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International Spillovers of Taxation

Prepared by Jacob A. Frenkel, Assaf Razin and Steven Symansky*

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Abstract

This paper highlights key issues pertinent for the understanding of international effects of domestic tax policies and of international tax harmonization. The analytical framework adopts the saving-investment balance approach to the analysis of international economic interdependence focusing on income, consumption, and international borrowing. A simulation model is developed that is richer in structure than the two period analytical model.

The analytical and simulation frameworks are used to analyze the consequences of revenue-neutral conversions between income and consumption (VAT) tax systems, the international effects of budget deficits and public-debt management, and the effects of international tax harmonization. We demonstrate that the effects of such changes in the structure of taxes depend critically on international differences in saving and investment propensities.

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Contents

Summary

This paper deals with the international effects of taxation. Tax policies have profound effects on the temporal composition and on the intertemporal evolution of the macro economy. The analysis highlights key issues pertinent for the understanding of international effects of domestic tax policies and of international tax harmonization. The analytical framework adopts the saving-investment balance approach to the analysis of international economic interdependence and includes a detailed specification of public and private sector behavior focusing on the roles played by taxes on income, consumption, and international borrowing. We present stylized facts on the average consumption and income tax rates for the seven major industrial countries. They reveal large international diversity of tax rates and tax structures.

The analytical framework is used to analyze the consequences of revenue-neutral conversions between income and consumption (VAT) tax systems. We demonstrate analytically that the effects of such changes in the structure of taxes depend critically on international differences in saving and investment propensities which in turn govern the time profile of the current account of the balance of payments. The key results are also illustrated by means of dynamic simulations. We then examine the international effects of budget deficits and public-debt management and demonstrate analytically as well as by means of dynamic simulations that these effects depend critically on whether the government manages its deficit through alterations in income or consumption (VAT) taxes. Finally, motivated by proposals for tax harmonization associated with the single market in Europe of 1992, we consider the effects of international tax harmonization. The main results, demonstrate that, in analogy with the effects of tax conversions, the effect of harmonization depends critically on the inter-country differences in saving and investment propensities. These differences are shown to yield conflicts of interests in the tax harmonization program.

I. Introduction

This paper deals with the international effects of taxation. Tax policies have profound effects on the temporal composition and on the intertemporal evolution of the macro economy. They influence saving and investment decisions of households and firms as well as decisions governing labor supply and demand. With integrated world markets for goods and capital the effects of tax policies undertaken by a single country spill over to the rest of the world. Recognition of such international economic interdependence stimulated interest in the international coordination of fiscal policies, in general, and of tax policies and tax reforms, in particular. The purpose of this paper is to highlight key issues pertinent for the understanding of some international effects of domestic tax policies and of international tax harmonization.

The analytical framework used in the paper adopts the saving-investment balance approach to the analysis of international economic interdependence. It thus emphasizes the effects of changes in the time profile of the various taxes on the intertemporal allocations of savings, investment and labor. In order to gain some feel for the magnitudes involved, we present in Section II stylized facts on the time profile of average consumption and income tax rates for the seven major industrial countries. These stylized facts reveal large international diversity of tax rates and tax structures. They also reveal the significant changes that took place over time in some of the countries.

In Section III, we present the basic international-intertemporal model. The model, grounded on microeconomic foundations, is neo-classical in nature and is suitable therefore for the analysis of the incentive effects of tax policies. It allows for rich tax structures and contains a detailed specification of public and private-sector behavior. The various economies are integrated through both goods and capital markets. Our formulation focuses on the roles played by taxes on income and consumption (value-added) as well as by a unified international market for capital.

In Section IV we apply the analytical framework to an examination of the international implications of tax reforms. In this context, we analyze the consequences of revenue-neutral conversions between income and consumption (VAT) tax systems. Reflecting our emphasis on the saving-investment balance we demonstrate that the effects of such changes in the composition of taxes depend critically on international differences in saving and investment propensities which in turn govern the time profile of the current account of the balance of payments. The key results are derived analytically and are also illustrated by means of dynamic simulations. In Section V, we shift the focus of analysis from the composition of taxes to the timing of taxes. We thus examine the international effects of budget deficits and public-debt management. We demonstrate analytically as well as by means of dynamic simulations that these effects depend critically on whether the government manages its deficit through alterations in income or consumption taxes.

In Section VI we combine the analytical framework of Section III, with the key elements of the analysis in Sections IV and V, to examine the effects of international tax harmonization. The impetus to such an examination is provided by the discussions surrounding the tax harmonization measures (notably the VAT) associated with the move towards the single market of Europe of 1992. The main results conform with those obtained from the analysis of revenue-neutral tax conversions. Accordingly, it is shown that the saving-investment balance approach is useful for the analysis of the effects of international tax harmonization. Specifically, the dynamic simulations demonstrate that these effects depend critically on the inter-country differences in saving and investment propensities. These differences underlie the current account position and its evolution over time. The paper ends with concluding remarks. The Appendix which follows the main text presents the details of the simulation model.

II. Tax Rates in Major Industrial Countries

In this section, we present stylized facts concerning (average) tax rates in the seven major industrial countries: Canada, the United States, Japan, France, Germany, Italy, and the United Kingdom. Since we focus our theoretical and simulation analysis on changes over time of income and consumption taxes, we attempt to present here some measures of the evolution of these tax rates.

It is important, however, to start with a word of caution: the marginal tax rates relevant for the analysis of investment, savings, and labor supply are relatively clear as a conceptual matter. In practice, however, due to the complexity of the tax code involving progressivity of taxes, exemptions, tax credits, tax evasion, delays and advances in payments of taxes and the like, the empirical counterparts to the conceptual marginal tax rates are less clear. Due to inter-country differences in the tax code in the factors underlying tax collections, and in the relative share of state and local governments in total tax revenue, the international comparison of tax rates are even more complex. Keeping these empirical difficulties in mind we nevertheless attempt to highlight some key features of inter-country differences in consumption and income tax rates. In calculating the various tax rates, we divide the general government tax-revenue data from OECD (1987a) by a corresponding computed tax base from OECD (1987b). We thus generate series of average tax rates for the major industrial countries. 1/

1/ We are grateful to Mario Blejer and Jonathan Levin who assisted us in obtaining the data and the interpretation of the various accounting measures.

Figure 1 exhibits the total-tax rate for the period 1973-86. 1/ It highlights the international diversity of this measure of the tax burden. While in Japan and the United States the total-tax rate is less than 30 percent by 1986, the rest of the OECD are substantially higher, reaching close to 45 percent in France. The other noteworthy feature apparent in Figure I is the different degree of variability of this measure of tax rates over time. For example, while for some countries (e.g. Italy, France and Japan) this measure of tax rates exhibits a positive trend, for other countries such a trend is less pronounced.

While the total-tax rate provides some information regarding the overall tax burden, the key decisions concerning investment, saving and labor supply depend on the detailed composition of taxes. Our main focus in this paper is on consumption and income taxes. We turn next, therefore, to examine more detailed information. Figure 2 exhibits the consumption-tax rate. As is evident the highest measure of the consumption tax rate prevails in France (about 15 percent) while the lowest prevails in Japan and the United States (about 3 percent). The Figure also reveals the upward trend (during the 1980s) prevailing in Canada, Italy, and the United Kingdom whose rate has risen to about 10 percent (the rate prevailing in Germany). In this context the sharp increase in the U.K. tax rate associated with the decision in 1979 to nearly double the value-added tax rate is especially noteworthy. The intra-European differences in the consumption tax rates are of special relevance in view of the tax harmonization proposals associated with the plans for Europe of 1992.

Figures 3-5 exhibit various measures of income-tax rates. The personal-income tax rates shown in Figure 3 reveal the international diversity. The highest rate prevails in Canada (about 22 percent) while the lowest rate prevails in France (about 10 percent). Also noteworthy is the upward trend in the Italian personal-income tax rate.

The income-tax rates shown in Figure 4 include both personal and corporate taxes. Based on this measure, the highest tax rates prevail in Canada and the United Kingdom. The height of the U.K. tax rate reflects its relatively high corporate income tax. The lowest tax rate (about 10 percent) prevails in France. The significant decline of this measure in 1982 in the United States reflects the sharp fall in the corporate income tax rates associated with the Tax Act of 1981.

The role of the social security and payroll tax rates and the internationally diversity thereof is presented in Figure 5. We first note the upward trend prevailing in all major industrial countries. A second noteworthy feature is the roles played by these tax rates relative to the income-tax rates in Canada and France. While France has the highest social security and payroll tax rate (exceeding one third), Canada has the

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1/ The definitions of the various statistics are provided in the footnote to Table 1.

lowest rate (below ten percent). This ranking of Canada and France is the opposite to the one obtained in Figure 4 pertaining to the personal income tax rate.

In concluding this section we present in Table 1 selected summary data on the various tax rates in the major industrial countries and on their changes over time. The international diversity of these rates, notably within Europe, is of special interest in view of the tax harmonization plans for Europe of 1992.

In the subsequent sections we provide a sketch of a theoretical analysis highlighting the key factors governing the macroeconomic effects of tax restructuring which is then developed further by means of dynamic simulations.

III. The Analytical Framework

In developing the analytical framework we start with a formulation of the budget constraint which serves to focus attention on the key economic variables and tax-policy parameters that play a central role in the subsequent analysis. 1/ The home country's private-sector (full-income) budget constraint applicable to period (t=0,1,...,T-1) is

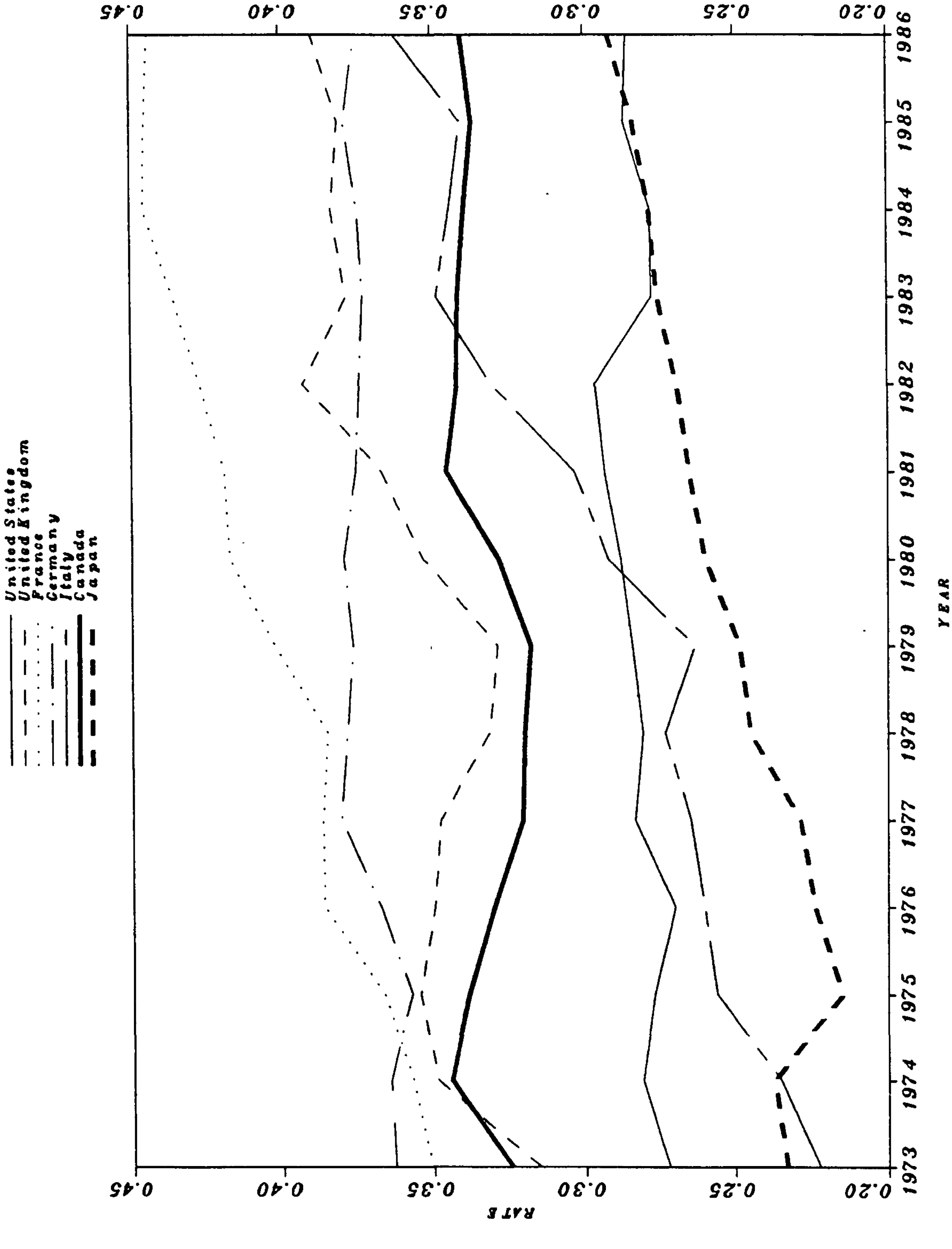
$$(1+\tau_{ct})C_t+(1-\tau_{yt})w_t(1-\ell_t)=(1-\tau_{yt})\;[w_t+r_{kt}(K_{t-1}+I_{t-1}) \tag{1}$$

$$-I_t(1+\frac{b}{2}\frac{I_t}{K_t})]+(1-\tau_{bt})[B^p_t-(1+r_{t-1})\;B^p_{t-1}]$$

Where τ_{ct}, τ_{yt} and τ_{bt} denote the cash-flow tax rates on consumption (VAT), income, and international borrowing, respectively. The levels of consumption, labor supply, capital stock, investment, and the private-sector international borrowing are denoted, respectively, by C_t, ℓ_t, K_t, I_t, and B^p_t. The wage rate, the capital-rental rate, and the interest rate are denoted, respectively by w_t, r_{kt}, and r_t. For convenience we normalize the endowment of leisure to unity and assume costs of adjustment in capital formation of the form $(\frac{1}{2})bI^2_t/K_t$. We note that in the final

1/ The analytical framework underlying the international-intertemporal approach to open-economy macroeconomics is based on Frenkel and Razin (1987, 1988b). For an analogous approach developed in a closed economy context see Auerbach and Kotlikoff (1987).

