PRINCETON STUDIES IN INTERNATIONAL FINANCE
No. 63, December 1988

SPENDING, TAXES, AND DEFICITS: INTERNATIONAL-INTERTEMPORAL APPROACH

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PRINCETON STUDIES IN INTERNATIONAL FINANCE

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Library of Congress Cataloging-in-Publication Data

Frenkel, Jacob A.
Spending, taxes, and deficits : international-intertemporal approach / Jacob A. Frenkel and Assaf Razin.

p. cm. — (Princeton studies in international finance, ISSN 0081-8070 : no. 63)
ISBN 0-88165-235-0
1. Government spending policy—Mathematical models. 2. Fiscal policy—Mathematical models. 3. Budget deficits—Mathematical models. 4. Foreign exchange—Mathematical models. 5. Interest rates—Mathematical models. I. Razin, Assaf. II. Title. III. Series
HJ192.F74 1988
336.3′9—dc19 88-39091
CIP

Printed in the United States of America by Princeton University Press at Princeton, New Jersey.

International Standard Serial Number: 0081-8070
International Standard Book Number: 0-88165-235-0
Library of Congress Catalog Card Number: 88-39091

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1 INTRODUCTION

This study addresses one of the issues of most concern to Frank Graham: the effects of government spending and tax policies on the economic system. In his book *Social Goals and Economic Institutions*, which in his own words "is of the nature of a confession of faith, and an argument for the conviction that is in me," he presents the logic underlying what is currently known as the "Ricardian Equivalence" proposition:

> Debt and credits can be indefinitely multiplied and might reach huge figures without any *necessary* disturbance to the economy. . . . Net social income would be unaffected. . . . The rise in government debt . . . has therefore no special significance. It is not inconceivable that the incidence of taxes to service, or perchance to extinguish, the debt would correspond with the receipt of interest on the government securities. If this should be the case and if, as is of course highly improbable, there had been no transfers of government debt from the hands of the original holders, the economic position of all the citizens would be precisely the same as if there had been no government debt at all. The debt could be wiped out, along with the taxes for its service, without any loss or gain to anybody (Graham, 1942, pp. 150, 159).

But then Graham raises doubts about the practical validity of Ricardian equivalence. Because he recognized that the necessary conditions are unlikely to be satisfied, owing to incentive effects associated with government finance, he was a sharp critic of deficit finance:

> Continuous deficit financing as a stimulus to the economy is reckless in the extreme and a confession of mental insolvency. It has been partially justified, however, by the intellectual bankruptcy of most "conservatives" who, in the face of break-down, could find nothing better to do than indulge in wringing of hands. Their plaints, though not their general attitude, were nevertheless warranted since debt, and inflation, are diseases to which democracies are peculiarly susceptible (Graham 1942, p. 163).

This study deals with the effects of government spending and tax policies on the evolution of real exchange rates and real interest rates in an interdependent world economy. We develop an analytical framework suitable for a detailed examination of the various channels through which the intertemporal effects of these policies are transmitted internationally. In our for-

We are indebted to Thomas Krueger, Jonathan Ostry, and Kei-Mu Yi for helpful comments and suggestions, and to Steve Symansky for his contribution to the simulations. This study was completed while Assaf Razin was a visiting scholar in the Research Department of the International Monetary Fund.

mulation, the tax system is so specified that deficit finance influences the world economy in a significant way, and the path of debt is critical in its effects on the economic system. Thus, Graham's own views are embodied in the model.

Our analysis is motivated by conditions that prevailed in the world economy through most of the 1980s. During this period, changes in national fiscal policies were unsynchronized, real interest rates were high and volatile, and real exchange rates exhibited diverging trends and large fluctuations. The fiscal policies pursued by the major industrial countries affected the rest of the world through the integrated goods and capital markets, with the result that every country became increasingly concerned about policy measures adopted in the rest of the world.

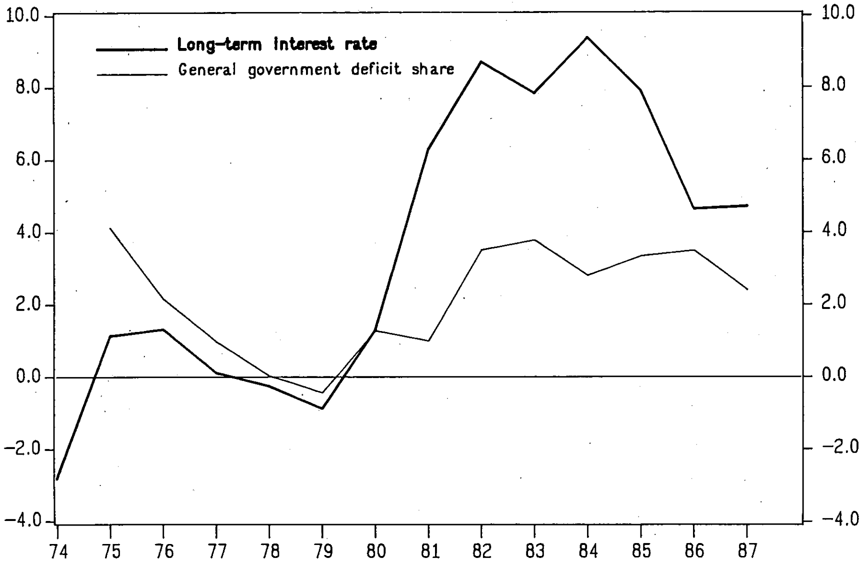
To illustrate the volatility of the key macroeconomic variables and highlight the complexity of the interactions among fiscal indicators, real interest rates, and exchange rates, we show in Figure 1 the paths of government spending (as a share of GNP) and the real exchange rate, and in Figure 2 the paths of the budget deficit (as a share of GNP) and the real interest rate, for the United States from 1974 to 1987.[1] As can be seen, the paths exhibit considerable variability, and the correlations among them vary over time. During some periods (e.g., 1986-87), a rise in U.S. government spending (as a share of GNP) is accompanied by a rise in the real exchange rate, while in other periods (e.g., 1978), the correlation is negative. Likewise, during some periods (e.g., the latter part of the 1970s), a rise in the U.S. budget deficit (as a share of GNP) is accompanied by a rise in the interest rate, while in other periods (e.g., 1986-87), the correlation is negative. An examination of the paths portrayed in the two figures reveals that the relationship between the real exchange rate and the real interest rate also varies over the years. Our analysis provides a framework and identifies key factors useful for interpreting such developments.

As is well known, in the absence of nontradable goods the effects of government spending on the world interest rate are clear-cut: a current transitory rise in government spending raises the interest rate, whereas an expected future transitory rise in spending lowers it. Further, in the absence of distortionary taxes a budget deficit tends to raise the interest rate. In the subsequent analysis, we extend the framework by incorporating nontradable goods and allowing for alternative tax systems, such as a consumption or income tax. Our analysis reveals the effects of government spending and

[1] In these charts, nominal government spending is deflated by the absorption deflator, and nominal GNP is deflated by the GNP deflator. The real exchange rate is defined as the ratio of export unit value to normalized unit labor cost in manufactures (1980 = 100). The real long-term interest rate is defined as the annual average yield on ten-year U.S. Treasury (constant-maturity) bonds, adjusted by the private-sector final domestic-demand deflator.

FIGURE 1
UNITED STATES: REAL EXCHANGE RATE AND SHARE OF GOVERNMENT SPENDING IN GNP

FIGURE 2
UNITED STATES: REAL LONG-TERM INTEREST RATE AND SHARE OF GENERAL GOVERNMENT DEFICIT IN GNP



tax policies in an interdependent world economy on interest rates, real exchange rates, real wages, and the current account of the balance of payments. The key factors are, on the one hand, the distribution of government spending between tradable and nontradable goods and the intertemporal allocations of this spending, and, on the other hand, the characteristics of the tax system, including the timing of taxes and the types of taxes used to finance the budget. In this context, we show that the consequences of a revenue-neutral conversion from an income-tax system to a consumption-tax system (and conversely) depend critically on the current-account position. These results indicate that open-economy considerations play a central role in a proper analysis of fiscal policies.

The study has two main chapters. Chapter 2 contains an analysis of the effects of government spending. Here we develop the analytical framework for the two-country model of the world economy, determine analytically the precise factors governing the international effects of government spending policies, and provide illustrative dynamic simulations of these effects. Chapter 3 deals with the effects of tax policies. Here we consider budget deficits arising from cuts in consumption taxes and income taxes, as well as alternative revenue-neutral tax-conversion schemes. Chapter 4 concludes the study with a summary of the chief results.

2 GOVERNMENT SPENDING POLICIES

In our analysis of the effects of government spending on world interest rates, real exchange rates, current-account positions, and related key economic variables, we focus on the unique role played by the detailed pattern of government expenditures. To highlight this role, we specify the model so as to ensure that the details of government finance, particularly the timing of taxes and borrowing, are immaterial. Accordingly, we abstract from monetary considerations and we assume that all taxes are lump-sum. Furthermore, we presume that the provision of government services does not alter the consumer marginal rates of substitution among private goods. To open the discussion, it is useful to cast the analysis in terms of the general principles of the "transfer-problem criterion" familiar from the literature on international transfers.[1] We start with a brief review of the effects of government spending on the world interest rate for the simple composite-good case. This case highlights the basic principles involved in the application of the transfer-problem criterion to the determination of the intertemporal terms of trade.

The Composite Tradable Good

The transfer-problem criterion involves a comparison between the marginal spending propensities of the private sector and of the government. Applied to the analysis of the effects of government spending on the world interest rate (the intertemporal terms of trade), this criterion requires a comparison between the "saving" propensities of the government and the private sector out of "wealth." For this purpose, the relevant concept of wealth is the sum of current spending and the discounted sum of future "lifetime" spending, and the relevant concept of saving is the discounted sum of future lifetime spending. If the government saving propensity exceeds the private saving propensity, a rise in home-country government spending improves the current account and lowers the world interest rate. This result stems from the redistribution of wealth from the home-country private sector to the government that is induced by the tax levy necessary to finance the rise in government spending. The assumed difference between the saving propensi-

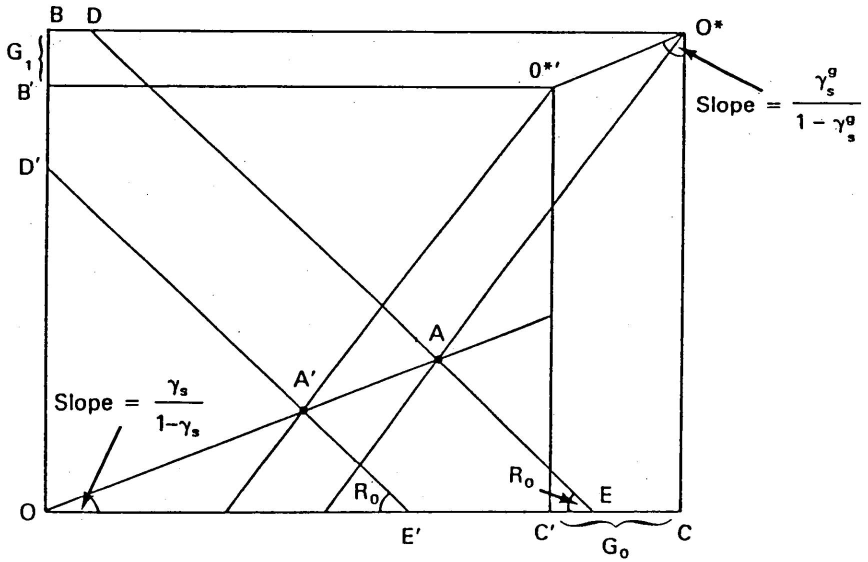
[1] This criterion was developed originally in the context of post-World War I discussions about the German reparations and was debated among Keynes (1929), Ohlin (1929), and Rueff (1929). The concept was further developed by Metzler (1942), Meade (1951), Samuelson (1952), Johnson (1956), and Mundell (1960). For an application of this criterion to the analysis of the international effects of government spending, see Frenkel and Razin (1985).

ties implies that this wealth redistribution raises savings in the home country, thereby improving its current account. The associated excess world savings (at the prevailing world interest rate) is eliminated through the reduction in the world interest rate.

