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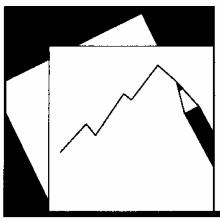

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A New-Open-Economy-Macro Model for Fiscal Policy Evaluation

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A New-Open-Economy-Macro Model for Fiscal Policy Evaluation

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Abstract

We develop a New-Open-Economy-Macro model in which Ricardian equivalence does not hold because of (i) distortionary labor and corporate income taxation; (ii) limited asset market participation; and (iii) because the overlapping-generations structure results in a disconnect between current and future generations. We consider a permanent increase in government debt following a cut in labor or corporate income taxes in a small and large open economy. We analyze the sensitivity of the results to the key structural parameters of the model and argue that under plausible assumptions there will be significant crowding-out effects associated with permanent increases in government debt.

JEL Classification Numbers: E62, F41, F42, H30, H63

Keywords: Finite lives, distortionary taxes, rule-of-thumb consumers, government debt

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Contents Page

I. Introduction

The crowding-out effect of government debt continues to be an area that is of considerable interest in policy circles. However, the emergence and popularity of the New-Open-Economy-Macroeconomics (NOEM) paradigm has resulted in monetary policy issues becoming the center of studying macroeconomic interdependence across countries while there has been much less attention directed at fiscal issues. Indeed, standard NOEM models typically specify an infinitely lived representative agent in a perfect-foresight setting with nondistortionary taxation implying that the Ricardian equivalence hypothesis holds, and the analysis of fiscal policy is confined to studying the effects of balanced-budget fiscal policies.[2] With the reemergence of fiscal deficits in the United States, as well as fiscal policy issues elsewhere, the idea of bringing the rigorous microfoundations of NOEM paradigm to the analysis of fiscal policies is very appealing.[3]

In this paper we develop a two-region NOEM model suitable for the evaluation of alternative fiscal policies when Ricardian equivalence is not expected to hold. There are three reasons why Ricardian equivalence does not hold in the model. First, the model features an overlapping-generations structure where current generations are disconnected from future generations. Second, both labor and corporate income taxes are distortionary because labor effort and capital formation respond to relative price movements that result directly from tax wedges. Third, it is also assumed that a certain proportion of wage income accrues to rule-of-thumb consumers who vary their consumption one-for-one with their after-tax labor income.

Relative to previous studies that have focused on the crowding-out effects of fiscal policy in economies with only traded goods, the multi-sectoral and multi-regional dimensions of the model provides a richer framework by allowing for additional channels through which fiscal policy can operate to induce changes in relative prices. Specifically, developing a fiscal model within the NOEM framework can bring insights beyond those from Real Business Cycle (RBC) or New Keynesian (NK) models, which face difficulties in adequately replicating the dynamic effects of fiscal policy—for example, see Blanchard and Perotti (2002). In order for an RBC model to capture the dynamic effects of government spending on the real economy, Fatas and Mihov (2001) argue that the model must be extended in order to replicate plausible dynamics by including features such as liquidity constraints, finite horizons, or some sort of myopic behavior. Similar arguments are made by Gali, López-Salido, and Vallés (2003) in their critique of NK models, which argue that inclusion of both nominal rigidities (price stickiness) and non-Ricardian (rule-of-thumb) consumers may be required for NK models to match the reduced-form empirical evidence on the

[2]See Obstfeld and Rogoff (1995, 1996), Betts and Devereux (2001), Caselli (2001), Corsetti and Pesenti (2001), and Ganelli (2003*a*). In a recent paper, Erceg, Guerrieri, and Gust (2005) add rule-of-thumb consumers to a model based on the representative agent paradigm and then use the model to study the effects of recent U.S. fiscal deficits on the current account deficit. Not surprisingly, they find much smaller effects than in models that allow for the possibility that permanent increases in government debt can have permanent consequences for the stock of net foreign liabilities and the world real interest rate.

[3]See Ganelli and Lane (2002) for a discussion about the need to give a greater role to fiscal policy in NOEM models.

effects of government spending shocks on consumption. This paper incorporates some of these suggestions by relying on a finite-horizon setup with distortionary taxes and rule-of-thumb consumers.

Bringing an overlapping generations setting into a NOEM model has been undertaken by Ghironi (2003*a* and 2003*b*) and by Ganelli (2003*b*).[4] The former does not consider the effects of government debt, but shows that an overlapping generations structure following Blanchard (1985) and Weil (1989) ensures the existence of a well-defined steady state for net foreign asset holdings (see also Buiter, 1981). Ghironi, Iscan, and Rebucci (2005) describe how differences in agents' discount factors across countries gives rise to nonzero net foreign asset positions in the long run.

Our model bears the closest resemblance to Ganelli (2003*b*), which is the first attempt to analyze alternative fiscal policies in a NOEM model with finite lives. This paper extends Ganelli (2003*b*) in various directions: (*i*) the utility function is less restrictive permitting more realistic and smaller values of the intertemporal elasticity of substitution; (*ii*) the production structure is extended to include endogenous capital formation, which provides an additional channel through which government debt can crowd out economic activity and allows for the consideration of corporate income taxation; (*iii*) the model features both traded and nontraded goods which allows us to consider the implications of home bias in either consumption or government spending; (*iv*) the labor supply decision is endogenous and consequently labor income taxes will be distortionary; and (*v*) the current setup features rule-of-thumb consumers, which provides a third channel through which government debt affects private activity.

The intuition of the resulting model is as follows. In general, a debt-financed reduction in taxes results in an increase in private consumption as agents perceive themselves to be wealthier. The extent to which they perceive this follows from the fact that they are disconnected from future generations, who help finance the interest burden associated with higher levels of government debt. The degree to which they increase consumption depends on their effective planning horizons, which are assumed to be zero for liquidity-constrained consumers and some finite number for other consumers. It also depends on the extent to which taxes are distortionary, which in turn depends on the elasticity of labor supply (for a reduction in labor income taxes) and the elasticity of substitution between capital and labor (in the case where corporate income taxes are being cut).

Twin deficits (government and the current account) emerge as a result of this change in fiscal policy, which implies that the real exchange rate needs to depreciate in the long run to generate the higher trade flows that are necessary to finance the higher stock of net foreign liabilities. Depending on the sensitivity of consumers to changes in the real interest rate (i.e., the intertemporal elasticity of substitution) as well as the size of the home economy in terms of the world economy, the real interest rate adjusts correspondingly in the long run, which affects capital accumulation and output. The exchange rate and interest rate movements, together with trade linkages, are the main channels through which

[4]See Frenkel and Razin (1992) for a diagrammatic exposition of a two-country overlapping-generations model without distortionary taxation.

spill-over effects to the rest of the world occur.

Thus, the time profile of taxes and deficits will have effects on labor effort, capital accumulation, and the aggregate savings rate of the economies at home and abroad. This will become clear in the base-case calibration of the model, for which we illustrate the model's predictions by considering the macroeconomic implications of a debt-financed reduction in labor income taxes and then compare this to a reduction in corporate income taxes.[5] In addition, we analyze the sensitivity of the base-case results to the key structural parameters of the model, which include: the planning horizon of agents; the share of rule-of-thumb consumers; the elasticity of labor supply; the elasticity of substitution between capital and labor; the intertemporal elasticity of substitution; and the size of the home economy in terms of world GDP.

The remainder of the paper has five sections. Section II presents the theoretical structure of the model. Section III discusses the base-case calibration of the model and then presents results for a fiscal policy shock where labor taxes are cut for ten years and are financed by issuing government debt. We discuss the effects on the home economy, the spillover effects on the foreign economy, as well as the implications for the nontradables and tradables sectors. As we will assume that wages and prices are perfectly flexible, the main emphasis throughout the paper will be on assessing the medium- and long-term effects of the tax cut rather than on whether the short-run multipliers match those obtained from empirical reduced-form evidence. In Section IV we discuss the sensitivity of the results to variations in the key structural parameters. Section V provides some concluding remarks and outlines possible extensions.

II. The Model

The world consists of two countries, home and foreign. Countries are populated with overlapping generations of agents with finite planning horizons as in Blanchard (1985) and Weil (1989).[6] In each period, n individuals are born in the home economy and $1-n$ individuals are born in the foreign economy. The assumption of finite lives by itself does not imply any deviations from Ricardian equivalence. However, in combination with the assumption that newly born agents own no financial assets or cash balances, government debt will be perceived as net wealth. Each agent is also assumed to have a planning horizon

[5] Although the version of the model discussed here only features a two-country setup, a multi-country version has also been developed—for an application of the multi-country version of the model see Kumhof, Laxton, and Muir (2005). In the two-country version of model, we will refer to the first country as the home country and the second country as the foreign country. For applications of the two-country version of the model see Bayoumi and Botman (2005), Bayoumi, Botman, and Kumar (2005), and Botman and Laxton (2004).

[6] For quantitative and theoretical examples of closed-economy, open-economy, and multi-country versions of macro models based on the Blanchard (1985) finite-planning horizon model, see Faruqee, Laxton, and Symansky (1997), Laxton and others (1998), Faruqee and Laxton (2000), Ghironi (2003a, 2003b), and Ghironi, Iscan, and Rebucci (2005).

of $1/(1-q)$, where q represents a constant probability of survival. Under the assumption that consumers face identical probabilities of survival that are identical across countries, the relative size of the home economy versus the foreign economy will be equal to $\frac{n}{1-n}$.

There is a unit measure of monopolistic firms in the world producing intermediate goods which are traded internationally, with n of those located in the home economy and $1-n$ located abroad. Firms survive forever and each firm specializes in the production of a single differentiated variety. As is customary in these models, the intermediate tradable goods are combined into a final traded good. A similar structure of production exists in the nontraded goods sector.

Asset markets are incomplete. The only assets traded internationally are nominal non-contingent bonds issued by each region. Both bonds are assumed to be denominated in the home currency. There is complete home bias in equity holdings: all shares of domestic (foreign) firms are owned by home (foreign) residents. The same assumption is made for government debt.

A. Households

A representative agent born in period a derives utility from consumption, leisure, and real money balances. Agents are endowed with one unit of time, part of which they spend working ($L_{a,s}$) with the remainder devoted to leisure. A representative agent of age a at time t has preferences that are assumed to be non-separable in consumption and leisure. Lifetime expected utility of home agent a (denoted as $U_{a,t}$) is assumed to be:

$$U_{a,t} = \mathsf{E}_t \sum_{s=t}^{\infty} (q\beta)^{s-t} \left[\frac{\left(C_{a,s}^{\eta}\left(1-L_{a,s}\right)^{1-\eta}\right)^{1-\rho}}{1-\rho} + \frac{\chi}{1-\rho}\left(\frac{M_{a,s}}{P_s}\right)^{1-\rho} \right] \tag{1}$$

where q is the probability of survival, β is the discount rate, $\rho > 0$ is the inverse of the intertemporal elasticity of substitution, $0 < \eta < 1$ and $\chi > 0$.[7]

Following Blanchard (1985) we assume the existence of insurance companies, which charge a premium of $\frac{(1-q)}{q}$ to those agents who survive each period and in the event of death are assumed to take possession of the agent's wealth.[8] The consumer's budget constraint in nominal terms is,

$$P_t C_{a,t} + M_{a,t} + F_{a,t+1} + S_t F^*_{a,t+1} + B_{a,t+1} + \int_0^n V_t^i x^i_{a,t+1} di \tag{2}$$

[7] This particular specification of period utility with equal elasticities for ρ allows for the derivation of aggregate per capita relationships from generation-specific first-order conditions. As ρ approaches unity the utility function reduces to the logarithmic case.

