ratios are independent of the labor income tax rates, the real exchange rates of both countries are independent of changes in labor income taxes.

3. Consumption taxes

Figures 9-12 plot the effects of increasing the home consumption tax, keeping the foreign consumption tax at 15 percent and the other taxes at their benchmark levels. In contrast with factor income taxes, the Laffer curve for the home country in Figure 9 is always increasing in the range of consumption tax rates considered. Thus, although like other taxes, consumption taxes have a negative effect on the tax base (i.e. they induce declines in the capital stock, consumption, and hours worked as illustrated in Figure 11), this effect is much weaker than in the case of factor income taxes, and in the range examined it cannot offset the positive revenue effect of the tax increase. Thus, consumption taxes are a very powerful revenue source because their tax base, while being about as large as the base of labor income taxes in terms of output, does not shrink rapidly as the tax increases. The Laffer curve for the foreign country resembles that of the labor income tax case in that it suggests that foreign tax revenues are independent of domestic consumption taxes. As in the previous case, this is not an obvious result. The consumption tax increases the home country's relative price of labor in terms of leisure and also induces a redistribution of wealth from the home to the foreign country. In this case, however, the wealth-redistribution effect is weaker because it works indirectly through the output effect of the decline in hours worked in Country 1, while in the labor income tax case it also operated directly since shares of ownership of world capital reflect after-tax output ratios (equation (36)). Thus, one can conclude that under the parameterization of the benchmark model, foreign revenues are generally independent of domestic tax policies.

Figure 10 illustrates the welfare costs of consumption taxes. The welfare cost curve in the home country is an increasing, almost linear, function of the consumption tax rate. In the foreign economy there is a slight welfare gain that results from very small increases in consumption of tradables and nontradables and a very small decline in hours worked induced by the wealth-redistribution effect.

Figures 11 and 12 plot the effects of the changes in the home consumption tax on macroeconomic aggregates. The economic intuition behind the movements reflected in the charts is similar to that provided for the labor income tax, except that quantitatively the effects are much weaker.

This is mainly because the distortion on the leisure-consumption choice introduced by increases in consumption taxes, for a given labor income tax, are smaller than those introduced by increases of the same magnitude in labor income taxes, for a given consumption tax. For instance, a 100 percent consumption tax, given τ_n=0, implies an increase in the effective relative price of labor in terms of leisure of 50 percent, whereas a 100 percent labor income tax, given τ_c=0, drives the relative price of labor to infinity and makes leisure a free good. The effects on macroeconomic aggregates are also weaker because wealth-redistribution effects are weaker under consumption tax increases than under labor income tax increases, as discussed above. However, comparisons with a closed-economy version of the model showed this latter effect to be of second order importance. Real exchange rates are independent of the level of the home consumption tax because they do not affect capital-output ratios.

4. Excess burden and tax policies

Figures 13 and 14 plot the excess burden per unit of revenues resulting from changes in the world capital tax and in the home country labor and consumption taxes. Recall that the excess burden represents the welfare cost relative to the first-best lump-sum taxation case. These charts are a clear illustration of the efficiency of indirect taxation relative to factor income taxation, which has also been observed in closed-economy models (see Cooley and Hansen (1992)). In the two countries, the excess burden per unit of revenue is roughly invariant to changes in τ_c and, for the range in which all three tax rates exceed 50 percent, it tends to be significantly smaller than the excess burden resulting from τ_k and τ_n.

If instead of comparing against the first-best world, one focuses exclusively on tax rates that would be needed to cover benchmark output shares of transfers and government expenditures using only one type of distortionary tax, one finds that the tax rates would be (τ_n=0.521 and τ_n^*=0.680), (τ_c=0.518, τ_c^*=0.686) or τ_k=0.8. With these tax policy options, the welfare cost per unit of revenues is minimized by making use of consumption taxes. This result provides some intuition explaining why a tax reform biasing the tax system towards indirect taxation easily improves upon the allocations of the benchmark model, even tough we do not provide a full solution of the Ramsey optimal taxation problem.

5. International transmission effects of fiscal policies

Figures 15-17 illustrate the effects of the variations in the tax rates on the current account, the trade balance, and the capital account of the home country. In interpreting these charts, it must be noted that the breakdown of capital ownership that allows us to decompose the current account and capital account elements of the balance of payments is not unique. We picked one solution to the household's portfolio problem--which is based on relative wealth proxied by after-tax international income comparisons--but it is possible to propose other solutions and hence plot