To illustrate the general principle, consider the two-period, two-country box diagram OBO^*C in Figure 3. The dimensions of the box measure the present and the future levels of world GDP net of government spending. At the initial equilibrium (with zero government spending), the international and intertemporal composition of world consumption is represented by point A, which denotes the intersection between the home and foreign countries' consumption-expansion loci OA and O^*A, respectively. For simplicity, the utility functions are assumed to be homothetic, so that the marginal and average saving propensities are equal. These loci correspond to the equilibrium interest rate (where R_o denotes 1 plus the interest rate). For further reference, the slope of the domestic-economy consumption-expansion locus OA equals the ratio $\gamma_s/(1 - \gamma_s)$, where γ_s, the private-sector propensity to save out of wealth, equals $(C_1/R_o)/[C_o + (C_1/R_o)]$ and C_i denotes the level of consumption in period i ($i = 0,1$). If the levels of the domestic-government spending (financed through lump-sum spending) on

FIGURE 3

THE EFFECTS OF GOVERNMENT SPENDING ON THE WORLD INTEREST RATE: THE COMPOSITE TRADABLE-GOODS CASE



DATA: $\gamma_s = \gamma_s^g$.

present and future goods are G_0 and G_1, respectively, then the size of the box diminishes because of the resource withdrawal.

Accordingly, in Figure 3 the length of the horizontal axis, measuring the supply of *present* goods net of government spending, is reduced from OC to OC', and the length of the vertical axis, measuring the supply of *future* goods net of government spending, is reduced from OB to OB'. The box diagram shrinks to $OB'O^{*\prime}C'$. The slope of the ray $O^*O^{*\prime}$ equals the ratio $\gamma_s^g/(1-\gamma_s^g)$, where γ_s^g, the government propensity to save out of its lifetime spending, equals $(G_1/R_o)/[G_o + (G_1/R_o)]$, where G_i denotes the level of government consumption in period i ($i = 0,1$). For illustrative purposes, we consider in Figure 3 the borderline case in which $\gamma_s = \gamma_s^g$. At the prevailing interest rate, foreign demand remains unchanged, as represented in Figure 3 by point A'. By construction, the parallel line segments O^*A and $O^{*\prime}A'$ are of equal length. Analogously, as long as the initial interest rate remains unchanged, the consumption-expansion locus of domestic residents remains unchanged, but, in view of the lower level of wealth (resulting from the tax-induced fall in disposable income), the new level of desired consumption is represented by the distance OA' instead of OA. Diagrammatically, point A' designates the intersection of the domestic consumption-expansion locus and the line $D'E'$. The latter is obtained by a leftward (parallel) shift of the initial budget line, DE, by the magnitude measuring the discounted sum of government spending, $G_o + (G_1/R_o)$. As is evident, in the borderline case in which $\gamma_s = \gamma_s^g$, the new equilibrium obtains at point A', so that the rise in government spending does not alter the world interest rate.

The interpretation of this result is given in terms of the transfer-problem criterion. In the present case, the transfer of income from the domestic private sector to the government (a transfer associated with the taxes levied to finance the rise in government spending) does not alter the level of national saving (private sector plus government), since it involves a transfer of income between units with identical saving patterns.

Therefore, the transfer does not alter the level of world saving, and the interest rate (the intertemporal terms of trade) does not change. This borderline case implies that if γ_s^g exceeds γ_s, the rise in government spending tilts the intertemporal composition of national spending toward the future and results in a fall in the world interest rate and an improvement in the domestic economy's current-account position. Conversely, if γ_s^g is less than γ_s, the rise in government spending tilts the intertemporal composition of national spending toward the present and thereby raises the world interest rate and worsens the current-account position.

The foregoing considerations imply that if the rise in government spending is expected to occur only in the *future* (so that the marginal saving propensity of the government is unity, which clearly exceeds the corresponding propensity of the private sector), then the home-country current account improves and the world interest rate falls. By similar reasoning, if the rise in government spending is temporary, occurring only in the *current* period (so that the marginal saving propensity of the government is zero, which clearly falls short of the corresponding private-sector propensity), then it raises the world interest rate and worsens the current-account position.[2]

Tradable and Nontradable Goods

The simple conclusions outlined above abstracted from induced changes in real exchange rates. It was assumed that the economy produces a single composite tradable commodity. To introduce a richer mechanism of adjustment, we extend the analytical framework to allow for the presence of nontradable goods. The extended analytical framework is capable of highlighting the role that the real exchange rates play in the adjustment mechanism. We show that the allowance for the new adjustment mechanism alters significantly the simple transfer-problem criterion governing the effects of government spending on the current account and the world interest rate.

The Analytical Framework. The analytical framework employs a general-equilibrium intertemporal approach for a two-country model of the world economy. Throughout we assume that there are two composite goods: an internationally tradable good denoted by x, and a nontradable good denoted by n. To allow for intertemporal considerations we assume, for simplicity, a two-period model, period 0 and period 1.[3] The relative price of the nontradable good (the inverse of the real exchange rate) in period t is p_{nt}, the exogenously given output of that good is $\bar{Y}_{nt}$, government purchases of the nontradable good are G_{nt}, and private-sector demand is c_{nt} ($t = 0,1$). The private-sector lifetime budget constraint is

$$(c_{x0} + p_{n0}c_{n0}) + \alpha_{x1}(c_{x1} + p_{n1}c_{n1}) = (\bar{Y}_{x0} + p_{n0}\bar{Y}_{n0}) + \alpha_{x1}(\bar{Y}_{x1} + p_{n1}\bar{Y}_{n1}) - (T_0 + \alpha_{x1}T_1) - (1 + r_{x,-1})B^p_{-1} \equiv W_0 , \qquad (1)$$

where $\alpha_{x1} = 1/(1 + r_{x0})$ denotes the discount factor in terms of tradable goods and where T_t, c_{xt}, and $\bar{Y}_{xt}$ denote, respectively, the level of lump-sum taxes, the level of consumption, and the exogenously given level of production of tradable goods in period t ($t = 0,1$). W_0 denotes wealth, r_{xt} ($t = -1,0$) denotes the world interest rate, and B^p_t denotes private-sector

[2] The statement outlined in the preceding paragraph draws on Frenkel and Razin (1986b).

[3] The two-country analysis in this section draws on Frenkel and Razin (1986c, 1987). A related analysis of fiscal policies and the real exchange rate within a small-country model is contained in Buiter (1986). For an extension of the small-country model to the analysis of the effects of terms-of-trade shocks on the real exchange rate, see Edwards (1987) and Ostry (1987).

debt in period t ($t = -1,0$). The values of taxes, wealth, debt, and the interest rates are measured in terms of tradable goods.

The individual maximizes lifetime utility subject to the lifetime budget constraint (1). We assume that the lifetime utility function can be expressed as a function of two linearly homogeneous subutility functions $C_0(c_{x0},c_{n0})$ and $C_1(c_{x1},c_{n1})$. Hence, lifetime utility is $U(C_0,C_1)$. The maximization of this utility function subject to the lifetime budget constraint (1) is carried out in two stages, where the first stage optimizes the composition of spending within each period and the second stage optimizes the intertemporal allocation of spending between periods.

The optimization of the intertemporal allocation of the (consumption-based) real spending yields the demand functions for real spending in each period, $C_t = C_t(\alpha_{c1},W_{c0})$, where α_{c1} is the (consumption-based) real wealth. Expressed in terms of tradable goods, the level of spending in each period is P_tC_t, where P_t is the consumption-based price index (the "true" price deflator). Thus, $\alpha_{c1} = \alpha_{x1} P_1/P_0$ and $W_{c0} = W_0/P_0$. Clearly, the price index in each period depends on the temporal relative price p_{nt} with an elasticity that equals the relative share of expenditure on nontradable goods, β_{nt}. Within each period, the utility-maximizing allocation of spending between goods depends on the relative price p_{nt}.[4]

The market for nontradable goods must clear in each country during each period. Accordingly,

$$c_{n0}[p_{n0},P_0C_0(\alpha_{c1},W_{c0})] = \bar{Y}_{n0} - G_{n0} \tag{2}$$

$$c_{n1}[p_{n1},P_1C_1(\alpha_{c1},W_{c0})] = \bar{Y}_{n1} - G_{n1}, \tag{3}$$

where the left-hand sides of these equilibrium conditions show the demand functions and the right-hand sides show the supply net of government purchases.[5] As we have seen, the demand functions depend on the relative price, p_{nt}, and on spending, P_tC_t, where P_t is the (consumption-based) price index, and C_t is (consumption-based) real spending. Real spending, in turn,

[4] A similar procedure is developed in Svensson and Razin (1983).

[5] The government present-value intertemporal budget constraint is:

$$(G_{x0} + p_{n0}G_{n0}) + \alpha_{x1}(G_{x1} + p_{n1}G_{n1}) = T_0 + \alpha_{x1}T_1 - (1 + r_{x,-1})B^g_{-1},$$

where G_{xt} and G_{nt} denote, respectively, government purchases of tradable and nontradable goods, and where B^g_t denotes government debt in period t. Consolidating the private-sector lifetime constraint (1) with that of the government (2) and imposing equality between consumption and production of nontradable goods in each period yields the economy's consolidated constraint:

$$c_{x0} + \alpha_{x1}c_{x1} = (\bar{Y}_{x0} - G_{x0}) + \alpha_{x1}(\bar{Y}_{x1} - G_{x1}) - (1 + r_{x,-1})B_{-1},$$

where $B_t = B^p_t + B^g_t$ denotes the economy's external debt in period t.

depends on the (consumption-based) real discount factor, α_{c1}. We assume that the utility function is homothetic, so that the elasticity of consumption demand with respect to spending, as well as the elasticity of spending with respect to wealth, is unity.

Spending Policies. In analyzing the effects of government spending, we obtain the equilibrium value of wealth, W_0, by substituting the government present-value budget constraint (from footnote 5) into the corresponding private-sector budget constraint. Accordingly,

$$W_0 = [p_{n0}(\bar{Y}_{n0} - G_{n0}) + (\bar{Y}_{x0} - G_{x0})] + \alpha_{x1}[(\bar{Y}_{n1} - G_{n1}) + (\bar{Y}_{x1} - G_{x1})] - (1 + r_{x,-1}) B_{-1}. \quad (4)$$

Thus, as usual, government spending absorbs resources that otherwise would have been available to the private sector. We assume that the public goods generated by these policies do not tilt the private-sector relative demand for private goods.

Next we determine the effects of government spending on the path of private-sector consumption of tradable goods. Analogously to the previous specification, the demand function for tradable goods in period t is

$$c_{xt} = c_{xt}[p_{nt}, P_t C_t(\alpha_{c1}, W_{c0})], \qquad t = 0,1. \quad (5)$$

Clearly, in contrast to the markets for nontradable goods, the consumption of tradable goods in any given period is not limited by the available domestic supply. It is shown in Appendix A that the *intertemporal-consumption ratio* of tradable goods, c_{x0}/c_{x1}, depends on the world discount factor according to

$$\frac{d \log (c_{x0}/c_{x1})}{d \log \alpha_{x1}} = \frac{\sigma_{nx}\sigma}{\beta_n\sigma + (1 - \beta_n)\sigma_{nx}}, \quad (6)$$

where β_n denotes the relative share of private-sector spending on nontradable goods and σ and σ_{nx} denote, respectively, the intertemporal and the temporal elasticities of substitution.[6] Equation (6) (which incorporates the induced change in the path of the real exchange rate) shows that the only factors governing the change in the intertemporal-consumption ratio are pure temporal and intertemporal substitution effects. The absence of wealth

[6] In general, these parameters may vary over time because they may depend on the time-varying relative prices. Equation (6) corresponds to an initial situation in which relative prices are stationary. In what follows, we consider the case in which the temporary elasticity of substitution, σ_{nx}, is close to unity, so that changes in relative prices do not have an appreciable effect on the expenditure share, β_n. Clearly, under such circumstances we can fully characterize the world economic system in terms of percentage rates of growth of the endogenous variables (prices and quantities).

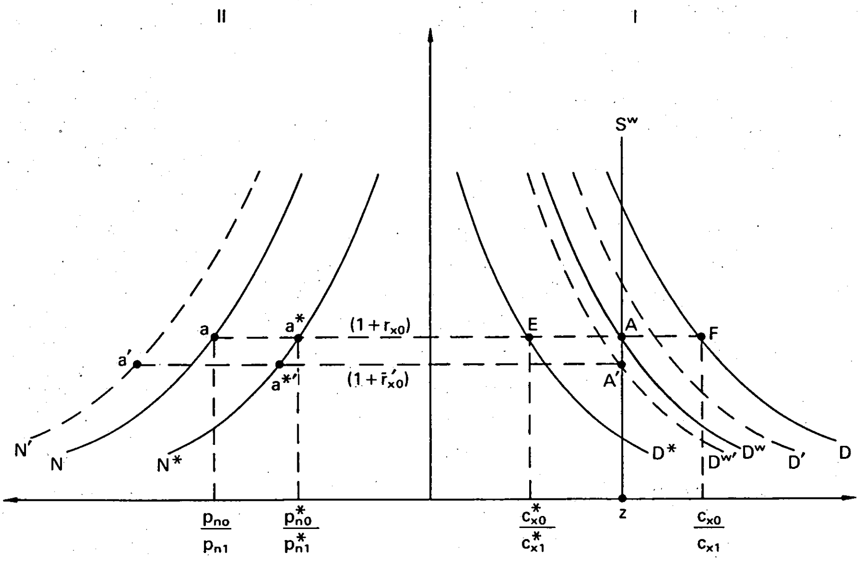
effects reflects the homotheticity assumption. The foreign economy is assumed to be characterized by a structure of demand and supply similar to that of the domestic economy.