[8] The turnover in the population is assumed to be large enough that the income receipts of the insurance companies exactly equals their payouts.

$$= \frac{1}{q}\left[M_{a,t-1} + (1+i_t)\left(F_{a,t} + B_{a,t}\right) + (1+i_t^*)\, S_t F_{a,t}^*\right]$$

$$+\frac{1}{q}\left[\int_0^n Div_t^i x_{a,t}^i di + \int_0^n V_t^i x_{a,t}^i di\right] + W_t(1-\tau_{L,t})L_{a,t} + \Phi_t$$

where $A_{a,t} = F_{a,t} + S_{t-1}F_{a,t}^*$ are net foreign asset holdings; $B_{a,t}$ is government debt; V_t^i represents the (ex dividend) value of a claim to all future profits of firm i whereas $x_{a,t}^i$ is the share of firm i owned by the representative home agent born in period a in the beginning of period t. Div_t^i is the after-tax amount of dividends paid by firm i in period t; $\tau_{L,t}$ is the tax rate on labor income and Φ_t is the revenue from adjustment costs rebated uniformly to all home households in a lump-sum fashion. As taxes are levied on labor income and labor supply is endogenous, changes in tax rates will have distortionary effects on consumption and leisure choices. Also, the assumption of finite lives combined with the assumption that newly born agents arrive without any assets (i.e., no bequests), $x_{t,t}^i = M_{t,t-1} = B_{\,t,t} = A_{t,t} = 0$, implies that part of government debt will be counted as net wealth. Consequently, government deficits will affect the aggregate savings rate of the economy, resulting in increases in real interest rates when economies are either closed or large and "twin" fiscal and current account deficits when economies engage in international trade.

Together, the agent a's lifetime expected utility, in tandem with her nominal budget constraint is a concise statement of the consumer's optimization problem, which results in the following first-order conditions. The optimal supply of labor is determined by the consumption-leisure trade-off and satisfies,

$$L_{a,t} = 1 - \frac{1-\eta}{\eta}\frac{P_t}{W_t(1-\tau_{L,t})}C_{a,t} \tag{3}$$

where η is a parameter that affects the extent to which labor supply is elastic (lower values of η imply a higher elasticity and when η approaches one labor supply becomes perfectly inelastic). Money demand takes the form,

$$\frac{M_{a,t}}{P_t} = \left(\frac{\chi}{\eta}\right)^{\frac{1}{\rho}}\left(\frac{1-\eta}{\eta}\frac{P_t}{W_t(1-\tau_{L,t})}\right)^{(1-\rho)(1-\eta)}\left(\frac{1+i_{t+1}}{i_{t+1}}\right)^{\frac{1}{\rho}} C_{a,t} \tag{4}$$

whereas the money supply is assumed to be fixed as the central bank is assumed to follow money targeting. The Euler equation that determines consumption or savings is the following.

$$C_{a,t+1} = \left(\beta\,(1+i_{t+1})\,\frac{P_t}{P_{t+1}}\right)^{\frac{1}{\rho}}\left(\frac{W_{t+1}(1-\tau_{L,t+1})/P_{t+1}}{W_t(1-\tau_{L,t})/P_t}\right)^{\left(1-\frac{1}{\rho}\right)(1-\eta)} C_{a,t} \tag{5}$$

Together with the optimality condition for the holdings of foreign bond holdings, this condition produces the standard uncovered interest parity condition.

$$1 + i_{t+1} = \left(1 + i^*_{t+1}\right) \frac{S_{t+1}}{S_t} \tag{6}$$

From the life-time budget constraint, eq. (2), and using the above first-order condition for the optimal consumption rule of optimizing agents, the decision rule of optimizing agents, denoted by $C^{opt.}_{a,t}$, can be written as the sum of human wealth and financial holdings,

$$P_t C^{opt.}_{a,t} = \tag{7}$$

$$D_t^{-1} \left\{ H_{a,t} + \frac{1}{q} \left[M_{a,t-1} + (1 + i_{t-1}) \left(A_{a,t-1} + B_{a,t-1} + n V^i_{a,t-1} x^i_{a,t-1} \right) \right] \right\}$$

where $H_{a,t} = \sum_{s=t}^{\infty} R_{t,s} q^{s-t} (1 - \Psi) \left[W_s L_s (1 - \tau_{L,s}) + \Phi_s \right]$ denotes (nominal) human wealth of agent a at time t and Ψ is the share of rule-of-thumb consumers and D_t^{-1} is the marginal propensity to consume out of total wealth. In the general case the inverse of the marginal propensity of consume evolves according to,

$$D_t = 1 + \frac{1-\eta}{\eta} + \left(\frac{\chi}{\eta}\right)^{\frac{1}{\rho}} \left(\frac{1-\eta}{\eta} \frac{P_t}{W_t(1-\tau_{L,t})} \right)^{(1-\rho)(1-\eta)} \left(\frac{i_{t+1}}{1+i_{t+1}} \right)^{1-\frac{1}{\rho}} + \tag{8}$$

$$\frac{q}{1+i_{t+1}} \frac{p_{t+1}}{p_t} \left(\beta \left(1 + i_{t+1}\right) \frac{p_t}{p_{t+1}} \right)^{\frac{1}{\rho}} \left(\frac{\frac{W_{t+1}(1-\tau_{L,t+1})}{P_{t+1}}}{\frac{W_t(1-\tau_{L,t})}{P_t}} \right)^{\left(1-\frac{1}{\rho}\right)(1-\eta)} D_{t+1}$$

while in the logarithmic case ($\rho = 1$) this expression reduces to $D_t = 1 + \frac{1-\eta}{\eta} + \left(\frac{\chi}{\eta}\right) + q\beta D_{t+1}$, which leads to a constant marginal propensity to consume of $\frac{1-q\beta}{1+\frac{1-\eta}{\eta}+\frac{\chi}{\eta}}$. In what follows we will assume that profits are uniformly distributed among optimizing agents. In this case, the Φ_t variable includes period profits (dividends) from every domestic firm, distributed equally across agents, besides rebates from adjustment costs. Since there are no shares traded in this case, $x^i_{a,t} = 0$, the consumption function can be written as,

$$P_t C^{opt}_{a,t} = D_t^{-1} \left\{ H_{a,t} + \frac{1}{q} \left[M_{a,t-1} + (1 + i_{t-1}) \left(A_{a,t-1} + B_{a,t-1} \right) \right] \right\} \tag{9}$$

By fixing the total number of shares outstanding issued by firm i at unity and defining the per capita equity value as $V_t = \frac{\frac{n V^i_{a,t}}{n}}{1-q} = (1-q) V^i_{a,t}$ one can easily aggregate the

consumption function for optimizing agents. Also, as a result of the competitive labor market assumption and uniform distribution of transfers, human wealth will be identical across optimizing agents and other per capita variables are easily aggregated as they are linear functions of generation-specific variables.

Total aggregate consumption consists of two components: consumption of optimizing agents and consumption by rule-of-thumb consumers. Thus, aggregate consumption is given by:

$$C_t = C_t^{opt.} + C_t^{rot} \tag{10}$$

with aggregate consumption of rule-of-thumb consumers given by,

$$P_t C_t^{rot} = \Psi \left(W_t L_t \left(1 - \tau_{L,t} \right) + \Phi_t \right) \tag{11}$$

B. Firms

There are two types of firms. A continuum of monopolistic firms indexed by i are assumed to produce a single differentiated good, which is either traded or nontraded, and a set of representative firms that combine the domestically traded good and an imported good with the nontraded good to produce three distinct final goods—a private consumption good C_t, a public consumption good G_t, or a private gross investment good $(I_t + CAC_t)$.

Consider final goods production in the home economy. The private consumption good is produced using a CES technology:

$$C_t = \left(\gamma^{\frac{1}{\epsilon}} C_t^{T^{\frac{\epsilon-1}{\epsilon}}} + (1-\gamma)^{\frac{1}{\epsilon}} C_t^{N^{\frac{\epsilon-1}{\epsilon}}} \right)^{\frac{\epsilon}{\epsilon-1}} \tag{12}$$

where $\varepsilon > 0$ is the elasticity of substitution between traded and nontraded consumption goods, and $0 \leq \gamma \leq 1$ governs the preference for traded over nontraded goods.

The utility-based price index corresponding to this basket has a similar form:

$$P_t = \left(\gamma P_t^{T^{1-\epsilon}} + (1-\gamma) P_t^{N^{1-\epsilon}} \right)^{\frac{1}{1-\epsilon}} \tag{13}$$

P_t serves as the consumer price deflator in this model, and is used to define inflation in the model:

$$P_t / P_{t-1} = 1 + \pi_t \tag{14}$$

Using θ^N to denote the elasticity of substitution over different varieties of a composite nontraded good we use the following CES aggregator and corresponding price index:

$$C_t^N = \left(\left(\frac{1}{n}\right)^{\frac{1}{\theta^N}} \int_0^n c_t^N(z)^{\frac{\theta^N - 1}{\theta^N}} dz \right)^{\frac{\theta^N - 1}{\theta^N}} \tag{15}$$

$$P_t^N = \left(\frac{1}{n} \int_0^n p_t^N(z)^{1-\theta^N} dz \right)^{\frac{1}{1-\theta^N}} \tag{16}$$

As for the traded consumption good C_t^T, it can be further decomposed into domestically-produced and imported components:

$$C_t^T = \left(\alpha^{\frac{1}{\varpi}} {C_t^H}^{\frac{\varpi - 1}{\varpi}} + (1-\alpha)^{\frac{1}{\varpi}} {C_t^F}^{\frac{\varpi - 1}{\varpi}} \right)^{\frac{\varpi}{\varpi - 1}} \tag{17}$$

where $\varpi > 0$ is the elasticity of substitution between home and foreign goods and $0 \leq \alpha \leq 1$ is the home bias parameter.

The equivalent price index for tradable goods in the home economy is:

$$P_t^T(H) = \left(\alpha \left(p_t^{T,H} \right)^{1-\omega} + (1-\alpha) \left(s_t * p_t^{T,F} \right)^{1-\omega} \right)^{\frac{1}{1-\varpi}} \tag{18}$$

which is a combination of the price of domestically produced tradables, $p_t^{T,H}$, and the price of tradable goods produced in the rest of the world, $p_t^{T,F}$, where s_t is the nominal exchange rate (defined as the price of home currency in terms of foreign currency). Foreign indices are expressed in foreign units and are analogous to the home indices. The law of one price holds for intermediate traded inputs, but the purchasing power parity (PPP) condition can be violated because of the presence of nontraded goods and home bias in consumption.

As with the nontraded good C_t^N, the domestically produced traded good C_t^H has the following demand function and the corresponding price index:

$$C_t^H = \left(\left(\frac{1}{n}\right)^{\frac{1}{\theta^H}} \int_0^n c_t^H(z)^{\frac{\theta^H - 1}{\theta^H}} dz \right)^{\frac{\theta^H - 1}{\theta^H}} \tag{19}$$

$$P_t^H = \left(\frac{1}{n} \int_0^n p_t^H(z)^{1-\theta} dz \right)^{\frac{1}{1-\theta^H}} \tag{20}$$

where θ^H is the elasticity of substitution over different varieties of the composite domestically produced traded good.

The imported consumption good C_t^F is produced in the foreign economy, and has analogous demand and price functions to C_t^H.

The final investment good I_t^T is produced in the same manner, while the government good G_t is composed uniquely of nontraded goods (home bias is unity in the government sector) so that $G_t = G_t^N$ and $P_t^G = P_t^N$.

At the level of the intermediate good level, firms produce either traded or nontraded goods. For notational simplicity, the T and N superscripts will be dropped. The remainder of the equations in this section apply equally to all firms producing either traded or nontraded goods.

