The International Spillovers of Capital Income Taxation: An Applied General Equilibrium Analysis

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THE INTERNATIONAL SPILLOVERS OF CAPITAL INCOME TAXATION:
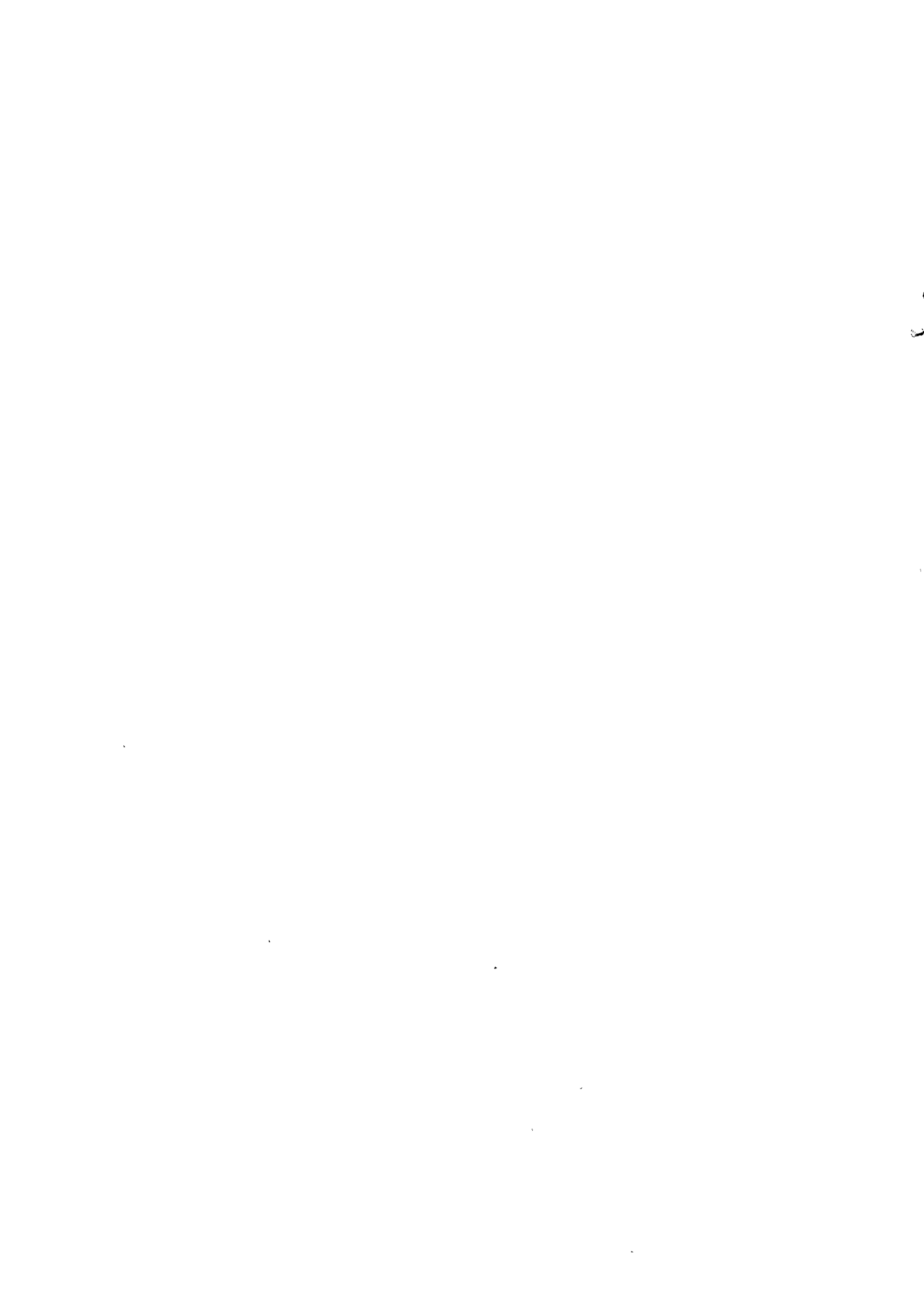AN APPLIED GENERAL EQUILIBRIUM ANALYSIS

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THE INTERNATIONAL SPILLOVERS OF CAPITAL INCOME TAXATION:
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This paper sheds light on the complex macroeconomic effects initiated by capital income taxation using a dynamic applied general equilibrium model of the U.S. economy. The model considers impacts of policy changes on the allocation of resources across both industries and countries, and over time. Within the model, a given change in capital income taxation abroad affects the domestic economy through capital flows, commodity flows and tax revenue effects. Thus, the model considers the spillovers associated with changes in commodity flows in addition to the usual spillovers generated by capital movements.