To determine the equilibrium in the world economy, we need to consider the factors governing world demand and world supply of tradable goods. The analysis is carried out with the aid of Figure 4. Panel I of Figure 4 shows the *relative* intertemporal domestic, D, foreign, D^*, and world, D^w, demands for tradable goods. The world relative demand is a weighted average of the domestic and foreign relative demands. That is,

$$D^w = \frac{c_{x0} + c^*_{x0}}{c_{x1} + c^*_{x1}} = \mu_d \frac{c_{x0}}{c_{x1}} + (1 - \mu_d) \frac{c^*_{x0}}{c^*_{x1}}, \tag{7}$$

where $\mu_d = c_{x1}/(c_{x1} + c^*_{x1})$. The relative-demand schedules relate the desired consumption ratio of tradable goods to the interest rate. Their slope reflects the negative relationship embodied in equation (6). These demand schedules are drawn for a given level of government spending. Analo-

FIGURE 4
THE EFFECTS OF GOVERNMENT SPENDING ON THE WORLD INTEREST RATE AND ON THE PATHS OF REAL EXCHANGE RATES



DATA: $\sigma > \sigma_{nx}$, $\gamma_s > \gamma^g_s$, $\beta^g_n = 1$.

gously, the relative world supply of tradable goods net of government purchases, z, is

$$z = \frac{(\bar{Y}_{x0} - G_{x0}) + (\bar{Y}^*_{x0} - G^*_{x0})}{(\bar{Y}_{x1} - G_{x1}) + (\bar{Y}^*_{x1} - G^*_{x1})}. \tag{8}$$

The relative-supply schedule, S^w, is drawn with a zero interest elasticity, since we abstract from investment. This schedule is also drawn for a given level of government spending.

The schedules N and N^* in panel II of Figure 4 show the relationship between the world interest rate and the internal relative-price structure (the path of the real exchange rate) in each country. The elasticity of these schedules is given by equation (9), which is derived in Appendix A:

$$\frac{d \log (p_{n0}/p_{n1})}{d \log \alpha_{x1}} = \frac{\sigma}{\beta_n \sigma + (1 - \beta_n)\sigma_{nx}}. \tag{9}$$

Equation (9) indicates that changes in the world interest rate influence the path of the real exchange rate only through the intertemporal substitution effect. Accordingly, a rise in the world interest rate (a fall in α_{x1}) induces intertemporal substitution of spending toward the future. It thereby lowers the current price of nontradable goods relative to the future price (i.e., it decelerates the rate of increase in the real exchange rate from period 0 to period 1). As before, the homotheticity assumption accounts for the absence of the wealth variable in equation (9).

The initial equilibrium is described in panel I by point A, in which the world interest rate is r_{x0}. The domestic and foreign intertemporal consumption ratios are indicated by points F and E. The periodic percentage changes of the domestic and the foreign real exchange rates associated with the initial equilibrium are shown in panel II by points a and a^*.

Consider the effects of a rise in the level of domestic-government spending.[7] This change alters the domestic relative demand and the domestic country weight, μ_d (and, thereby, the world relative demand), as well as the world relative supply. A rise in the level of domestic-government spending influences world relative demand in two ways: (1) through its effect on domestic relative demand, and (2) through its effect on the domestic-country weight, μ_d. The effect of the rise in government spending on the domestic relative demand (derived in Appendix A) is given by

$$\frac{d \log (c_{x0}/c_{x1})}{dG} = \frac{\beta_n \beta^g_n \phi_n (1 - \gamma_s)(\sigma_{nx} - \sigma)}{\beta_n \sigma + (1 - \beta_n)\sigma_{nx}} \left[\frac{(1 - \gamma^g_s)}{(1 - \gamma_s)} - \frac{\gamma^g_s}{\gamma_s} \right], \tag{10}$$

[7] Here and in what follows we assume that the initial level of government spending is zero and we denote the rise in the discounted sum of government spending by dG.

where ϕ_n denotes the inverse of the value of private consumption of nontradable goods in period 0, that is, $\phi_n = 1/p_{n0}c_{n0}$. The intertemporal and temporal allocations of government spending are governed by the government saving propensity, γ_s^g, defined as the ratio of future government spending (in present-value terms) to the discounted sum of spending, and by the relative share of government spending on nontradables in total government spending in period t, β_n^g. Finally, γ_s, defined as the ratio of private-sector future consumption (in present-value terms) to the discounted sum of private-sector spending, denotes the private-sector saving propensity.

As shown in equation (10), the direction of the change in the relative-demand schedules depends on the *government-induced bias* in the intertemporal net supply of nontradable goods and on the *temporal-intertemporal substitution bias* in private-sector demand. Indeed, if either σ equals σ_{nx} or γ_s equals γ_s^g, the change in government spending does not alter the position of the relative-demand schedule.

The direction of the change in the world demand due to the induced change in the weight μ_d, while maintaining c_{x0}/c_{x1} constant, is equal to

$$\frac{d \log [(c_{x0} + c_{x0}^*)/(c_{x1} + c_{x1}^*)]}{dG} = \frac{1}{(c_{x0} + c_{x0}^*)} (1 - \mu_d)(1 - \beta_n)\gamma_s \cdot \left[\frac{1 - \gamma_s^*}{\gamma_s^*} - \frac{1 - \gamma_s}{\gamma_s}\right]. \quad (11)$$

Note that this effect vanishes if γ_s equals γ_s^*.

In order to determine the direction of the change in the relative-supply schedule, we differentiate equation (8) with respect to government spending. Accordingly,

$$\frac{d \log z}{dG} = \lambda_x^g(1 - \beta_n^g)(1 - \gamma_s^g) \cdot \left[\frac{\gamma_s^g}{1 - \gamma_s^g} - \mu_d \frac{\gamma_s}{1 - \gamma_s} - (1 - \mu_d) \frac{\gamma_s^*}{1 - \gamma_s^*}\right], \quad (12)$$

where λ_x^g denotes the reciprocal of the world output of tradable goods net of government purchases of these goods in period 1. Thus, $\lambda_x^g = 1/[(\bar{Y}_x - G_x) + (\bar{Y}_x^* - G_x^*)]$. Equation (12) indicates that the direction of the change in the relative supply reflects the bias in the intertemporal allocation of government spending on tradable goods. For example, a temporary *current* rise in government spending ($\gamma_s^g = 0$) induces a leftward shift of the relative-supply schedule, whereas a temporary *future* rise in government spending ($\gamma_s^g = 1$) induces a rightward shift of the relative supply.

Similar considerations apply to the effects of government spending on the paths of the domestic and foreign real exchange rates. For a given value of the world interest rate (measured in terms of tradable goods), the effects of the rise in government spending on the time path of the real exchange rate, p_{n0}/p_{n1}, is found by differentiating equations (2) and (3) around $G = 0$, subtracting the resulting equations from each other, and using the Slutsky decomposition. This yields[8]

$$\frac{d \log (p_{n0}/p_{n1})}{dG} = \frac{\beta_n^g \phi_n (1 - \gamma_s)}{\beta_n(\beta_n \sigma + (1 - \beta_n)\sigma_{nx})} \left[\frac{1 - \gamma_s^g}{1 - \gamma_s} - \frac{\gamma_s^g}{\gamma_s} \right]. \quad (13)$$

Equation (13) reveals that the direction of the change in the path of the real exchange rate depends on the temporal and the intertemporal allocations of government demand for nontradable goods relative to the corresponding allocations of private-sector demand. If the ratio of the relative share of government spending on nontradable goods in the current period, $\beta_n^g(1 - \gamma_s^g)$, to the private-sector share, $\beta_n(1 - \gamma_s)$, exceeds the corresponding ratio in the future period, $\beta_n^g\gamma_s^g/\beta_n\gamma_s$, then a rise in government spending raises the percentage rate of change of the real exchange rate, and vice versa.

This result can be interpreted in terms of a transfer-problem criterion relating the temporal and intertemporal spending patterns of the government and the domestic private sector. Accordingly, the rise in government spending raises the current price of nontradable goods relative to its future price if the pattern of government spending is biased toward current nontradable goods in comparison with the pattern of private-sector spending. As indicated by equation (12), depending on the temporal and intertemporal spending patterns of the government, the rise in government spending may induce a rightward or leftward shift of the N schedule in panel II of Figure 4.

In order to illustrate the working of the model, we consider in Figure 4 the effects of government spending for a benchmark case in which the intertemporal elasticity of substitution, σ, exceeds the temporal elasticity, σ_{nx}; the ratio of the shares of government spending to private spending in the current period, $(1 - \gamma_s^g)/(1 - \gamma_s)$, exceeds the corresponding ratio of future spending, γ_n^g/γ_s; government spending falls entirely on nontradable goods (so that $\beta_n^g = 1$); and the domestic private sector's saving propensity equals the foreign propensity. As indicated by equation (10), in this benchmark case the domestic, and thereby the world, relative-demand schedules shift leftward from the position indicated by D and D^w to the position indicated by D' and $D^{w\prime}$, respectively. Further, as indicated by equation (12),

[8] For detailed derivations, see Frenkel and Razin (1987, Chap. 9).

with $\beta_n^g = 1$ the relative supply of world tradable goods does not change. It follows that in this case the equilibrium point shifts from point A to point A' in panel I of Figure 4, and the world interest rate falls from r_{x0} to $\tilde{r}'_{x0}$.

In panel II of Figure 4 we show the effects of the rise in government spending on the paths of the domestic and foreign real exchange rates. As indicated by equation (13), in this benchmark case the N schedule shifts outward and, given the new lower world interest rate, the domestic and foreign equilibrium points shift from a and a^* to a' and $a^{*\prime}$, respectively. Accordingly, the percentage change (per unit of time) in the real exchange rates increases in both countries. In concluding the presentation of this benchmark case, we note that since the world interest rate (measured in terms of tradable goods) falls, and since in both countries the time paths of the real exchange rates steepen, it follows that in both countries the consumption-based real interest rates fall (even though, in general, the magnitude of this decline need not be the same for both countries).

We chose this specific benchmark case in which the rise in government spending lowers the world interest rate in order to highlight the implications of government spending on nontradable goods. In fact, if government spending falls entirely on tradable goods (so that $\beta_n^g = 0$), then the rise in spending does not alter the relative-demand schedules in Figure 4, as seen from equation (10) with $\beta_n^g = 0$, but it induces a leftward shift of the relative-supply schedule, as seen from equation (12) for the case $\gamma_s^g < \gamma_s$, $\beta_n^g = 0$. Thus, under such circumstances, the rise in government spending raises the equilibrium interest rate. This case underlies the simple transfer-problem criterion described in the introduction to this chapter.

The more general configurations of the effects of government spending on the world interest rate, as implied by equations (8) and (10), are summarized in Table 1, where we assume that initially $\gamma_s = \gamma_s^*$. The table demonstrates that if the commodity composition of government spending is strongly biased toward goods that are internationally tradable (so that β_n^g is small), then the key factor determining the direction of the change in the world interest rate is the intertemporal allocation of government and private-sector spending. If government spending is biased toward the current period relative to private-sector spending, so that γ_s exceeds γ_s^g, then the world interest rate rises, and vice versa. On the other hand, if the commodity composition of government spending is strongly biased toward nontradable goods (so that β_n^g is close to unity), then the direction of the change in the interest rate depends on the interaction between the intertemporal allocation of government spending relative to the private sector and the difference between the temporal and the intertemporal elasticities of substitution of the domestic private sector. In fact, since in this case the effects of government spending operate only through changes in the relative-de-

TABLE 1

THE EFFECTS OF A RISE IN GOVERNMENT SPENDING ON THE WORLD INTEREST RATE IN A MODEL WITH NONTRADABLE GOODS

Relationship between Temporal and Intertemporal Elasticities of Substitution	Intertemporal and Temporal Allocations of Government Spending: $\gamma_s > \gamma_s^g$, $\beta_n^g = 0$	$\gamma_s > \gamma_s^g$, $\beta_n^g = 1$	$\gamma_s < \gamma_s^g$, $\beta_n^g = 0$	$\gamma_s < \gamma_s^g$, $\beta_n^g = 1$
$\sigma_{nx} > \sigma$	+	+	–	–
$\sigma_{nx} = \sigma$	+	0	–	0
$\sigma_{nx} < \sigma$	+	–	–	+

NOTE: The world rate of interest is measured in terms of internationally tradable goods. This table assumes that initially $\gamma_s = \gamma_s^*$.

mand schedules, the interest rate rises if $(\sigma_{nx} - \sigma)(\gamma_s - \gamma_s^g)$ is positive, and vice versa.