A firm is assumed to maximize the discounted value of current and all future dividends:

$$\max_{\{P_s(i),L_{i,s},I_{i,s},K_{i,s}\}} \sum_{s=t}^{\infty} R_{t,s} P_s \begin{pmatrix} Div_{i,s} \\ -\tau_{\pi,s} P_s \lambda_s (MPK_s - \delta) K_s \end{pmatrix} \tag{21}$$

subject to the production of Y_s with a CES production technology,

$$Y_{i,s} = \left(\mu^{\frac{1}{\xi}} K_{i,s}{}^{\frac{\xi-1}{\xi}} + \left(1-\mu^T\right)^{\frac{1}{\xi}} \left(Z_s L_{i,s}\right)^{\frac{\xi-1}{\xi}} \right)^{\frac{\xi}{\xi-1}} \tag{22}$$

and the law of motion of capital,

$$K_{i,s+1} = (1-\delta) K_{i,s} + I_{i,s} \tag{23}$$

with K_i denoting the capital stock of firm i, L_i the amount of labor the firm employs and Z_t is a stochastic process governing productivity. ξ is the elasticity of substitution between the factors of production, while μ is the bias towards the use of capital in the production of. the traded good. I_i represents gross investment and δ represents the depreciation rate on capital. We assume that adjustment of the capital stock is subject to quadratic adjustment costs[9]:

$$CAC_{i,t} = \frac{\psi}{2} \frac{(I_{i,t})^2}{K_{i,t}} \tag{24}$$

The after-tax dividends of a representative firm (which are economic profits) are defined as

[9]Specificying adjustment costs on the level of investment follows Chari, Kehoe, and McGrattan (2000) among others. In contrast, Christiano, Eichenbaum, and Evans (2001) argue that adjustment costs on changing investment is better able to replicate a hump-shaped response of investment to a monetary policy shock.

$$Div_{i,t} = (1 - \tau_{\pi,s}) \left[\frac{(P_t(i))^{1-\theta}}{(P_t^H)^{\theta}} Y_t - W_t L_{i,t} - P_t(I_{i,t} + \frac{\psi}{2} \frac{(I_{i,t})^2}{K_{i,t}}) \right] \tag{25}$$

where $\tau_{\pi,t}$ denotes the corporate income tax rate.

We can define the shadow price of capital, with some transformation as Tobin's Q, $Q_{i,t}$, while the shadow price associated with the production constraint is marginal cost $MC_{i,t}$. Furthermore, the equilibrium price that arises from profit maximization under monopolistic competition satisfies the familiar pricing rule,

$$P_{i,t} = \frac{\theta}{\theta - 1} MC_{i,t} \tag{26}$$

where price is a constant markup over (nominal) marginal cost.[10]

C. Government

We assume that all government consumption G_t is met by the supply of nontraded goods so that $P_t^G = P_t^N$.[11] In order to finance its consumption, the government collects taxes (T_t) by imposing a tax rate on labor income ($T_{L,t} = \tau_{L,t} W_t L_t$) and on corporate incomes in the traded and nontraded goods sectors respectively
($T_{\pi,t} = \tau_{\pi,t} \left(p_t^T Y_t^T - W_t L_t^T - I_t^T \right) + \tau_{\pi,t} \left(p_t^N Y_t^N - W_t L_t^N - I_t^N \right)$, where Y_t^T and Y_t^N denote total output in the traded and nontraded sectors respectively. Other sources of financing include seigniorage and the issuance of debt. In nominal terms, the government budget constraint takes the form (for both the home and foreign countries):

$$P_t^G G_t + (1 + i_t) B_t = T_t + (M_t - M_{t-1}) + B_{t+1} \tag{27}$$

Fiscal closure is achieved by specifying a target path for the desired level of government debt as a ratio of GDP (b_t^*). In the standard version of the model the aggregate tax rate adjusts until the government debt ratio reaches its long-run target level. The tax rate is determined by the following 2 equations,

[10] In an alternative specification of the model we include sticky prices in the short run following Rotemberg (1982) by using the form $\Gamma_t^i = \frac{\phi}{2} \left(\frac{P_t(i)}{P_{t-1}(i)} - \bar{\pi} \right)^2$. Since Betts and Devereux (2001) find that the degree of pass-through is relatively unimportant for the international transmission mechanism of fiscal shocks we assume that prices are always sticky in the producers' currency (implying full pass-through of the exchange rate into prices). Further work is needed to extend the model to allow for wage stickiness. At that point the model could be used effectively for short-run analysis and the study of the interaction of fiscal and monetary policies.

[11] This has already been noted above. This choice is simply for ease of exposition below—the model could just as easily allow for various degrees of home bias in government spending. For example government spending could fall on both domestic and foreign goods in the same proportions as consumer spending, so that $P_t^G = P_t$, or P_t^G could simply be some CES aggregator of P_t^T and P_t^N.

$$\tau_t = \varkappa_{1,t}(\tau_t + DEBT^{GAPS}) + (1 - \varkappa_{1,t})\,\bar{\tau}_t \tag{28}$$

$$DEBT^{GAPS} = \left(\frac{B_t}{GDP_t} - v_1 b_t^* - (1 - v_1)\frac{B_{t-1}}{GDP_{t-1}}\right) + v_2\left(\frac{\Delta B_t}{GDP_t} - \Delta b_t^*\right) \tag{29}$$

where B_t is government debt, GDP_t is nominal income (gross national product), $\varkappa_{1,t}$ is an exogenous variable that allows temporary fixes of the tax rate at some pre-specified rate $\bar{\tau}_t$, and the two parameters (v_1, v_2) will determine the speed at which the actual government debt to GDP ratio ($\frac{B_t}{GDP_t}$) is adjusted to its desired path (b_t^*).[12] Note, that when $\varkappa_{1,t} = 1$ the tax rate drops out of equation (28) and the rule becomes a simple error-correction model that gradually closes the gap between the actual and target government debt to GDP ratio.[13]

$$\frac{B_t}{GDP_t} = v_1 b_t^* + (1 - v_1)\frac{B_{t-1}}{GDP_{t-1}} - v_2\left(\frac{\Delta B_t}{GDP_t} - \Delta b_t^*\right) \tag{30}$$

When $(v_1, v_2) = (1, 0)$ the rule would imply that tax rates would be adjusted completely to achieve the desired debt ratio in each period. The problem with such a rule is that it could result in large swings in tax rates when there are significant deviations between actual and the desired debt levels. This problem can be resolved in most cases by imposing a smaller value for v_1, that allows for partial adjustment where only part of the debt gap is eliminated over time. The last term in equations (29) and (30) is a flow condition and is included to prevent excessive cycling in the tax rate and the real economy. Experience has shown that this simple rule with $(v_1, v_2) = (0.1, 1.0)$ seems to work well in practice for conducting experiments that result in permanent shifts in the government debt ratio, without causing excessive cycling in tax rates and the real economy—the only purpose for which the rule has been designed in the experiments considered here.

To illustrate how the tax rule can be used in practice, suppose we are interested in the effects of a cut in taxes for 10 years. Then we would set $\varkappa_{1,t} = 0$ for $t = 1, ..., 10$ and $\bar{\tau}_t$ will reflect the shock (for example, a one-percentage point of GDP tax cut). After ten years, $\varkappa_{1,t} = 1$ and the tax tax rate, τ_t, is determined by equation (28). There is no particular reason why all of the adjustment has to be imposed on labor taxes and it is straight forward to consider cases where tax rate adjustments are assumed to fall on capital income or government spending, or some combination of capital and labor taxes and spending.

[12] At some point the endogenous component of the tax rule has to be turned on to stabilize the government debt ratio. In this sense there is a fundamental role for fiscal policy to provide an anchor for government debt by being committed to adjust its fiscal instruments to ensure stability in expectations about future government policies. This is similar to the fundamental role of monetary policy where the central bank has to be committed to adjusting the interest rate to provide a nominal anchor to the system. The condition for the last problem is derived from microfoundations and resource constraints, that clearly delineates what monetary policy can and cannot be expected to achieve. The condition for fiscal policy is much simpler and is motivated by a no-Ponzi-game condition that the real interest rate on government debt in equilibrium will generally be higher than the real growth rate of the economy.

[13] Note, that even though the tax rate drops out of equation (28) when $\varkappa_{1,t} = 1$, the tax rate will still be the endogenous variable that does all of the adjusting to close the gap between the actual and desired debt ratio.

D. Characteristics of "the Rest of the World"

The foreign economy is identical to the home economy, apart from the fact that the internationally traded assets are denominated in the home currency. The current account balance for the home economy is the sum of interest receipts on the stock of net foreign assets plus the trade balance,

$$CBAL_t = i_{t-1}A_{t-1} + TBAL_t \tag{31}$$

where $TBAL_t$ is defined to be equal to nominal exports minus nominal imports. The change in net foreign assets will simply be equal to the current account balance.

$$A_t - A_{t-1} = CBAL_t \tag{32}$$

For the foreign economy the mirror image of this expression will be the following.

$$A_t^* = -\frac{n}{1-n}\frac{A_t}{S_t} \tag{33}$$

The nominal exchange rate, with RER_t denoting the real exchange rate, is given by the following expression.

$$S_t = RER_t \frac{P_t}{P_t^*} \tag{34}$$

From the uncovered interest parity (UIP) condition, the real exchange rate, with r denoting the real interest rate, will be the following.

$$RER_{t+1} = RER_t \frac{1+r}{1+r^*} \tag{35}$$

The equivalent nominal form of the UIP condition is:

$$S_{t+1} = S_t \frac{1+i}{1+i^*} \tag{36}$$

In the steady state, the real exchange rate will be constant, so we know that $r = r^*$. And as long as both regions have the same steady-state inflation rate, it follows that $i = i^*$.

By definition, the home economy can hold its net foreign assets A_t in either currency as F_t or F_t^*. The pure UIP condition insures the same nominal return. For a given holding as either $\bar{F}_t$ or $\frac{n}{1-n}S_t\bar{F}_t^*$, the real returns are exactly equivalent. By applying the nominal UIP condition to $(1+i_t)\,\bar{F}_t$ and $(1+i_t^*)\,\frac{n}{1-n}S_t\bar{F}_t^*$ we can see the return is always i^*. This

means there is no need to differentiate between F_t or F_t^*. A_t and A_t^* will share the same properties for its returns; $(1+i_t)\,S_t A_t^* = -\,(1+i_t^*)\,\frac{n}{1-n}A_t$ so that net foreign assets will be in zero net supply worldwide.

Finally, the terms of trade is defined as:

$$TOT_t = \frac{P_t^{T,H}}{P_t^{T,F}/S_t} \tag{37}$$

where $P_t^{T,H}$ is the price of tradables in the home economy and $P_t^{T,F}$ is the price of tradables in the foreign economy.

III. The Effects of Tax Cuts in a Small and Large Open Economy

In this section, we discuss the baseline calibration of the model and the implications of tax cuts when the home economy accounts for either a small (1 percent) or a large share of the world economy (60 percent). In the latter case the model is calibrated to equal the share of the OECD membership in world GDP during the 1980s, which was about 60 percent. This allows us to relate the implications of the model to the empirical evidence on the effects of the build-up in government debt in the OECD economies in the 1980s on the world real interest rate.[14] The first experiment we consider is a debt-financed cut in labor income taxes, which increases the primary deficit by one percent of GDP for 10 years. Starting in the 11^{th} year, the tax rate is allowed to rise to gradually stabilize the government debt-to-GDP ratio at its new higher steady-state level. An increase in taxes will also be necessary to finance the higher interest rate burden that results from higher levels of government debt.

A. Initial Steady State

The parameter values and steady-state values for the baseline calibration of the model are reported in Tables 1 to 3. For simplicity we assume identical parameters in both countries and as a consequence all relative prices will be equal to one and neither region will be a net debtor nor creditor in the initial steady state. The discount rates for both countries are computed residually to generate a steady-state real interest rate of 3 percent, a value that is close to the average value of real long-term interest rates in the U.S. and other OECD countries over the last 25 years. In general, differences in discount rates across countries

[14] Using a sample of countries and time periods where capital markets were integrated, Ford and Laxton (1999) provide estimates of the effects of the increase in government debt in OECD countries in the 1980s on the world real interest rate. In particular, they show that these effects were both economically and statistically very significant, suggesting that Ricardian equivalence is rejected by the data.

determine if a country is a net debtor or creditor in the steady state. In addition to being non-Ricardian, this was another important reason why several modelers adopted the Blanchard (1985) OLG framework and incorporated it into both small open-economy models as well as multi-region models.[15] Throughout the experiments, wages and prices are assumed to be fully flexible.[16] We assume complete home bias in government spending, but no home bias in private spending. This is clearly an exaggeration, but is an innocuous assumption for examining the effects of tax cuts.