FIGURE 9. STEADY STATE TAX REVENUE FROM TRADABLES AND HOME CONSUMPTON TAX

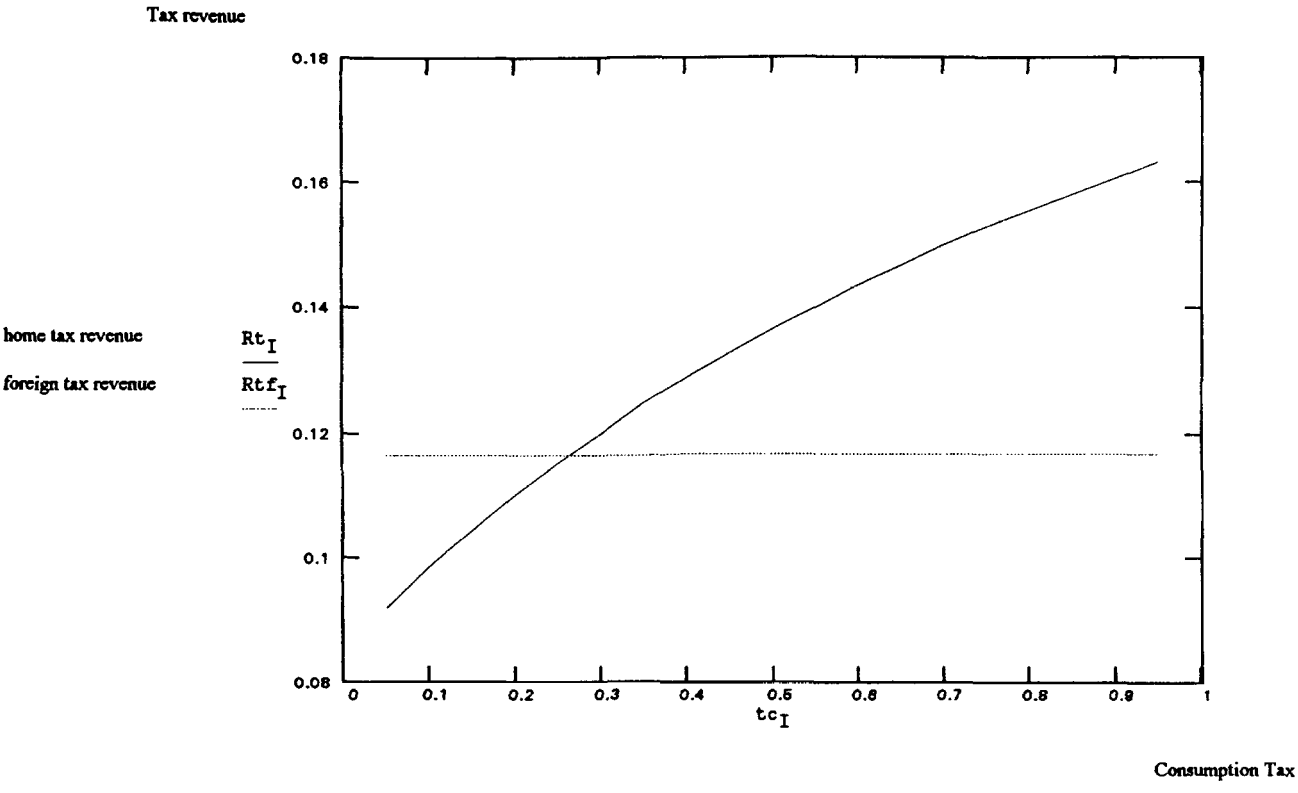


FIGURE 10. STEADY STATE WELFARE LOSS AND HOME CONSUMPTION TAX

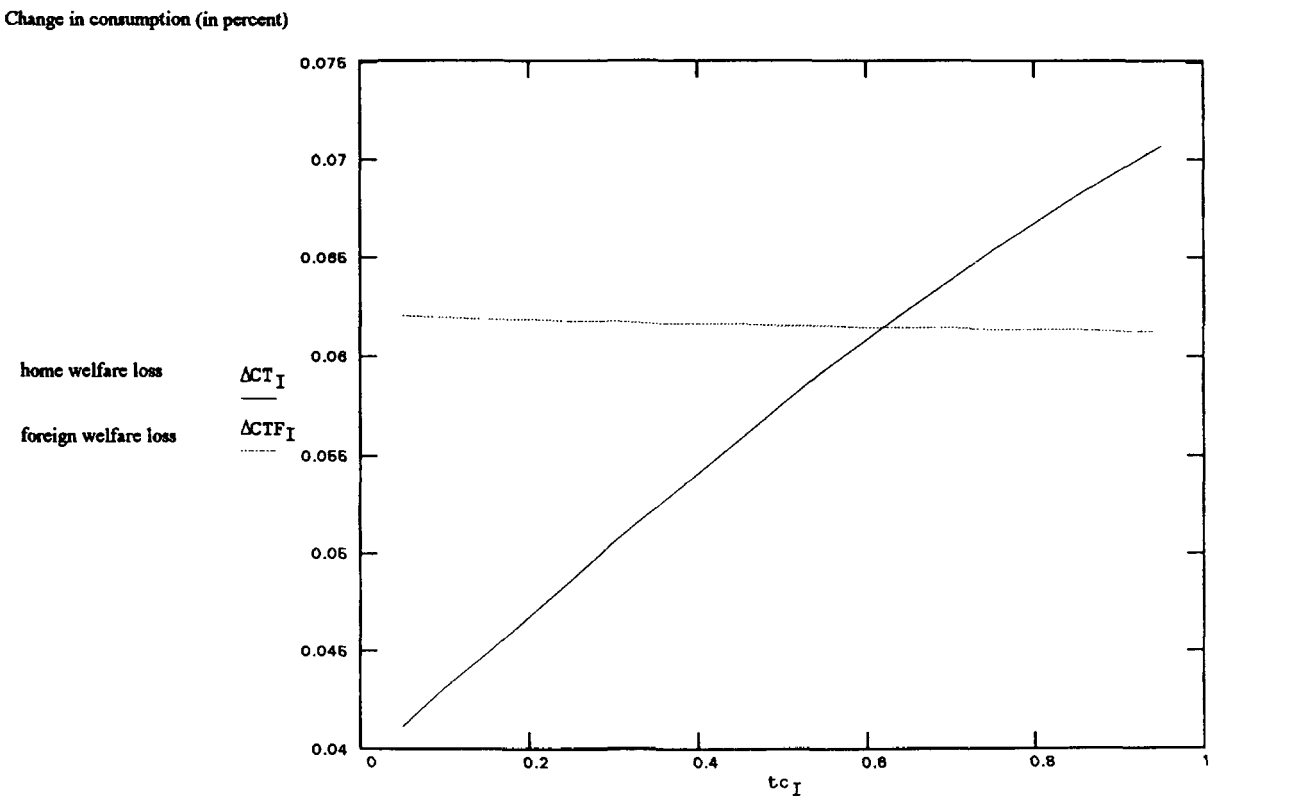


FIGURE 11. HOME ECONOMY STEADY STATE EQUILIBRIA UNDER DIFFERENT HOME CONSUMPTION TAX RATES

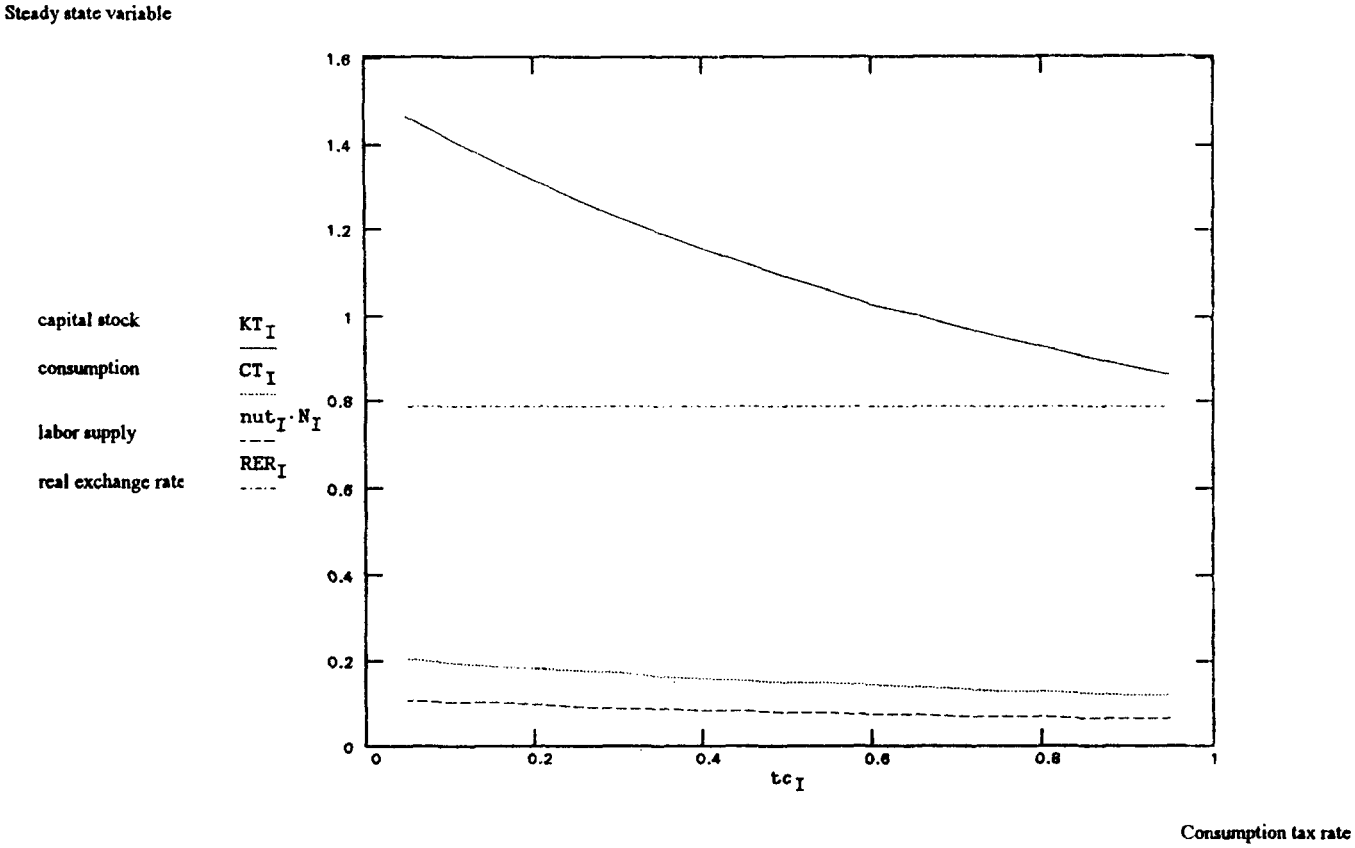
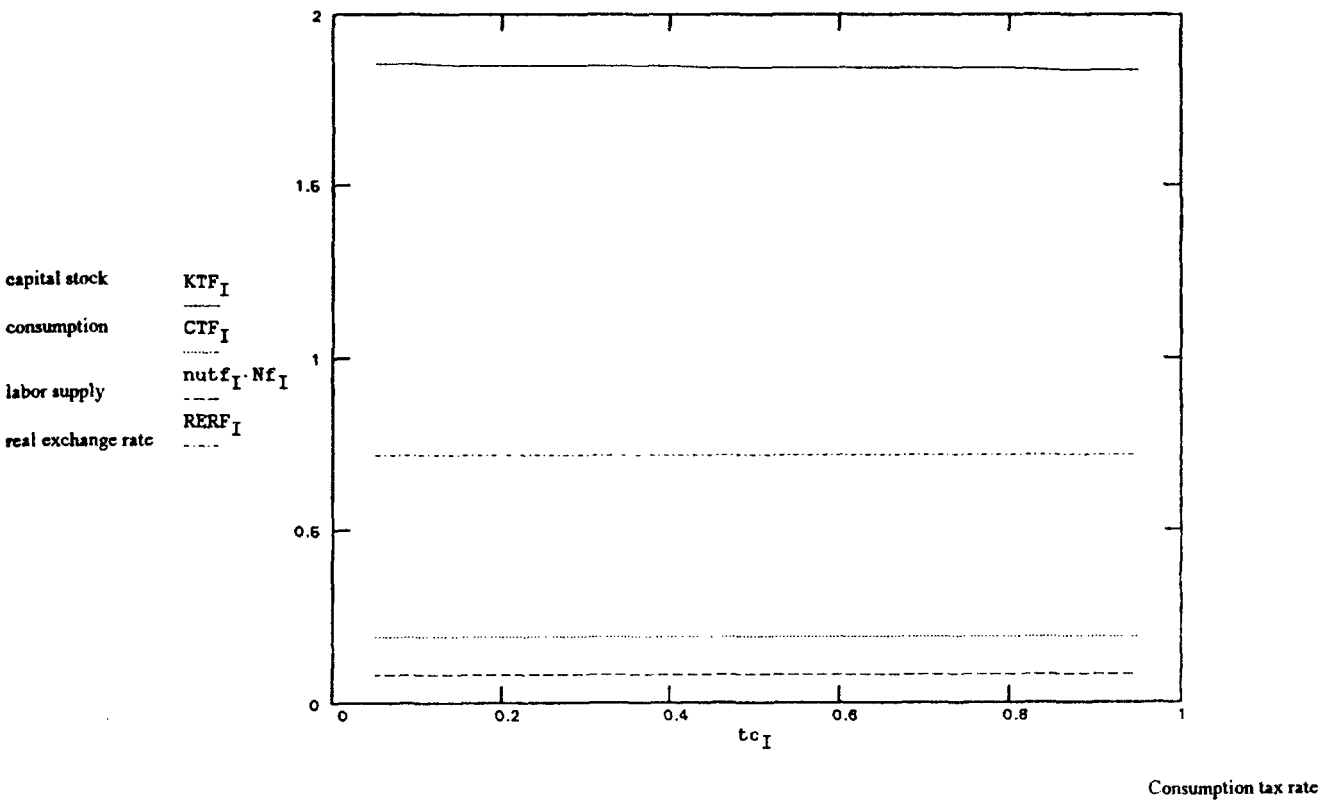


FIGURE 12. FOREIGN ECONOMY STEADY STATE EQUILIBRIA UNDER DIFFERENT HOME CONSUMPTION TAX RATES



different charts for net international factor payments on capital and net flows of foreign direct investment. For instance, one alternative is to assume that only residents of a particular country are allowed to own capital physically located in that country. In that case, the capital account in the model would be zero, and the trade balance would be offset by net after-tax foreign interest payments on bonds. By allowing trade in equity we are able to capture a richer set of international effects resulting from country specific fiscal policy changes.

Before discussing the international effects of tax policies plotted in the charts, it is useful to begin by characterizing the model's balance of payments equality. After some manipulation of the equilibrium system (26)-(46), it is easy to show that in Country 1 the ratio of net exports to *aggregate* output is given by:

$$\frac{NX}{Y} = \left(\frac{\psi}{1+\psi}\right)\left[(1-\phi^T)(1-\alpha T)-\phi^T(1-\alpha T^*)\left(\frac{yt^*}{yt}\right)+\phi^T sit^*\left(\frac{yt^*}{yt}\right)-(1-\phi^T)sit-sb(\gamma-1)\right] \qquad (57)$$