The various possibilities concerning the relative magnitudes of the key parameters also imply that the effects of government spending on the time path of the domestic and foreign real exchange rates are not clear-cut. The possible outcomes are summarized in Table 2. The results show that if the commodity composition of government spending is strongly biased toward internationally tradable goods (so that β_n^g is about zero), then, as implied by equation (13), the change in government spending does not materially displace the *N* schedule in panel II of Figure 4. Therefore, the induced change in the path of the domestic real exchange rate mirrors only the change in the interest rate, since it involves a movement along the given *N* schedule. It follows that, with a small β_n^g, the change in the time path of the domestic real exchange rate is inversely related to the change in the world interest rate. This inverse relationship is verified from a comparison between the entries appearing in Tables 1 and 2 in the columns corresponding to the case of $\beta_n^g = 0$. Indeed, in this case the direction of the change in the path of the real exchange rate depends only on the simple transfer-problem criterion involving the saving propensities of the domestic private and public sectors.

In the other extreme case, in which government spending falls mainly on nontradable goods (so that β_n^g is close to unity), then, as long as the temporal elasticity of substitution, σ_{nx}, does not exceed the intertemporal elasticity of substitution, σ, the key factor determining whether the path of the real exchange rate steepens or flattens is the intertemporal allocation of government spending. If government spending is biased toward the current period relative to private-sector spending, so that γ_s exceeds γ_s^g, the rise in

TABLE 2

THE EFFECTS OF A RISE IN GOVERNMENT SPENDING ON THE PATHS OF DOMESTIC AND FOREIGN REAL EXCHANGE RATES

Relationship between Temporal and Intertemporal Elasticities of Substitution	The Real Exchange Rate in the	Intertemporal and Temporal Allocations of Government Spending			
		$\gamma_s > \gamma_s^g$		$\gamma_s < \gamma_s^g$	
		$\beta_n^g = 0$	$\beta_n^g = 1$	$\beta_n^g = 0$	$\beta_n^g = 1$
$\sigma_{nx} > \sigma$	Domestic economy	−	?	+	?
	Foreign economy	−	−	+	+
$\sigma_{nx} = \sigma$	Domestic economy	−	+	+	−
	Foreign economy	−	0	+	0
$\sigma_{nx} < \sigma$	Domestic economy	−	+	+	−
	Foreign economy	−	+	+	−

NOTE: The paths of the real exchange rates are measured by p_{n0}/p_{n1} and p_{n0}^*/p_{n1}^*. This table assumes that initially $\gamma_s = \gamma_s^*$.

spending accelerates the time path of the real exchange rate, and vice versa. On the other hand, if σ_{nx} exceeds σ, the time path of the real exchange rate is influenced by two conflicting forces, the one operating through a movement along the N schedule (induced by the change in the interest rate) and the other operating through a shift in the N schedule (induced by the direct effect of government spending on the relative supply of nontradable goods).

Finally, note that the foreign schedule, N^*, is not affected by domestic-government spending, so that the time path of the foreign real exchange rate, p_{n0}^*/p_{n1}^*, is always related negatively to the world interest rate. But since the correlation between the time path of the domestic real exchange rate and the world interest rate may be positive, zero, or negative (as can be verified by comparing the results reported in Tables 1 and 2), it follows that the cross-country correlations between the paths of the real exchange rates and between the (consumption-based) real interest rates may also be negative, zero, or positive. The analysis underlying Tables 1 and 2 identifies the main factors governing the signs of the various cross-country correlations.

Illustrative Simulations

The analytical framework and the theoretical model underlying the foregoing analysis were based on a two-period model of the world economy. This two-period model provides the main ingredients necessary for a dynamic intertemporal analysis. As illustrations of the working of the mechanisms we have developed, in this section we present dynamic simulations. To perform them we extend the two-period model to a multiperiod model with a longer time horizon. This extension permits a more detailed examination of the dynamic effects of government spending policies. The formal simulation model is presented in Appendix B.

After computing a baseline equilibrium, we disturb it by an exogeneous 10 percent rise in government spending. To construct the baseline equilibrium, we choose parameter values that yield trendless paths of the key economic variables. With this construction, the pure effects of exogeneous shocks can be easily ascertained.[9] We focus in the simulations on (1) the time profile of government spending in comparison with the private sector, that is, on whether γ_s^g exceeds or falls short of γ_s (or equivalently on whether temporary government spending occurs in the present or is anticipated to occur in the future); (2) the commodity composition of government spending in comparison with that of the private sector, that is, on whether β_n^g exceeds or falls short of β_n; and (3) the relative magnitudes of the temporal and intertemporal elasticities of substitution, that is, on whether σ_{nx} exceeds or falls short of σ. These simulations are shown in Figures 5 to 12 as percentage deviations from the corresponding baseline equilibrium paths. In all the figures, we show the effects of government spending on the paths of the world interest rate, r; on domestic and foreign real exchange rates, $q = 1/p_n$ and $q^* = 1/p_n^*$; on domestic and foreign real consumption, C and C^* (all measured as percentage deviations from baseline); and on the path of the domestic economy's external debt, B (measured in terms of tradable goods). On the whole, these figures provide multiperiod illustrations to the two-period results reported in Tables 1 and 2.

Figure 5 shows the effects of a temporary current rise in government spending on tradable goods for the case in which σ exceeds σ_{nx}. As can be seen, the temporary rise in government spending induces a temporary rise in the contemporaneous world interest rate and raises the contemporaneous domestic and foreign real exchange rates (the reciprocal of the relative price of nontradable goods). These changes are necessary to eliminate the excess demand for current tradable goods and the excess supply of current nontradable goods induced by the current rise in government spending and its

[9] Accordingly, we assumed that the paths of outputs in both countries are flat (normalized to unity), the subjective discount factors (δ and δ^*) are equal to 0.97, the intertemporal elasticities of substitution σ and σ^* are equal to unity, and the domestic and foreign expenditure shares are equal to each other. In addition, the baseline equilibrium zero current-account position implies that interest-rate changes exert only intertemporal substitution effects on the foreign economy, since income effects are absent.

associated tax burden. The fall in p_{no}^{*} reflects the reduced foreign demand for current nontradable goods arising from intertemporal substitution induced by the rise in the interest rate. The paths of these real exchange rates exhibit a downward trend as government spending falls back to its original level. The directions of changes in the contemporaneous interest rate and in the time paths of the real exchange rates are the same as those shown in Tables 1 and 2 for case $\beta_n^g = 0$, $\gamma_s > \gamma_s^g$, and $\sigma_{nx} < \sigma$. As can be seen in the medium and long run, the domestic relative price of nontradable goods exceeds the baseline, while the foreign relative price of nontradable goods falls short of the baseline. The lower panel of Figure 5 shows that the qualitative effects of the rise in government spending on the levels of domestic and foreign real consumption, C and C^*, are inversely related to the effect on the corresponding real exchange rates. Finally, note that throughout the adjustment process the path of external debt, B, exceeds the baseline path, reflecting the induced cumulative current-account deficit of the domestic economy.

Figure 6 employs the same parameter values as Figure 5 except that the temporary current government spending falls on nontradable goods. In that case, the direction of the change in the contemporaneous levels of the interest rate and of the domestic and foreign real exchange rates is opposite to the one portrayed in Figure 5. These results also correspond to those shown in Tables 1 and 2 for the case $\beta_n^g = 1$, $\gamma_s > \gamma_s^g$, and $\sigma_{nx} < \sigma$. Figure 6 also shows that in the medium and long run the domestic relative price of nontradable goods is below the baseline, while the foreign relative price exceeds the baseline. The paths of real consumption are again related inversely to those of the real exchange rate, while in the present case the path of external debt lies below the baseline and exhibits a negative trend. This reflects the cumulative surplus in the domestic economy's current account.

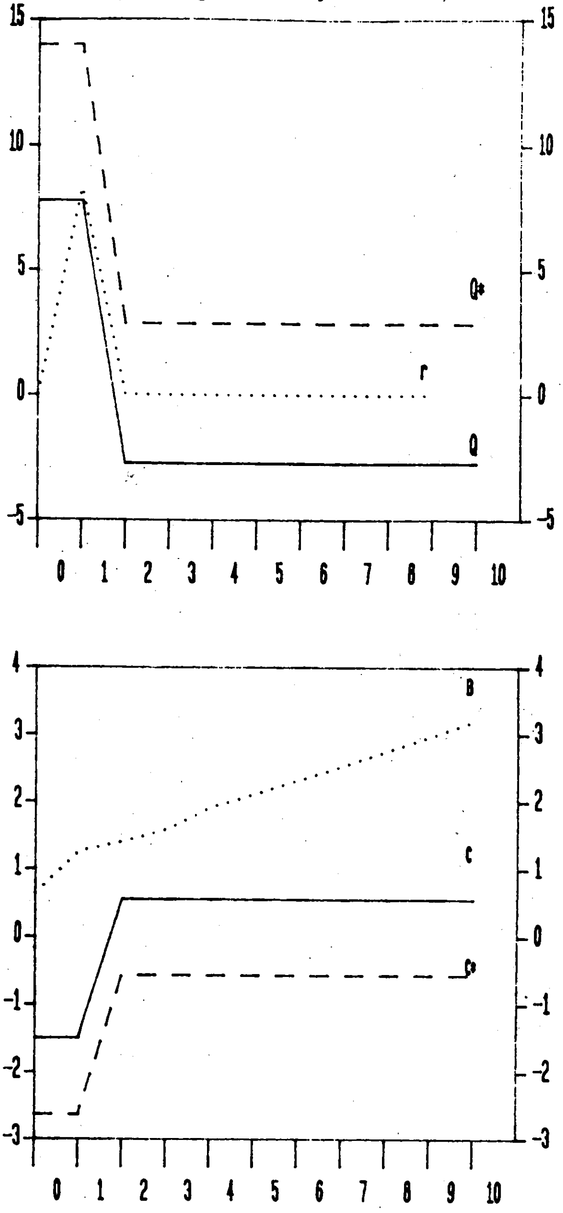
Figures 7 and 8 show the effects of an anticipated future temporary rise in government spending. Except that this assumption implies that γ_s falls short of γ_s^g, these figures use, respectively, the same parameter values as Figures 5 and 6. As can be seen, the effects of the future government spending on the current period are the opposite of those shown in Figures 5 and 6. These results conform with those reported in Tables 1 and 2 for the case $\gamma_s < \gamma_s^g$ and $\sigma_{nx} < \sigma$.

Figures 9 to 12 correspond to the case in which the temporal elasticity of substitution exceeds the intertemporal elasticity, so that σ_{nx} exceeds σ. As can be seen by comparison with the previous charts and by reference to Tables 1 and 2, the relative magnitudes of σ_{nx} and σ do not influence materially the qualitative effects of government spending if the latter is used for tradable goods (so that $\beta_n^g = 0$). On the other hand, if government

FIGURE 5

THE EFFECTS OF A TEMPORARY CURRENT RISE IN GOVERNMENT SPENDING ON TRADABLE GOODS ($\sigma_{nx} < \sigma$)

(percentage deviations from baseline)



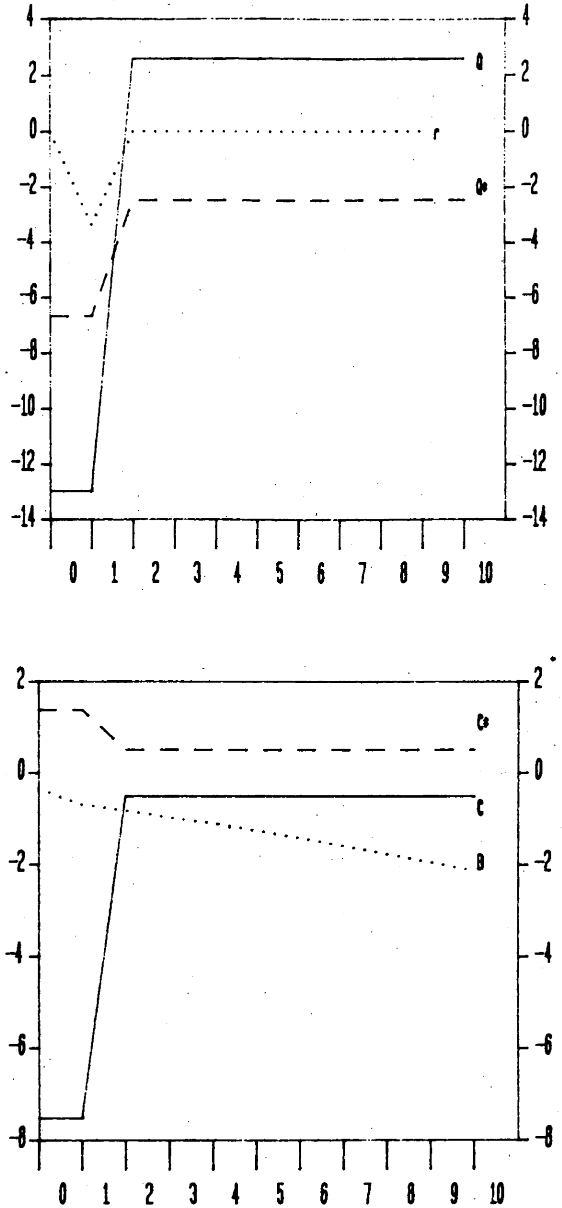
DATA: $\sigma = 1$, $\sigma_{nx} = 0.5$, $\gamma_s = 0.97$, $\gamma_s^g = 0$, $\beta_n^g = 0$.