FIGURE 1: TOTAL TAX



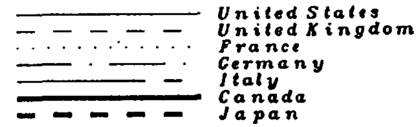


FIGURE 2: CONSUMPTION TAX

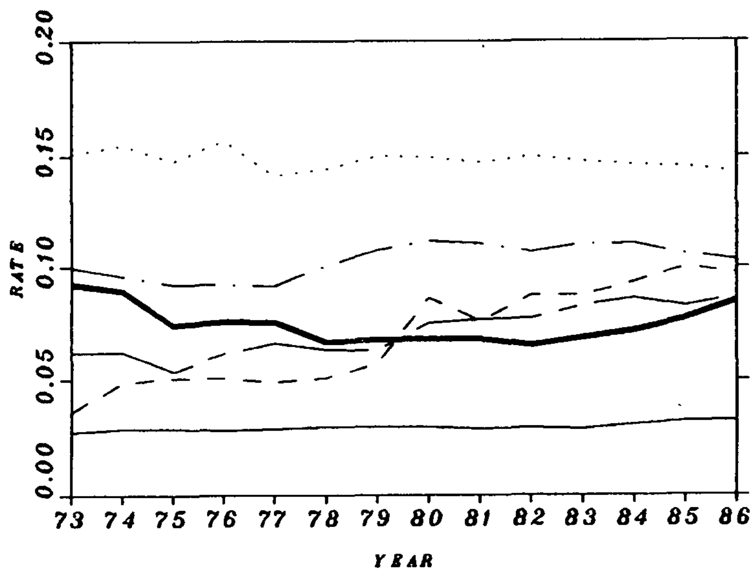


FIGURE 3: PERSONAL INCOME TAX

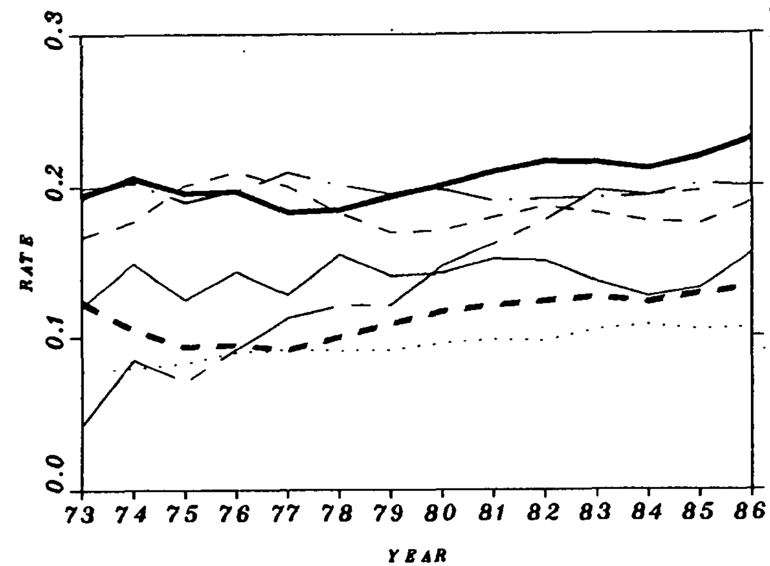


FIGURE 4: INCOME TAX

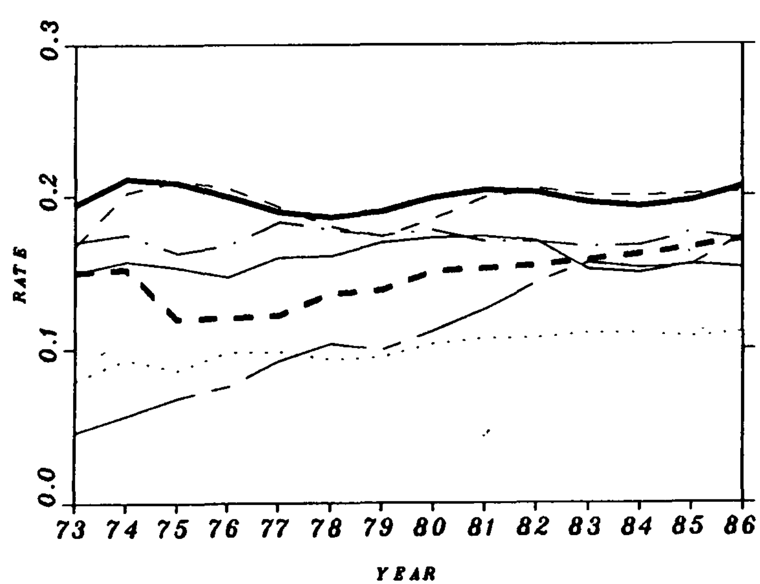


FIGURE 5: SOCIAL SECURITY + PAYROLL TAX

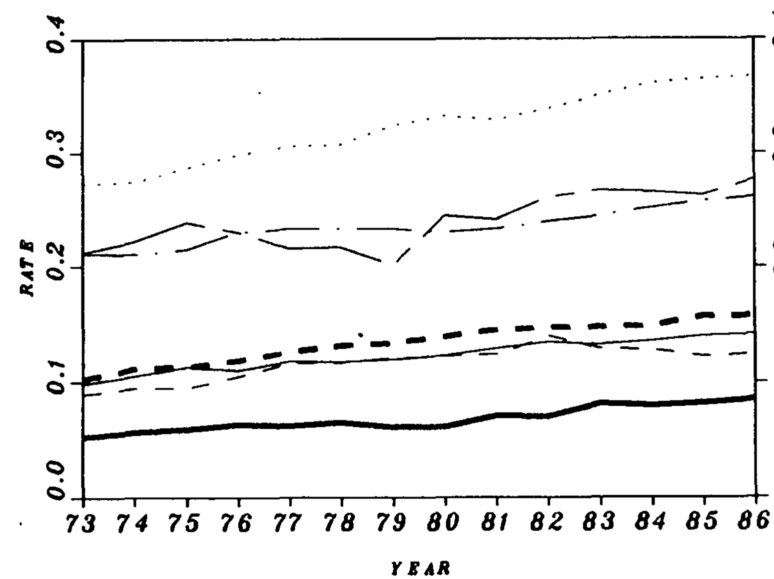


Table 1. Average Tax Rates in the Major Industrial Countries
(General Government)

	Total Tax Rate				Consumption Tax Rate				Personal Income Tax Rate				Income Tax Rate				Social Security and Payroll Tax Rate			
	1975	1980	1985	1986	1975	1980	1985	1986	1975	1980	1985	1986	1975	1980	1985	1986	1975	1980	1985	1986
CANADA	33.8	32.8	33.6	34.0	7.4	6.8	7.7	8.5	19.6	20.1	22.0	23.2	20.9	19.9	19.7	20.6	6.0	6.2	8.3	8.6
UNITED STATES	27.7	28.8	28.6	28.5	2.9	3.0	3.2	3.3	12.5	14.2	13.2	15.5	15.3	17.2	15.5	15.3	11.3	12.3	14.0	14.1
JAPAN	21.5	26.0	28.3	29.2	...	...	...	...	9.4	11.6	12.8	13.2	12.0	15.0	16.7	17.2	11.3	13.9	15.7	15.7
FRANCE	36.6	41.7	44.5	44.4	14.8	15.0	14.6	14.3	8.3	9.6	10.4	10.6	8.6	10.3	10.8	11.1	28.7	33.4	36.6	36.8
GERMANY	35.7	38.0	37.9	37.5	9.2	11.1	10.5	10.3	18.9	19.8	20.2	20.0	16.3	17.7	17.6	17.2	21.5	23.0	25.7	26.1
ITALY	25.6	29.2	34.0	36.2	5.4	7.5	8.3	8.7	7.0	14.7	19.6	...	6.9	11.2	15.4	17.4	23.9	24.4	26.3	27.7
UNITED KINGDOM	35.4	35.3	38.1	39.0	5.1	8.6	10.0	9.7	20.1	17.0	17.4	18.9	21.1	18.4	20.2	20.3	9.5	12.3	12.3	12.4

Source: Computed from OECD (1987a), OECD (1987b).

Note: Our measure of the consumption-tax rate is computed as the ratio of general taxes on goods and services (including value-added taxes, sales taxes and other general taxes on goods and services) to private final consumption. For income taxes we use various measures distinguishing between individuals and corporations as well as between social security and the more conventional definition of income taxes. Accordingly, the personal income-tax rate is computed as taxes on incomes, profits and capital gains of individuals divided by compensation of employees (a broader internationally-comparable tax base is unavailable). The income-tax rate is computed as the taxes on income, profits and capital gains (including individual and corporate taxes) divided by the compensation of employees plus property and entrepreneurial income. The social-security and payroll-tax rate is computed as social security contributions and payroll taxes of the work force divided by compensation of employees. Finally, the total-tax rate is computed as taxes on income, profits and capital gains plus social security contributions plus payroll taxes plus property taxes plus taxes on goods and services all divided by GNP or GDP. To maintain a consistent use of the OECD data, we have used GNP for the United States, Japan and Germany and GDP for Canada, France, Italy and the United Kingdom.

period (period T) the private sector settles its debt commitments and no new investment or new borrowing occurs. Accordingly, $I_T = B_T^P = 0$. 1/

To simplify the exposition we assume a linear production function with fixed coefficients. Thus, the competitive equilibrium conditions imply that the wage rate and the capital-rental rates, w and r_k, are constant. To simplify further we also assume that the historical debt commitment of the private sector, B_{-1}^P, is zero.

The formulation of the periodic budget constraint illustrates the <u>equivalence relation</u> existing among the taxes on consumption, income, and international borrowing. Indeed, the real effects of any given combination of the three taxes can be duplicated by a policy consisting of any two of them. 2/ For example, consider an initial situation with a positive consumption tax rate, $\bar{\tau}_c$, and zero income and international-borrowing tax rates. If the consumption tax was eliminated and the income and international-borrowing taxes were both set equal to $\bar{\tau}_c/(1+\bar{\tau}_c)$, then the <u>effective</u> tax rates associated with this new combination of taxes are zero income and international-borrowing taxes and a positive ($\bar{\tau}_c$) consumption tax. It follows that the real equilibrium associated with the new tax pattern ($\tau_c=0$, $\tau_y=\tau_b=\bar{\tau}_c/(1+\bar{\tau}_c)$) is identical to the one associated with the initial tax pattern ($\tau_c=\bar{\tau}_c$, $\tau_y=\tau_b=0$).

The periodic (full-income) budget constraints specified in equation (1) can be consolidated to yield the lifetime present-value budget constraint. To facilitate the diagrammatic analysis of subsequent sections we illustrate the lifetime present-value budget constraint for a two-period case (t=0,1). Accordingly,

$$C_0 + \alpha_c C_1 + \left\{\frac{1-\tau_{y0}}{1+\tau_{c0}}\right\} \left\{w(1-\ell_0) + \alpha_L w(1-\ell_1)\right\} = \left\{\frac{1-\tau_{y0}}{1+\tau_{c0}}\right\} w \qquad (2)$$

1/ Our formulation reflects the assumption that except for the final period, bolted capital cannot be consumed. However, in the final period, the capital stock, K_T can be transformed into consumption at the rate equals to aK_T, where $0 \le a \le 1$. This assumption serves to mitigate abrupt changes in the behavior of the economy arising in the final period of the finite horizon model. Accordingly, the budget constraint applicable to the final period (period T) is analogous to the one shown in equation 1 with an added term on the right-hand-side equal to $a(K_{T-1}+I_{T-1})=aK_T$. For a formulation of a model highlighting the interaction between investment, government spending policies, and international interdependence within an infinite-horizon model see Buiter (1987).

2/ A detailed analysis of the various equivalence relations in international macroeconomics and their policy implications is contained in Auerbach, Frenkel and Razin (forthcoming).

$$+ \quad \left\{\frac{1-\tau_{y1}}{1+\tau_{c1}}\right\} \quad \alpha_c w$$

$$+ \quad \left\{\frac{1-\tau_{y0}}{1+\tau_{c0}}\right\} \quad \left[r_k K_0 + \alpha_I (\alpha + r_k) K_1 - I_0 (1 + \frac{b}{2} \frac{I_0}{K_0})\right]$$

where

$$\alpha_c = \frac{(1+\tau_{c1})}{(1+\tau_{c0})} \frac{(1-\tau_{b0})}{(1-\tau_{b1})} \frac{1}{(1+r_0)} \text{ and } \alpha_L = \alpha_I = \frac{(1-\tau_{y1})}{(1-\tau_{y0})} \frac{(1-\tau_{b0})}{(1-\tau_{b1})} \frac{1}{(1+r_0)} .$$

As indicated, the discount factors α_c, α_L, and α_I are the <u>effective</u> (tax-adjusted) discount factors governing intertemporal consumption, leisure, and investment decisions, respectively. 1/ The <u>intratemporal</u> choice between labor supply (leisure) and consumption of ordinary goods is governed by the prevailing effective <u>intratemporal tax ratio</u> $(1-\tau_y)/(1+\tau_c)$. We note that in this cash-flow formulation the effective discount factor governing <u>intertemporal</u> consumption decisions, α_c, is independent of the income tax whereas the effective discount factor governing investment and leisure decisions, α_I and α_L, are independent of the consumption tax. In addition the effective discount factors depend on the <u>time path</u> of the various taxes rather than on their levels. Specifically, if the various tax rates do not vary over time, then their time paths are "flat" and the effective discount factors α_c, α_L, and α_I are equal to the undistorted tax-free factor, $\alpha = 1/(1+r_0)$. In that case the intertemporal allocations are undistorted while the intratemporal allocations are distorted if the intratemporal tax ratio differs from unity.

Having discussed the formulation of the private-sector budget constraint, we turn next to the specification of the multi-period utility function. To facilitate the discussion of the simulations reported in subsequent sections we need to specify its form in some detail. We thus suppose that the homothetic intraperiod utility function between consumption of ordinary goods and leisure is

$$u_t = \left\{\beta C_t^{\frac{\sigma-1}{\sigma}} + (1-\beta)\,(1-\ell_t)^{\frac{\sigma-1}{\sigma}}\right\}^{\frac{\sigma}{\sigma-1}} \tag{3}$$

1/ Obviously, with more than two periods, these discount factors are replaced by the appropriate present value factors.

while the interperiod utility function is

$$U_0 = \sum_{t=0}^{T} \delta^t \log(u_t) \tag{4}$$

where σ is the temporal elasticity of substitution between leisure and consumption of ordinary goods, β is the distributive parameter of consumption, and δ is the subjective discount factor.

Maximizing the utility functions in equations (3) and (4) subject to the life-time present-value budget constraint (the multi-period analogue to equation (2)) yields the utility-based real spending, u, its associated price index, P, and the periodic demand functions for the consumption of ordinary goods, C, and leisure, $1-\ell$, as follows:

$$u_t = \left[\sum_{s=0}^{T} \delta^s \right]^{-1} \frac{W_0}{P_t} \frac{\delta_t}{\alpha_t} \tag{5}$$

where α_t is period t present-value factor (that is, $\alpha_t = [(1+r_0)(1+r_1)\ldots(1+r_{t-1})]^{-1}$).

$$P_t = \left[\beta^\sigma \left\{\frac{1+\tau_{ct}}{1-\tau_{bt}}\right\}^{1-\sigma} + (1-\beta)^\sigma \left(\left\{\frac{(1-\tau_{yt})}{(1-\tau_{bt})}\right\} w\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}, \tag{6}$$

$$C_t = \frac{\beta^\sigma \left\{\frac{(1+\tau_{ct})}{(1-\tau_{bt})}\right\}^{-\sigma} P_t u_t}{\beta^\sigma \left\{\frac{1+\tau_{ct}}{1-\tau_{bt}}\right\}^{1-\sigma} + (1-\beta)^\sigma \left\{\frac{(1-\tau_{yt})}{(1-\tau_{bt})} w\right\}^{1-\sigma}}, \text{ and} \tag{7}$$

$$1 - \ell_t = \frac{(1-\beta)^\sigma \left\{\frac{(1-\tau_{yt})}{(1-\tau_{bt})} w\right\}^{-\sigma} P_t u_t}{\beta^\sigma \left\{\frac{1+\tau_{ct}}{1-\tau_{bt}}\right\}^{1-\sigma} + (1-\beta)^\sigma \left\{\frac{(1-\tau_{yt})}{(1-\tau_{bt})} w\right\}^{1-\sigma}}, \tag{8}$$

where t=1, 1,...T and where wealth is

$$W_0 = \sum_{t=0}^{T} \alpha_t \frac{(1-\tau_{yt})}{(1-\tau_{bt})} \left[w + r_k K_t - I_t (1 + \frac{b}{2} \frac{I_t}{K_t})\right] + \alpha_T \frac{(1-\tau_{yT})}{(1-\tau_{bT})} a K_T .$$

To complete the description of the private-sector behavior we maximize the representative individual wealth, W_0, with respect to investment, I_t. 1/ This yields

$$-\frac{1-\tau_{yt}}{1-\tau_{bt}} \alpha_t (1 + b \frac{I_{t-1}}{K_{t-1}}) + \sum_{s=t}^{T} \frac{(1-\tau_{ys})}{(1-\tau_{bs})} \alpha_s \left[r_k + \frac{b}{2} (\frac{I_s}{K_s})^2\right] + (r_k + a)\alpha_T = 0 \quad (9)$$

Equation (9) represents the implicit investment rule. The negative term is equal to the marginal cost of investment in period t while the positive terms are equal to the marginal benefits consisting of the rise in output resulting from the increased capital stock (the terms with r_k and a) and the fall in the future cost of investment (the terms associated with $(b/2) \cdot (I/K)^2$); all terms are expressed as present values adjusted for taxes. For the two-period case the investment function implied by equation (9) is:

$$I_0 = \frac{1}{b} (\alpha_I (a + r_k) - 1) K_0 \quad (9a)$$

Equation (9a) together with the assumption that $(a+r_k)$ exceeds unity (an assumption necessary for a positive level of investment in the two-period case) implies that the level of investment rises with the initial capital stock, K_0, with the effective (tax-adjusted) discount factor, α_I, with the rental rate, r_k, and with the consumption-coefficient, a, attached to the final-period capital. On the other hand, investment falls with an increase in the cost-of-adjustment parameter, b.

This completes the presentation of the key building blocks of the model. In the subsequent sections we use the model for the analysis of three issues in tax restructuring: revenue-neutral tax conversions, budgetary imbalances arising from changes in the time-profile of taxes, and international tax harmonization.

1/ The investment behavior could have been generalized to include the depreciation of the capital stock. The simulation model used in this paper and described in the Appendix includes capital depreciation.