In the right-hand side of this equation, the expression in square brackets is the trade balance as a ratio of tradables output, which, using balance-of-payments accounting, is equal to the negative of the capital account--i.e. net foreign direct investment--minus net foreign payments on rental services of capital, minus net foreign interest payments on bonds. Then net exports are expressed as a fraction of aggregate output by multiplying that ratio by the ratio of tradables to nontradables output. Thus, given exogenous parameters, equation (57) describes how the trade balance-output ratio responds to fiscal policy changes depending on how these changes affect investment rates in tradables industries (sit and sit^*), the distribution of ownership of capital in tradables industries (ϕ)--which is proportional to the ratio of disposable incomes in the two countries--the ratio of foreign to domestic pre-tax tradables output (yt^*/yt), and the ratio of tradables to nontradables output in each country (ψ).

Figures 15-17 illustrate that labor and capital income tax policies have noticeable international spill-overs, while once again consumption taxes are approximately neutral. As factor income taxes are increased the current account worsens in Figure 15. In the case of τ_k the economy starts with a surplus of about 1 percent of GDP when the tax rate is close to zero, and as the tax approaches 100 percent the current account approaches zero. In the case of the labor income tax, the economy starts with a surplus in excess of 1 percent of GDP and ends with a deficit of nearly 5 percent of output for very high labor income tax rates. In contrast, increasing the consumption tax rate results only in a slight increase in the current account surplus.