Government spending is assumed to rise by 10 percent from baseline in periods 0 and 1.

FIGURE 6

The Effects of a Temporary Current Rise in Government Spending on Nontradable Goods ($\sigma_{nx} < \sigma$)

(percentage deviations from baseline)



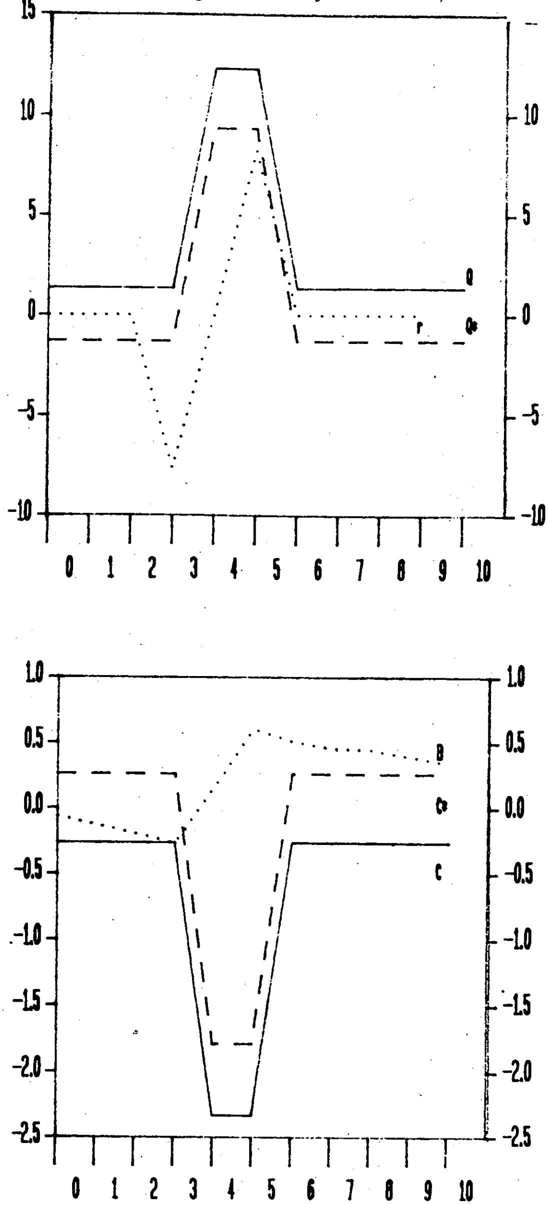
DATA: $\sigma = 1$, $\sigma_{nx} = 0.5$, $\gamma_s = 0.97$, $\gamma_s^g = 0$, $\beta_n^g = 1$.

Government spending is assumed to rise by 10 percent from baseline in periods 0 and 1.

FIGURE 7

THE EFFECTS OF A TEMPORARY FUTURE RISE IN GOVERNMENT SPENDING ON TRADABLE GOODS ($\sigma_{nx} < \sigma$)

(percentage deviations from baseline)



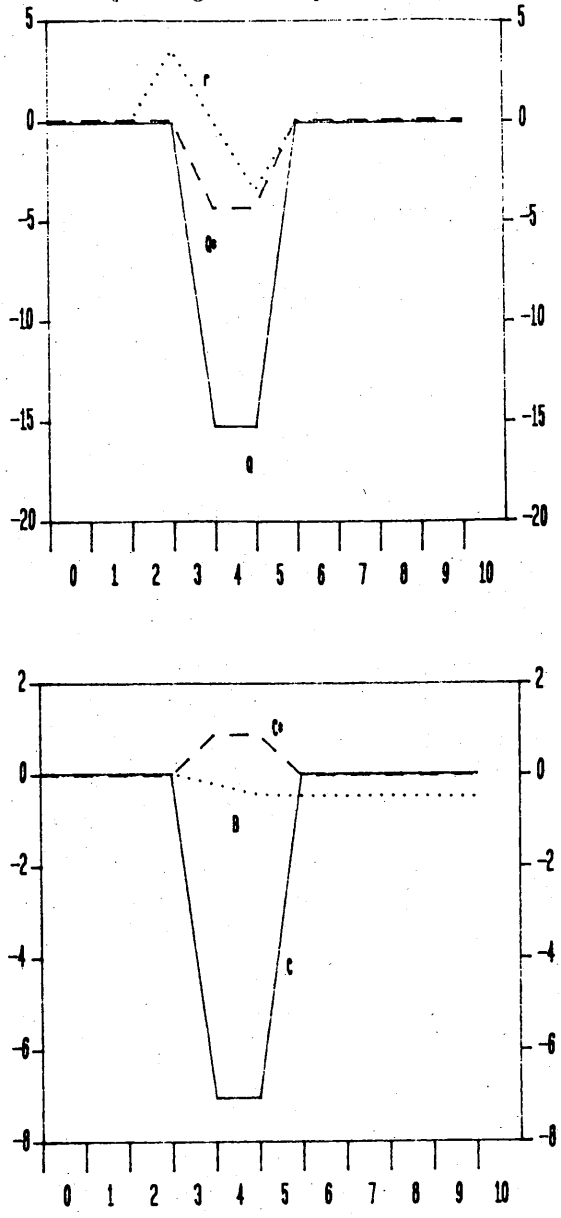
DATA: $\sigma = 1$, $\sigma_{nx} = 0.5$, $\gamma_s = 0.97$, $\gamma_s^g = 1$, $\beta_n^g = 0$.

Government spending is assumed to rise by 10 percent from baseline in periods 3 and 4.

FIGURE 8

THE EFFECTS OF A TEMPORARY FUTURE RISE IN GOVERNMENT SPENDING ON NONTRADABLE GOODS ($\sigma_{nx} < \sigma$)

(percentage deviations from baseline)



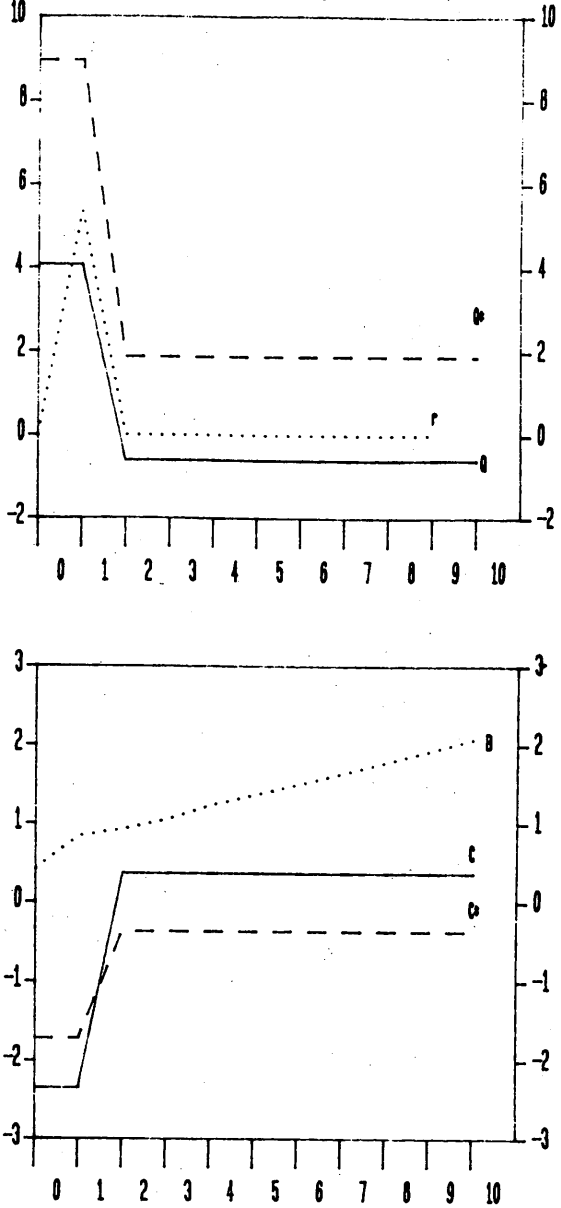
DATA: $\sigma = 1$, $\sigma_{nx} = 0.5$, $\gamma_s = 0.97$, $\gamma_s^g = 1$, $\beta_n^g = 1$.

Government spending is assumed to rise by 10 percent from baseline in periods 3 and 4.

FIGURE 9

THE EFFECTS OF A TEMPORARY CURRENT RISE IN GOVERNMENT SPENDING ON TRADABLE GOODS ($\sigma_{nx} > \sigma$)

(percentage deviations from baseline)



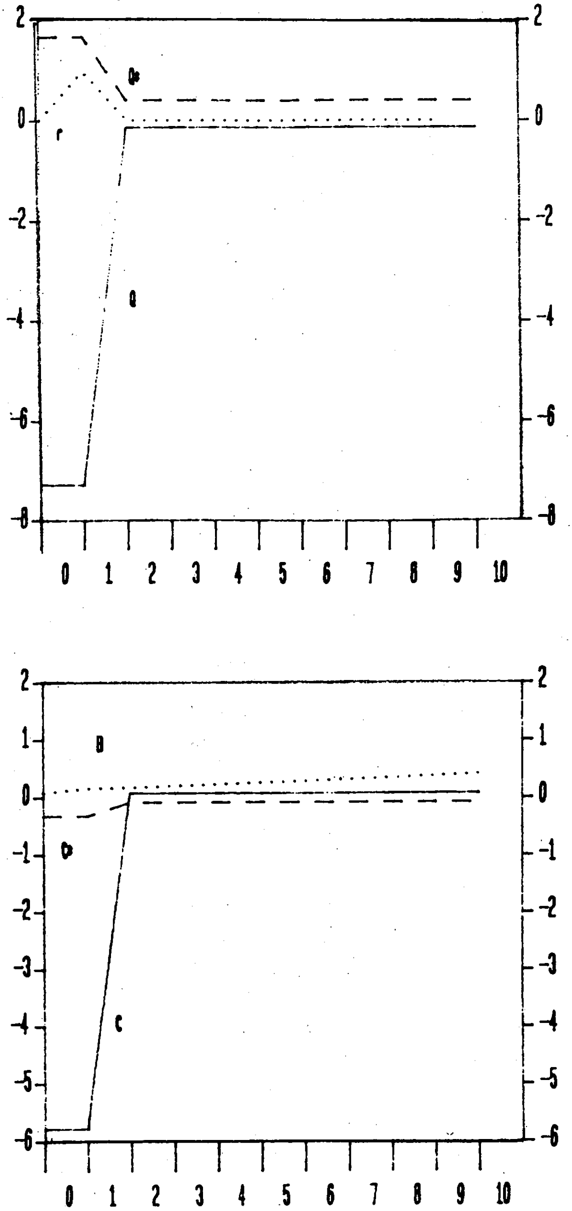
DATA: $\sigma = 1$, $\sigma_{nx} = 1.5$, $\gamma_s = 0.97$, $\gamma_s^g = 0$, $\beta_n^g = 0$.

Government spending is assumed to rise by 10 percent from baseline in periods 0 and 1.