Table 2 shows the key structural parameters of the model whose values will be varied to perform some sensitivity analysis. One of the key structural parameters that will determine the extent of crowding out in the model will be the effective planning horizon $(1/q)$ of consumers. In the baseline calibration of the model, we set this value equal to 10 years, which translates into a value of q equal to 0.90. A value of this magnitude for q is obviously much lower than the probability of survival for most of the population, but it is a simple way of introducing a form of myopia into the model that many others have emphasized is necessary to generate plausible dynamics.[17] We assume that labor supply is moderately elastic ($\eta = 0.96$ whereas if η was equal to unity, labor supply would be completely inelastic) allowing for a second channel through which taxes can affect the private sector behavior. The share of liquidity-constrained consumers is assumed to be equal to 25 percent of the population, a value that is consistent with estimates from the empirical literature. This combined with a planning horizon of 10 years generates plausible dynamics and correlations between consumption and disposable income.[18]

The intertemporal elasticity of substitution $(1/\rho)$ is set at 0.20 ($\rho = 5$). This is around the mid-range of econometric estimates derived from models without habit formation. We also consider the implications of a value for the intertemporal elasticity of substitution of 1/3 ($\rho = 3$), which is consistent with the upper end of the range of empirical models without

[15] For a collection of early models with these features, see Buiter (1981), Blanchard (1985), Weil (1989), McKibbin and Sachs (1991), Black and others (1994, 1997), Faruqee, Laxton, and Symansky (1997), Laxton and others (1998), and Faruqee and Laxton (2000).

[16] Although the model discussed in Section 2 allows for the possibility of sticky prices, we have not yet considered the case of sticky wages because of the difficulties associated with aggregation. One way to overcome these aggregation problems would be to build a much larger OLG version of the model with a large number of overlapping generations and then keep track of the behavior of each generation. This approach would result in a significant increase in the computational burden of solving multi-country versions of the model, but is becoming increasingly feasible with the development of better perfect-foresight solution algorithms and more powerful computer technology—see Julliard and Laxton (1996), Armstrong and others (1998) and Juillard and others (1998). The advantage of such an approach is that it would make the model more suitable to examine the implications of pension systems and demographic issues.

[17] Other studies that have been based on finite-planning horizons have sometimes employed even smaller values for q. For example, in a model without liquidity-constrained consumers, McKibbin and Sachs (1991) assume a much lower value of 0.70 so that they can generate a sufficiently high correlation between consumption and income. In this paper we employ a higher value of q because we also allow for the fact that a certain fraction of consumers are liquidity constrained.

[18] Models without finite planning horizons, such as infinitely-lived representative agent models, sometimes assume a much larger share liquidity-constrained consumers to generate a more plausible correlation between disposable income and consumption—see Erceg, Guerrieri, and Gust (2005) which use a value of 0.5.

habit persistence.[19] We set the elasticity of substitution between home and foreign goods $(1/\omega)$ equal to 0.40 ($\omega = 2.5$). This is in line with estimates used in NOEM models, but is significantly higher than the mid-point of the range of econometric estimates, which falls closer to one.[20] The elasticity of substitution between capital and labor (χ) is set equal to 0.8 and we contrast this to the Cobb-Douglas case when discussing the results from the sensitivity analysis.

Table 3 shows the initial steady-state ratios to nominal GDP for a number of key variables. Again apart from size, the model calibration is symmetric. As a result, the real exchange rate and terms of trade are equal to unity and there is no net international borrowing and lending; the net foreign asset position, trade balance, and current account are all equal to zero. Liquidity-constrained consumers represent one-fourth of the population, but because they do not have any wealth they only account for about one-seventh of total private consumption.

Table 4 reports the fiscal characteristics of the initial steady state. The initial level of government debt is assumed to be zero. Consequently, in the initial steady state there is no interest burden on government debt so aggregate taxes have to be collected to finance only the level of government expenditures. The labor income tax rate is assumed to be higher than the corporate income tax rate. The corporate income tax is applied to a base consisting of capital income as well as pure economic profits that arise because of the assumption of monopolistic competition.[21]

B. Increase in Government Debt from Lower Labor Income Taxes in a Small Economy

A cut of one percentage point of GDP in tax revenue requires a reduction in labor income taxes of about two percentage points—see Figure 1. As a result of the tax cut government

[19] The extent of crowding out associated with increases in government debt will depend on the sensitivity of the savings rate to changes in the real interest rate. Low values of the intertemporal elasticity of substitution will result in larger increases in real interest rates when government debt increases. Patterson and Pesaran (1992) and Attanasio and Weber (1993) argue that the elasticity of intertemporal substitution falls between 0.1 and 0.3 in models with habit formation.

[20] See for example, Erceg, Guerrieri, and Gust (2005), Bayoumi, Laxton, and Pesenti (2004), and Obstfeld and Rogoff (2000), which employ estimates of 2, 3, and 6, respectively. Imposing higher estimates is usually based on general-equilibrium considerations and an argument that econometric estimates based on aggregate data are biased downward. It is important to note that estimates around 2.5 combined with adjustment costs on imports results in dynamic reponses for imports that is not inconsistent with typical impulse response functions over 1-2 year horizons. However, the issue is far from settled. For example, Bergin (2004) finds evidence for a unitary long-run elasticity. But empirical estimates based on disaggregated data are substantially higher. In an attempt to reconcile low short-run and medium-term elasticities with large long-run elasticities, Bayoumi and others (2004) develop a model with endogenous tradability where there are significant adjustment costs and time-to-market lags to develop foreign markets.

[21] As a result, corporate income taxes are less distortionary compared to models with perfect competition. The reason is that increasing price mark-ups, while maintaining capital and labor's relative shares in national income, implies a lower capital stock in the initial steady state and the tax distortions of monopolistic rents are smaller than the return to capital.

debt starts accumulating and the government debt-to-GDP ratio reaches a value that is about 12 percentage points higher than baseline after 10 years. The NFA-to-GDP ratio falls by a similar magnitude, but converges at a slower speed to its new steady-state value.[22] Over the first 10 years of the simulation the current account balance declines by around half the amount of the fiscal balance.

In the short run, the real exchange rate appreciates in response to persistently higher real interest rate differentials. This appreciation and increase in real interest rate differentials is consistent with constraining domestic demand forces in response to lower taxes, but is also necessary to generate the current account and trade deficits that are consistent with the preferences of consumers. In this case the appreciation in the currency of the home economy is only a proximate cause of the trade deficit, as the real fundamental cause of the trade deficit is a reduction in savings by the public sector. To service the higher interest payments on the accumulated stock of net foreign liabilities, the home economy will need to generate trade balance surpluses in the new steady state, which is achieved over the medium term and long run by a depreciation in the real exchange rate.

Real GDP, consumption, and labor effort all rise over the first 10 years of the simulation in response to lower labor income taxes, but higher real interest rates crowd out investment.[23] Consumption of rule-of-thumb consumers rises by almost 3 percent as their consumption responds fully to lower labor income taxes and the rise in real income that it causes. By contrast, consumption of optimizing forward-looking agents is more muted as these consumers partially account for the future tax burden that will be associated with the tax cut.

Over time, higher taxes, lower profits, and the depreciation of the real exchange rate reduce real wealth of the home economy. Together with the crowding-out effects on investment because of higher interest rates we see that real GDP, the capital stock, and consumption all decline permanently. Despite a large reduction in real wages, labor effort falls only modestly in the long run, reflecting a relatively low elasticity of labor supply. Given the small size of the home economy, the spill-over effects of higher government debt on the rest of the world are negligible and are not reported.

[22] By contrast, a model with Ricardian equivalence posits that net foreign liabilities and real interest rates do not depend on the level of government debt in the long run. Lane and Milesi-Ferretti (2002) find empirical support that the stock of public debt is an important determinant of the net foreign asset position in both industrial and developing countries, but they find an elasticity based on pooling data that is smaller than one. An elasticity of less than one would be consistent with cases where the economy is large enough to affect the world real interest rate, or if the change in debt in a small country was large enough that foreigners required a risk premium to help finance it.

[23] Real GDP increases in the very short run, but the quantitative response over the first 2 years of the simulation could be significantly larger under wage-price stickiness and if monetary policy were to respond by providing the necessary monetary accomodation by delaying the increase in real interest rates—for examples of short-run multipliers and how they depend on the response of monetary policy, see Laxton and others (1998).

C. Increase in Government Debt from Lower Corporate Income Taxes in a Small Economy

The qualitative results for a cut in corporate income taxes are very similar to the results of a cut in labor income taxes (see Figure 2) and the quantitative spill-over effects to the rest of the world remain small. However, there are two interesting differences. First, real GDP and consumption increase slightly less in the short run. Consumption increases less because liquidity-constrained consumers do not benefit directly from the tax cut as they are assumed to not own capital or any other asset. In this case their rise in consumption is solely a result of higher before-tax labor income, which increases as a result of the real wage.

Second, the cut in corporate taxes causes an investment boom in the short run, which is short-lived because of rising real interest rates. Real GDP declines by more in the long run than in the previous exercise because the rise in corporate income taxes necessary to finance the higher debt servicing costs is more distortionary than labor taxes. This is a reflection of the fact that the labor supply elasticity is small, while taxes on corporate income can have significantly larger effects on capital accumulation.

D. Increase in Government Debt from Lower Labor Income Taxes in a Large Economy

An accumulation of government debt in a single large economy, or a large group of smaller economies, caused by lower labor income taxes has a significant permanent effect on the world real interest rate and results in large crowding-out effects (Figure 3). Indeed, for each 12.5 percentage point increase in the government debt ratio, the real interest rate increase by about 100 basis points, suggesting that the 20 percentage point increase in government debt in the OECD countries during the 1980s would have accounted for about a 160 basis point increase in real interest rates in this period. This estimate is similar to reduced-form empirical evidence concerning the increase in world interest rates during this period in countries with integrated capital markets—see Ford and Laxton (1999). As a result of the rise in the world real interest rate, investment declines substantially and results in a smaller short-run output multiplier relative to the earlier case when the home economy was small. The long-run crowding out effects of government debt are substantial both in the home and in the foreign economy (Figure 4). The initial effect on output in the rest of the world is small as the increased demand for their goods is offset by rising interest rates and the negative wealth effect associated with a depreciation of the real exchange rate. While not reported, a cut in corporate income taxes in a large open economy results in a slightly larger increase in the real interest rate and the spill-over effects to the rest of the world are correspondingly greater as well.

IV. Sensitivity Analysis

In this section we present some sensitivity analysis of the results presented earlier by changing the five key structural parameters of the model. This includes: (1) making the savings rate more sensitive to future tax increases (by lengthening the planning horizon of agents); (2) reducing the supply-side effects of tax cuts (by making labor supply inelastic); (3) reducing the effects of deficits on interest rates (by increasing the intertemporal elasticity of substitution); (4) increasing the effective planning horizon of agents (by setting the share of rule-of-thumb consumers equal to zero); and (5) increasing the substitutability between factors of production (by setting the elasticity of substitution between capital and labor equal to unity, which is the Cobb-Douglas case). The results are reported in Tables 5 to 16.

Tables 5 to 7 report the effects for the small open-economy example of a cut in labor income taxes on the home economy. In this case the results are not very sensitive to changes in the assumptions. In particular, the distortionary effects of labor income taxes and the presence of rule-of-thumb consumers matter little for the non-Ricardian features of the model. The most important change in the results is the change in the effective planning horizon, which is important for influencing the speed at which net foreign assets decline in response to a permanent increase in government debt. The alternative value for q chosen ($q = 0.95$ instead of $q = 0.90$) translates into an effective planning horizon of 20 years. A much longer planning horizon makes optimizing agents more Ricardian and as a result the effects of higher government deficits on current account deficits and real interest rates become smaller over the first 10 years of the simulation horizon. As optimizing consumers prepare for higher future tax liabilities by adjusting their savings rates, consumption and therefore output increase by less in the short run. The same parameter is key for determining the quantitative implications of a cut in corporate income taxes—see Tables 8 to 10.

For the large-open economy case where size is equal to 60 percent of the world economy, the sensitivity analyses reported in Tables 11 to 14 reveal that the planning horizon of agents continues to be a key assumption determining the effects of a temporary cut in labor income taxes. Compared to the baseline case, a much longer planning horizon implies a much smaller increase in real interest rates in the long run and significantly less crowding out of private sector activity (GDP and investment) and spillovers to the rest of the world.