Figure 16 shows the behavior of net exports and by comparing it with Figure 15 one can infer the behavior of the net factor payments account, which includes net payments to capital and net interest payments on bonds. It is interesting to note that increases in the labor income tax cause the

trade balance to move from a deficit of 2 percent of GDP to a surplus of about 7 percent. This movement is exactly the opposite of what is obtained for the current account as a whole, so it implies that the increase in the labor tax is inducing a substantial widening of the deficit in net factor payments. The capital account also moves from a deficit into a significant surplus, indicating that labor income tax increases induce substantial net inflows of foreign direct investment. These effects are mainly a reflection of the wealth redistribution induced by the effect of the increase in the tax rate on the ratio of after-tax domestic to foreign tradables output. As the home labor tax rises, and disposable income in Country 1 falls relative to Country 2, Country 1 households reduce their share of ownership in the world capital stock of tradables industries from about 56 percent, with a zero tax, to around 3 percent, when the tax is close to 100 percent. Thus, income from capital held abroad by Country 1 households declines relative to payments for the services of capital located at Country 1 but owned by foreign residents, despite the fact that the rental prices remain at $1-\alpha T$ and $1-\alpha T^*$ in each country respectively. Similarly, direct investment by Country 1 households abroad falls relative to direct investment by foreigners in Country 1 capital, although investment rates in both countries are unaffected by the labor tax. In contrast, movements in interest payments on bonds and bond accumulation as the labor tax rises are negligible because the net bond position as a percent of output is too small.

The movements in the trade balance, factor payments account, and capital account that result from capital and consumption taxes can be interpreted in a similar manner. In contrast with labor tax increases, capital tax increases induce a deterioration of the balance of trade and much weaker improvements in the current and capital accounts. This is because the capital income tax is increased at the same time in both countries, and hence the wealth-redistribution effect is weakened--in fact, disposable income in Country 1 rises relative to Country 2 because of its smaller share of capital income on total income. The consumption tax has much weaker effects on the components of the balance of payments because it has minimal effects on the relative position of disposable incomes, as it affects after-tax output only via the substitution effect on leisure, and hence there is only a very small wealth-redistribution effect.

Since in the exercises plotted in figures 15-17 we assume that steady-state transfers adjust as necessary to balance the budget, the implications for the co-movement between the budget deficit and the trade balance or the current account vary depending on the specifics of tax policy. Reducing the home labor income tax widens the budget deficit and it also causes the trade balance to deteriorate, although it induces an improvement in the current account. A reduction in world capital taxation widens the public deficit but it induces a narrowing of both the trade balance and the capital account deficits. Finally, a reduction in the home consumption tax widens the budget deficit but does not have significant effects on net exports and the current account.

FIGURE 13. WELFARE COSTS AS A SHARE OF REVENUES IN THE HOME COUNTRY UNDER DIFFERENT TAX POLICIES
(variations in world capital income tax and home labor and consumption taxes)

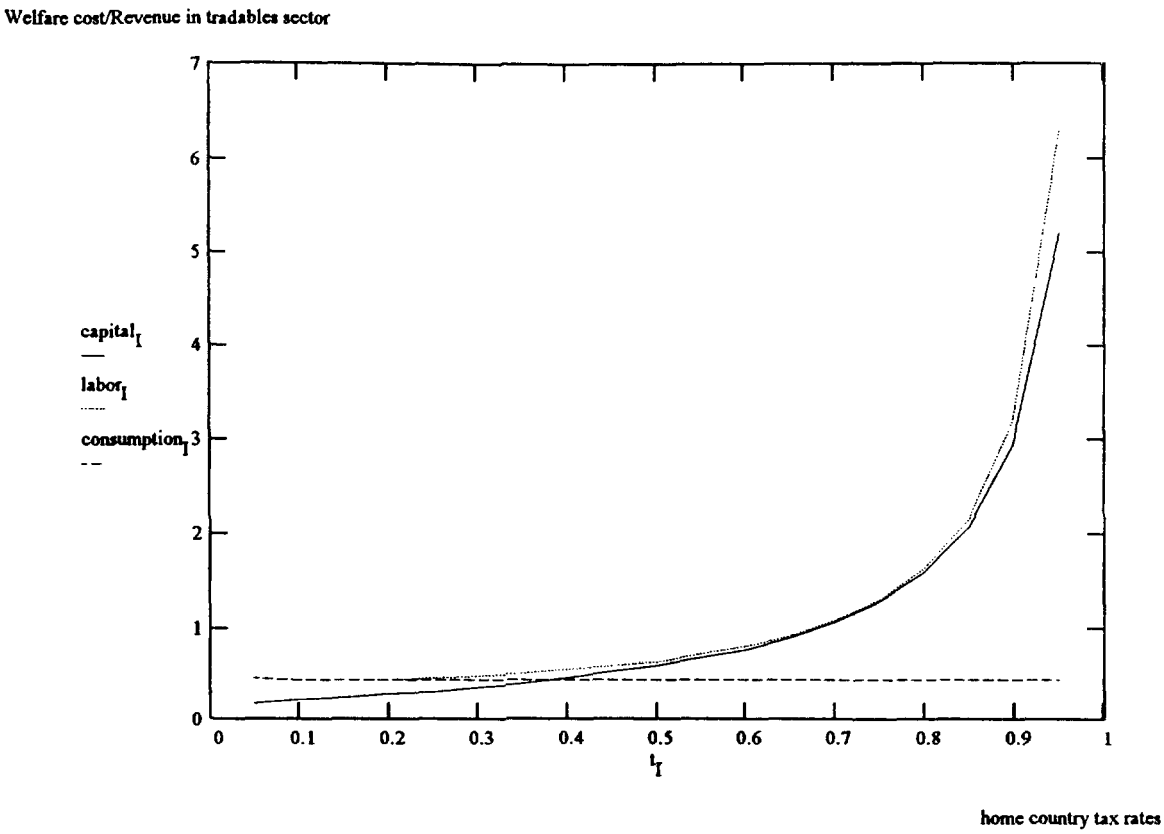


FIGURE 14. WELFARE COSTS AS A SHARE OF REVENUES IN THE FOREIGN COUNTRY UNDER DIFFERENT TAX POLICIES.
(variations in world capital income tax and home labor and consumption taxes)