FIGURE 10

THE EFFECTS OF A TEMPORARY CURRENT RISE IN GOVERNMENT SPENDING ON NONTRADABLE GOODS ($\sigma_{nx} > \sigma$)

(percentage deviations from baseline)



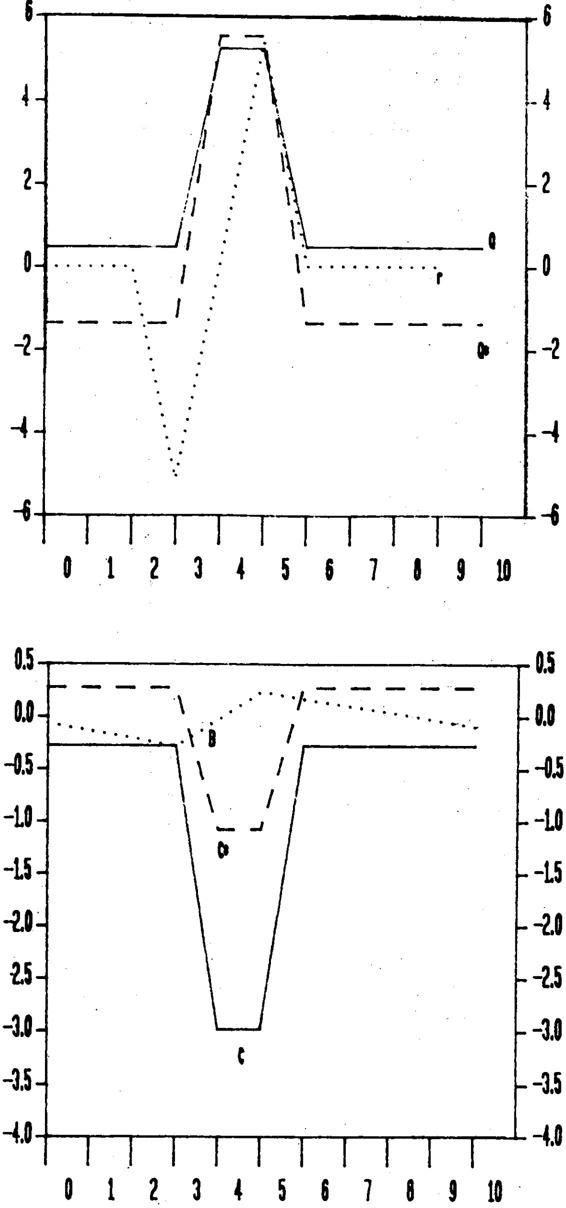
DATA: $\sigma = 1$, $\sigma_{nx} = 1.5$, $\gamma_s = 0.97$, $\gamma_s^g = 0$, $\beta_n^g = 1$.

Government spending is assumed to rise by 10 percent from baseline in periods 0 and 1.

FIGURE 11

THE EFFECTS OF A TEMPORARY FUTURE RISE IN GOVERNMENT SPENDING ON TRADABLE GOODS ($\sigma_{nx} > \sigma$)

(percentage deviations from baseline)



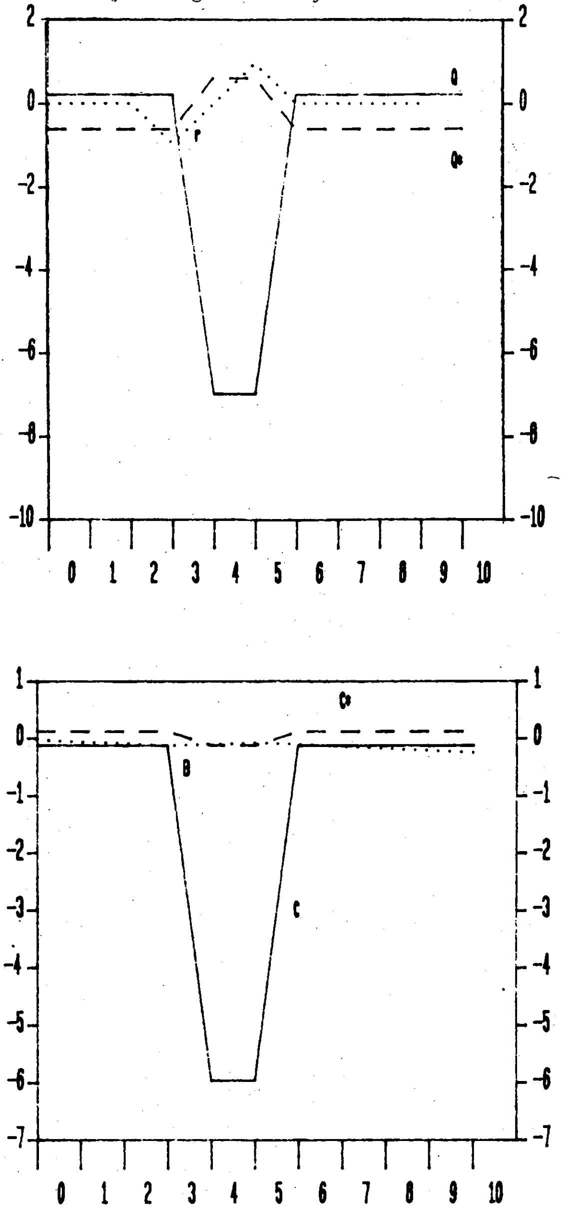
DATA: $\sigma = 1$, $\sigma_{nx} = 1.5$, $\gamma_s = 0.97$, $\gamma_s^g = 1$, $\beta_n^g = 0$.

Government spending is assumed to rise by 10 percent from baseline in periods 3 and 4.

FIGURE 12

THE EFFECTS OF A TEMPORARY FUTURE RISE IN GOVERNMENT SPENDING ON NONTRADABLE GOODS ($\sigma_{nx} > \sigma$)

(*percentage deviations from baseline*)



DATA: $\sigma = 1$, $\sigma_{nx} = 1.5$, $\gamma_s = 0.97$, $\gamma_s^g = 1$, $\beta_n^g = 1$.

Government spending is assumed to rise by 10 percent from baseline in periods 3 and 4.

spending falls on nontradable goods (so that $\beta_n^g = 1$), then, in conformity with the results shown in Tables 1 and 2, a change in the relative magnitudes of the two elasticities of substitution influences materially the direction of changes in the interest rate, the real exchange rates, and the current account.

3 TAX POLICIES

Heretofore, we have analyzed the effects of government spending under the assumption that taxes are nondistortionary. We next analyze the effects of tax policies by examining the effects of changes in distortionary taxes under the assumption that government spending remains intact.[1] To focus on tax policies, we set government spending at zero. To isolate the key mechanism through which tax policies influence private-sector behavior, we incorporate taxes into the definition of the discount factor and consider two tax systems: a consumption tax system and an income tax system. We analyze two forms of tax policies: tax-reduction policies resulting in budget deficits and tax-conversion policies that do not alter the path of government revenue.

Budget Deficits

The key proposition here is that the effects on the world economy of budget deficits arising from tax cuts depend critically on the tax system. To demonstrate this point, we examine first the effects of a consumption tax cut and then the effects of an income tax cut.

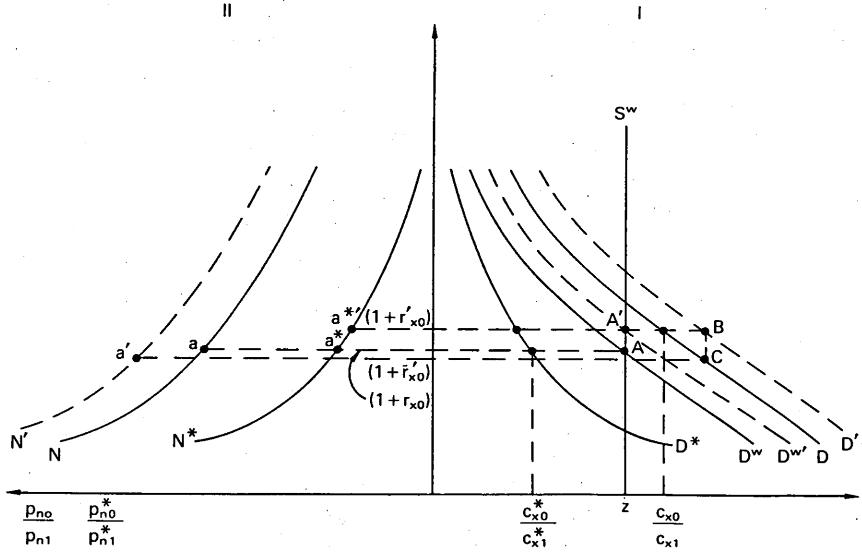
Effects of a Consumption Tax Cut. Consider a value-added tax system (VAT) under which exports are exempt. Clearly, this tax is equivalent to a consumption tax. In the presence of such a tax, the effective (tax-adjusted) discount factor is denoted by $\alpha_{x\tau 1}$, which is related to the undistorted world discount factor, α_{x1}, according to $\alpha_{x\tau 1} = [(1 + \tau_{c1})/(1 + \tau_{c0})]\alpha_{x1}$, where τ_{ct} is the ad valorem consumption tax rate in period t ($t = 0,1$). Correspondingly, the effective (consumption-based) real discount factor is denoted by $\alpha_{c\tau 1}$, where $\alpha_{c\tau 1} = (P_1/P_0)\,\alpha_{x\tau 1}$. With such a tax, private-sector demands depend on $\alpha_{c\tau 1}$ rather than on α_{c1}, and therefore changes in the time profile of taxes alter private-sector behavior. To simplify, we assume that foreign-government spending and taxes are zero.

A budget deficit arising from a current-period tax cut (a reduction in τ_{c0}) must be accompanied by a corresponding rise in future taxes (a rise in τ_{c1}) so as to maintain government solvency as long as government spending policies remain intact. The effects of such a change in the time profile of taxes are analyzed with the aid of Figure 13. The initial equilibrium is described

[1] For an elaborate analysis of distortionary tax systems, see Frenkel and Razin (1988). An alternative mechanism through which lump-sum tax policies influence the real exchange rate and the economic system, in which the horizons governing the private and public sectors' behavior do not coincide, is provided in Frenkel and Razin (1986a).

FIGURE 13

THE EFFECTS OF A BUDGET DEFICIT ARISING FROM A CUT IN A VALUE-ADDED TAX ON THE WORLD INTEREST RATE AND ON THE PATHS OF THE REAL EXCHANGE RATES



in panel I by point A, in which the world interest rate is r_{x0}. For convenience of exposition we assume that initially the time profile of taxes is "flat" ($\tau_{c0} = \tau_{c1}$), so that the domestic and foreign interest rates (in terms of tradable goods) are equal. Thus, the flat tax system is neutral with respect to the real equilibrium. The time paths of the domestic and foreign real exchange rates associated with the initial equilibrium are indicated in panel II by points a and a^* along the N and the N^* schedules. Thus, the initial equilibrium is identical to the one portrayed in Figure 4.

Consider the effects of a budget deficit arising from a tax cut. Such a tax policy breaks the "flatness" of the tax system. Given the initial value of the world interest rate, r_{x0}, the reduction in τ_{c0} and the increase in τ_{c1} (implied by the government budget constraint) raise the domestic effective discount factor, $\alpha_{x\tau 1}$, and induce an upward displacement of the domestic relative-demand schedule from D to D'. Assuming that initially γ_s equals γ_s^*, so that the change in the domestic-country weight in the world relative demand does not affect the world relative demand, the proportional vertical displacement of the schedule equals the proportional change in the effective discount factor. This displacement is necessary in order to offset the effect of the tax-induced reduction in the effective interest rate on the desired domestic consumption ratio. Corresponding to the new domestic schedule D', the world relative-demand schedule shifts from D^w to $D^{w\prime}$. The new equilibrium is described by point A' in panel I of Figure 13. Hence the world interest rate rises from r_{x0} to r'_{x0}. The proportional vertical displacement of the world relative-demand schedule, D^w (indicated by the distance AA'), is smaller than the corresponding displacement of the domestic schedule, D (indicated by the distance BC), since the world schedule is a weighted average of the domestic and the (given) foreign schedules. It follows that the domestic effective interest rate must fall from r_{x0} to a lower level such as $\tilde{r}'_{x0}$.

The change in the time profile of taxes, which (for any given level of the world interest rate) raises the effective discount factor, also alters the position of the domestic schedule N in panel II of Figure 13. By analogy to the previous analysis of the displacement of the relative-demand schedule, the proportional vertical displacement of the N schedule equals the percentage change in the effective discount factor. As indicated by equation (9), this displacement is necessary in order to offset the effects of the tax-induced reduction in the effective interest rate on the time path of the domestic real exchange rate. Hence, given the new domestic effective interest rate $\tilde{r}'_{x0}$, the rate of increase in the domestic real exchange rate from period 0 to period 1 accelerates (as p_{n0}/p_{n1} rises). Likewise, given the new world interest rate, r'_{x0}, the rate of increase in the foreign real exchange rate decelerates (as p^*_{n0}/p^*_{n1} falls). These changes are indicated in panel II of Figure 13 by the displacement of the equilibrium points a^* and a to $a^{*\prime}$ and a', respectively.