IV. Revenue-Neutral Tax Conversions

In examining the effects of tax conversions between income and consumption tax systems we focus on revenue-neutral reforms. By ensuring that the restructuring of the tax system does not result in budgetary imbalances (which are considered separately in Section V) we obtain the pure effects of tax conversions. The present section is divided into four subsections. The first lays the groundwork by considering tax conversions in a small open economy, the second extends the analytical framework to a two-country model of the world economy, the third examines tax conversions in this extended framework, and the fourth reports on some dynamic simulations.

1. Tax conversions in a small open economy

In considering revenue-neutral tax reforms, we note that such reforms are characterized by a change in the composition of a given tax revenue among different tax bases. It is obtained through alterations in the various tax rates designed to keep total tax revenue in each period intact. In what follows we focus on a reform that substitutes a consumption-tax (VAT) system for an income-tax system. 1/

Even though the focus is on consumption and income tax systems, the equivalence relation that exists among the consumption, income, and international borrowing taxes permits us to simplify the exposition. Accordingly, we set the explicit consumption tax rate, τ_c, equal to zero while maintaining the rates of the other taxes, τ_b and τ_y, different from zero so as to assure a constant tax revenue. To simplify further, we consider the two-period case with inelastic labor supply 2/ and an international borrowing tax equal to a fixed proportion, θ, of the income tax. Accordingly,

$$\tau_{ct} = 0, \quad \tau_{bt} = \theta\tau_{yt}, \quad 0 \leq \theta \leq 1, \quad t = 0,1. \tag{10}$$

Substituting (10) into the expressions for the effective discount factors (in equation (2)) yields

$$\alpha_c = \frac{(1-\theta\tau_{y0})}{(1-\theta\tau_{y1})} \alpha , \qquad \alpha_I = \frac{(1-\tau_{y1})\ (1-\theta\tau_{y0})}{(1-\tau_{y0})\ (1-\theta\tau_{y1})} \alpha \tag{11}$$

1/ This analysis is based on Frenkel and Razin (1989)

2/ In terms of the utility function this assumption amounts to setting β=1 in equation (3). The simulation analysis relaxes these assumptions by considering multi-period simulations with a variable labor supply.

In the extreme case for which the proportionality factor, θ, is equal to zero, equation (11) implies that the effective-discount factor applicable to consumption decisions, α_c, equals the undistorted tax-free discount factor α. In that case the tax system amounts to a pure income-tax system. In the other extreme case for which the proportionality factor, θ, is equal to unity, equation (11) implies that the effective discount factor applicable to investment decisions, α_I, is equal to the tax-free discount factor α. In that case the tax system amounts to a pure consumption-tax system.

In Figure 6 we analyze the effects of revenue-neutral conversions involving consumption and income tax systems. 1/ In the Figure we portray combinations of the intertemporal income-tax rates, τ_{y1}/τ_{y0}, and the intratemporal (constant) proportionality factor, $\theta = \tau_b/\tau_y$, which generate constant tax revenue. The resulting iso-tax-revenue schedule is denoted by RR. The slope of the schedule depends on the initial-period trade-balance position. For the case drawn, the trade-balance position is in surplus and the schedule is negatively sloped.

To verify that with a trade-balance surplus the iso-tax-revenue schedule is downward sloping, consider a change from a consumption-tax system, in which $\theta = 1$ (e.g. point B), to an income-tax system, in which $\theta = 0$ (e.g. point A). This change can be thought of as consisting of two components. First, it involves a permanent reduction of the prevailing (consumption) tax and a permanent equiproportional rise of the other tax (income tax). Second, it involves further adjustments in the newly introduced tax aimed at restoring the initial level of tax revenue. If the economy runs a current-period trade-balance surplus, so that in the current period income minus investment (the income-tax base) exceeds consumption (the consumption-tax base) while in the future, due to the intertemporal budget constraint, this pattern is reversed, the first component of the reform results in a budget surplus in the current period and in a budget deficit in the future. Evidently, the second component of the reform aimed at restoring the initial level of tax revenue lowers the income-tax rate in the current period and raises the income tax rate in the future. As a result, the intertemporal income-tax ratio, τ_{y1}/τ_{y0}, rises. It follows that the fall in the proportionality factor, θ, from 1 to 0, holding tax revenue intact, must be associated with a rise in the ratio τ_{y1}/τ_{y0}. In Figure 6 this is reflected by the negative slope of the iso-tax-revenue schedule connecting points A and B. If on the other hand, the initial period trade-balance position is in deficit, the iso-tax-revenue schedule is positively sloped.

The II schedule in Figure 6 portrays combinations of the intertemporal ratio, τ_{y1}/τ_{y0}, and the proportionality factor, θ, along which the level of investment remains intact. As is evident from the definition of the effective discount factor α_I in equation (11), a rise in the proportionality factor, θ, raises the effective discount factor, α_I, and

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1/ We are indebted to Alan Auerbach for suggesting this diagram.

encourages investment if the intertemporal income-tax ratio, τ_{y1}/τ_{y0}, exceeds unity. In that case, in order to maintain the initial level of investment intact, the rise in θ (which raises α_I) must be accompanied by a rise in the intertemporal income-tax ratio (which lowers α_I). This is the case shown by the positively sloped II schedule in Figure 6.

The CC schedule in Figure 6 portrays combinations of τ_{y1}/τ_{y0} and θ which maintain a given growth rate of consumption (indicated by the intertemporal consumption ratio C_1/C_0). Applying a similar reasoning to the analysis of the effects of changes in θ and τ_{y1}/τ_{y0} on the effective discount factor α_c in equation (11), it can be verified that the iso-consumption-growth schedule, CC, is negatively sloped if the intertemporal income-tax ratio exceeds unity. The slopes of the II and the CC schedules are reversed if the intertemporal income-tax ratio falls short of unity. In the border-line case in which the path of the income tax rates is flat (so that $\tau_{y1}/\tau_{y0}=1$), the two schedules coincide with the horizontal line DE. 1/

These ingredients can now be used to analyze the consequences of a revenue-neutral tax conversion. As should be evident from the foregoing discussion, the key factor governing the effects of such tax policies is the initial trade-balance position. In terms of Figure 6, if the economy runs a current-period trade-balance surplus, and the intertemporal income-tax ratio exceeds unity, then a revenue-neutral tax reform that replaces a consumption-tax system (indicated by point B) by an income-tax system (indicated by point A) moves the economy to new iso-investment and iso-consumption growth schedules passing through point A (not drawn). These new schedules correspond to lower investment and growth rate of consumption. A similar argument shows that if the economy runs a current-period trade-balance deficit, the same tax conversion reduces the level of investment and lowers the growth rate of consumption. 2/

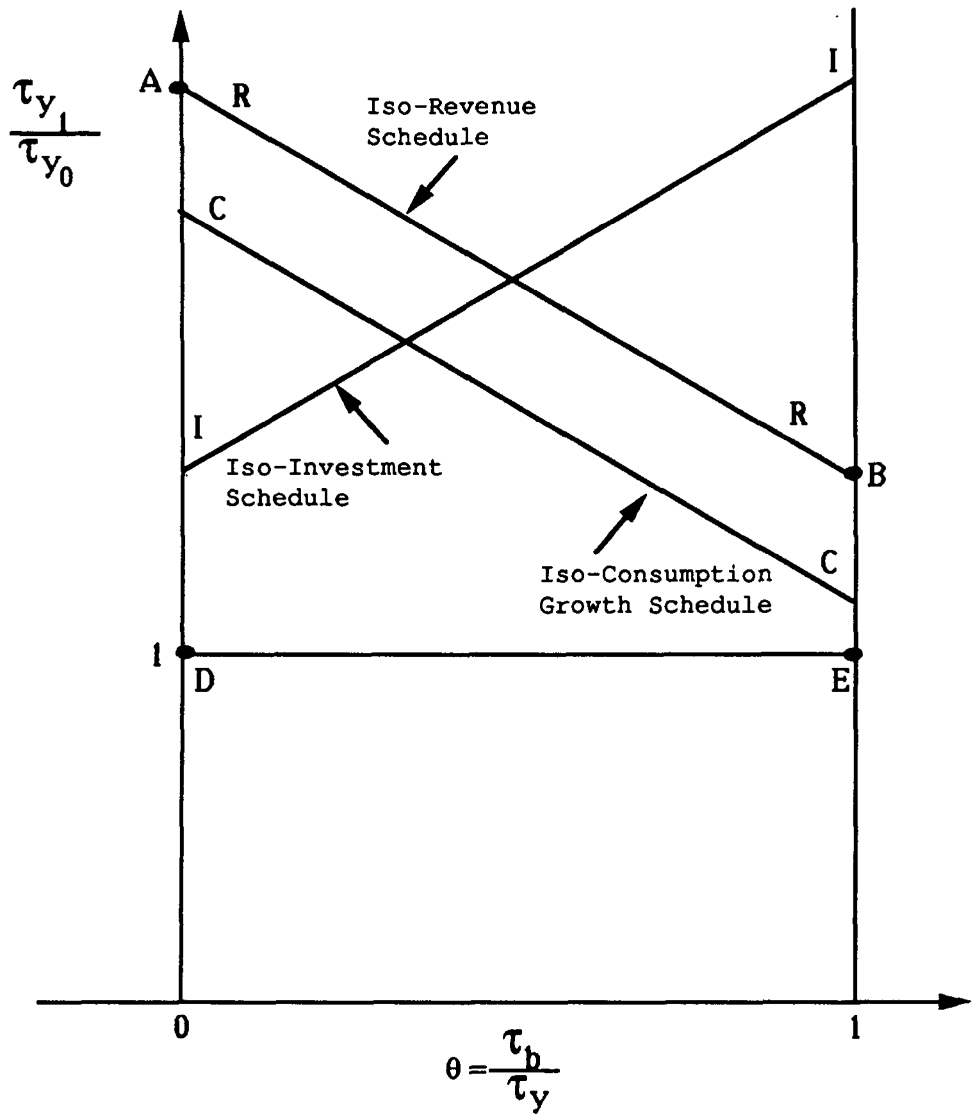
If the tax conversion is in the opposite direction so that an income-tax system is replaced by a consumption-tax system and the economy runs a trade-balance surplus, then such a conversion shifts the equilibrium from point A to point B in Figure 6. The iso-investment and iso-consumption growth schedules passing through point B (not drawn) indicate that the new equilibrium is associated with a higher level of investment and growth rate of consumption. The opposite results obtain if the initial position is of trade-balance surplus.

1/ These considerations imply that in the neighborhood of a flat path of income tax, if the intertemporal income-tax ratio exceeds unity, then the CC schedule is flatter than the RR schedule (assuming an initial-period trade-balance deficit). This is the case shown in Figure 6.

2/ It can be verified that the quantitative results of the tax conversion remain the same if the intertemporal income tax ratio falls short of unity though in the latter case the slopes of the CC and the II schedules are reversed (but the II schedule is flatter than the RR schedule in the neighborhood of $\tau_{y1}/\tau_{y0} = 1$).

FIGURE 6

REVENUE-NEUTRAL TAX CONVERSIONS IN A SMALL, OPEN ECONOMY



Data: $B^P_{-1}=0$, $\tau_{c_t}=0$, $\tau_{b_t}=\theta\tau_{y_t}$, $0<\theta<1$,
the economy runs a current-period trade balance surplus

2. The world economy

We now extend the analysis to a two-country model of the world economy consisting of the domestic and the foreign countries. The economic structure of the foreign economy is similar to that of the domestic economy described in Section IV.1. The endowments and the parameters of the production and utility functions, however, may differ across countries. Variables pertaining to the foreign country are denoted by asterisks. In contrast with the small-country case, the world rate of interest is endogenously determined in the two-country model. To facilitate the exposition we assume that initially all taxes are zero. Thus, in terms of equation (2), the domestic discount factors governing consumption and investment decisions, α_C and α_I, respectively are initially equal to the world discount factor $\alpha = 1/(1+r_0)$.

In what follows, we carry out the analysis by means of a simple diagrammatic apparatus. 1/ The initial equilibrium is portrayed in Figure 7 in which the upward sloping schedule, S^w, describes the ratio, z, of current to future world GDP net of investment (denoted by z), as an increasing function of the rate of interest. Accordingly, the world relative supply (evaluated at $r=r_0$) is

$$z^w = \frac{Y_0 - I_0(1 + \frac{1}{2}b(I_0/K_0)) + Y_0^* - I_0^*(1 + \frac{1}{2}b^*(I_0^*/K_0^*))}{Y_1 + Y_1^*} \tag{12}$$

where Y denotes output.

The positive dependence of z on the rate of interest reflects the fact that a rise in the rate of interest lowers investment. The world relative supply schedule, S^w, is a weighted average of the domestic country relative supply schedule, S, (where $S = \left[Y_0 - I_0 (1 + \frac{1}{2} b \frac{I_0}{K_0})\right]/Y_1$) and the foreign country relative supply schedule, S^*,

(where $S^* = \left[Y_0^* - I_0^* (1 + \frac{1}{2} b^* \frac{I_0^*}{K_0^*}) \right]/Y_1^*$).

1/ To facilitate the diagrammatic exposition we continue to assume that labor supply is fixed (so that $\beta = 1$ in equation (3)). The diagrammatic analysis could also allow for variable labor supply if leisure and ordinary consumption are separable in the utility function as in Frenkel and Razin (1987).

Accordingly,

$$S^w = \mu_s S + (1-\mu_s)S^* \tag{13}$$

where the domestic-country weight is:

$$\mu_s = \frac{Y_1}{Y_1 + Y_1^*} . \tag{14}$$

The downward sloping schedules in Figure 7 plot the desired ratio of current to future consumption as a decreasing function of the rate of interest. The domestic and foreign relative demands are denoted by D and D*, respectively, and their values at the point in which $C_0/C_1 = C_0^*/C_1^* = 1$ are one plus the subjective rate of time preference, $1/\delta$ and $1/\delta^*$.

Analogously to the construction of the world relative supply, the world relative demand $D^w = C_0^w/C_1^w = (C_0+C_0^*)/(C_1+C_1^*)$, is a weighted average of the two countries' relative demands, $D = C_0/C_1$ and $D^* = C_0^*/C_1^*$. Accordingly,

$$D^w = \mu_d D + (1-\mu_d)D^* \tag{15}$$

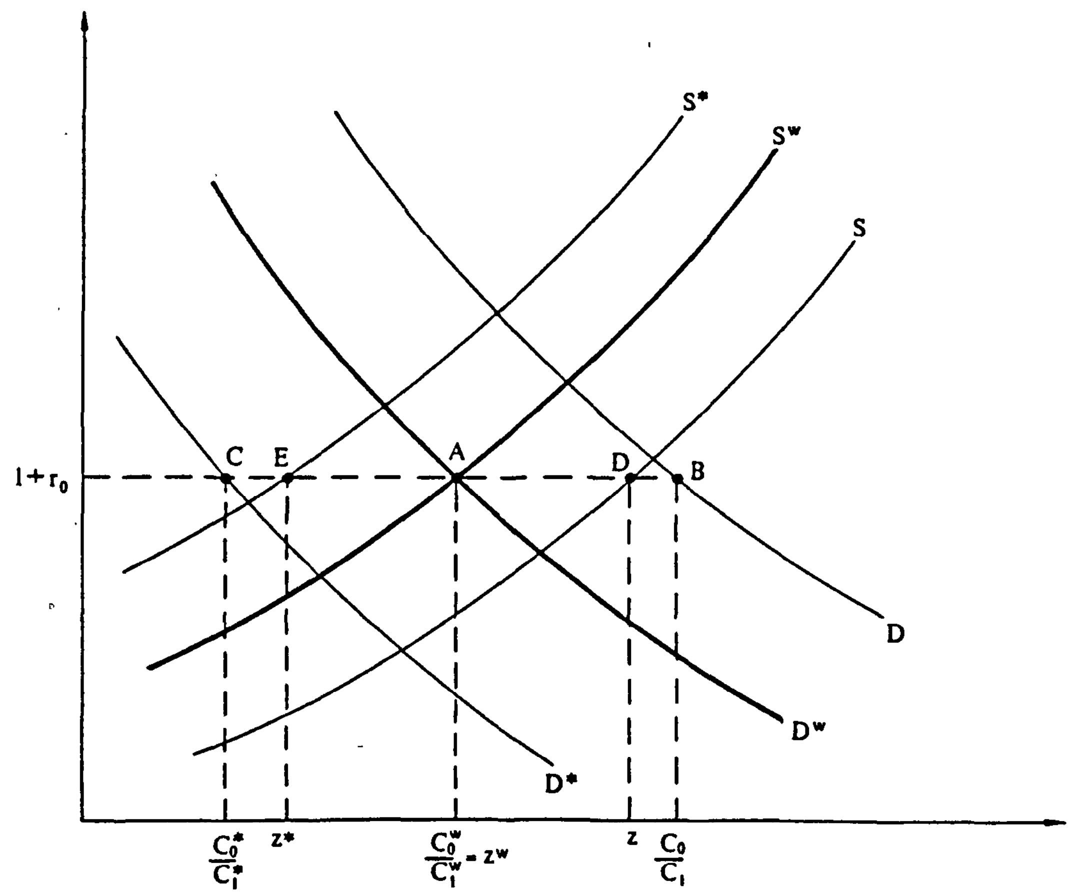
where the domestic country weight is

$$\mu_d = \frac{C_1}{C_1 + C_1^*} . \tag{16}$$

The initial equilibrium is exhibited by point A in Figure 7. As shown, the world rate of interest is r_0 and the world consumption ratio (indicating the reciprocal of the growth rate of world consumption) is C_0^w/C_1^w. The domestic and foreign consumption ratios corresponding to this equilibrium are C_0/C_1 and C_0^*/C_1^*, as indicated by points B and C, respectively. We also note that the domestic and foreign relative supplies associated with this equilibrium are z and z* as indicated by points D and E, respectively. As is evident, these levels of relative supplies are associated with the equilibrium levels of domestic and