Additional parameters that are important for the large-open economy case are the elasticity of labor supply, the share of rule-of-thumb consumers, and the intertemporal elasticity of substitution. Setting the elasticity of labor supply to approximately zero effectively eliminates any effects on labor effort, but increases the long-run crowding-out effects on GDP, consumption and investment as more of an increase in real interest rates is necessary to re-equilibrate savings and investment flows.[24] A higher intertemporal elasticity of substitution reduces the effects of deficits on interest rates as it requires a smaller increase in world real interest rates to re-equilibrate world savings and investment flows.

[24] We cannot set the elasticity of labor supply exactly zero without switching to a different functional form for the utility function.

The long-run crowding out effects of government debt are correspondingly smaller. The case where only optimizing agents are present makes the model more Ricardian, implying a smaller increase in long-run interest rates. Not surprisingly, as Table 14 shows, the size of the spill-over effects to the rest of the world also critically depends on the planning horizon of agents, the elasticity of labor supply, the intertemporal elasticity of substitution, and the share of rule-of-thumb consumers via their effect on the world real interest rate.

The quantitative effects of a temporary corporate income tax cut in a large open economy depends on the same four parameters as well—see Tables 15 to 16. In addition, the elasticity of substitution between capital and labor now also plays a role, albeit to a smaller extent compared to the other key parameters. As it is easier to substitute between factors of production, output falls by a smaller amount in the long run as firms substitute capital for labor in response to higher real interest rates and higher corporate income taxes. This opportunity for more substitution also reduces the negative spill-over effects to the foreign economy and mitigates the decline in consumption as real wages fall by less.

In addition to the sensitivity analysis discussed above we considered the sensitivity of the results to two additional assumptions. First, the assumption of complete home bias in government spending matters little for both the quantitative and qualitative results of the model, although this assumption would be much more important for shocks to government spending. Second, when we introduce home bias in private consumption, the sensitivity of the trade balance to real exchange rate changes is reduced so the real exchange rate needs to depreciate by more in the long run for the home economy to generate the required future trade surpluses.

V. Conclusion

This paper develops a two-region general equilibrium model with microfoundations and non-Ricardian features. There are three reasons why Ricardian equivalence does not hold in the model. First, the model features an overlapping-generations structure where current generations are disconnected from future generations. Second, both labor and corporate income taxes are distortionary because labor effort and capital formation respond to relative price movements that result directly from tax wedges. Third, it is also assumed that a certain proportion of wage income accrue to rule-of-thumb consumers who vary their consumption one-for-one with their after-tax labor income.

The primary goal was to estimate the quantitative effects of fiscal policy shocks for both a small-open-economy case and a large open-economy case. In the small open-economy case an increase in government debt does not have significant spill-over effects on the rest of the world and shows up mainly as an increase in net foreign liabilities. However, when the economy is large, an increase in government debt raises the world real interest rate and results in significant spillover effects to the rest of the world. Corporate income taxes are more distortionary than labor income taxes. However, in our model corporate income taxation is relatively less distortionary compared to models of perfect competition as part

of the tax falls on monopolistic rents. Finally, the effective planning horizon is the key determinant of the real effects of government debt, more so than the presence of liquidity constrained consumers or the fact that taxes are distortionary in the model.

There are several extensions to the model that would be useful, and indeed some of them have either already been completed or are in the process of being implemented. First, it would be useful to extend the model to a multi-region setting. This has already been done to specifically study the effects of fiscal deficits in the United States—see Kumhof, Laxton, and Muir (2005). Second, it would be useful to extend the model to allow for more nominal and real rigidities so that the model could also be used for short-run analysis and provide a more realistic characterization of alternative monetary policy regimes—this extension is currently underway. Third, it would be useful to introduce additional forms of taxation, such as a consumption tax (VAT) and a personal income tax. The latter has recently been incorporated to study the macroeconomic effects of tax reform in the United States—see Bayoumi, Botman, and Kumar (2005). Finally, so that the model can be used in applications in emerging markets, it would be useful to include a financial accelerator mechanism, following Bernanke, Gertler, and Gilchrist (1999).

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Table 1: Baseline Parameters

Parameters:	Value
Discount Rate β	0.99
Depreciation Rate on Capital δ	0.10
Capital Adjustment Cost Parameter ψ	2.00
Elasticity of Substitution between Varieties θ	
Tradables sector	6.00
Price Markup $\theta/(\theta$-1)	1.20
Nontradables sector	3.50
Price Markup $\theta/(\theta$-1)	1.40
Capital Share in Production in Tradables Sector μ^T	0.50
Capital Share in Production in Nontradables Sector μ^N	0.50
Utility from Real Money Balances χ	0.02
Price Stickiness Parameter φ	0.00
Home Bias in Government Consumption	yes
Home Bias in Consumption Home Economy $\left(\alpha^H = n\right)$	no
Home Bias in Consumption Foreign Economy $\left(\alpha^F = n\right)$	no
Elast. of Subst. between Traded and Nontraded goods $1/\epsilon$ ($\epsilon \approx 1.33$)	0.75
Home Bias towards Traded Goods γ	0.40
Steady-state inflation (the inflation target)	0.02

Table 2: Baseline Parameters (Varied Later For Sensitivity Analysis)

Parameters:	Value
Size of the Home Economy n	
if home economy is small	0.01
if home economy is large	0.60
Planning Horizon of Consumers ($1/q$)	10 Years
Labor Disutility Parameter η	0.96
Share of Rule-of-thumb-consumers	0.25
Intertemporal Elasticity of Substitution $1/\rho$ ($\rho = 5.0$)	0.20
Elast. of Subst. between Home and Foreign Goods $1/\omega$ ($\omega = 2.5$)	0.40
Elasticity of Substitution between Capital and Labor χ	0.80

Table 3: Initial Steady-State Ratios

	Value
Sectoral Shares as a Ratio to Nominal GDP:	
tradables sector	0.31
nontradables sector	0.69
Labor Income Shares as a Ratio to Nominal GDP:	
tradables sector	0.62
nontradables sector	0.62
Consumption-to-Nominal GDP Ratios:	
private consumption	0.64
forward-looking	0.55
rule-of-thumb	0.09
Government Consumption-to-Nominal-GDP Ratio:	0.20
Investment-to-Nominal-GDP Ratios:	0.16
domestic	0.10
imported	0.06
Exports-to-Nominal GDP Ratio	0.31
Imports-to-Nominal-GDP Ratio	0.31
NFA-to-Nominal-GDP Ratio	0.00
Real Interest Rate	0.03
Terms of Trade	1.00
Tax-Revenue-to-Nominal-GDP Ratio	0.19
Bilateral real exchange rate	1.00

Table 4: Initial Steady State of Fiscal Variables

Parameters:	Value
Government Debt to GDP S_B_t	0.00
Tax Rate on Total Income	0.19
Labor Income Tax Rate	0.23
as a percent of total income	0.11
Corporate Income Tax Rate (on capital income)	0.15
as a percent of total income	0.03
Corporate Income Tax Rate (on dividend income)	0.15
as a percent of total income	0.05

Figure 1. Effects on the Home Economy: small-open economy case
Home: Ten-year 1.0 Percent of GDP Cut in Income Taxes
Deviation From Control
(In percentage points; unless otherwise stated)

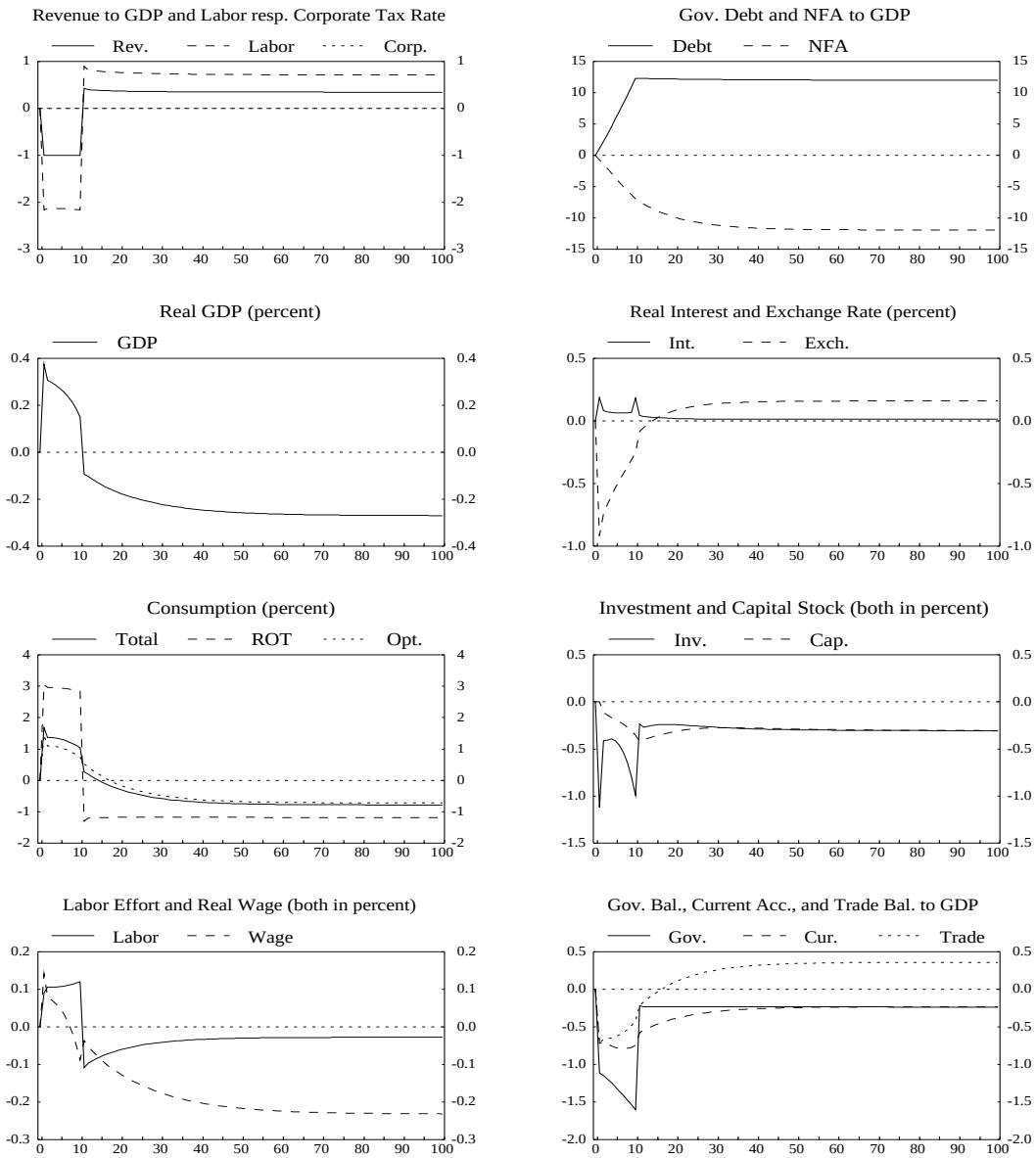

Figure 2. Effects on the Home Economy: small-open economy case
Home: Ten-year 1.0 Percent of GDP Cut in Corporate Taxes
Deviation From Control
(In percentage points; unless otherwise stated)