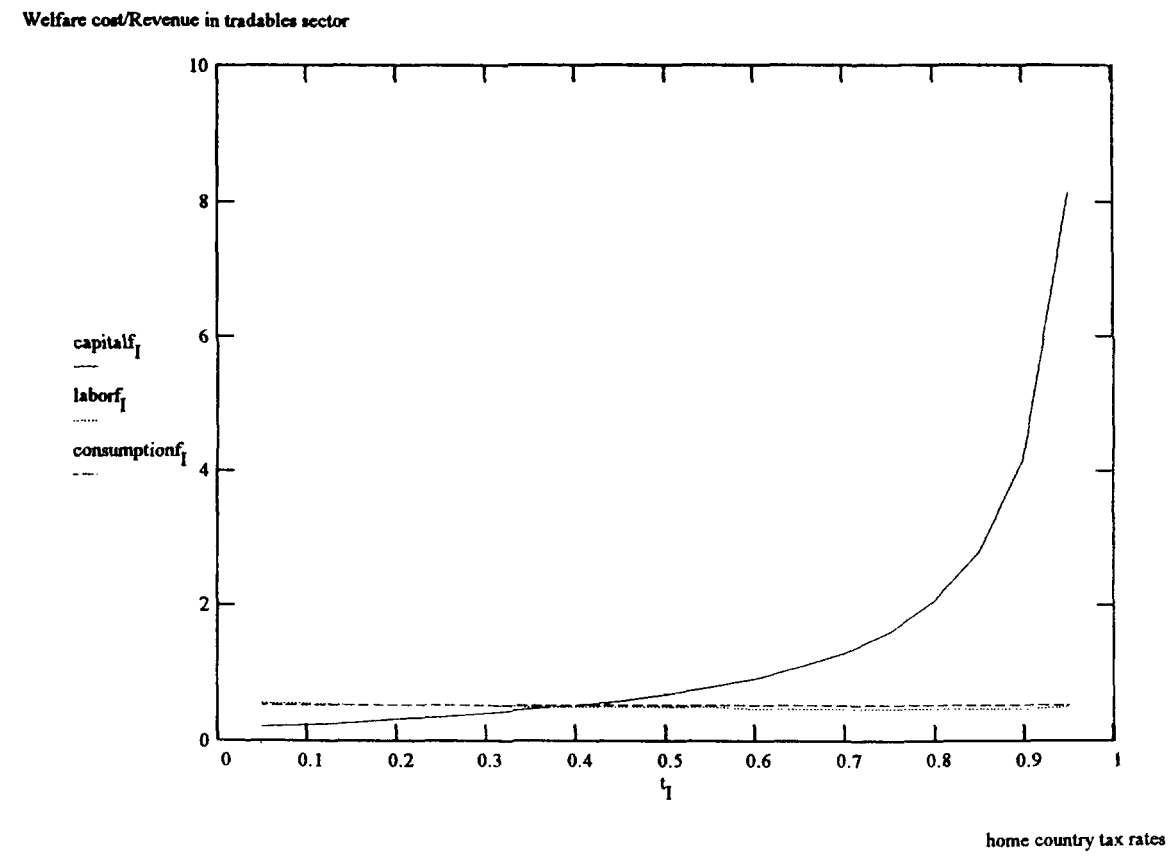


FIGURE 15. THE CURRENT ACCOUNT IN THE HOME COUNTRY UNDER DIFFERENT TAX POLICIES

(variations in world capital income tax and home labor and consumption taxes)

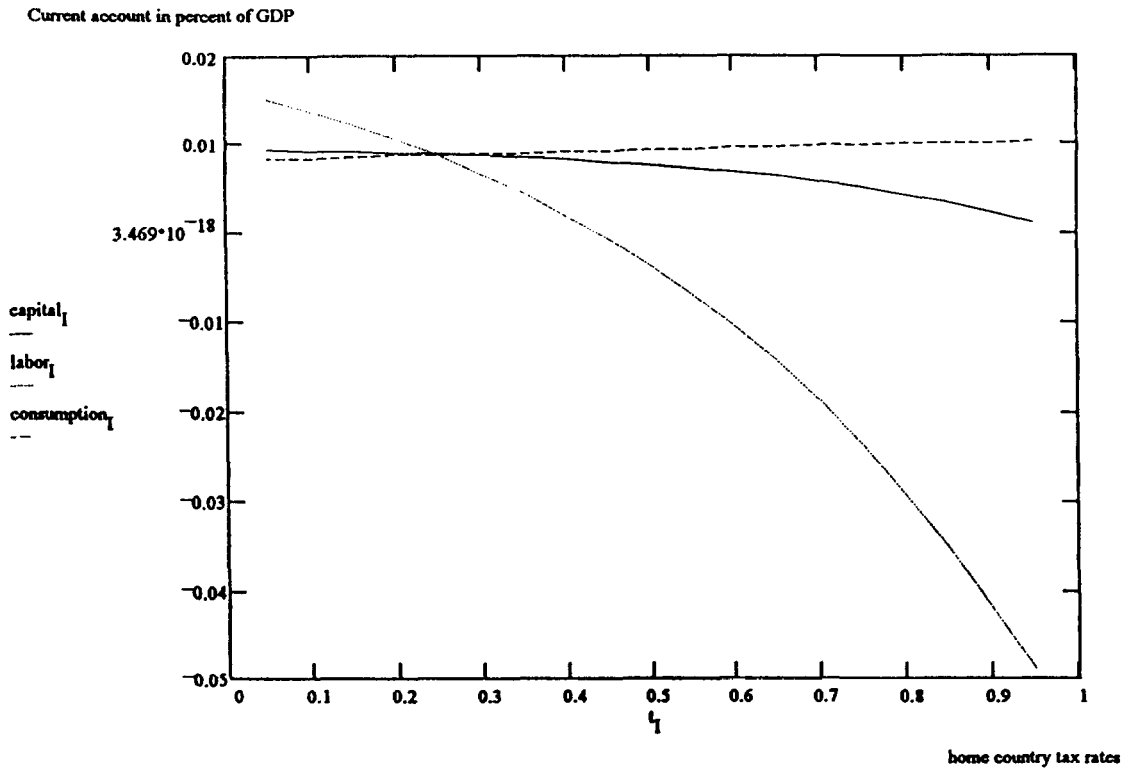


FIGURE 16. THE TRADE BALANCE IN THE HOME COUNTRY UNDER DIFFERENT TAX POLICIES.

(variations in world capital income tax and home labor and consumption taxes)