Effects of an Income Tax Cut. The foregoing analysis focused on the effects of budget deficits arising from a change in consumption taxes. We now examine the effects of a corresponding change in income taxes. For this purpose, the analytical framework, which allows for tradable and nontradable goods, can be reinterpreted and applied to the analysis of the effects of income tax policies on *real wages* in a model with variable labor supply. The reinterpretation of the model treats leisure as the nontradable good, the real wage as the real exchange rate, and the temporal elasticity of substitution as the (compensated) elasticity of labor supply. With this interpretation, government hiring of labor is viewed as government purchases of nontradable goods, and the relative share of government expenditure on nontradable goods, β^g_n, corresponds to the relative share of wages in the government budget. Likewise, the private-sector expenditure share, β_n, is viewed as the relative share of leisure in private-sector total spending (inclusive of the imputed value of leisure).[2] With this interpretation, an in-

[2] This interpretation suggests that the effects of government spending on the interest rate

come tax operates like a tax on tradable goods only (since leisure—the nontradable good—is not taxable).

To provide a meaningful analysis of the effects of income tax policies, we relax the assumption that labor is inelastically supplied. To simplify, we suppose that the production functions are linear, that preferences are homothetic, that the leisure and ordinary goods (in our case, the tradable goods) are separable in the utility function, and that the amounts of leisure (the nontradable good) consumed in two consecutive periods are gross substitutes. These assumptions imply that the effective discount factor governing the relative supply of tradable goods, $S = Y_{x0}/Y_{x1}$, is $\alpha_{n\tau1} = [(1-\tau_{y1})/(1-\tau_{y0})]\alpha_{c1}$, which measures the price of future leisure in terms of current leisure. As is evident, the relative supply depends negatively on the effective discount factor $\alpha_{n\tau1}$.

The positively sloped S schedule in Figure 14 reflects the positive dependence of the relative supply on the interest rate. A higher interest rate (measured in terms of tradable goods) corresponds to a higher consumption-based real interest rate which, in turn, induces substitution of current-period labor for future-period labor, resulting in a higher relative supply of tradable goods. The positively sloped S^* schedule is derived in an analogous manner for the foreign economy. The relative-supply schedule pertaining to the world, S^w, is a weighted average of the domestic and foreign relative supplies, so that $S^w = \mu_s S + (1 - \mu_s)S^*$, where the domestic country weight μ_s corresponds to the relative share of domestic output of tradable goods in world output in the second period. That is, $\mu_s = Y_{x1}/(Y_{x1} + Y^*_{x1})$.[3] Finally, in Figure 14, the world relative-demand schedule, D^w, as well as the nontradable goods market equilibrium schedules N and N^*, are analogous to the corresponding schedules in Figures 4 and 13, where the real wages w and w^* are identified with the relative price of nontradable goods.[4] The initial equilibrium is shown in Figure 14 by point A, at which the world interest rate is r_{x0}, and the world relative quantities of tradable goods are indicated by point z. The paths of the domestic and foreign real wages (the reciprocals of the real exchange rates) are indicated by points a and a^*, respectively.

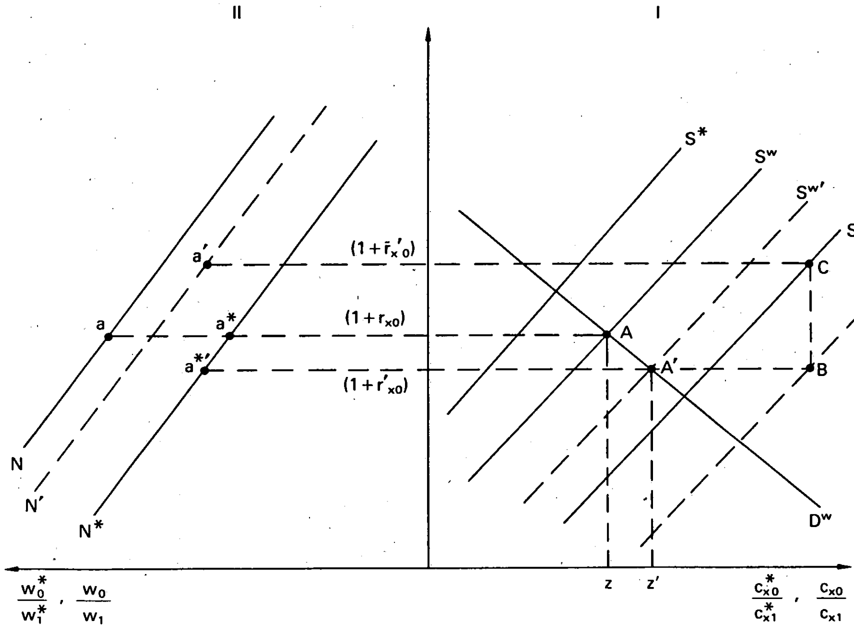
A budget deficit arising from a current cut in the income tax rate, τ_{y0}, which is compensated by a corresponding rise in the future income tax rate

and on the time path of real wages depend critically on the relative importance of wages in the government budget. For the remainder of this section we continue to assume zero government spending.

[3] Thus, the expression specifying the world relative supply is the analogue to equation (8) modified to allow for a variable labor supply with zero government spending.

[4] Again, in the present case the N and N^* schedules are adjusted for the dependence of the relative output of nontradable goods on the percentage growth rate of the real exchange rate.

FIGURE 14
THE EFFECTS OF A BUDGET DEFICIT ARISING FROM A CUT IN INCOME TAX ON THE WORLD INTEREST RATE AND ON THE PATH OF REAL WAGES (REAL EXCHANGE RATES)



τ_{y1}, lowers the effective discount factor $\alpha_{n\tau 1}$ at any given level of α_{c1}. This change induces an equiproportional downward displacement of the domestic relative-supply schedule (drawn against the reciprocal of the world discount factor) from S to S′. Since the world relative-supply schedule is a weighted average of the corresponding domestic and foreign schedules, and assuming that initially $\gamma_s = \gamma_s^*$, so that the change in the domestic-country weight, μ_s, does not affect the world relative supply, the displacement of the domestic schedule induces a smaller displacement of the world schedule from S^w to $S^{w'}$. Unlike the effect of this shift in the timing of income taxes on the relative-supply schedules, the relative-demand schedules remain intact since relative demand for tradable goods depends on the consumption discount factor, α_{c1}, which is not influenced by income taxes. As seen in Figure 14, the new equilibrium obtains at point A', at which the world interest rate falls from r_{x0} to r'_{x0} and the relative quantity of tradable goods rises from z to z'. In the new equilibrium, the domestic effective interest rate (applicable to the intertemporal labor-supply decision) rises to

$\tilde{r}'_{x0}$. The wedge between the world and the domestic effective interest rates is indicated by the distance BC, reflecting the existence of income taxes.

The change in the time profile of income taxes also alters the position of the domestic market-clearing schedule for nontradable goods, from N to N' in panel II of Figure 14. This downward shift in the schedule is necessary in order to eliminate the excess supply of current-period labor induced by the change in the time profile of taxes, because a lower interest rate raises current demand for leisure relative to future demand and thereby eliminates the current excess supply of labor. Hence, given the new lower world interest rate, the rate of growth in the foreign real wage decelerates, as indicated by the move from point a^* to point $a^{*\prime}$ along the N^* schedule. Analogously, given the new higher domestic effective interest rate, the rate of growth of the domestic wage accelerates, as indicated by the move from point a, along the N schedule, to point a', along the N' schedule.

The key consequences of the budget deficits are summarized in Table 3, which highlights the contrast between the consumption and the income tax systems.[5]

TABLE 3

THE EFFECTS OF DOMESTIC BUDGET DEFICITS ARISING FROM A CUT IN TAXES ON CONSUMPTION AND INCOME

	r_{x0}	$\tilde{r}_{xc}$	r_{x1}	g_w	g^*_w
Consumption taxes	+	−	+	−	+
Income taxes	−	−	+	+	−

NOTE: r_{x0}, r_{xc} and r_{x1} denote, respectively, the world rate of interest and the domestic effective rates of interest applicable to decisions concerning consumption of tradable goods and leisure; g_w and g^*_w denote, respectively, the growth rates of domestic and foreign real wages measured in terms of tradable goods (the growth rates of the reciprocals of the corresponding real exchange rates). This table assumes that initially $\gamma_s = \gamma^*_s$.

Revenue-Neutral Tax Conversions

The foregoing analysis can also be cast to illuminate key international effects of tax reforms that involve revenue-neutral tax conversions.[6] For this purpose, we consider an economy undertaking a tax reform that substitutes a consumption tax system for an income tax system. To maintain revenue

[5] The reader can infer some additional consequences concerning the growth rates of tradable-goods consumption from Figures 13 and 14.

[6] This analysis draws on Frenkel and Razin (forthcoming).

neutrality, we assume that consumption tax rates are adjusted so as to keep intact total tax revenue in each period. As an analytical matter, the tax reform can be thought of as consisting of two components. First, it involves a permanent reduction in the prevailing income tax and a permanent equiproportional rise in the consumption tax. Clearly, since this component of the reform does not alter the time profile of tax rates, it keeps intact the effective discount factors governing intertemporal decisions concerning consumption and labor supply.[7] Second, to maintain revenue neutrality in each period, the periodic consumption tax rates may need further adjustment. The extent and direction of this additional adjustment depend on whether the first component of the reform generates a budgetary surplus or a deficit. Since the offsetting changes in tax *rates* are equiproportional to each other, it follows that the only factor governing the change in the tax revenue is the size of the *consumption tax base* relative to that of the *income tax base*. If the consumption tax base exceeds the income tax base, the first component of the conversion from an income tax system to a consumption tax system generates a budgetary surplus, and vice versa.

In an open economy, the relative size of these two tax bases reflects the economy's current-account position. Specifically, if the domestic economy runs an initial-period trade-balance deficit, then the level of its consumption exceeds income and the equiproportional conversion from income to consumption tax generates a corresponding *initial-period* budgetary surplus. By the same token, the economy's intertemporal solvency necessitates a future trade-balance surplus so that consumption falls short of income. It follows that the same equiproportional tax conversion generates a *future-period* budgetary deficit. These departures from revenue neutrality imply that the second component of the reform involves a reduction in the current-period consumption tax rate, τ_{c0}, and a corresponding rise in the future-period tax rate, τ_{c1}. These changes raise the effective discount factor, $\alpha_{x\tau1}$ (applicable to consumption decisions), while keeping intact the effective discount factor, $\alpha_{n\tau1}$ (applicable to intertemporal labor-supply decisions).

Note that the changes in the effective discount factors arising from the tax changes in the conversion from an income tax system to a consumption tax system are always in the same direction as in our analysis of budget deficits arising from consumption tax cuts. Thus, Figure 13 can also be used to determine the effects of this tax conversion. Accordingly, as indicated by the first row in Table 3, if the conversion takes place in an economy running a current-account deficit, the world interest rate rises, the effective interest rate governing domestic consumption decisions falls, and the corresponding

[7] This can be verified by recalling that the effective discount factors are $\alpha_{x\tau1} = [(1 + \tau_{c1})/(1 + \tau_{c0})]\alpha_{x1}$ and $\alpha_{n\tau_1} = [(1 - \tau_{y1})/(1 - \tau_{y0})]\alpha_{c1}$.

interest rate governing labor-supply decisions also falls. In addition, the growth rate of domestic real wages declines while the corresponding foreign rate rises. Using the same arguments, the opposite pattern prevails if the tax conversion takes place in an economy running a current-account surplus.

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 conversion yields a budgetary surplus if the initial-period current-account position was in surplus (so that income exceeds consumption). The restoration of revenue neutrality therefore involves a reduction in the initial-period income tax rate, τ_{y0}, and a corresponding rise in the future-period income tax rate, τ_{y1}. These changes in the time profile of income taxes lower the effective discount factors governing consumption decisions, $\alpha_{n\tau1}$, while keeping intact the effective discount factors governing consumption decisions, $\alpha_{n\tau1}$.

These changes are qualitatively similar to those obtained in our previous analysis of a budget deficit arising from income tax cuts, shown in Figure 14. As indicated in the figure and shown in the second row of Table 3, with this tax conversion both the world interest rate and the effective interest rate governing consumption decisions fall, and the effective interest rate governing domestic labor-supply decisions rises. In addition, the growth rate of domestic real wages rises, while the corresponding foreign growth rate falls. The opposite changes take place if the initial current-account position was in deficit.

The principal result derived from this section is that the direction of change in key macroeconomic variables (such as the world interest rate) caused by revenue-neutral tax reforms depends critically on the economy's current-account position.