FIGURE 7

RELATIVE DEMANDS, RELATIVE SUPPLIES AND WORLD EQUILIBRIUM



foreign investment. Finally, since point B lies to the right of point D, while point C lies to the left of point E, the domestic economy runs an initial period trade-balance deficit while the foreign economy runs a corresponding trade-balance surplus. This pattern of trade imbalances is implied from the assumed zero level of the predetermined initial debt position. Obviously, solvency implies that this configuration of trade imbalances is reversed in the subsequent period. We also note that this pattern of trade imbalances implies that the equilibrium domestic relative demand weight, μ_d, falls short of the corresponding relative supply weight, μ_s. 1/

3. Tax conversions in a two-country world economy

Consider a revenue-neutral tax reform that introduces a consumption-tax system in place of an income-tax system. As before the tax reform can be divided into two components. We first introduce permanent consumption taxes at the rate τ_c accompanied by the equiproportional reduction in income taxes. 2/ As is evident from our previous discussions this tax shift creates a current-period government budget surplus if the domestic economy runs a current-period trade-balance deficit and vice versa. Obviously, this pattern of budgetary and trade imbalances is reversed in the subsequent period. The second component of the tax reform aims at restoring revenue neutrality in each period. Since the economy has adopted a consumption-tax system, it is assumed that the restoration of revenue neutrality is achieved through appropriate further adjustments in the consumption-tax rates.

Suppose that the domestic economy runs an initial-period trade-balance deficit. Under such circumstances the first component of the tax reform results in an initial-period government budget surplus and in a corresponding future-period deficit. To restore revenue neutrality the current-period consumption tax rate, τ_{c0}, must be lowered while the corresponding future-period rate, τ_{c1}, must be raised. This pattern of tax rates, breaks the initial flatness of the time profile of the consumption tax so that $\tau_{c0} < \tau_{c1}$. The new configuration of the consumption tax rates raises α_c--the effective discount factor applicable to consumption decisions--so that $\alpha_c = [(1+\tau_{c1})/(1+\tau_{c0})]\alpha$ exceeds the world discount factor $\alpha = 1/(1+r_0)$. Since income taxes remain flat, the effective discount factor applicable to investment decisions remains intact, so that $\alpha_I = \alpha$.

1/ This follows from the fact that in equilibrium the denominators of μ_s and μ_d are equal to each other. Thus, if the domestic economy runs a trade surplus in the second period then $C_1 < Y_1$, and since $C + C_1^* = Y_1 + Y_1^*$, it follows that $\mu_d < \mu_s$.

2/ In the subsequent analysis we find it convenient to set the international-borrowing tax, τ_b, equal to zero, and to use explicitly the consumption and income tax rates rather than using the equivalence relations as in Section III.1.

Armed with this information we analyze in Figure 8 the effects of this tax reform. The initial equilibrium is portrayed by point A at which the world rate of interest is r_0 (as in Figure 7). The rise in the effective discount factor applicable to consumption (that is, the reduction in the corresponding effective rate of interest) induces an intertemporal substitution in domestic demand towards current-period consumption. Thus, for each and every value of the world rate of interest, the domestic (relative) demand schedule shifts to the right from D to D'. The proportional vertical displacement of the schedule equals the proportional tax-induced rise in the effective discount factor. This proportion is $(1+\tau_{c1})/(1+\tau_{c0})$. Associated with the new levels of domestic demand, the new world relative demand $(C_0+C_0^*)/(C_1+C_1^*)$ also shifts to the right from D^w to $D^{w'}$ in Figure 8. This shift reflects the substitution from future to current-period consumption in the domestic economy. 1/ Furthermore, the proportional displacement of the world relative demand schedule is smaller than the corresponding displacement of the domestic relative demand schedule. 2/

In contrast with the effects of the tax reforms on the relative demand schedules, this reform does not affect the effective discount factor applicable to investment decisions and it leaves the world relative supply schedule intact. The new equilibrium obtains at the intersection

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1/ Our assumptions that the initial undistorted equilibrium was with a current-account balance imply that the real-income effects induced by the departure from the flat tax pattern and by changes in the world rate of interest are dominated by the substitution effect.

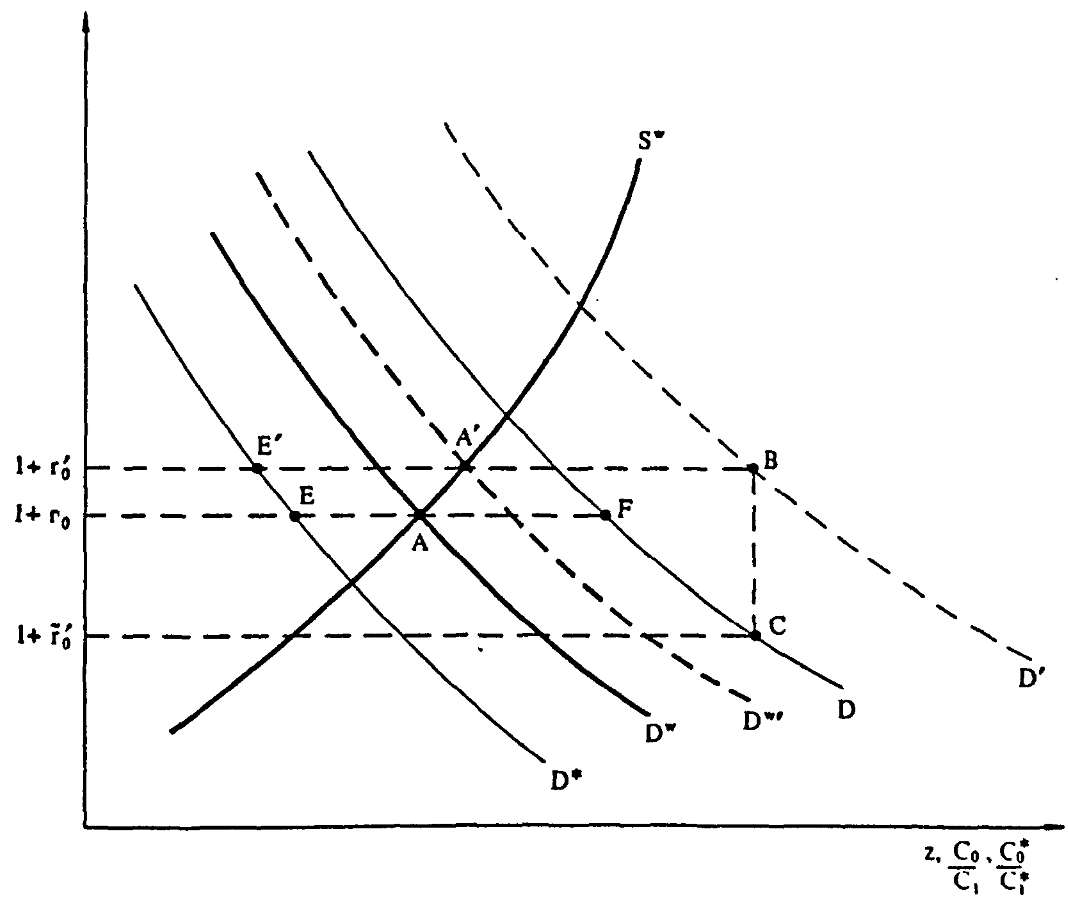
2/ To verify this point we note that

$$\hat{D}^w = \frac{C_0}{(C_0+C_0^*)}\hat{D} + \left[\frac{C_0}{(C_0+C_0^*)} - \frac{C_1}{(C_1+C_1^*)}\right]\hat{C}_1 ,$$

where a "hat" denotes a proportional change in the variable. Accordingly, the proportional change in the world relative demand is composed of two components. The first consists of the product of the proportional change of the domestic relative demand and a fraction (the relative share of current-period home consumption in the world consumption), and the second consists of the product of the proportional change in future-period consumption and a term measuring the difference between the relative shares of current and future-periods home consumption in world consumption. This latter bracketed term reflects the difference between the domestic and foreign saving propensities. If the current period trade-balance deficit arises from a relative low domestic saving propensity, then this bracketed term is positive. We also note that $\hat{C}_1$ is negative since the change in the time profile of consumption taxes induces a substitution away from future period consumption. It follows that under such circumstances $\hat{D}^w < \hat{D}$ and, therefore, the displacement of the D^w schedule is smaller than that of the D schedule.

FIGURE 8

THE EFFECTS OF A REVENUE–NEUTRAL TAX SHIFT FROM INCOME TAXES TO CONSUMPTION TAXES WITH AN INITIAL-PERIOD DOMESTIC TRADE–BALANCE DEFICIT



of the (unchanged) world relative supply schedule, S^w, and the new world relative demand schedule, $D^{w'}$. This equilibrium is indicated by point A' in Figure 8 at which the world rate of interest has risen from r_0 to r_0'.

To determine the incidence of this change on the domestic effective rate of interest, we subtract from $1+r_0$ the distance BC representing the tax-induced percentage change in the effective discount factor. This yields $1 + \tilde{r}_0$ in Figure 8. As is evident, $\tilde{r}_0$ is lower than the initial world rate r_0 since the vertical displacement of the D^w schedule is smaller than the magnitude represented by the distance BC.

In view of the rise in the world rate of interest, both domestic and foreign investment fall, and the rate of growth of foreign consumption, as indicated by the move from point E to point E' in Figure 8, rises. On the other hand, the fall in the domestic effective rate of interest applicable to consumption lowers the rate of growth of domestic consumption as indicated by the move from point F to point C. Thus, this tax reform crowds out both domestic and foreign investment and results in a negative correlation between the rates of growth of domestic and foreign consumption. Using similar reasoning, we can show that in the presence of an initial surplus in the balance of trade the tax reform crowds in both domestic and foreign investment, lowers the rate of growth of foreign consumption while raising the growth rate of domestic consumption. As in the small-country case (discussed in Section IV.1) this analysis also underscores the critical importance of the trade-balance position in determining the domestic and international effects of such a tax reform.

The same reasoning can be used to analyze the opposite tax conversion, from a consumption-tax system to an income-tax system. In that case, the first component of the tax restructuring yields a budgetary deficit if the initial-period current-account position was in deficit (so that income net of investment falls short of consumption). The restoration of revenue neutrality therefore involves a rise in the initial-period income-tax rate, τ_{y0}, and a corresponding reduction in the future-period income-tax rate, τ_{y1}. These changes in the time profile of income taxes raise the effective discount factor governing investment decisions, α_I, while keeping intact the effective discount factor governing consumption decisions, α_c. In terms of Figures 7-8 the rise in investment induces a leftward shift of the relative supply schedule, resulting in a higher world rate of interest. The rise in the world rate of interest crowds out foreign investment while the fall in the domestic effective rate of interest applicable to domestic investment decisions crowds in domestic investment. This tax conversion also raises the rates of growth of domestic and foreign consumption. As is evident, in contrast with the case shown in Figure 8 in which the tax conversion from income to consumption-tax system alters the relative demand schedules, in the present case where the conversion is from a consumption to an income-tax system, the reform alters the world equilibrium through its effect on the relative supply schedules. Obviously, these results reflect the assumed initial-period trade-balance deficit. They are reversed if the initial-period trade-balance position is in surplus.

4. Dynamic simulations of tax conversions

The foregoing analysis identified the key factors determining the domestic and international consequences of revenue-neutral tax reforms. We turn next to highlight these features by means of dynamic simulations. For that purpose we return to the multi-period model and allow for a variable labor supply. The detailed specification of the two-country dynamic-simulation model is provided in the Appendix.

In performing the simulations we first computed a baseline equilibrium. This equilibrium was then perturbed by the assumed tax conversion. The various Figures presented below show the effects of the tax restructuring measured as percentage deviations from the baseline levels.

As indicated by the theoretical analysis, a key factor governing the effects of such revenue-neutral tax conversions is the time pattern of the trade-balance position. Since the trade-balance position can be expressed in terms of the saving-investment gap, trade imbalances reflect inter-country differences in either saving propensities induced for example by differences between the subjective discount factors, δ and δ^*, or in investment patterns (induced, for example, by differences between the productivities of capital, r_k and r_k^*). In Figures 9-12 we plot the simulation results for cases distinguished according to the time pattern of trade imbalances. We focus in these simulations on tax conversions from an income to a consumption tax system. Throughout we assume that the home country reduces permanently its income tax rates by five percent and restores its tax revenue by raising consumption tax rates.

Consider first Figures 9 and 10. These Figures characterize the situation in which in the early periods the home country runs trade-balance deficits. Obviously the intertemporal budget constraints imply that in later periods the country runs trade-balance surpluses. The initial domestic trade deficits may arise from either a relatively low saving propensity ($\delta < \delta^*$)--shown in Figure 9; or from a relatively high productivity of capital ($r_k > r_k^*$)--shown in Figure 10. These Figures demonstrate the results obtained in the simplified theoretical analysis as well as new results reflecting the multi-period-variable labor supply model. As seen, the revenue-neutral tax conversion policy from income to <u>consumption</u> taxes raises the world rates of interest, lowers domestic and foreign investment and worsens the home country's (early-periods) current account of the balance payments. Reflecting the solvency requirement the simulations show that in the medium-term the home country's current account improves. Throughout the adjustment process the home country external-debt position worsens. The changes in the domestic tax structure induce corresponding changes in labor supply and output. As seen, both domestic employment and output decline in the early periods following the tax conversion. In the medium term the level of domestic employment rises. The medium-term effects of the tax conversion on the level of domestic output reflect the rise in employment and the decline in the capital stock. Figure 9 shows a case in which output rises in the

Figure 9
Tax Conversion: Consumption Tax Replacing 5% Income Tax
$\delta < \delta^*$
(Percentage deviations)