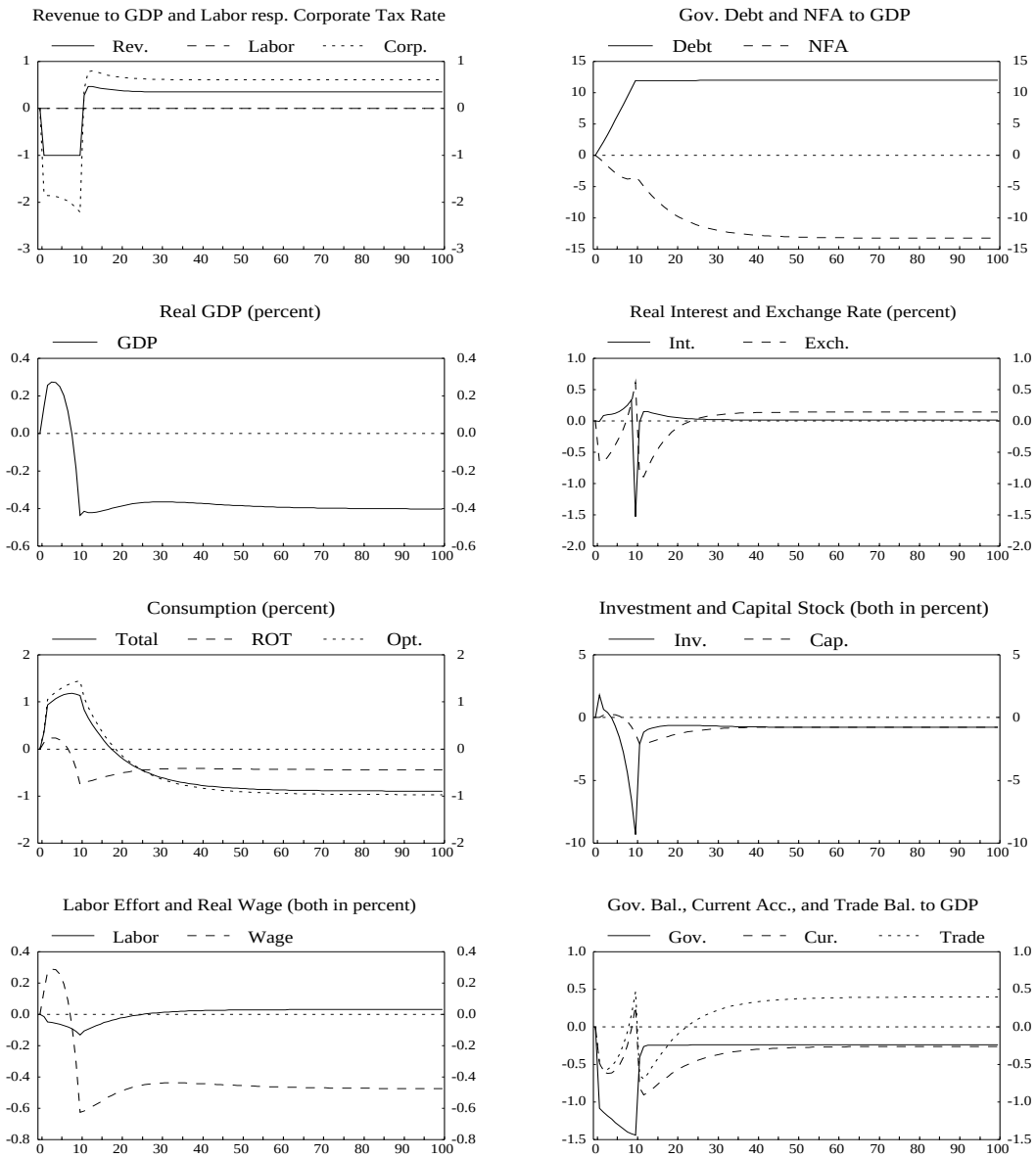

Figure 3. Effects on the Home Economy: large-open economy case
Home: Ten-year 1.0 Percent of GDP Cut in Income Taxes
Deviation From Control
(In percentage points; unless otherwise stated)

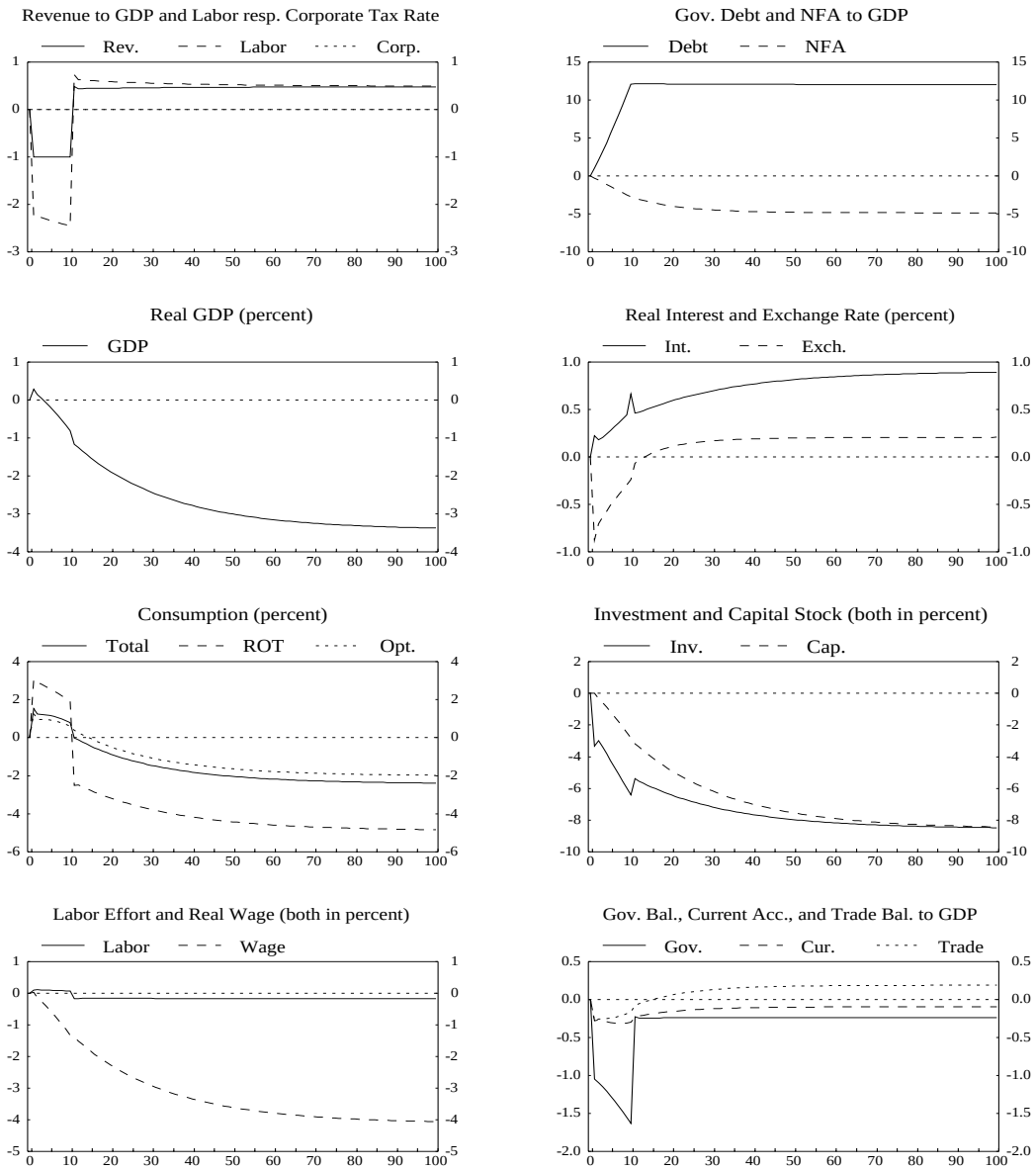

Figure 4. Spill Over Effects to the Foreign Economy: large-open economy case
Home: Ten-year 1.0 Percent of GDP Cut in Income Taxes
Deviation From Control
(In percentage points; unless otherwise stated)

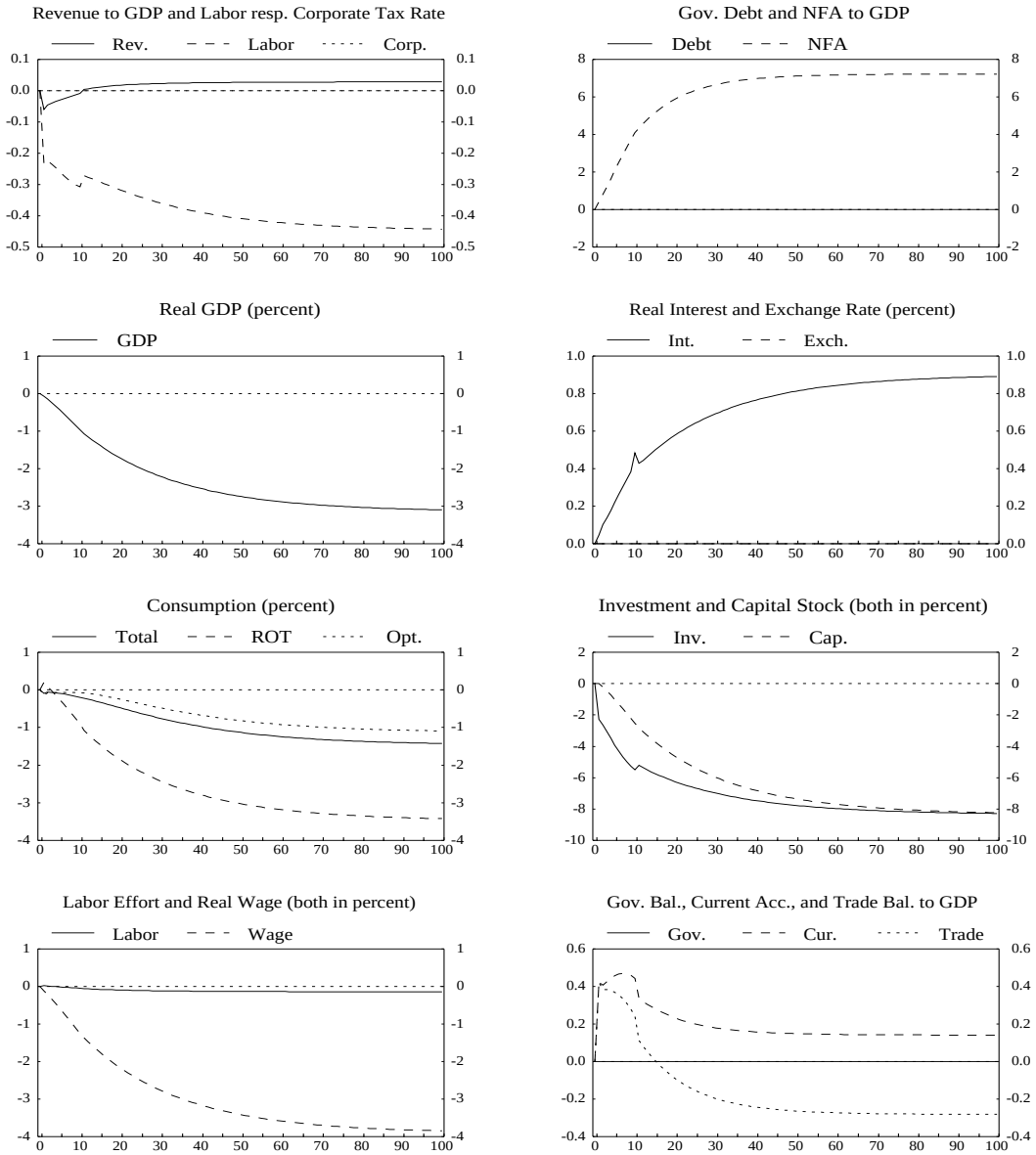

Table 5: Sensitivity Analysis: effects on the Home Economy (cut in labor taxes; small-open economy)

	Baseline	$q = 0.95^{1/}$	$\eta = 1.0^{2/}$	$\rho = 3.0^{3/}$	$\Psi = 0.0^{4/}$	$\xi = 1.0^{5/}$
Tax rate						
Impact	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
First 10 years (average)	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
Long run	0.35	0.35	0.35	0.35	0.35	0.35
Government debt to GDP						
Impact	1.11	1.08	1.11	1.10	1.09	1.10
11th Year	12.29	12.05	12.29	12.28	12.13	12.22
Long run	12.00	12.00	12.00	12.00	12.00	12.00
Net foreign assets to GDP						
Impact	-0.72	-0.54	-0.71	-0.65	-0.61	-0.74
11th Year	-7.35	-5.30	-7.30	-7.16	-6.31	-7.35
Long run	-11.88	-12.02	-11.86	-11.88	-11.92	-11.87
Government balance to GDP						
Impact	-1.11	-1.08	-1.11	-1.10	-1.09	-1.10
First 10 years (average)	-1.34	-1.31	-1.34	-1.33	-1.32	-1.33
Long run	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24
Current Account balance to GDP						
Impact	-0.72	-0.54	-0.71	-0.65	-0.61	-0.74
First 10 years (average)	-0.75	-0.54	-0.75	-0.73	-0.64	-0.76
Long run	-0.23	-0.24	-0.23	-0.23	-0.23	-0.23
Trade Balance to GDP						
Impact	-0.72	-0.54	-0.71	-0.65	-0.61	-0.74
First 10 years (average)	-0.59	-0.43	-0.59	-0.58	-0.50	-0.59
Long run	0.36	0.36	0.36	0.36	0.36	0.36
Real interest rate						
Impact	0.18	0.17	0.18	0.13	0.15	0.16
First 10 years (average)	0.09	0.07	0.09	0.08	0.06	0.08
Long run	0.01	0.00	0.02	0.01	0.01	0.01

1/ Longer planning horizon; 2/ Inelastic labor supply; 3/ Higher intertemporal elasticity of substitution; 4/ Share of rule-of-thumb consumers; 5/ Higher elasticity of subst. between capital and labor.