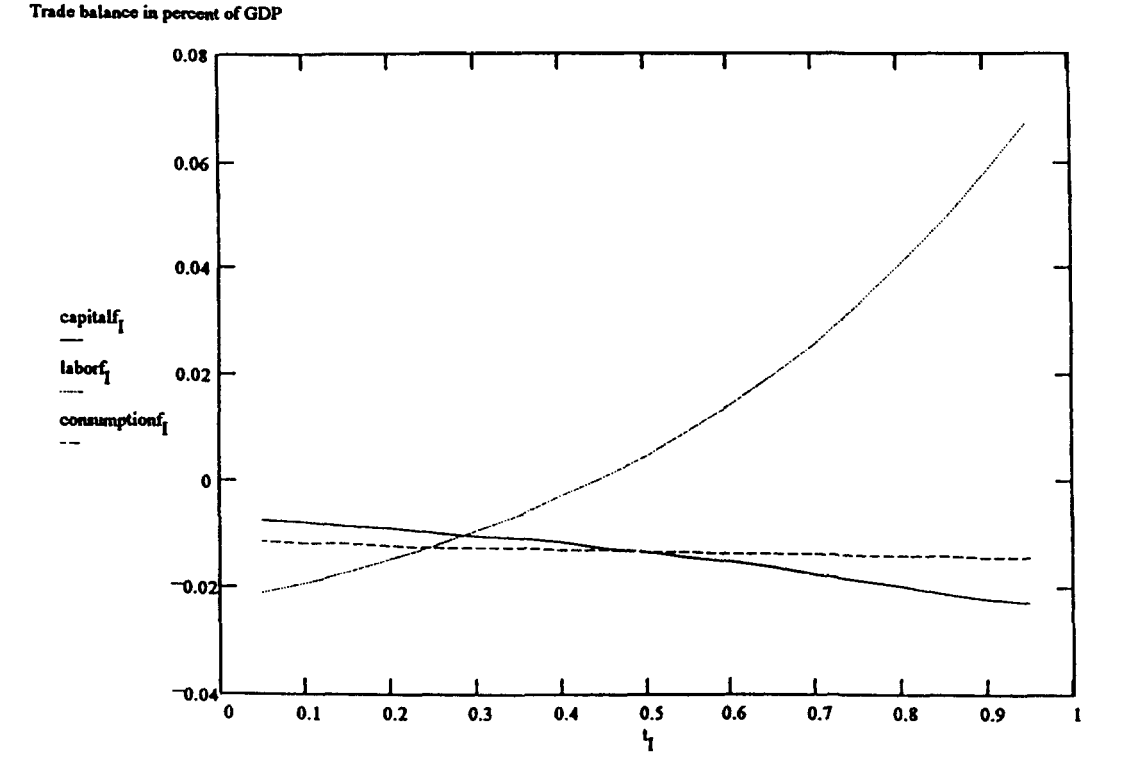
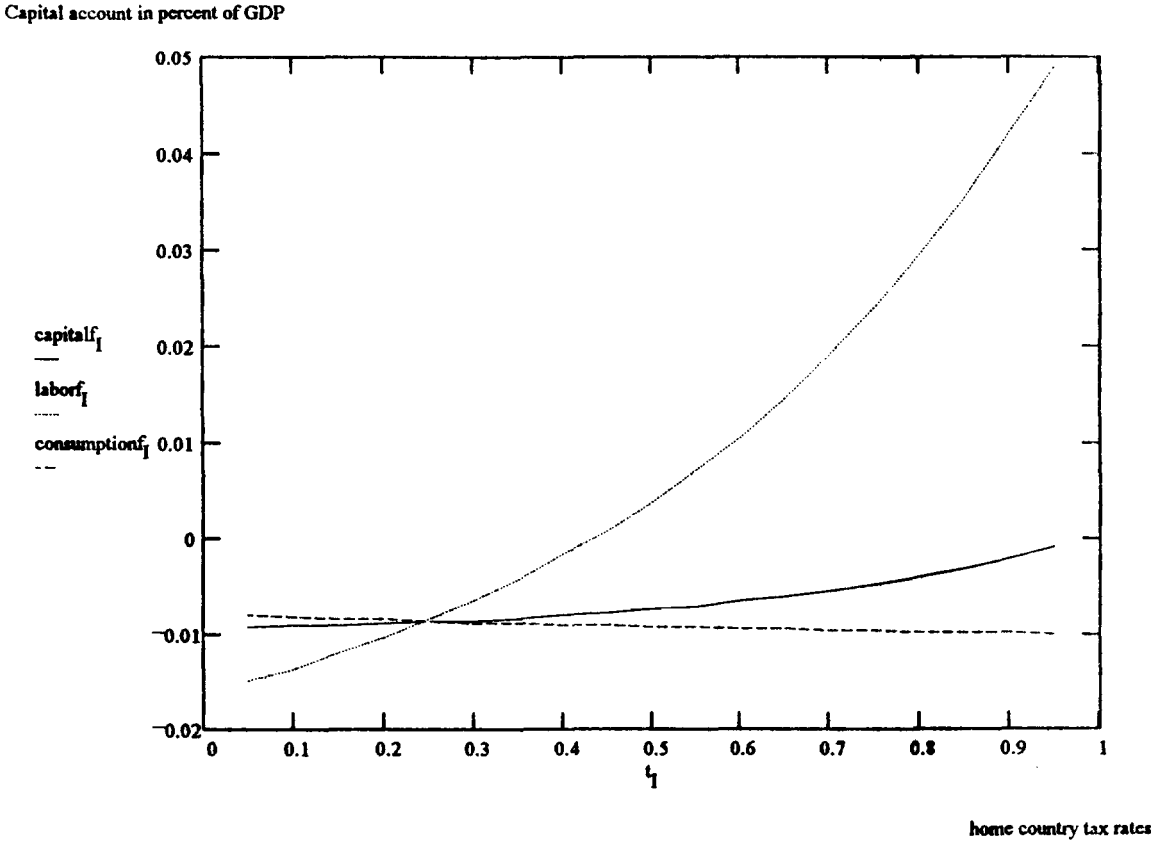


FIGURE 17. THE CAPITAL ACCOUNT IN THE HOME COUNTRY UNDER DIFFERENT TAX POLICIES.

(variations in world capital income tax and home labor and consumption taxes)



6. Government expenditure

Tables 5 and 6 report the effects of changes in Country 1 government expenditures on macroeconomic aggregates in the two countries. We examine increases in expenditures financed by lump-sum taxes (i.e. steady-state-debt) and by consumption taxes. In the first case we allow transfers to fall, or the home public deficit to widen, and in the second we assume that the home consumption tax is adjusted to support both the extra government expenditures as well as the benchmark level of nontradables transfers (i.e. the experiment corresponds roughly to a balanced budget fiscal expansion). Each experiment is also conducted for the case in which both tradables and nontradables government expenditures are increased and for the case in which only nontradables expenditures change.

The tables illustrate important differences on the implications of increases in government purchases depending on how they are financed and how they are allocated across sectors, as well as some implications on international spill-overs of a purely domestic fiscal expansion. The most interesting result is that the supply of labor reacts very differently to the fiscal expansion depending on the sectoral allocation of expenditures and on whether the expansion is debt- or tax-financed.

Table 5 shows that if the increase in government expenditures is debt-financed and uniform across sectors, the resulting negative wealth effect in Country 1, which is illustrated by the sharp decline in the consumption-output ratio, induces Country 1 agents to increase labor supply (i.e. consume less leisure), and hence aggregate output grows. The debt-financed fiscal expansion has an obvious negative effect on the transfers-output ratio and induces a decline in tax revenue associated with the shrinking base of the consumption tax. There are also some international spill-overs because, as the domestic tradables output grows relative to the foreign, wealth-redistribution effects reduce moderately the trade deficit of Country 1. In contrast, when the debt-financed fiscal expansion is directed only to nontradables, the wealth effect induces agents to work more in the nontradables sector by substituting labor away of the tradables sector. At the aggregate level, total hours are almost unchanged, so the effects on aggregate output are much weaker than before. In this case the domestic tradables output falls relative to the foreign tradables output, but nevertheless the same moderate improvement in the aggregate net exports-output ratio is observed. This result follows from the fact that, as labor is reallocated to nontradables, the ratio of tradables in total domestic output falls, and hence there are two offsetting effects on the aggregate net exports-output ratio--the fall in the share of tradables in total output vis a vis the increase in the trade deficit in units of tradables resulting from the adverse redistribution of wealth.