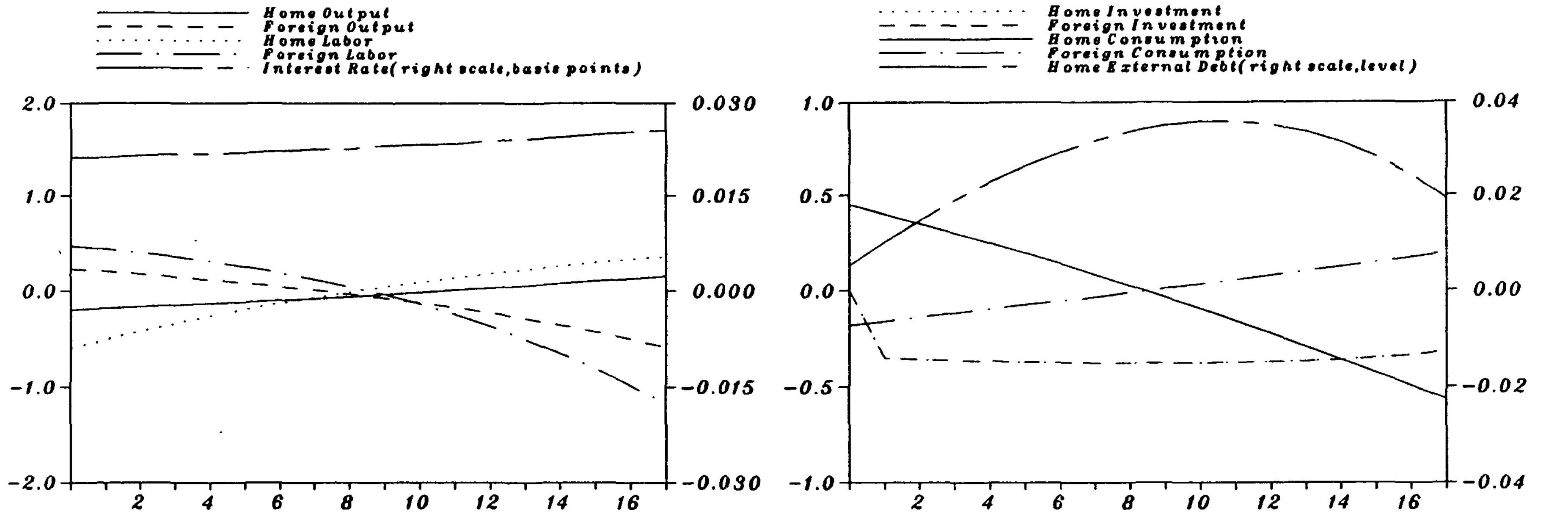
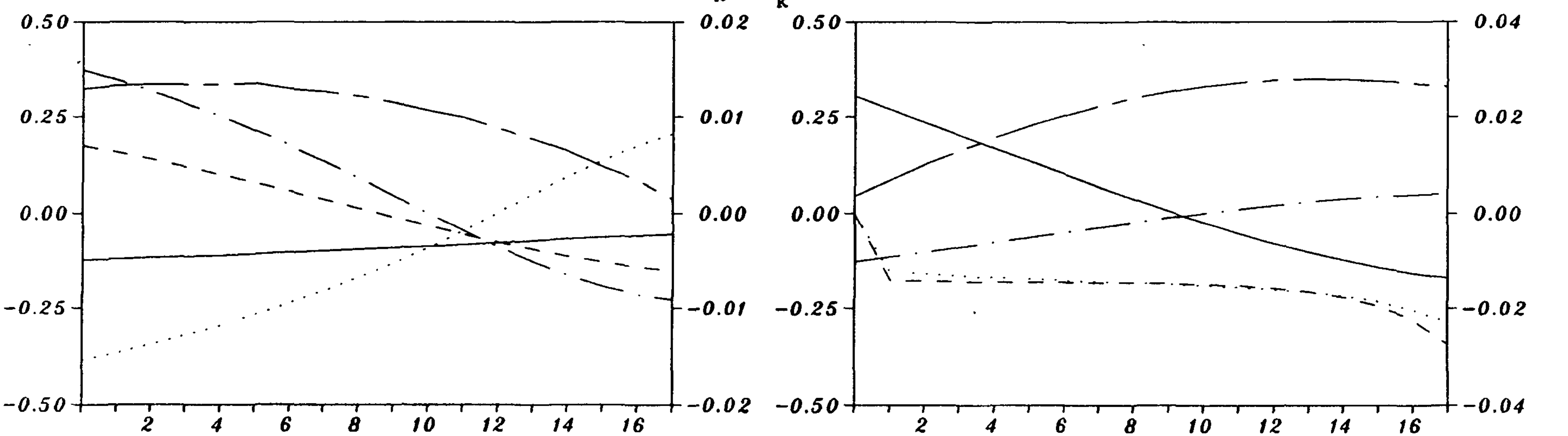


Figure 10
Tax Conversion: Consumption Tax Replacing 5% Income Tax
$r_k > r_k^*$



medium-term while Figure 10 shows the opposite case. These results which correspond to the case in which the home country runs trade-balance deficits in the early period, are reversed in the opposite case in which the country runs early-periods trade surpluses. Such an opposite pattern is exhibited in Figures 11 and 12 corresponding, respectively, to the cases in which the home country has a high saving propensity ($\delta > \delta^*$) and low investment ($r_k < r_k^*$).

V. Budget Deficits Under Consumption and Income-Tax Systems

The analysis in Section IV focused on the effects of changes in the composition of taxes while maintaining in each period a given value of total tax revenue. Such revenue-neutral tax restructuring ensures that the tax-conversion policies do not affect the budgetary imbalances. In this section we use the same analytical framework to shed light on the domestic and international macroeconomic consequences of changes in the timing of taxes, and provide dynamic simulations. 1/

1. Budget deficits in a two-country world economy

Consider the effects of budget deficits arising from a current tax cut. Of course, the intertemporal government budget constraint implies that as long as government spending remains intact, the current tax cut must be followed by a future rise in taxes. The main conclusion of the analysis is that the effect of budget deficits depend critically on whether it arises from changes in the timing of consumption or income taxes.

Consider first a budget deficit arising from a current-period consumption-tax cut (followed by a corresponding rise in future consumption taxes). As is evident from the definitions of the effective discount factors in equation (2), such a tax shift raises the effective discount factor governing consumption decisions, α_c, while leaving the discount factor governing investment decisions intact. These changes induce a substitution of demand from future to current consumption and induce rightward shifts of the domestic (and the world) relative demand schedules in Figure 7, while leaving the relative supply schedules intact. 2/

Figure 8 which was used for the analysis of tax conversion from income to consumption tax systems is also fully applicable for the analysis of the budget deficit under the consumption tax system. Accordingly the budget deficit raises the world rate of interest and crowds out domestic and foreign investment. It also lowers the growth

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1/ This analysis is based on Frenkel and Razin (1988a).

2/ We recall that in developing Figure 7 we have used for simplicity a two-period model with fixed labor supply (so that β=1 in equation (3)). As before, these assumptions are relaxed in the dynamic-simulation model.

rate of domestic consumption while raising the growth rate of foreign consumption.

By the same reasoning a budget deficit arising from a cut in current income-tax rates (and followed by a corresponding rise in future income-tax rates) yields results similar to those obtained under a revenue-neutral tax conversion from consumption to income-tax systems. Again, as is evident from the definitions of the effective discount factors in equation (2), this change in the timing of income tax rates lowers the effective discount factor governing investment decisions, α_I, and discourages domestic investment, while leaving α_c intact. In terms of Figure 7, these tax changes induce a rightward shift of the domestic (and the world) relative supply schedule while leaving the relative demand schedules intact. As a result the world rate of interest falls, foreign investment rises while the domestic investment is crowded out. At the same time the lower world rate of interest lowers the growth rate of both domestic and foreign consumption.

2. Dynamic simulations of budget deficits

The simulations which allow for a variable labor supply in a multi-period model illustrate the key relations implied by the theoretical model: they underscore the critical importance of the underlying tax system in determining the macroeconomic effects of budget deficits. They also provide further insights into the dynamic consequences of budget deficits.

Figures 13 and 14 contain selected simulations of the dynamic effects of current-period budget deficits under a consumption-tax system and under an income-tax system, respectively. We assume that the current-period deficit arises from a ten percent reduction in tax rates which is made up for by a permanent rise in tax rates in all future periods. By and large the direction of changes in the various variables in the two Figures are opposite to each other. This underscores the key proposition of the theoretical analysis. In addition, the simulations show that the effects of the budget deficit on the qualitative characteristics of the time path of employment and output also depend critically on the underlying tax system. Specifically, under a consumption-tax system a domestic budget deficit exerts recessionary effects on the contemporaneous levels of domestic employment and output and expansionary effects on the corresponding levels abroad. These employment and output effects are reversed in all future periods. 1/ In contrast, under an income tax system, the same budget deficit induces a contemporaneous expansion at home and a

1/ In performing the simulations we allow for a variable labor supply. Thus, we assume that $\beta < 1$ in equation (8). Our simulations are based on the assumption that the elasticity of substitution between consumption and leisure, σ, is smaller than unity. The time path of employment following a current-period cut in consumption tax rates may be reversed if this elasticity was assumed to exceed unity.

Figure 11
Tax Conversion: Consumption Tax Replacing 5% Income Tax
$\delta > \delta^*$
(Percentage deviations)

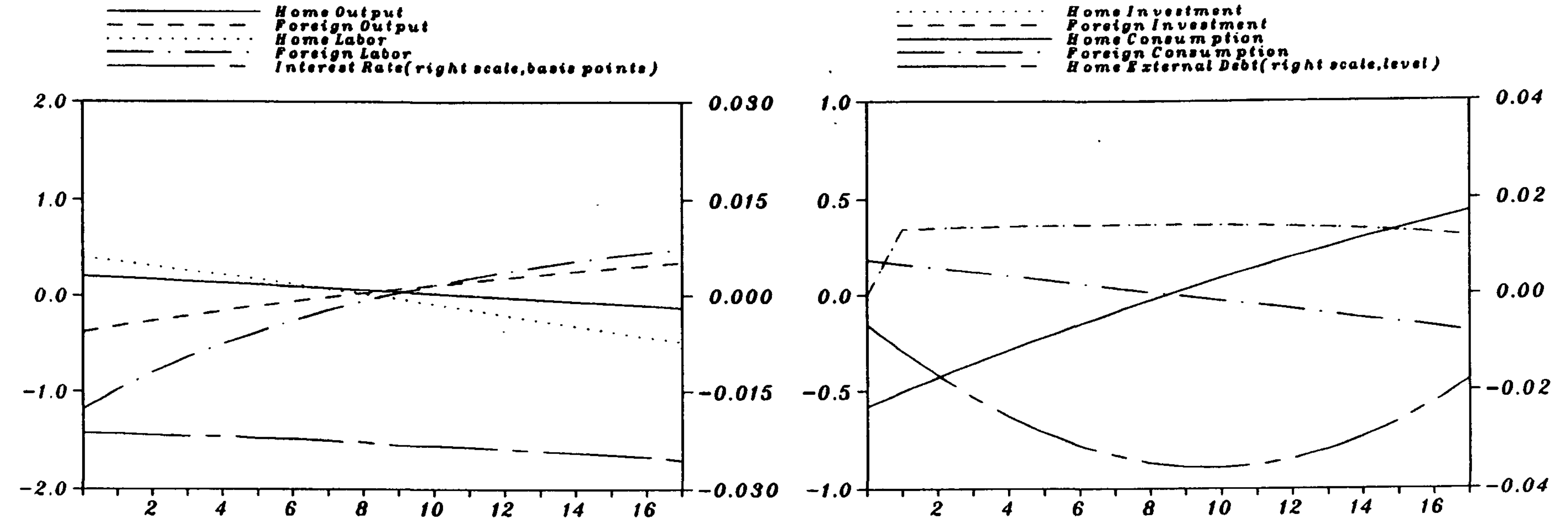


Figure 12
Tax Conversion: Consumption Tax Replacing 5% Income Tax
$r_k < r_k^*$

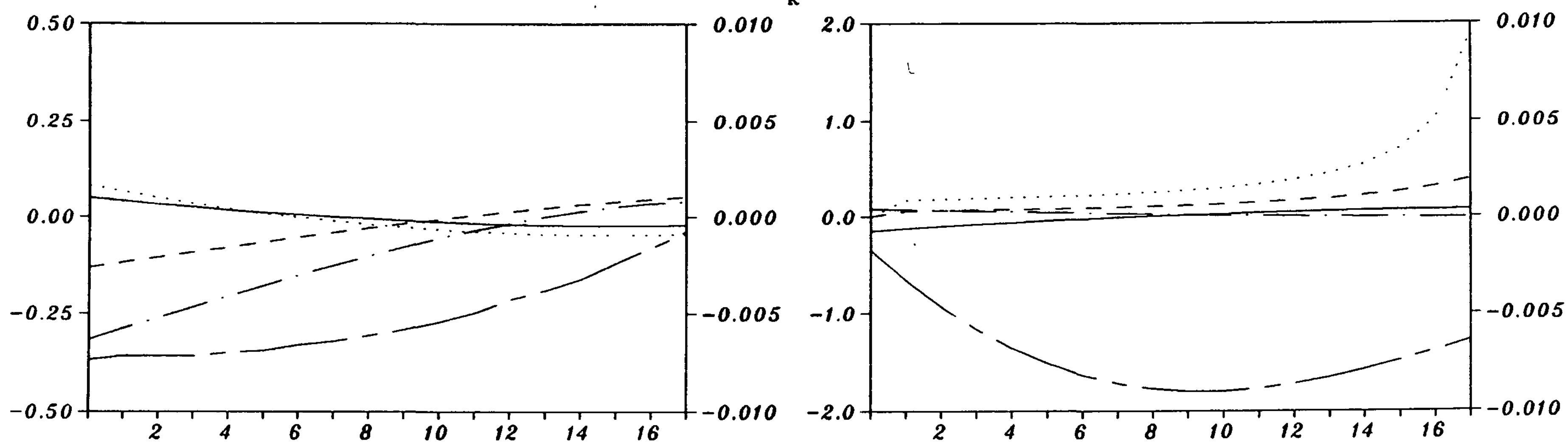


Figure 13
Budget Deficit Under a Consumption Tax System: 10% Decrease in Consumption Tax in year 0

$\delta = \delta^* \ , \ r_k = r_k^*$

(Percentage deviations)

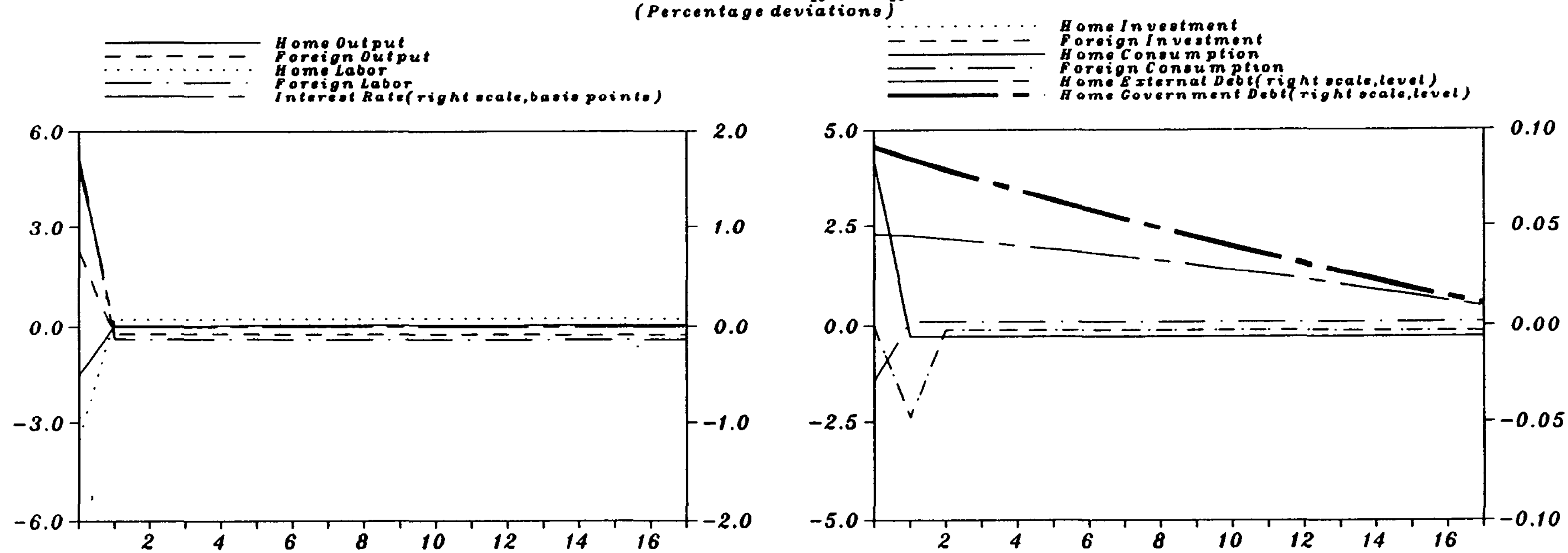
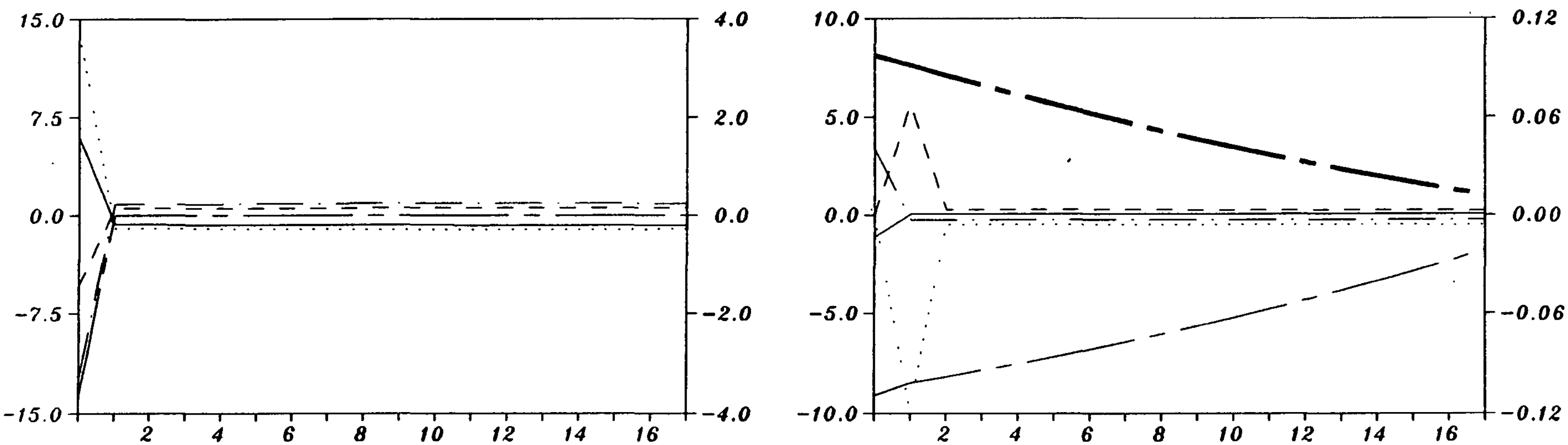


Figure 14
Budget Deficit Under an Income Tax System: 10% Decrease in Income Tax in year 0

$\delta = \delta^* \ , \ r_k = r_k^*$



recession abroad. These changes are reversed in subsequent periods. In general, the international transmission of the effects of budget deficits is shown to be negative in both the short and medium runs.