Table 6: Sensitivity Analysis: effects on the Home Economy continued (cut in labor taxes; small-open economy)

	Baseline	$q = 0.95^{1/}$	$\eta = 1.0^{2/}$	$\rho = 3.0^{3/}$	$\Psi = 0.0^{4/}$	$\xi = 1.0^{5/}$
Real exchange rate (percent)						
Impact	-0.92	-0.67	-0.92	-0.83	-0.77	-0.81
First 10 years (average)	-0.53	-0.37	-0.55	-0.51	-0.43	-0.49
Long run	0.16	0.16	0.16	0.16	0.16	0.16
Real GDP (percent)						
Impact	0.37	0.30	0.33	0.34	0.33	0.38
First 10 years (average)	0.26	0.22	0.20	0.26	0.24	0.27
Long run	-0.27	-0.24	-0.26	-0.25	-0.26	-0.27
Consumption (percent)						
Impact	1.68	1.30	1.64	1.47	1.42	1.64
First 10 years (average)	1.29	0.96	1.23	1.26	1.08	1.26
Long run	-0.79	-0.77	-0.77	-0.77	-0.78	-0.76
Investment (percent)						
Impact	-1.12	-0.91	-1.22	-0.77	-0.89	-0.95
First 10 years (average)	-0.62	-0.39	-0.69	-0.53	-0.36	-0.58
Long run	-0.31	-0.21	-0.31	-0.24	-0.28	-0.34
Labor effort (percent)						
Impact	0.09	0.11	0.01	0.10	0.11	0.08
First 10 years (average)	0.11	0.13	0.01	0.11	0.12	0.10
Long run	-0.03	-0.03	-0.00	-0.03	-0.03	-0.02
Real wage (percent)						
Impact	0.14	0.08	0.19	0.12	0.10	0.17
First 10 years (average)	0.03	0.00	0.07	0.04	0.02	0.08
Long run	-0.23	-0.19	-0.25	-0.20	-0.22	-0.21

1/ Longer planning horizon; 2/ Inelastic labor supply; 3/ Higher intertemporal elasticity of substitution; 4/ Lower share of rule-of-thumb consumers; 5/ Higher elasticity of subst. between capital and labor.

Table 7: Sensitivity Analysis: effects on the Foreign Economy (cut in labor taxes; small-open economy)

	Baseline	$q = 0.95^{1/}$	$\eta = 1.0^{2/}$	$\rho = 3.0^{3/}$	$\Psi = 0.0^{4/}$	$\xi = 1.0^{5/}$
Real GDP (percent)						
Impact	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
First 10 years (average)	-0.01	-0.00	-0.01	-0.01	-0.01	-0.01
Long run	-0.05	-0.02	-0.06	-0.03	-0.04	-0.05
Consumption (percent)						
Impact	-0.00	0.00	-0.00	-0.01	-0.00	-0.00
First 10 years (average)	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
Long run	-0.02	-0.00	-0.03	-0.01	-0.02	-0.02
Investment (percent)						
Impact	-0.04	-0.04	-0.04	-0.01	-0.02	-0.04
First 10 years (average)	-0.07	-0.03	-0.08	-0.04	-0.04	-0.07
Long run	-0.14	-0.05	-0.17	-0.08	-0.12	-0.16
Real interest rate						
Impact	0.00	0.00	0.00	-0.00	-0.00	0.00
First 10 years (average)	0.00	0.00	0.00	0.00	0.00	0.00
Long run	0.01	0.00	0.02	0.01	0.01	0.01
Labor effort (percent)						
Impact	0.00	0.00	0.00	0.00	0.00	0.00
First 10 years (average)	-0.00	0.00	-0.00	0.00	-0.00	-0.00
Long run	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
Real wage (percent)						
Impact	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
First 10 years (average)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Long run	-0.07	-0.02	-0.08	-0.04	-0.05	-0.05

1/ Longer planning horizon; 2/ Inelastic labor supply; 3/ Higher intertemporal elasticity of substitution; 4/ Lower share of rule-of-thumb consumers; 5/ Higher elasticity of subst. between capital and labor.

Table 8: Sensitivity Analysis: effects on the Home Economy (cut in corporate taxes; small-open economy)

	Baseline	$q = 0.95^{1/}$	$\eta = 1.0^{2/}$	$\rho = 3.0^{3/}$	$\Psi = 0.0^{4/}$	$\xi = 1.0^{5/}$
Tax rate						
Impact	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
First 10 years (average)	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
Long run	0.35	0.35	0.35	0.35	0.35	0.35
Government debt to GDP						
Impact	1.08	1.06	1.08	1.07	1.08	1.07
11th Year	11.93	11.68	11.90	11.94	11.91	11.88
Long run	12.00	12.00	12.00	12.00	12.00	12.00
Net foreign assets to GDP						
Impact	-0.48	-0.34	-0.48	-0.45	-0.46	-0.49
11th Year	-4.08	-1.66	-4.02	-4.04	-4.01	-4.02
Long run	-13.22	-14.56	-13.23	-13.22	-13.17	-13.16
Government balance to GDP						
Impact	-1.08	-1.06	-1.08	-1.07	-1.08	-1.07
First 10 years (average)	-1.28	-1.25	-1.28	-1.28	-1.28	-1.28
Long run	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24
Current Account balance to GDP						
Impact	-0.48	-0.34	-0.48	-0.45	-0.46	-0.49
First 10 years (average)	-0.38	-0.14	-0.37	-0.37	-0.37	-0.37
Long run	-0.26	-0.29	-0.26	-0.26	-0.26	-0.26
Trade Balance to GDP						
Impact	-0.48	-0.34	-0.48	-0.45	-0.46	-0.49
First 10 years (average)	-0.26	-0.07	-0.26	-0.26	-0.26	-0.26
Long run	0.40	0.44	0.40	0.40	0.40	0.40
Real interest rate						
Impact	-0.01	0.02	0.00	-0.03	-0.01	-0.03
First 10 years (average)	-0.02	-0.03	-0.02	-0.02	-0.02	-0.02
Long run	0.02	0.01	0.02	0.01	0.01	0.02

1/ Longer planning horizon; 2/ Inelastic labor supply; 3/ Higher intertemporal elasticity of substitution; 4/ Lower share of rule-of-thumb consumers; 5/ Higher elasticity of subst. between capital and labor.

Table 9: Sensitivity Analysis: effects on the Home Economy continued (cut in corporate taxes; small-open economy)

	Baseline	$q = 0.95^{1/}$	$\eta = 1.0^{2/}$	$\rho = 3.0^{3/}$	$\Psi = 0.0^{4/}$	$\xi = 1.0^{5/}$
Real exchange rate (percent)						
Impact	-0.65	-0.46	-0.65	-0.61	-0.62	-0.58
First 10 years (average)	-0.22	0.05	-0.20	-0.22	-0.21	-0.20
Long run	0.14	0.16	0.14	0.14	0.14	0.14
Real GDP (percent)						
Impact	0.14	0.10	0.15	0.13	0.13	0.15
First 10 years (average)	0.09	0.03	0.12	0.10	0.09	0.10
Long run	-0.40	-0.38	-0.43	-0.38	-0.39	-0.42
Consumption (percent)						
Impact	0.36	0.17	0.38	0.25	0.31	0.35
First 10 years (average)	1.03	0.64	1.05	1.04	1.02	1.01
Long run	-0.90	-0.95	-0.93	-0.88	-0.89	-0.88
Investment (percent)						
Impact	1.79	1.60	1.77	1.97	1.83	2.14
First 10 years (average)	-2.24	-2.04	-2.18	-2.24	-2.20	-2.49
Long run	-0.79	-0.70	-0.84	-0.72	-0.76	-0.94
Labor effort (percent)						
Impact	-0.01	-0.00	-0.00	-0.01	-0.01	-0.01
First 10 years (average)	-0.07	-0.05	-0.01	-0.07	-0.07	-0.07
Long run	0.03	0.04	0.00	0.03	0.03	0.03
Real wage (percent)						
Impact	0.15	0.11	0.14	0.14	0.14	0.16
First 10 years (average)	0.05	-0.00	0.02	0.06	0.06	0.06
Long run	-0.48	-0.45	-0.48	-0.44	-0.46	-0.42

1/ Longer planning horizon; 2/ Inelastic labor supply; 3/ Higher intertemporal elasticity of substitution; 4/ Lower share of rule-of-thumb consumers; 5/ Higher elasticity of subst. between capital and labor.

Table 10: Sensitivity Analysis: effects on the Foreign Economy (cut in corporate taxes; small-open economy)

	Baseline	$q = 0.95^{1/}$	$\eta = 1.0^{2/}$	$\rho = 3.0^{3/}$	$\Psi = 0.0^{4/}$	$\xi = 1.0^{5/}$
Real GDP (percent)						
Impact	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
First 10 years (average)	-0.01	-0.00	-0.01	-0.00	-0.00	-0.01
Long run	-0.06	-0.02	-0.07	-0.03	-0.05	-0.06
Consumption (percent)						
Impact	-0.00	0.00	-0.00	-0.01	-0.00	-0.00
First 10 years (average)	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
Long run	-0.03	-0.00	-0.03	-0.01	-0.02	-0.03
Investment (percent)						
Impact	-0.02	-0.02	-0.03	-0.00	-0.02	-0.03
First 10 years (average)	-0.04	-0.00	-0.04	-0.02	-0.03	-0.04
Long run	-0.16	-0.06	-0.18	-0.09	-0.13	-0.18
Real interest rate						
Impact	-0.00	0.00	-0.00	-0.00	-0.00	-0.00
First 10 years (average)	0.00	0.00	0.00	0.00	0.00	0.00
Long run	0.02	0.01	0.02	0.01	0.01	0.02
Labor effort (percent)						
Impact	0.00	0.00	0.00	0.00	0.00	0.00
First 10 years (average)	-0.00	0.00	-0.00	0.00	-0.00	-0.00
Long run	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
Real wage (percent)						
Impact	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
First 10 years (average)	-0.01	-0.00	-0.01	-0.00	-0.01	-0.01
Long run	-0.07	-0.02	-0.09	-0.04	-0.06	-0.06

1/ Longer planning horizon; 2/ Inelastic labor supply; 3/ Higher intertemporal elasticity of substitution; 4/ Lower share of rule-of-thumb consumers; 5/ Higher elasticity of subst. between capital and labor.