Macroeconomic aggregates in Country 2 are generally independent of the domestic debt-financed fiscal expansion, other than some moderate effects on net exports and consumption that reflect the small magnitude of the wealth redistribution effects. The uniform increase in government expenditures increases the trade surplus in Country 2, while the increase in expenditures

Table 5. Effects of a Debt-Financed Increase in Country 1 Government Expenditures

(Variables in percent of GDP of each country)

	$G^T/Y^T = G^N/Y^N =$			$G^T/Y^T = 18.0$, $G^N/Y^N =$		
	10.0	30.0	50.0	10.0	30.0	50.0
Country 1						
Consumption	73.8	53.7	33.5	69.5	59.2	44.3
Capital stock	519.7	520.0	520.6	517.9	523.1	530.6
Investment	17.4	17.4	17.4	17.3	17.5	17.7
Savings	16.2	16.3	16.5	16.1	16.4	16.8
Net exports	-1.2	-1.1	-0.9	-1.2	-1.1	-0.9
Government expenditure	10.0	30.0	50.0	14.4	24.4	38.9
Tax revenue	31.0	29.8	28.6	30.8	30.2	29.3
Transfers	21.0	-0.2	-21.4	16.4	5.7	-9.7
Hours 1/	18.2	23.4	32.9	20.0	19.9	19.9
Country 2						
Consumption	59.1	58.9	58.8	59.0	59.1	59.3
Capital stock	593.4	593.3	593.3	593.3	593.4	593.4
Investment	19.8	19.8	19.8	19.8	19.8	19.8
Savings	20.9	21.0	21.2	20.9	20.8	20.7
Net exports	1.1	1.2	1.4	1.1	1.0	0.9
Government expenditure	20.0	20.0	20.0	20.0	20.0	20.0
Tax revenue	35.9	35.8	35.7	35.8	35.9	36.0
Transfers	15.9	15.8	15.7	15.8	15.9	16.0
Hours 1/	20.0	19.9	19.9	14.0	14.0	13.9
Memorandum						
Real exchange rates: 2/						
Country 1	78.5	78.5	78.5	78.5	78.5	78.5
Country 2	72.3	72.3	72.3	72.3	72.3	72.3
Aggregate GDP:						
Country 1	0.29	0.38	0.54	0.32	0.33	0.39
Country 2	0.35	0.35	0.35	0.35	0.35	0.35

1/ Percent of total time.
2/ Equilibrium relative price of nontradable goods.

Table 6. Effects of a Consumption Tax-Financed Increase in Country 1 Government Expenditures 1/

(Variables in percent of GDP of each country)

	G^N/Y^N = G^T/Y^T =			G^T/Y^T = 18.0, G^N/Y^N =		
	10.0	30.0	50.0	10.0	30.0	50.0
Country 1						
Consumption	73.8	53.7	33.7	69.5	59.3	44.4
Capital stock	519.7	520.1	520.8	517.9	523.2	530.6
Investment	17.4	17.4	17.4	17.3	17.5	17.7
Savings	16.2	16.2	16.2	16.2	16.3	16.6
Net exports	-1.2	-1.2	-1.2	-1.1	-1.2	-1.1
Government expenditure	10.0	30.0	50.0	14.4	24.4	39.0
Tax revenue	22.3	43.1	64.9	22.5	44.8	76.8
Transfers	12.3	13.1	14.9	8.2	20.3	37.9
Hours 2/	20.1	19.9	19.5	22.0	16.8	10.9
Country 2						
Consumption	59.1	59.1	59.1	59.0	59.2	59.6
Capital stock	593.4	593.4	593.4	593.3	593.5	593.6
Investment	19.8	19.8	19.8	19.8	19.8	19.8
Savings	20.9	20.9	20.9	21.0	20.7	20.4
Net exports	1.1	1.1	1.1	1.2	0.9	0.6
Government expenditure	20.0	20.0	20.0	20.0	20.0	20.0
Tax revenue	35.8	35.8	35.9	35.8	35.9	36.2
Transfers	15.8	15.8	15.9	15.8	15.9	16.2
Hours 2/	14.0	14.0	14.0	14.0	14.0	13.9
Memorandum						
Real exchange rates: 3/						
Country 1	78.5	78.5	78.5	78.5	78.5	78.5
Country 2	72.3	72.3	72.3	72.3	72.3	72.3
Aggregate GDP:						
Country 1	0.33	0.32	0.32	0.35	0.28	0.21
Country 2	0.35	0.35	0.35	0.35	0.35	0.35

1/ Consumption tax rates are -0.063, 0.301, 1.125, for G^N/Y^N equal to 0.1, 0.3 and 0.5 respectively.

2/ Percent of total time.

3/ Equilibrium relative price of nontradable goods.

allocated only to nontradables has the opposite effect. 1/ Real exchange rates are independent of increases in government expenditures and of their sectoral allocation, since expenditures cannot affect the steady-state ratios of real wages in tradables and nontradables industries.

Table 6 shows that the labor supply implications of a tax-financed increase in Country 1 government expenditures are strikingly different than those observed in Table 5. When the increase is uniform across tradables and nontradable goods, there is a very small decline in hours worked, as the wealth effect is offset by the substitution effect induced by the influence of the consumption tax on the after-tax relative price of leisure. In this case, there are only marginal changes in domestic output levels, and hence the relative output of tradables between Countries 1 and 2 is not altered and international spill-overs are very weak. In contrast, an increase in expenditures allocated only to nontradable goods results in a sharp reduction in labor supply. In this case, wealth and substitution effects tend to offset each other in the nontradables sector, but since consumption is taxed uniformly across tradables and nontradables, the post-tax relative price of leisure in the tradables industry falls and thus hours worked decline. As the output of tradables in Country 1 falls, tradables output falls relative to nontradables output, the relative share of world capital of tradables owned by home households falls, and tradables output falls relative to Country 2 tradables output. From equation (57), it follows that these changes result in a narrowing of the trade surplus abroad, while leaving the domestic net export-output ratio unchanged.

Increases in government expenditures are always costly in terms of welfare in our model, because there are no production or consumption benefits derived from the government's activities. When increases in expenditures are debt financed, welfare losses are almost a linear function of expenditures, whereas a tax-financed increase in expenditures introduces convexity as welfare losses increase not only because of the share of output taken by government, but also because of the increasing costs of distortionary taxation examined before. A Country 1, debt-financed increase in expenditures from 10 to 50 percent of output results in an increase in welfare costs to that country from 8 to 116 percent in terms of the trend level of consumption, when compared with a regime in which all tax revenue is rebated to the consumers. Welfare in Country 2 is virtually unchanged. In contrast, tax-financed government expenditures of 50 percent of GDP result in a social cost of 129 percent in Country 1--with welfare in Country 2 again virtually unchanged.

1/ In Country 2 there are no sectoral changes in the distribution of output across tradables and nontradables, so changes in the net exports-output ratio are a better measure of how changes in government expenditures affect trade via changes in the relative income and wealth positions of the two countries.

7. Maastricht: tax harmonization and public debt convergence

Consider now an alternative parameterization of the model in which Country 1 and Country 2 are calibrated to mimic some basic stylized facts of Italy and France respectively. Table 7 lists the outcome of a benchmark simulation, as well as alternative policy scenarios for the case in which consumption taxes are harmonized at the 15 percent level in both countries, the case in which transfers as a ratio of GDP in Country 1 increase by 7 percentage points by means of a contraction in government expenditures, and the case in which both these policies are simultaneously implemented. The experiment on increasing transfers is a proxy for the Maastricht treaty convergence requirement of reducing public debt to no more than 60 percent of GDP. As of end-1992 France's debt ratio would satisfy this criterion, so no adjustment would be required, while Italy's gross general government debt to GDP ratio at about 109 percent would require adjustment. 1/

Table 7 shows that in the model the current policy proposals regarding harmonization of indirect taxes and debt convergence do not have significant effects on the ratios of various macroeconomic aggregates relative to GDP. This is because neither changes in consumption tax policy, nor debt convergence, viewed as an increase in steady state transfer payments, attained via a contraction in government expenditures, affect the long-run conditions governing capital accumulation, and hence investment and capital output ratios remain constant. The consumption-output ratio in Country 1 increases by the same amount as transfers in the debt convergence exercise, reflecting the contraction in government expenditures. These policies have negligible international spill-overs, as indicated by the invariance of the net exports-output ratio, and by the fact that Country 2 is virtually unaffected by debt convergence in Country 1.