We also note that the current-period budget deficit exerts opposite effects on the levels of domestic and foreign consumption. Under a consumption tax system the deficit raises current-period domestic consumption and lowers the corresponding level of foreign consumption. These changes are reversed in subsequent periods. In contrast, under an income-tax system domestic consumption falls in the current period while foreign consumption rises and, as before, these changes are reversed in subsequent periods. Again, in terms of the correlations between domestic and foreign consumption the simulations demonstrate the negative transmission of the effects of domestic budget deficits.

The effects of the budget deficits on the time paths of consumption and leisure influence the levels of domestic and foreign welfare. Using the utility function specified in equation (4), our simulations show that the current-period budget deficit, arising from a ten percent reduction in the consumption-tax rate, raises the level of domestic welfare (by about two percent) and lowers the level of foreign welfare (by about one and a half percent). In contrast, if the current-period budget deficit arises from a ten percent reduction in the income-tax rate then the level of domestic welfare falls (by about three percent) while the corresponding foreign welfare rises (by about three and a half percent). These opposite changes in the levels of domestic and foreign welfare reflect the negative transmission of the effects of budget deficits.

The effects of an expected future-period budget deficit are shown in Figures 15-16. These simulations show the consequences of an expected ten percent tax cut in periods four and five which is then made up for by a permanent rise in tax rates in all subsequent periods. An before they reveal the central role played by the tax system. They also reveal the general feature of a negative transmission. However, since the various changes in tax rates occur only in the more distant future, our simulations show that their effects on the levels of domestic and foreign utility (viewed from the stand point of the current period) are very small.

VI. Tax Harmonization

In this section we use the key features of the analytical framework to examine the dynamic effects of international tax harmonization. Such policies form an important ingredient of the wide ranging measures associated with the move towards the single market of Europe of 1992. In the fiscal area the European Commission has drawn up various proposals on the approximation of the rates and the harmonization of the structures of VAT.

The process of harmonization of the VAT systems has started with the First Council Directive of April 1967 and has proceeded thereafter through consecutive Directives. The process involved the Adoption of VAT in various member countries and the continuous convergence of rates and structures among members of the community. For 1992 the Commission envisages a standard VAT rate ranging between 14 and 20 percent, and a reduced rate (applied to selected categories, such as foodstuffs) ranging between 4 and 9 percent. The Commission proposes to abolish the higher rate that presently exists in some member countries on certain categories of goods. Table 2 provides a summary information on VAT in the European Community. It illustrates the disparities among the various member-country VAT rates.

One of the central issues is the budgetary consequences of the harmonization in the VAT systems. A few member states (notably Denmark and Ireland) would suffer considerable revenue losses while others (notably Spain, Luxembourg and Portugal) would see their revenue go up considerably. These budgetary consequences will need to be addressed.

In what follows, we present dynamic simulations of the consequences of international harmonization of VAT. We use our two-country model and presume that prior to the VAT harmonization, the two countries use very different tax systems. The home country tax revenue stems from high VAT while the foreign country revenue stems from high income tax. The harmonization of VAT entails a reduction in the home country VAT rate and an equivalent rise in the corresponding foreign rate.

In analyzing the harmonization, we do not alter the levels of government spending. To avoid the budgetary imbalances consequent on the changes in the VAT rates, we modify the income tax rates so as to restore the budgetary balance. Thus, in the home country, the reduction in the VAT is accompanied by a rise in income tax rates whereas in the foreign country the rise in the VAT is accompanied by a corresponding reduction in income taxes. 1/ The narrowing of the international disparities between VAT, captures the Commission's proposal of reducing the disparities of VAT rates among member countries and categories of goods. The maintenance of budgetary balance through appropriate changes in income tax rates makes the analysis of revenue-neutral tax conversion of Section IV applicable to the problem at hand.

Figures 17-22 contain the dynamic simulations of the effects of VAT harmonization alternative configurations of the key parameters underlying

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1/ These periodic adjustments alter the intertemporal pattern of income tax rates. The permanent changes in the consumption tax rates, however, do not alter the intertemporal pattern of these rates. The reader may note that the case analyzed in Figure 8 pertains to the situation where budgetary balance is maintained through periodic adjustments in the consumption-tax rates while maintaining the intertemporal pattern of income-tax rates unchanged.

Figure 15

Budget Deficit Under a Consumption Tax System: 10% Decrease in Consumption Tax in years 4 & 5

$\delta = \delta^*$, $r_k = r_k^*$

(Percentage deviations)

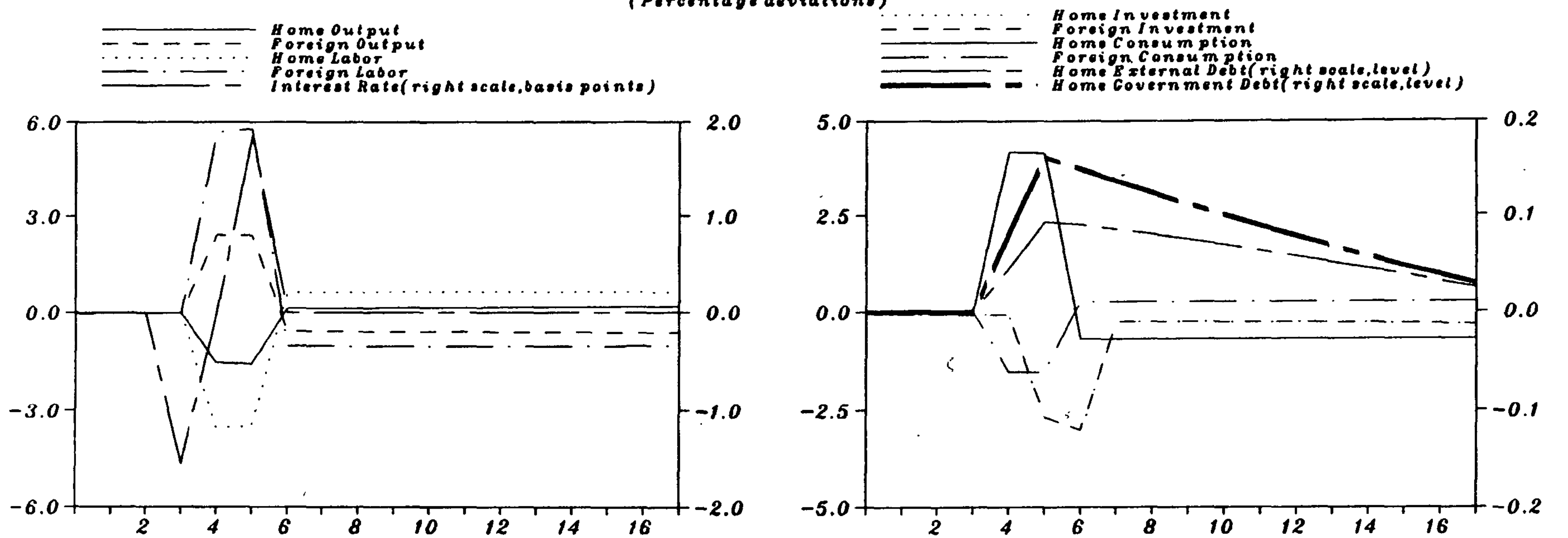
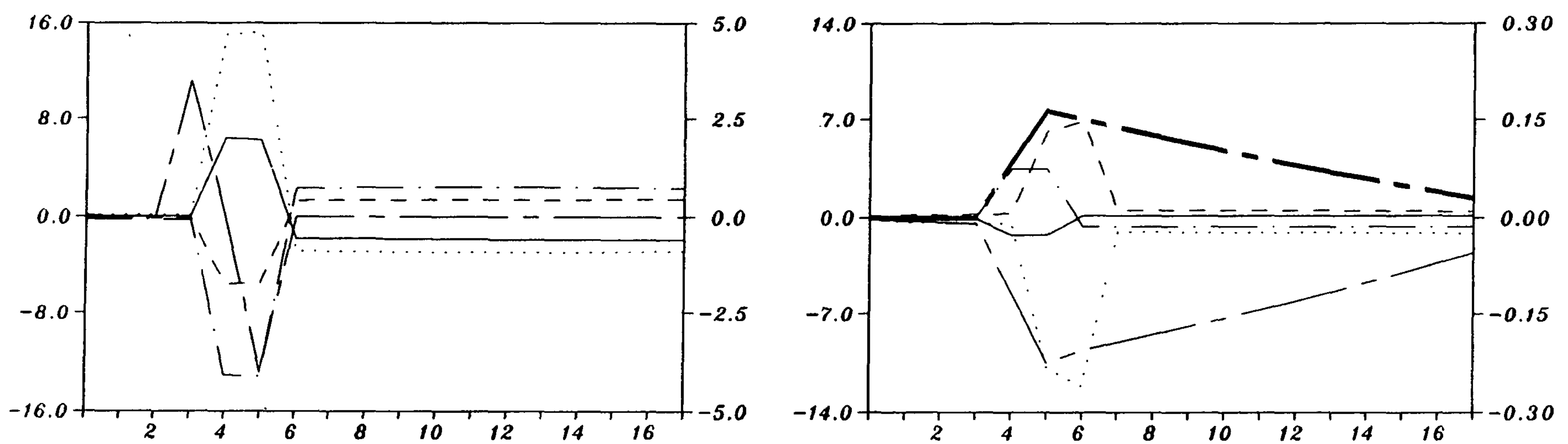


Figure 16

Budget Deficit Under an Income Tax System: 10% Decrease in Income Tax in years 4 & 5

$\delta = \delta^*$, $r_k = r_k^*$



Tax Harmonization: The Paths of Income Tax Rates
(10% Permanent Reduction in Home Country VAT and 10% Permanent Increase in Foreign Country VAT)

Figure 17
Home Country Income Tax Rates
(deviations from baseline)

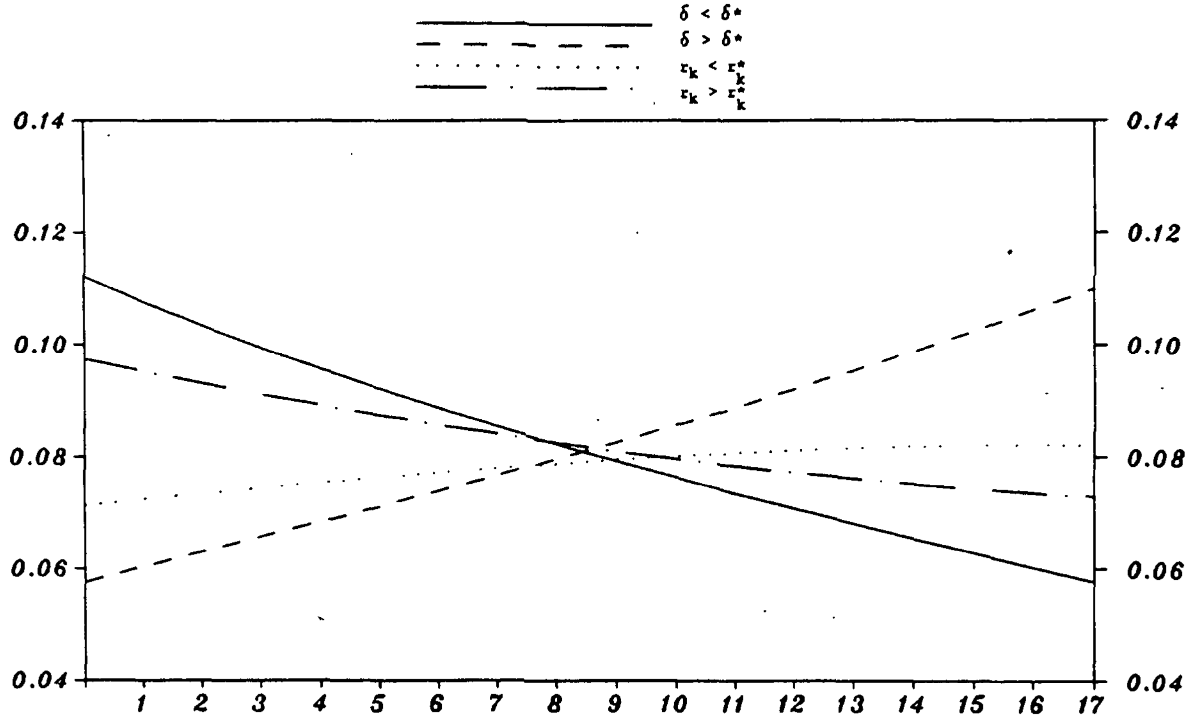


Figure 18
Foreign Country Income Tax Rates
(deviations from baseline)

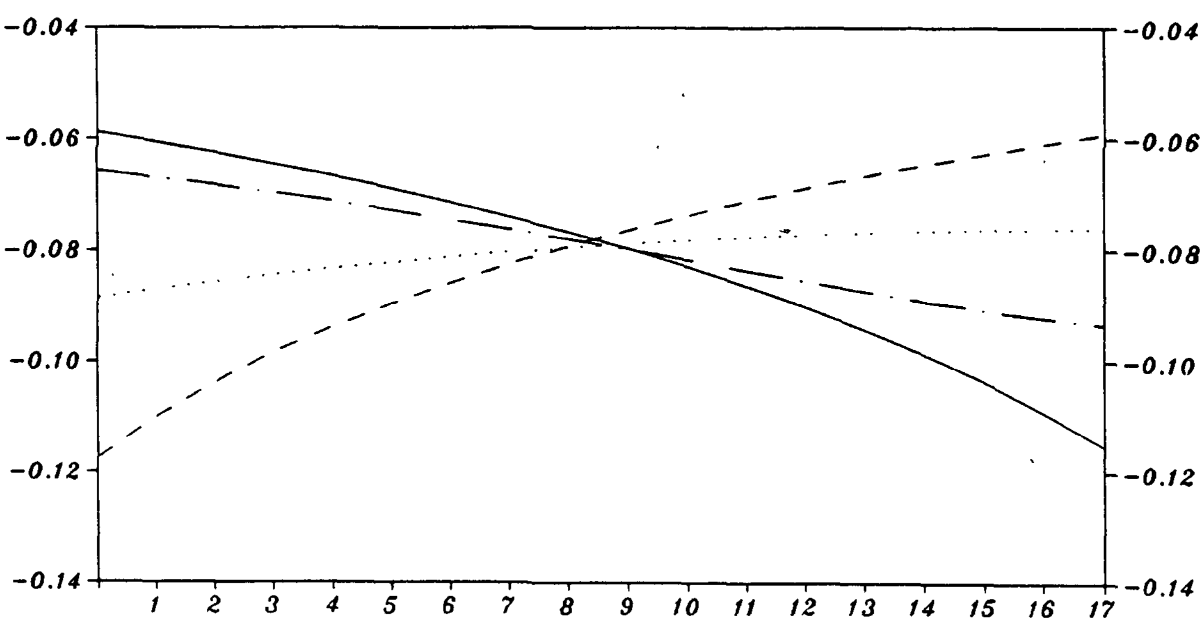


Figure 19
Tax Harmonization: 10% Permanent Reduction in Home Country VAT and 10% Permanent Increase in Foreign Country VAT
$\delta < \delta*$
(Percentage deviations)