Table 11: Sensitivity Analysis: effects on the Home Economy (cut in labor taxes; large-open economy)

	Baseline	$q = 0.95^{1/}$	$\eta = 1.0^{2/}$	$\rho = 3.0^{3/}$	$\Psi = 0.0^{4/}$	$\xi = 1.0^{5/}$
Tax rate						
Impact	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
First 10 years (average)	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
Long run	0.48	0.39	0.50	0.43	0.45	0.47
Government debt to GDP						
Impact	1.05	1.04	1.05	1.05	1.04	1.04
11th Year	12.12	11.87	12.16	12.10	11.96	12.09
Long run	12.00	12.00	12.00	12.00	12.00	12.00
Net foreign assets to GDP						
Impact	-0.28	-0.21	-0.28	-0.25	-0.24	-0.29
11th Year	-2.90	-2.11	-2.88	-2.83	-2.48	-2.91
Long run	-4.83	-4.89	-4.82	-4.83	-4.85	-4.82
Government balance to GDP						
Impact	-1.05	-1.04	-1.05	-1.05	-1.04	-1.04
First 10 years (average)	-1.32	-1.29	-1.32	-1.31	-1.30	-1.31
Long run	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24
Current Account balance to GDP						
Impact	-0.28	-0.21	-0.28	-0.25	-0.24	-0.29
First 10 years (average)	-0.30	-0.22	-0.30	-0.29	-0.25	-0.30
Long run	-0.09	-0.10	-0.09	-0.09	-0.10	-0.09
Trade Balance to GDP						
Impact	-0.28	-0.21	-0.28	-0.25	-0.24	-0.29
First 10 years (average)	-0.23	-0.17	-0.23	-0.22	-0.19	-0.23
Long run	0.19	0.16	0.20	0.17	0.18	0.19
Real interest rate						
Impact	0.23	0.41	0.25	-0.03	0.15	0.24
First 10 years (average)	0.33	0.20	0.37	0.21	0.21	0.33
Long run	0.90	0.29	1.07	0.48	0.73	0.86

1/ Longer planning horizon; 2/ Inelastic labor supply; 3/ Higher intertemporal elasticity of substitution; 4/ Lower share of rule-of-thumb consumers; 5/ Higher elasticity of subst. between capital and labor.

Table 12: Sensitivity Analysis: effects on the Home Economy continued (cut in labor taxes; large-open economy)

	Baseline	$q = 0.95^{1/}$	$\eta = 1.0^{2/}$	$\rho = 3.0^{3/}$	$\Psi = 0.0^{4/}$	$\xi = 1.0^{5/}$
Real exchange rate (percent)						
Impact	-0.88	-0.65	-0.88	-0.80	-0.74	-0.78
First 10 years (average)	-0.50	-0.36	-0.52	-0.49	-0.42	-0.46
Long run	0.21	0.18	0.22	0.18	0.20	0.21
Real GDP (percent)						
Impact	0.28	0.25	0.24	0.22	0.24	0.28
First 10 years (average)	-0.25	-0.06	-0.35	-0.08	-0.11	-0.23
Long run	-3.42	-1.22	-3.85	-1.93	-2.81	-3.35
Consumption (percent)						
Impact	1.52	1.35	1.59	0.90	1.13	1.48
First 10 years (average)	1.12	0.70	1.12	0.95	0.85	1.09
Long run	-2.43	-1.02	-2.65	-1.47	-2.03	-2.31
Investment (percent)						
Impact	-3.32	-3.11	-3.82	-1.17	-2.15	-3.55
First 10 years (average)	-4.55	-2.24	-5.09	-3.04	-2.94	-4.87
Long run	-8.55	-2.97	-9.87	-4.80	-7.04	-9.37
Labor effort (percent)						
Impact	0.10	0.11	0.01	0.14	0.12	0.09
First 10 years (average)	0.09	0.13	0.01	0.11	0.12	0.09
Long run	-0.18	-0.09	-0.02	-0.12	-0.15	-0.12
Real wage (percent)						
Impact	0.02	-0.00	0.07	-0.00	0.00	0.05
First 10 years (average)	-0.62	-0.35	-0.66	-0.40	-0.42	-0.47
Long run	-4.11	-1.41	-4.84	-2.28	-3.37	-3.37

1/ Longer planning horizon; 2/ Inelastic labor supply; 3/ Higher intertemporal elasticity of substitution; 4/ Lower share of rule-of-thumb consumers; 5/ Higher elasticity of subst. between capital and labor.

Table 13: Sensitivity Analysis: effects on the Foreign Economy (cut in labor taxes; large-open economy)

	Baseline	$q = 0.95^{1/}$	$\eta = 1.0^{2/}$	$\rho = 3.0^{3/}$	$\Psi = 0.0^{4/}$	$\xi = 1.0^{5/}$
Real GDP (percent)						
Impact	-0.08	-0.04	-0.08	-0.11	-0.08	-0.08
First 10 years (average)	-0.50	-0.28	-0.54	-0.34	-0.34	-0.49
Long run	-3.14	-0.98	-3.59	-1.68	-2.55	-3.08
Consumption (percent)						
Impact	-0.09	0.08	0.02	-0.53	-0.24	-0.09
First 10 years (average)	-0.11	-0.23	-0.04	-0.26	-0.18	-0.12
Long run	-1.46	-0.18	-1.68	-0.60	-1.10	-1.38
Investment (percent)						
Impact	-2.28	-2.26	-2.69	-0.43	-1.31	-2.68
First 10 years (average)	-4.02	-1.89	-4.49	-2.57	-2.64	-4.37
Long run	-8.35	-2.79	-9.69	-4.62	-6.84	-9.15
Real interest rate						
Impact	0.05	0.24	0.07	-0.15	0.00	0.08
First 10 years (average)	0.25	0.14	0.28	0.14	0.15	0.25
Long run	0.90	0.29	1.07	0.48	0.73	0.86
Labor effort (percent)						
Impact	0.02	0.01	0.00	0.04	0.03	0.02
First 10 years (average)	-0.01	0.00	-0.00	0.00	-0.00	-0.01
Long run	-0.14	-0.06	-0.02	-0.09	-0.12	-0.09
Real wage (percent)						
Impact	-0.11	-0.08	-0.11	-0.12	-0.10	-0.12
First 10 years (average)	-0.66	-0.36	-0.74	-0.44	-0.45	-0.55
Long run	-3.90	-1.23	-4.62	-2.09	-3.16	-3.17

1/ Longer planning horizon; 2/ Inelastic labor supply;3/ Higher intertemporal elasticity of substitution; 4/ Lower share of rule-of-thumb consumers; 5/ Higher elasticity of subst. between capital and labor.

Table 14: Sensitivity Analysis: effects on the Home Economy (cut in corporate taxes; large-open economy)

	Baseline	$q = 0.95^{1/}$	$\eta = 1.0^{2/}$	$\rho = 3.0^{3/}$	$\Psi = 0.0^{4/}$	$\xi = 1.0^{5/}$
Tax rate						
Impact	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
First 10 years (average)	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
Long run	0.49	0.40	0.51	0.44	0.46	0.48
Government debt to GDP						
Impact	1.03	1.02	1.03	1.03	1.03	1.03
11th Year	11.91	11.68	11.94	11.92	11.85	11.90
Long run	12.00	12.00	12.00	12.00	12.00	12.00
Net foreign assets to GDP						
Impact	-0.18	-0.13	-0.18	-0.18	-0.18	-0.19
11th Year	-1.60	-0.68	-1.58	-1.61	-1.57	-1.59
Long run	-5.20	-5.83	-5.17	-5.30	-5.23	-5.19
Government balance to GDP						
Impact	-1.03	-1.02	-1.03	-1.03	-1.03	-1.03
First 10 years (average)	-1.28	-1.25	-1.28	-1.28	-1.27	-1.27
Long run	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24
Current Account balance to GDP						
Impact	-0.18	-0.13	-0.18	-0.18	-0.18	-0.19
First 10 years (average)	-0.15	-0.06	-0.15	-0.15	-0.15	-0.15
Long run	-0.10	-0.11	-0.10	-0.10	-0.10	-0.10
Trade Balance to GDP						
Impact	-0.18	-0.13	-0.18	-0.18	-0.18	-0.19
First 10 years (average)	-0.11	-0.03	-0.10	-0.11	-0.10	-0.10
Long run	0.21	0.20	0.21	0.19	0.20	0.20
Real interest rate						
Impact	-0.04	0.11	-0.01	-0.17	-0.07	-0.05
First 10 years (average)	0.12	0.02	0.15	0.04	0.07	0.12
Long run	0.97	0.35	1.15	0.53	0.79	0.93

1/ Longer planning horizon; 2/ Inelastic labor supply; 3/ Higher intertemporal elasticity of substitution; 4/ Lower share of rule-of-thumb consumers; 5/ Higher elasticity of subst. between capital and labor.

Table 15: Sensitivity Analysis: effects on the Home Economy continued (cut in corporate taxes; large-open economy)

	Baseline	$q = 0.95^{1/}$	$\eta = 1.0^{2/}$	$\rho = 3.0^{3/}$	$\Psi = 0.0^{4/}$	$\xi = 1.0^{5/}$
Real exchange rate (percent)						
Impact	-0.62	-0.43	-0.62	-0.61	-0.60	-0.55
First 10 years (average)	-0.21	-0.06	-0.19	-0.21	-0.20	-0.19
Long run	0.20	0.19	0.21	0.18	0.19	0.20
Real GDP (percent)						
Impact	0.06	0.04	0.07	0.03	0.04	0.06
First 10 years (average)	-0.22	-0.09	-0.21	-0.11	-0.15	-0.21
Long run	-3.76	-1.56	-4.24	-2.22	-3.12	-3.70
Consumption (percent)						
Impact	0.14	0.14	0.24	-0.24	-0.02	0.14
First 10 years (average)	0.86	0.46	0.95	0.79	0.79	0.84
Long run	-2.66	-1.26	-2.92	-1.66	-2.24	-2.53
Investment (percent)						
Impact	0.68	0.30	0.33	2.06	1.22	0.81
First 10 years (average)	-4.05	-2.16	-4.36	-3.14	-3.36	-4.41
Long run	-9.46	-3.92	-10.83	-5.63	-7.88	-10.40
Labor effort (percent)						
Impact	-0.01	-0.01	-0.00	0.02	0.01	-0.01
First 10 years (average)	-0.09	-0.04	-0.01	-0.07	-0.07	-0.08
Long run	-0.15	-0.05	-0.02	-0.08	-0.12	-0.09
Real wage (percent)						
Impact	0.06	0.04	0.06	0.04	0.05	0.06
First 10 years (average)	-0.33	-0.14	-0.42	-0.18	-0.23	-0.26
Long run	-4.58	-1.89	-5.33	-2.70	-3.80	-3.76

1/ Longer planning horizon; 2/ Inelastic labor supply; 3/ Higher intertemporal elasticity of substitution; 4/ Lower share of rule-of-thumb consumers; 5/ Higher elasticity of subst. between capital and labor.

Table 16: Sensitivity Analysis: effects on the Foreign Economy (cut in corporate taxes; large-open economy)

	Baseline	$q = 0.95^{1/}$	$\eta = 1.0^{2/}$	$\rho = 3.0^{3/}$	$\Psi = 0.0^{4/}$	$\xi = 1.0^{5/}$
Real GDP (percent)						
Impact	-0.06	-0.04	-0.06	-0.09	-0.07	-0.07
First 10 years (average)	-0.33	-0.13	-0.36	-0.22	-0.25	-0.33
Long run	-3.39	-1.18	-3.86	-1.86	-2.75	-3.33
Consumption (percent)						
Impact	-0.07	0.05	0.03	-0.41	-0.21	-0.07
First 10 years (average)	-0.09	-0.15	-0.02	-0.20	-0.15	-0.09
Long run	-1.58	-0.23	-1.81	-0.66	-1.20	-1.49
Investment (percent)						
Impact	-1.50	-1.40	-1.87	-0.22	-0.93	-1.75
First 10 years (average)	-2.24	-0.34	-2.64	-1.23	-1.55	-2.41
Long run	-8.97	-3.33	-10.37	-5.07	-7.37	-9.83
Real interest rate						
Impact	-0.04	0.11	-0.01	-0.17	-0.06	-0.03
First 10 years (average)	0.13	0.04	0.16	0.06	0.08	0.13
Long run	0.97	0.35	1.15	0.53	0.79	0.93
Labor effort (percent)						
Impact	0.01	0.00	0.00	0.03	0.02	0.01
First 10 years (average)	-0.01	0.00	-0.00	0.00	-0.00	-0.01
Long run	-0.15	-0.08	-0.02	-0.10	-0.13	-0.10
Real wage (percent)						
Impact	-0.09	-0.06	-0.08	-0.10	-0.09	-0.09
First 10 years (average)	-0.43	-0.16	-0.49	-0.28	-0.33	-0.36
Long run	-4.21	-1.48	-4.96	-2.31	-3.42	-3.42

1/ Longer planning horizon; 2/ Inelastic labor supply; 3/ Higher intertemporal elasticity of substitution; 4/ Lower share of rule-of-thumb consumers; 5/ Higher elasticity of subst. between capital and labor.