4 CONCLUDING REMARKS

We have dealt here with the effects of government spending and tax policies on the world economy. Using the modern international-intertemporal approach, our analysis has shown the precise manner in which the effects of government spending depend critically on two biases: the bias in the *intertemporal* allocation of government spending relative to the domestic private sector, and the bias in the commodity *composition* of government purchases relative to the domestic private sector. When government spending is strongly biased toward purchases of tradable goods, the key factor determining whether the world interest rate rises or falls is the intertemporal pattern of government spending relative to the private sector: if the government intertemporal pattern is biased toward current spending, the interest rate rises, and vice versa.

The analysis has also provided information about the time paths of the domestic and foreign real exchange rates. When the share of government spending on tradable goods is relatively high, a rise in government spending decelerates the rates of change of the domestic and foreign real exchange rates if the intertemporal allocation of government spending (relative to the private sector) is biased toward the present. But if the intertemporal allocation of government spending (relative to the private sector) is biased toward the future, the rates of change of the real exchange rates accelerate. It follows that, in this case, government spending induces positive cross-country correlations between the time paths of the real exchange rates as well as between the (consumption-based) real interest rates.

In contrast, if the commodity composition of government spending is strongly biased toward purchases of nontradable goods, the interest-rate effects depend on the interaction between the bias in the intertemporal allocation of government spending relative to the private sector and the temporal-intertemporal substitution bias of the domestic private sector. It is important to emphasize that, even though there is no presumption concerning the precise effects of government spending on the world interest rate and on the time paths of the real exchange rates, we identify the key (estimatable) parameters whose relative magnitudes determine these effects. The analytical results obtained from the compact model are supplemented by dynamic simulations that illustrate the dynamic characteristics governed by these principles.

After analyzing government spending policies, we examined the effects of tax policies under alternative tax systems—consumption tax and income tax systems. We showed that with consumption taxes a budget deficit raises the world interest rate and lowers the domestic effective interest rate applicable to domestic consumption decisions. In addition, the deficit decelerates the rate of change of the domestic real exchange rate and accelerates the corresponding foreign rate of change. The deficit thereby lowers the domestic (consumption-based) effective real interest rate and raises the corresponding foreign real interest rate. These changes result in a negative cross-country correlation between the (consumption-based) real effective interest rates. In contrast, under an income tax system, the same budget deficit *lowers* the world interest rate and raises the domestic effective rate applicable to intertemporal labor-supply decisions. We showed that the deficit accelerates the rate of growth of the domestic real wage and decelerates the corresponding foreign growth rate.

Our analysis of budget deficits arising from tax cuts was designed to illuminate the effects of revenue-neutral tax-conversion schemes. We demonstrated that the effects of such shifts between income and consumption tax systems *raise* the world interest rate if the current-account position is in deficit. The revenue-neutral tax conversions *lower* the world interest rate if the current-account position is in surplus.

We conclude by reiterating one of the principal implications of this study. A proper analysis of the effects of fiscal policies on the world economy cannot be carried out on the basis of a single aggregate measure of the fiscal stance such as the budget deficit. It must be based on more detailed and specific information on government spending and taxes. On the spending side, such information must specify the distribution of spending between tradable and nontradable goods and its intertemporal allocation. On the revenue side, the information must specify the characteristics of the tax system, including the timing of taxes and the types of taxes used to finance the budget.

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APPENDIX A

THE World INTEREST RATE, TRADABLE-GOODS CONSUMPTION, AND THE REAL EXCHANGE RATE

In this appendix, we derive the effects of the world discount factor on the growth rate of consumption of tradable goods and on the path of the real exchange rate. Recall that the market for nontradable goods must clear during each period. The equilibrium conditions indicated by equations (2) to (3) of the text are:

$$c_{n0}[p_{n0}, P_0C_0(\alpha_{c1}, W_{c0})] = \bar{Y}_{n0} - G_{n0} \tag{A.1}$$

$$c_{n1}[p_{n1}, P_1C_1(\alpha_{c1}, W_{c0})] = \bar{Y}_{n1} - G_{n1}. \tag{A.2}$$

Using these equations and the Slutsky decomposition, the percentage changes in $p_{nt}(t = 0,1)$ for a given percentage change in the world discount factor are:

$$\hat{p}_{n0} = \left[\frac{\gamma_s\sigma}{\beta_n\sigma + (1 - \beta_n)\sigma_{nx}} + \frac{\gamma_s(\mu_1 - 1)}{(1 - \beta_n)\sigma_{nx}}\right]\hat{\alpha}_{x1} \tag{A.3}$$

$$\hat{p}_{n1} = \left[\frac{-(1 - \gamma_s)\sigma}{\beta_n\sigma + (1 - \beta_n)\sigma_{nx}} + \frac{\gamma_s(\mu_1 - 1)}{(1 - \beta_n)\sigma_{nx}}\right]\hat{\alpha}_{x1}\ , \tag{A.4}$$

where a circumflex ($\hat{}$) denotes percentage change of a variable, and where μ_1 denotes the ratio of future net output to private consumption. Subtracting (A.4) from (A.3) yields equation (A.5), which is equation (9) of the text:

$$\frac{d\log(p_{n0}/p_{n1})}{d\log\alpha_{x1}} = \frac{\sigma}{\beta_n\sigma + (1 - \beta_n)\sigma_{nx}}\ . \tag{A.5}$$

In determining the percentage change in c_{xt} $(t = 0,1)$, we differentiate equation (5) in the text and use the Slutsky decomposition. This yields

$$\hat{c}_{x0} = \beta_n(\sigma_{nx} - \gamma_s\sigma)\hat{p}_{n0} + \beta_n\gamma_s\sigma\hat{p}_{n1} + \gamma_s(\sigma + \mu_1 - 1)\hat{\alpha}_{x1} \tag{A.6}$$

$$\begin{aligned}\hat{c}_{x1} &= \beta_n(1 - \gamma_s)\sigma\hat{p}_{n0} + \beta_n[\sigma_{nx} - (1 - \gamma_s)\sigma]\hat{p}_{n1} \\ &\quad - [(1 - \gamma_s\sigma - \gamma_s(\mu_1 - 1)]\hat{\alpha}_{x1}\ .\end{aligned} \tag{A.7}$$

We can use these equations to determine the elasticity of the consumption ratio, c_{x0}/c_{x1}, with respect to the growth rate of the real exchange rate, p_{n0}/p_{n1}. This yields

$$\frac{d \log (c_{x0}/c_{x1})}{d \log (p_{n0}/p_{n1})} = \beta_n(\sigma_{nx} - \sigma) \, . \tag{A.8}$$

Equation (A.8) shows that the qualitative effects of the changes in the price ratio p_{n0}/p_{n1} on the consumption ratio of tradable goods, c_{x0}/c_{x1}, depend only on whether the temporal elasticity of substitution, σ_{nx} exceeds or falls short of the intertemporal elasticity of substitution, σ. A rise in the relative price of nontradable goods, p_{nt}, induces substitution of consumption of tradable goods for nontradable goods *within* period t. The magnitude of this temporal substitution is indicated by σ_{nx}. Further, if p_{n0} rises by more than p_{n1} (so that the ratio p_{n0}/p_{n1} also rises), the extent of the temporal substitution within the current period exceeds the corresponding substitution within the future period. As a result, the ratio of current to future consumption of tradable goods rises. This is reflected by the positive term $\beta_n\sigma_{nx}$ in equation (A.8). The same rise in the intertemporal price ratio p_{n0}/p_{n1} raises the (consumption-based) real interest rate (and lowers the corresponding real discount factor, α_{c1}). This rise in the real interest rate induces substitution of spending *between* periods: from the present to the future period. The magnitude of this intertemporal substitution is indicated by the negative term $-\beta_n\sigma$ in equation (A.8). Finally, we note that the change in the intertemporal consumption ratio does not depend on private wealth. This reflects the homotheticity assumption, which implies that the tax-induced fall in wealth lowers current and future demand for tradable goods by the same proportion.

In order to determine the elasticity of tradable-goods consumption with respect to the discount factor we substitute equations (A.3) to (A.4) into (A.6) to (A.7), and obtain

$$\hat{c}_{x0} = \gamma_s \left[\frac{\sigma_{nx}\sigma}{\beta_n\sigma + (1 - \beta_n)\sigma_{nx}} + \frac{\mu_1 - 1}{1 - \beta_{nx}} \right] \hat{\alpha}_{x1} \tag{A.9}$$

$$\hat{c}_{x1} = \left[\frac{-(1 - \gamma_s)\sigma_{nx}\sigma}{\beta_n\sigma + (1 - \beta_n)\sigma_{nx}} + \frac{\gamma_s(\mu_1 - 1)}{1 - \beta_n} \right] \hat{\alpha}_{x1} \, . \tag{A.10}$$

Subtracting (A.10) from (A.9) yields equation (A.11), which is equation (6) of the text:

$$\frac{d \log (c_{x0}/c_{x1})}{d \log \alpha_{x1}} = \frac{\sigma_{nx}\sigma}{\beta_n\sigma + (1 - \beta_n)\sigma_{nx}} \, . \tag{A.11}$$

Finally, combining equations (13) and (A.8) yields equation (10) of the text.

APPENDIX B

THE MULTIPERIOD SIMULATION MODEL

In this appendix, we present the analytical model underlying the illustrative simulations in Chapter 3. For this purpose, suppose that the utility function is

$$U = \sum_{t=0}^{T} \delta^t \log C_t + \sum_{t=0}^{T} \delta^t V(G_{nt}, G_{xt}) \tag{B.1}$$

and

$$C_t = [\beta_n c_{nt}^{\rho} + (1 - \beta_n) c_{xt}^{\rho}]^{1/\rho}, \tag{B.2}$$

where T denotes the time horizon, δ denotes the subjective discount factor, and where β_n and ρ are parameters of the utility function. Equation (B.1) implies that the intertemporal elasticity of substitution, σ, is unity and equation (B.2) implies that the temporal elasticity of substitution, σ_{nx}, is $1/(1-\rho)$. As formulated in equation (B.1), the utility derived from government spending is indicated by the function $V(G_{nt}, G_{xt})$, which enters separably into the utility function. This separability assumption implies that the private-sector demand functions are independent of government services.

The private-sector wealth constraint, analogous to the text equation (4), is

$$W_0 = \sum_{t=0}^{T} \alpha_{xt}[\bar{Y}_{xt} - G_{xt} + p_{nt}(\bar{Y}_{nt} - G_{nt})] - (1 + r_{x,-1})B_{-1}, \tag{B.3}$$

where α_{xt} denotes the world present-value factor.

Maximization of the utility function subject to the wealth constraint yields the demand functions for tradable and nontradable goods, c_{xt} and c_{nt}, as well as the consumption-based price index P_t and the expenditure function $E_t = P_t C_t$, where C_t denotes the consumption-based real expenditure (i.e., real consumption):

$$c_{xt} = \frac{(1 - \beta_n)^{\sigma_{nx}}}{[(1 - \beta_n)^{\sigma_{nx}} + \beta_n^{\sigma_{nx}} p_{nt}^{1 - \sigma_{nx}}]} E_t \tag{B.4}$$

$$c_{nt} = \frac{\beta_n^{\sigma_{nx}} p_{nt}^{- \sigma_{nx}}]}{[(1 - \beta_n)^{\sigma_{nx}} + \beta_n^{\sigma_{nx}} p_{nt}^{1 - \sigma_{nx}}]} E_t \tag{B.5}$$

$$P_t = [(1 - \beta_n)^{\sigma_{nx}} + \beta_n{}^{\sigma_{nx}} p_{nt}{}^{1 - \sigma_{nx}}]^{\frac{1}{1 - \sigma_{nx}}} \quad \text{(B.6)}$$

$$E_t = \frac{\delta^t}{\alpha_{xt}} \frac{(1 - \delta)}{(1 - \delta^T)} W_0 \ . \quad \text{(B.7)}$$

Analogous functions pertain to the foreign economy, with asterisks denoting foreign quantities. The market-clearing conditions for nontradable goods are

$$c_{nt} = \bar{Y}_{nt} - G_{nt} \quad \text{(B.8)}$$

$$c^*_{nt} = \bar{Y}^*_{nt} - G^*_{nt} \ , \quad \text{(B.9)}$$

and the corresponding condition for the world tradable-good market is

$$c_{xt} + c^*_{xt} = (\bar{Y}_{xt} - G_{xt}) + (\bar{Y}^*_{xt} - G^*_{xt}) \ . \quad \text{(B.10)}$$

The system of equations (B.4) to (B.7), along with their foreign-economy counterparts, and the market-clearing conditions (B.8) to (B.10) are used to generate the simulations.

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ISBN 0-88165-235-0