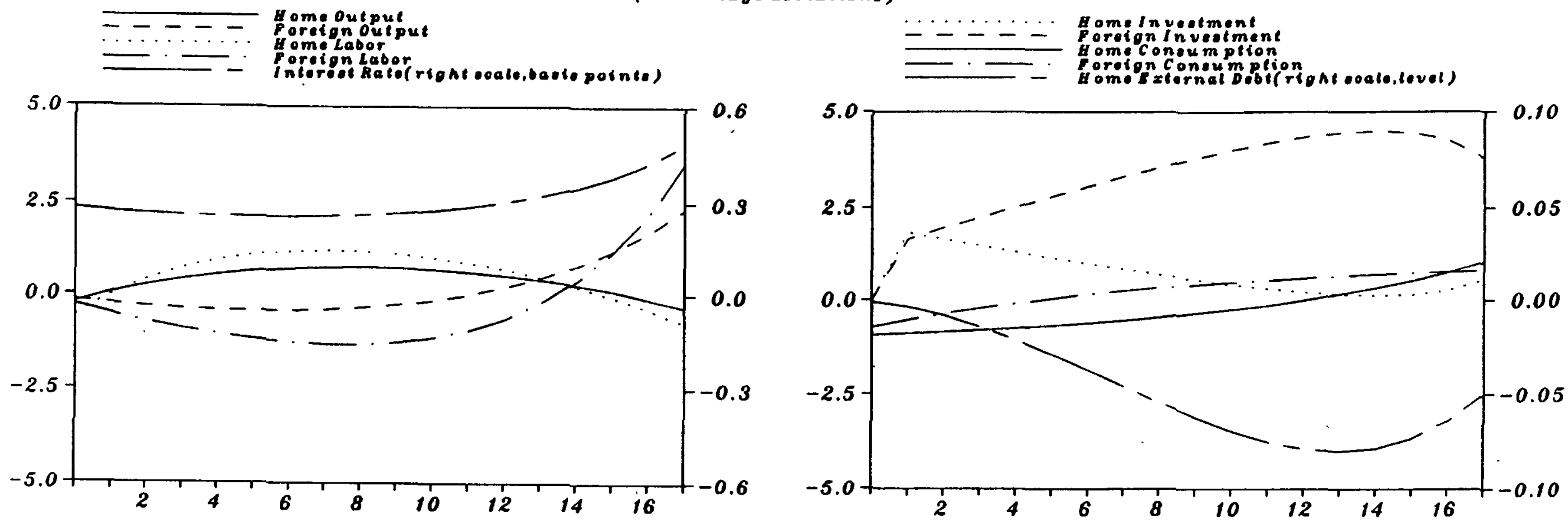


Figure 20
Tax Harmonization: 10% Permanent Reduction in Home Country VAT and 10% Permanent Increase in Foreign Country VAT
$\delta > \delta*$

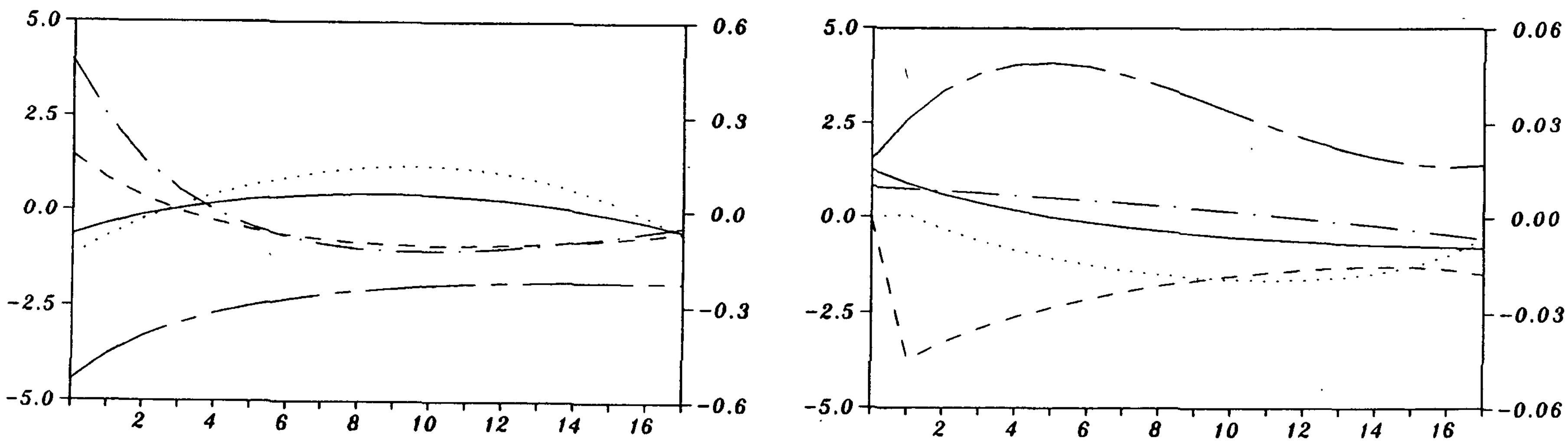


Figure 21
Tax Harmonization: 10% Permanent Reduction in Home Country VAT and 10% Permanent Increase in Foreign Country VAT
$r_k > r_k^*$
(Percentage deviations)

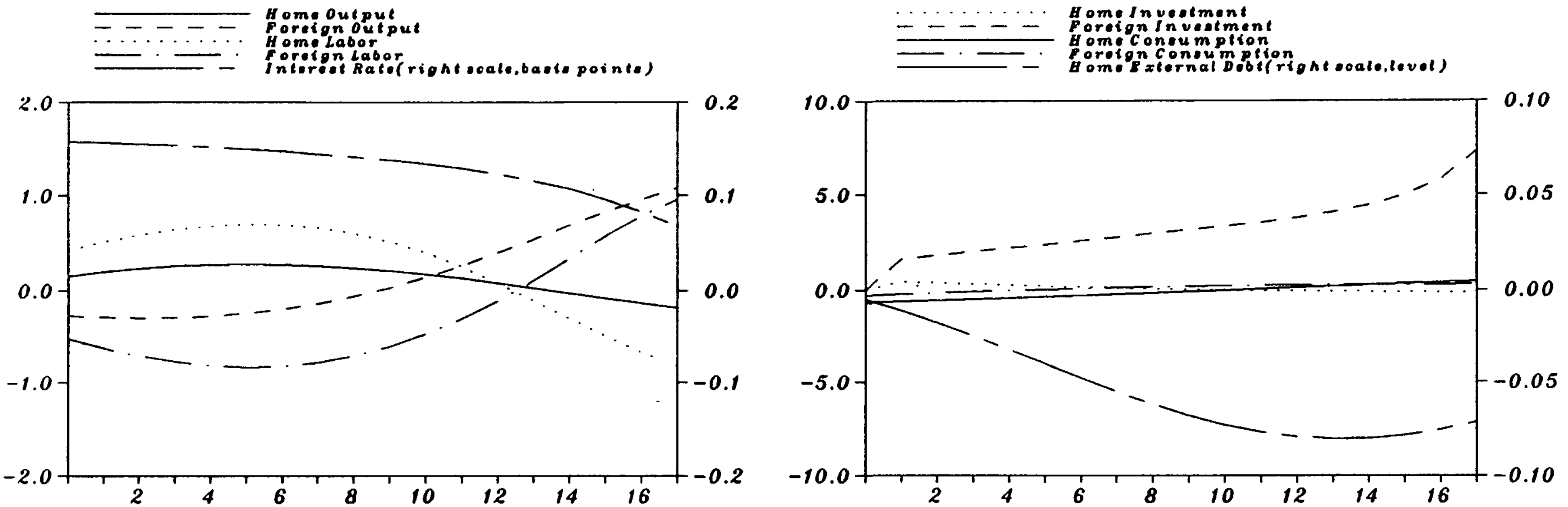


Figure 22
Tax Harmonization: 10% Permanent Reduction in Home Country VAT and 10% Permanent Increase in Foreign Country VAT
$r_k < r_k^*$

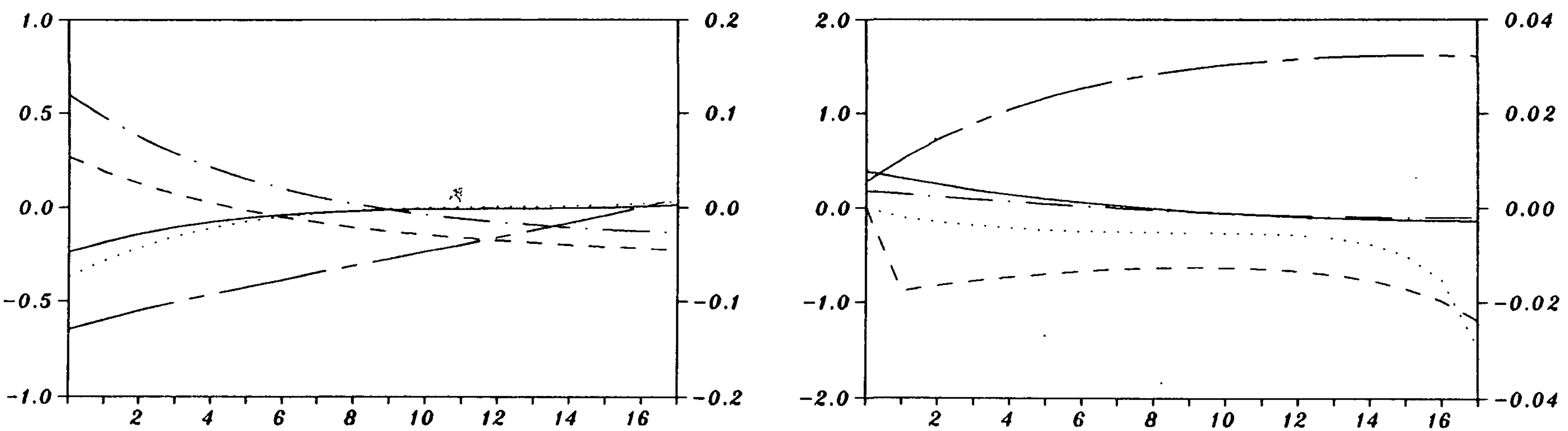


Table 2. VAT rates in the European Community (1987)

Country (Year of VAT Introduction)	Statutory Rates (percent) Reduced rate	Standard rate	Higher rate	Revenue Contribution as percentage of total tax Revenue (1983)
Belgium (1971)	1,6 and 17	19	25 and 33	16.7
Denmark (1967)	0	22	-	22.1
France (1968)	2.1, 4, 5.5, and 7	18.6	33.33	20.5
Germany (1968)	7	14	-	17.0
Greece	6	18	36	...
Ireland (1972)	2.4 and 10	25	-	21.1
Italy (1973)	2 and 9	18	38	14.9
Luxembourg (1970)	3 and 6	12	-	12.1
Netherlands (1969)	6	20	-	...
Portugal (1986)	0 and 8	16	30	...
Spain (1986)	6	12	33	...
United Kingdom (1973)	0	15	-	13.9
Commission proposal	4 to 9	14 to 20	abolished	

Sources: Table 2.1 in Cnossen and Shoup (1987) and Table 3.5.1 in European Economy (March 1988).

the saving-investment balance. As before, the simulations illustrate percentage deviations from baseline. In Figures 17-18, we show the time path of the endogenously-determined home and foreign income tax rates. These rates are adjusted in each period so as to offset the budgetary implications of the VAT harmonization. The changes in the time-profile of income taxes influence the present-value factors governing intertemporal investment and labor-supply decisions. In addition, the constant changes in the VAT rates relative to the corresponding periodic changes in income tax rates may influence the intratemporal consumption-leisure choices due to changes in the intratemporal tax ratios $(1-\tau_y)/(1+\tau_c)$. In Figures 19-22, we show the corresponding output, employment, investment and consumption, as well as the world rate of interest and the current account position.

The key features of the various simulations are summarized in Table 3 which also reports the implied welfare implications of the VAT harmonization. In order to capture the essence of the dynamic evolution of the various variables we report in Table 3 the direction of changes for both the short and the medium runs.

In conformity with the tax-conversion analysis of Section IV the results in Table 3 demonstrate the key role played by the current-account position. Specifically, if in the early stage the home country runs a current-account deficit due to low saving or high investment (e.g., if $\delta < \delta^*$ or $r_k > r_k^*$), then the paths of domestic and foreign income tax rates fall over time. In that case, domestic and foreign investment rise (both in the short and in the medium runs). In the short run domestic output and employment rise, foreign output and employment fall, and both domestic and foreign assumption fall while the domestic current account improves. The direction of these short-run effects are reversed in the medium run.

If on the other hand the configuration of saving and investment propensities is such that the home country runs a current-account surplus in the early stage then the dynamic effects of the VAT harmonization are reversed. Specifically, if in the home country's saving is high or investment is low (e.g. if $\delta > \delta^*$ or $r_k < r_k^*$), then the paths of domestic and foreign investment decline (both the short and the medium runs) while the world rates of interest fall.

The final two lines in the Table show the welfare implications of the VAT harmonization. What is noteworthy is the international conflict of interests that is implied by the opposite direction of domestic and foreign changes in welfare. A resolution of such conflict of interests may necessitate international fiscal transfers from countries who benefit from the VAT harmonization to countries that lose. The negative correlation between domestic and foreign changes in output and employment (for both the short and the medium runs) may also yield conflicts of interest the resolution of which may require international transfer of resources.

Table 3. Dynamic Effects of VAT Harmonization (deviation from baseline)

Variable	$r_k = r_k^*$				$\delta = \delta^*$			
	$\delta < \delta^*$		$\delta > \delta^*$		$r_k > r_k^*$		$r_k < r_k^*$	
	SR	MR	SR	MR	SR	MR	SR	MR
Y	+	-	-	+	+	-	-	+
Y^*	-	+	+	-	-	+	+	-
L	+	-	-	+	+	-	-	+
L^*	-	+	+	-	-	+	+	-
I	+	+	-	-	+	+	-	-
I^*	+	+	-	-	+	+	-	-
C	-	+	+	-	-	+	+	-
C^*	-	+	+	-	-	+	+	-
r	+	+	-	-	+	+	-	-
CA	+	-	-	+	+	-	-	+
Path of τ_y	falling		rising		falling		rising	
Path of τ_y^*	falling		rising		falling		rising	
U	falls		falls		falls		rises	
U^*	rises		rises		rises		falls	

Note: The VAT harmonization obtains through a permanent reduction in τ_c and a rise in τ_c^*. Budgetary balance obtains through appropriate adjustments in the periodic income tax rates, τ_y and τ_y^*. SR and MR denote, respectively, the short run and the medium run. For Y and L when $r_k = r_k^*$, the short run refers to the early periods excluding the initial period.

VII. Concluding Remarks

The increased integration of world goods and capital markets have stimulated interest in the policy implications of international economic interdependence. In this paper we have analyzed several aspects of such interdependence focusing on the international transmission of tax policies. For this purpose we have presented an analytical framework suitable for the examination of the dynamic effects of tax restructuring. In our analysis we considered the international effects of changes in the composition and the timing of taxes. Accordingly, we have analyzed the consequences of revenue-neutral tax conversions between income and consumption taxes as well as budget deficits that arise under alternative tax systems. Motivated by the various proposals for tax harmonizations associated with the creation of a single market in Europe of 1992, we have also analyzed the effects of international VAT harmonization. Throughout, we have complemented our analytical results with illustrative dynamic simulations. We have identified key factors governing the international effects and transmission of tax policies. These include the inter-country differences in saving and investment propensities. Accordingly, we have shown that the effects of tax policies depend critically on whether the country adopting these policies runs a deficit or a surplus in the current account of its balance of payments. We have also shown that the qualitative and quantitative effects of budget deficits depend critically on whether the deficit arises from changes in income taxes or in VAT. These factors were shown to play a central role in determining the effects of international tax harmonization.