Nevertheless, welfare effects, although much smaller than those obtained in the taxation exercises of Section III, are sizable. Tax harmonization results in a 1 percent welfare loss in Country 1, where the consumption tax is increased, and a gain of 2.8 percent in Country 2, where the tax is reduced. This induces incentives for policy-makers in Country 1 either to opt out of the harmonization agreement, or to exploit many of the well-known tax equivalences (as examined in Frenkel, Razin, and Sadka (1991)) to try to undo the effects of the tax increase. For instance, Country 1 could reduce labor income taxes in a revenue-neutral manner so as to offset the welfare loss. The analysis from the first part of this section would suggest that such offsetting tax policy could be implemented without significantly affecting incentives in Country 2. Thus, it would

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1/ Following the figures reported in p. 37 of International Monetary Fund (1993), we estimate that if the public debt convergence criterion is met, given 1992 public debt ratios and a Maastricht-level long-term interest rate of 11 percent, Italy would need to reduce public debt interest payments from 14.2 percent of GDP to 6.6 percent of GDP. In the model, this would imply an increase in the long-term ratio of transfers to GDP of 7.6 percentage points.

Table 7. Macroeconomic Effects of European Tax Harmonization and Debt Convergence

(In percent)

Variable	Country 1				Country 2			
	Benchmark 1/	Tax Harmonization 2/	Debt Convergence 3/	Both Policies	Benchmark 1/	Tax Harmonization 2/	Debt Convergence 3/	Both policies
Aggregate output ratios:								
Consumption	65.5	65.5	71.5	71.5	61.8	61.8	61.8	61.9
Investment	19.9	19.9	19.9	19.8	19.8	19.8	19.8	19.8
Net exports	-0.3	-0.3	-0.3	-0.3	0.3	0.3	0.3	0.3
Savings	19.6	19.6	19.6	19.5	20.2	20.2	20.2	20.2
Government expenditure	15.0	15.0	9.0	9.0	18.0	18.0	18.0	18.0
Tax revenue	41.3	42.9	42.1	43.8	48.8	44.8	48.8	44.8
Transfers	26.3	27.9	33.0	34.8	30.8	26.8	30.8	26.8
Welfare gain	--	-1.04	4.54	3.37	--	2.83	0.01	2.84

1/ Benchmark parameters: τ_c=12.5, τ_c^*=21.5, τ_k=τ_k^*=0.4, τ_n=38.3, τ_n^*=43.5, sg=0.15, sg*=0.18, αT=α_T^*=0.55, αN=αN^*=0.5, a=2.5, a*=2.4, sb=-0.01, and all other parameters as in Table 2.

2/ Tax harmonization policy: τ_c=τ_c^*=0.15, everything else unchanged.

3/ Debt convergence: sg=9.0, which represents close to an increase of 7 percentage points in the ratio of transfers to GDP, everything else unchanged.

seem that tax harmonization agreements would need to be more comprehensive in order to be credible.

The welfare gain of debt convergence in Country 1 is about 4.5 percent, reflecting the fact that the reduction in debt is matched by a reduction in the amount of unproductive government expenditures. Thus, the trend level of private consumption grows as crowding out by the government diminishes. Welfare in Country 2 is virtually unaffected by the fiscal consolidation in Country 1. It must be noted, however, that if the debt reduction is reflected in tax breaks, or if the reduction in government expenditures is not uniform across tradable and nontradable sectors, the quantitative results would change.

The combination of tax harmonization and debt convergence results in a welfare gain of 3.4 percent for Country 1 and 2.8 percent for Country 2. In Country 1, the tax increase accompanied by a reduction in government expenditures produces a net gain in welfare, and hence eliminates incentives for strategic behavior affecting the effectiveness of tax harmonization agreements. Country 2 realizes a welfare gain, but again this mainly reflects the tax break, as debt convergence in Country 1 has negligible effects.

V. Concluding Remarks

This paper examined the long-run macroeconomic effects of fiscal policies in the context of a two-country, two-sector dynamic equilibrium model of a growing world economy. Specifically, we made use of numerical simulations to study the effects of changes in tax and expenditure policies on the long-run levels of welfare and macroeconomic variables that correspond to competitive equilibria along an exogenous balanced growth path.

Prior to undertaking the numerical experiments, the model was calibrated to mimic features of the current stance of fiscal policies in large industrial countries (particularly the GDP ratios of government expenditures and the effective rates of taxation on factor incomes and consumption) and was also set to reproduce other important observed stylized facts (such as average growth rates and labor income shares in GDP). The solution of a benchmark model parameterized in this manner showed that the model explains the observed output shares of consumption, investment, net exports, tax revenue, and government transfers.

Numerical simulations of the benchmark case also produced results showing that welfare losses associated with the distortions implicit in existing tax policies are large (in excess of 20 percent of the trend level of consumption per capita), that the potential gains of tax reforms oriented towards replacing factor income taxes with indirect taxes are also large (in excess of 13 percent), and that, in contrast, incentives for immigration are small. Simple calculations of the costs involved in the transition from one steady state to another show that long-run welfare gains of tax reforms

favoring indirect taxes are drastically reduced, to about 1.5 percent. Even at this level, welfare gains of tax reform are much higher than existing estimates of welfare gains derived from price and output stability, from international risk-sharing aimed at smoothing consumption, and from reducing policy uncertainty. Further work on the computation of transitional dynamics in the open economy is needed in order to provide stronger support for this result.

A quantitative analysis of unilateral changes in tax policies in one country showed that consumption taxes are the most efficient, in the sense that they generate smaller welfare costs per unit of tax revenue than labor or capital income taxes. The capital income tax is particularly inefficient because it is the only tax that distorts savings plans and hence affects the long-run capital-output ratio, as well as the long-run investment rate. These findings cast some doubt on proposals to reduce budget deficits in industrial countries partly by shifting the tax system towards heavier factor income taxation, particularly by imposing higher taxes on capital income.

The welfare implications of tax policies do not depend significantly on whether the economy is closed or open, although these policies do have significant effects on the trade balance, the factor payments account, and net foreign direct investment. We also found that it is not always the case that a widening fiscal deficit, resulting from tax reductions, would result in a widening trade deficit. This is true for the labor income tax, but the opposite is true for capital and consumption taxes.

Simulations of permanent changes in unproductive government expenditures showed that the effects of these changes depend critically on whether they are uniform across tradable and nontradable goods, and on whether they are financed with distortionary taxes or lump-sum taxes (the latter being equivalent to debt in the steady state). An expansion of expenditures financed with lump-sum taxes has significant macroeconomic effects when it is uniform across sectors, but not when it is biased towards nontradable goods. The opposite is true for a consumption tax-financed increase in expenditures.

Numerical simulations were also undertaken to quantify the effects of tax harmonization and debt convergence as envisaged for European countries in the Maastricht treaty. These policies have small effects on macroeconomic aggregates, but their welfare implications are not negligible. Tax agreements that focus only on indirect tax harmonization induce incentives for low-tax countries to modify factor income taxation in order to offset welfare losses. Debt convergence may result in welfare gains in excess of 4 percent of the trend level of consumption for high-debt countries, with little impact on the performance of low-debt countries.

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