Our analysis focused on a two-country model of the world economy. A useful extension would consider a three-country world and examine the consequences of tax harmonization between two of the three countries. Such an extension would facilitate an analysis of "trade creation" and "trade diversion" in both goods and capital markets in Europe of 1992.

The Simulation Model

The model described in this appendix was used in the simulations discussed in the main text. We present below the exact computer printout of the model which is based on the theoretical model described in the text. However, this model was developed to be more general in order to evaluate a wider range of policy questions than are discussed in this paper.

Attempt has been made to use the same notation in the computer model as in the theoretical model. Whenever possible, reference is made to the relevant equations in the main text. There are several additional definitions and specifications in the simulation mode, but none of these should alter the theoretical propositions of the paper. First, a number of definitions have been added to the model in order to enhance our understanding of the model's properties or to simplify the presentation of an equation (e.g. the definition of income). In addition, equations have been added in order to examine many possible government policy scenarios (e.g. tax reaction functions). Finally, some equations have been added to account for endpoint and starting point conditions (e.g. consumption of end point capital).

A few general notational rules were followed in order to make the reading of the model a little easier. Since the computer does not recognize greek letters, they have either been written out explicitly (e.g. BETA for β, SIGMA for σ etc) or an arabic letter has been substituted (e.g. "TYH" for τ_{yh}).

Also $\sum_{i=1}^{T} X_i$ is written out as "SUM (I=1 to T: X(i))".

In general, all home country variables end with an "H" and foreign variables with an "F". The model was always simulated for years 20 to 40.

1. Endogenous variables

BH	-	current account balance (-BH for the foreign country)
BPH(F)	-	home(foreign) private sector international borrowing
CH(F)	-	home(foreign) private consumption
EH(F)	-	home(foreign) private total expenditures (inclusive of leisure consumption)
INVADJH(F)	-	home(foreign) net investment
INVH(F)	-	home(foreign) gross investment
KH(F)	-	home(foreign) capital stock
LH(F)	-	home(foreign) labor supply

PCH(F)	-	home(foreign) tax adjusted price of consumption
PH(F)	-	home(foreign) price index of utility based real spending
PLH(F)	-	home(foreign) tax adjusted price of labor
R	-	rate of interest plus 1
RR	-	tax adjusted present value plus 1 (referred to as $1/\alpha$ in text)
R20(R20F)	-	home(foreign) tax adjusted present value factor in period T
SURPH(F)	-	home(foreign) cumulative government surplus
TBH(F)	-	home(foreign) tax rate on bonds (τ_b in the text)
TCH(F)	-	home(foreign) consumption tax rate (τ_c in the text)
TERKH(F)	-	home(foreign) capital stock consumed in period T
TYH(F)	-	home(foreign) income tax rate (τ_y in the text)
UH(F)	-	home(foreign) utility based total expenditure
WH(F)	-	home(foreign) wealth
YH(F)	-	home(foreign) income
VH(F)	-	home(foreign) lifetime utility from t=0 to T

2. <u>Exogenous variables and parameters</u>

GH(F)	-	home(foreign) government spending
INVOH(F)	-	home(foreign) investment in period 0
TCH(F)BAR	-	home(foreign) consumption tax rate when income tax rate endogenous
TYH(F)BAR	-	home(foreign) income tax rate when consumption tax rate endogenous
WAGEH(F)	-	home(foreign) wage rate (w in the text)
ALPHAH(F)	-	home(foreign) fraction of consumption of end period capital stock (a in the text)

KADJH(F) - home(foreign) adjustment parameter of the capital stock (b in the text)

BETAH(F) - home(foreign) distributive parameter of consumption (β in the text)

DELTAH(F) - home(foreign) subjective discount rate

MPKH(F) - home(foreign) marginal product of capital (r_k in the text)

SIGMAH(F) - home(foreign) consumption - leisure elasticity of substitution (σ)

THETAH(F) - home(foreign) rate of depreciation of capital stock

TAXDUMH(F) - home(foreign) tax dummy (1(0) income(consumption) tax endogenous)

TBTYH(F) - home(foreign) determines relationship between bond and income taxes (θ in the text)

TERSURPH(F) - home(foreign) value of terminal budget deficit

3. Equations

(1) YH = WAGEH*LH+(MPKH-THETAH)*KH

(2) YF = WAGEF*LF+(MPKF-THETAF)*KF

(3) CH = (1-BETAH)**SIGMAH*PCH**(-SIGMAH)*EH/((1-BETAH)**SIGMAH *PCH**(1-SIGMAH)+BETAH**SIGMAH*PLH**(1-SIGMAH))

(4) CF = (1-BETAF)**SIGMAF*PCF**(-SIGMAF)*EF/((1-BETAF)**SIGMAF *PCF**(1-SIGMAF)+BETAF**SIGMAF*PLF**(1-SIGMAF))

(5) 1-LH = BETAH**SIGMAH*PLH**(-SIGMAH)*EH/((1-BETAH)**SIGMAH *PCH**(1-SIGMAH)+BETAH**SIGMAH*PLH**(1-SIGMAH))

(6) 1-LF = BETAF**SIGMAF*PLF**(-SIGMAF)*EF/((1-BETAF)**SIGMAF *PCF**(1-SIGMAF)+BETAF**SIGMAF*PLF**(1-SIGMAF))

(7) PH = ((1-BETAH)**SIGMAH*PCH**(1-SIGMAH)+BETAH**SIGMAH *PLH**(1-SIGMAH))**(1/(1-SIGMAH))

```
(8)       PF = ((1-BETAF)**SIGMAF*PCF**(1-SIGMAF)+BETAF**SIGMAF
               *PLF**(1-SIGMAF))**(1/(1-SIGMAF))
(9)        0 = IF YEAR() EQ 20 THEN INVADJH-INVOH ELSE
               (-(1-TYH(-1)))/(1-TBH(-1))/RR(-1)*
               (1+KADJH*INVADJH/KH(-1))+(1-THETAH)**(20-TIME)*(MPKH+
               ALPHAH)/R20+SUM(I = 0 TO 19 : (1-THETAH)**I*(1-TYH(I))/
               (1-TBH(I))/RR(I)*IDUM(I)*(MPKH-THETAH+KADJH/
               2*(INVADJH(I+1)/KH(I))**2))
(10)       0 = IF YEAR() EQ 20 THEN INVADJF-INVOF ELSE
               (-(1-TYF(-1)))/(1-TBF(-1))/RR(-1)
               *(1+KADJF*INVADJF/KF(-1))+(1-THETAF)**(20-TIME)
               *(MPKF+ALPHAF)/R20F+SUM(I = 0 TO 19 : (1-THETAF)
               **I*(1-TYF(I))/(1-TBF(I))/RR(I)*IDUM(I)
               *(MPKF-THETAF+KADJF/2*(INVADJF(I+1)/KF(I))**2))
(11)      KH = (1-THETAH)*KH(-1)+INVADJH
(12)      KF = (1-THETAF)*KF(-1)+INVADJF
(13)    INVH = INVADJH*(1+KADJH/2*INVADJH/KH(-1))
(14)    INVF = INVADJF*(1+KADJF/2*INVADJF/KF(-1))
(15)     PLH = WAGEH*(1-TYH)/(1-TBH)
(16)     PLF = WAGEF*(1-TYF)/(1-TBF)
(17)     PCH = (1+TCH)/(1-TBH)
(18)     PCF = (1+TCF)/(1-TBF)
(19)      UH = (1-DELTAH)*WH/PH/(1-DELTAH**21)*DELTAH**TIME*RR
(20)      UF = (1-DELTAF)*WF/PF/(1-DELTAF**21)*DELTAF**TIME*RR
(21)      EH = PH*UH
(22)      EF = PF*UF
```

```
(23)    WH = IF YEAR() EQ 20 THEN SUM(J=0 TO 19 :
             (1-TYH(J)/(1-TBH(J)))*(WAGEH(j)+(MPKH-THETAH)
             *KH(J)-INVH(J+1))/RR(J))+(1-TYH(20)/(1-TBH(20)))
             *(WAGEH(20)+(MPKH-THETAH)*KH(20)+TERKH(20))/
             RR(20)-R(-1)*BH(-1) ELSE WH(-1)
(24)    WF = IF YEAR() EQ 20 THEN WF-R+1 ELSE WF(-1)
(25) SURPH = SURPH(-1)+1/RR*(TBH*(BPH-R*BPH(-1))+TCH*
             CH+TYH*(LH*WAGEH+(MPKH-THETAH)*KH-INVH(1)+TERKH)-GH)
(26) SURPF = SURPF(-1)+1/RR*(TBF*(BPF-R*BPF(-1))+TCF
             *CF+TYF*(LF*WAGEF+(MPKF-THETAF)*KF-INVF(1)+TERKF)-GF)
(27)   TYH = TAXDUMH*(IF YEAR() LT 21 THEN TYHBAR ELSE
             (IF YEAR() EQ 21 THEN (TERSURPH-SURPH(-1)-SUM(J = 0 TO
             19 : 1/RR(J)*(TBH(J)*(BPH(J)-R(J)*BPH(J-1))+TCH(J)
             *CH(J)-GH(J))))/SUM(I = 0 TO 19 : (LH(I)*
             WAGEH(I)+(MPKH-THETAH)*KH(I)-INVH(I+1)+TERKH(I))/
             RR(I)) ELSE TYH(-1)))+(1-TAXDUMH)*TYHBAR
(28)   TYF = TAXDUMF*(IF YEAR() LT 21 THEN TYFBAR ELSE
             (IF YEAR() EQ 21 THEN (TERSURPF-SURPF(-1)-SUM(J = 0 TO
             19 : 1/RR(J)*(TBF(J)*(BPF(J)-R(J)*BPF(J-1))+TCF(J)
             *CF(J)-GF(J))))/SUM(I = 0 TO 19 : (LF(I)*
             WAGEF(I)+(MPKF-THETAF)*KF(I)-INVF(I+1)+TERKF(I))/
             RR(I)) ELSE TYF(-1)))+(1-TAXDUMF)*TYFBAR
```

```
(29)    TCH = (1-TAXDUMH)*(IF YEAR() LT 21 THEN TCHBAR ELSE (IF YEAR()
              EQ 21 THEN (TERSURPH-SURPH(-1)-SUM(J = 0 TO 19 :
              1/RR(J)*(TBH(J)*(BPH(J)-R(J)*BPH(J-1))+TYH(J)*(LH(J)
              *WAGEH(J)+(MPKH-THETAH)*KH(J)-INVH(J+1)+TERKH(J)
              -GH(J)))))/SUM(I = 0 TO 19 : 1/RR(I)*CH(I)) ELSE
              TCH(-1)))+TAXDUMH*TCHBAR

(30)    TCF = (1-TAXDUMF)*(IF YEAR() LT 21 THEN TCFBAR ELSE (IF YEAR()
              EQ 21 THEN (TERSURPF-SURPF(-1)-SUM(J = 0 TO 19 :
              1/RR(J)*(TBF(J)*(BPF(J)-R(J)*BPF(J-1))+TYF(J)*(LF(J)
              *WAGEF(J)+(MPKF-THETAF)*KF(J)-INVF(J+1)+
              TERKF(J)-GF(J)))))/SUM(I = 0 TO 19 : 1/RR(I)*CF(I))
              ELSE TCF(-1)))+TAXDUMF*TCFBAR

(31)    TBH = TBTYH*TYH

(32)    TBF = TBTYF*TYF

(33) TERKH = IF YEAR() LT 40 THEN 0 ELSE ALPHAH*KH

(34) TERKF = IF YEAR() LT 40 THEN 0 ELSE ALPHAF*KF

(35)    BPH = ((1+TCH)*CH-(1-TYH)*(YH+TERKH-INVH(1))
              +R*BPH(-1))/(1-TBH)

(36)    BPF = ((1+TCF)*CF-(1-TYF)*(YF+TERKF-INVF(1))
              +R*BPF(-1))/(1-TBF)

(37)     VH = SUM(I = 0 TO 20 : DELTAH**I*LOG(UH(I)))

(38)     VF = SUM(I = 0 TO 20 : DELTAF**I*LOG(UF(I)))

(39)    R20 = IF YEAR() EQ 20 THEN RR(20)/(1-TYH(20)) ELSE R20(-1)

(40)   R20F = IF YEAR() EQ 20 THEN RR(20)/(1-TYF(20)) ELSE R20F(-1)

(41) GH+GF+CH+CF+INVH(1)+INVF(1) = YH+YF+TERKH+TERKF

(42)     RR = EXP(SUM(J = -19 TO 0 : LOG(R(J))))
```

(43) BH = CH-YH+R*BH(-1)+INVH(1)+GH-TERKH

Equations (1) and (2) define home and foreign country income as labor income plus the return on capital. Equations (3) - (8) are the behavioral equations derived by maximizing utility subject to the life-time present-value budget constraint. Equation (3) is the home consumption equation and identical to equation 7 of the main text. Equation (5) is the leisure equation and (7) the price equation and represent equations 8 and 6 of the main text. The foreign country equations for these three variables are (4), (6), and (8).

The home and foreign investment equations, (9) and (10), derived by maximizing wealth, differ slightly from equation 9 in the main text in so far as the rate of depreciation (THETA) is included here but omitted from the theoretical description. Equations (11) and (12) define the home and foreign capital stocks and equations (13) and (14) adjust investment demands for adjustment costs.

Equations (15) - (19) are definitions of tax adjusted prices that are then substituted in other equations. For example, a comparison of equation 6 of the text to equation (7) of the simulation model shows that PCH is used in place of $(1-\tau_{ct})/(1-\tau_{bt})$.

Real utility based expenditures (equation 5 of the text) are given in equations (19) and (20) while the values in terms of the consumption good of these expenditures are defined in (21) and (22). Home country wealth is defined by equation (23) and is identical to the wealth equation in the main text. A similar equation could be written for foreign wealth, but by Walras law, we have dropped this equation from the model and use the relationship to solve for the interest rate. Note that these equations solve for W_0 and R_0 in period t = 0 (year 20 in the computer model). However, for t=1 to T, these equations set wealth to their previous values (i.e. WH_0 and WF_0) thereafter.

The next eight equations are used to describe government behavior and vary depending upon the type of scenario that we are simulating. Equations (25) and (26) define the home and foreign country's cumulated surplus as tax receipts less spending. Various combinations of the next six equations and values for dummy variables are used in the simulations to capture alternative tax and spending policies. For example, in the simulation of a revenue neutral conversion of consumption for income tax, equations (27) and (29) are dropped from the model and the income tax rate, TYH, and the government surplus, SURPH, are assumed exogenous while the consumption tax rate, TCH, can be thought of as balancing the government's net revenue position. For the budget deficit simulations, the model is altered in a very different way. For example, in order to analyze a current income tax shift, the consumption tax equation, (29), is dropped from the model, and the consumption tax rate is assumed exogenous. Then, an exogenous income tax rate is imposed in the relevant year(s) and equation (27) is used to alter future income tax rates so that the budget is balanced by year T. Analogous assumptions can be made for consumption tax shifts. Equations (31) and (32) define the international borrowing tax rates as described in equation 10 in the main text and the coefficient, TBTYR (θ in the text) can be set in order to consider a wide variety of tax conversion policies as a result of the tax equivalence relationship between the consumption, income, and international borrowing taxes.

Equations (35) and (36) define the privately held home (foreign) stock of international borrowings. The definitions of lifetime utility are given in equations (37) and (38). Note that since the model is simulated for only 20 years, the only relevant calculation for VH and VF is in the first year. Equations (39) and (40) define period T's tax adjusted value of the discount factor used in the investment equations.

The final three equations do not have home and foreign counterparts. Equation (41) is the equilibrium condition for world output; demand for world output must equal the supply of world output. Equation (42) defines the present value factor which is referred to in the text as α. Finally, the balance of payments for the home country is defined in equation (43). Obviously, the negative of BH defines the foreign country's balance of payment position.

The parameter values used in the baseline simulations are: $\beta = \beta^* = .4$, $\delta = \delta^* = .97$, $\sigma = \sigma^* = 0.3$, $r_k = r_k^* = 0.3$, and $\alpha = \alpha^* = 0.2$. For inter-country differences in the parameter values of the discount factor we use: ($\delta = .95$, $\delta^* = .97$) or ($\delta = .97$, $\delta^* = .95$); while for inter-country differences in the parameter values of the marginal product of capital we use: ($r_k = 0.2$, $r_k^* = 0.3$) or ($r_k = 0.3$, $r_k^* = 0.2$).

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