The simulation results illustrate rather well that personal and corporate income taxation yield very different conclusions in terms of macroeconomic consequences and that it is important to distinguish between short- and long-run policy implications of the two types of capital income tax policies.

$$* \quad * \quad *$$

L'objectif premier de ce texte vise à mettre en évidence les impacts macroéconomiques complexes résultant de l'imposition des revenus du capital. Pour ce faire, l'analyse fait appel à un modèle d'équilibre général appliqué de type dynamique construit pour les Etats-Unis. Ce modèle permet d'analyser les effets d'un changement de politique sur l'allocation des ressources au niveau industriel de même qu'au niveau international. Les propriétés dynamiques du modèle permettent également de tracer le processus d'ajustement temporel de ces effets. Ainsi, un changement donné dans l'imposition des revenus du capital à l'étranger affectera l'économie domestique par le biais des flux de capitaux et de marchandises de même que par l'intermédiaire des revenus d'imposition. Le modèle permet donc d'analyser les effets de contagion associés aux flux de marchandises en plus des habituels effets de contagion engendrés par les mouvements de capitaux.

Les résultats des simulations montrent que les impacts complexes découlant de l'imposition des revenus des personnes physiques et de même que de ceux des sociétés donnent lieu à des conclusions fort distinctes en termes macroéconomiques. En outre, ces résultats indiquent des effets à court et à long termes très différents, selon le régime d'imposition des revenus du capital envisagé.

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THE INTERNATIONAL SPILLOVERS OF CAPITAL INCOME TAXATION:
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by

François Delorme, Lawrence H. Goulder and Philippe Thalmann[1]

I. Introduction and summary

A country's capital income taxes may have economic effects in other countries, especially if the country is large. An attempt is made in this paper to identify the complex macroeconomic effects of capital income taxation and to quantify their spillover effects using applied general equilibrium analysis.

The results show that, for a given impact over time on the budget balance, the effects of a change in one country's capital income tax policies on the other country in a two-country world depend on the taxes concerned. A personal income tax cut abroad yields global benefits to both the home country (the United States) and the foreign country, given enforced residence-based taxation. On the other hand, a cut in corporate income taxation, which is source-based, mainly benefits the country making the cut. Contrary to what is generally believed, the international spillover effects from the introduction of the investment tax credit in the early 1980s, and its subsequent withdrawal are likely to have been smaller than those resulting from changes in personal income taxation.

The time pattern of the spillovers also depends on the taxes which are changed. A reduction in personal income taxation in the foreign country benefits U.S export-oriented industries, helping to improve the trade account surplus over time. However, the induced real exchange rate depreciation has negative consequences for the real income of U.S. residents, which declines by almost 1 per cent in the long run. By contrast, the increase in the foreign country's investment tax credit implies a reduction of the U.S. trade surplus over time but, under the impetus of foreign investment, does not have negative spillover effects on U.S. real income, as in the personal taxation scenario.

As expected, these spillover effects are magnified with higher international capital mobility. The simulation results illustrate rather well that personal and corporate income taxation yield very difficult conclusions in terms of macroeconomic consequences and that it is important to distinguish between near-term and long-run policy implications of the two types of capital income tax policies.

The structure of the paper is as follows: the conceptual framework is discussed in Section II. An overview of the model is given in Section III. The simulation results are presented in Section IV. The sensitivity of the results to key changes in model parameters (including the degree of international capital mobility) is given in Section V.

II. A framework to assess international spillovers

During the past decade, policy-makers have made increasing use of applied general equilibrium models as a tool to help better understand the economic transmission effects of tax reforms. This methodology is well established for domestic taxation issues and the relative strengths and weaknesses are well known.[2] It hence represents a potentially useful tool for quantifying the international spillovers.

The Goulder-Thalmann (hereafter GT) model (Goulder (1991) and Goulder and Thalmann (1990)) considers impacts of policy changes on the allocation of resources across industries, across countries, and over time. Within the model, a given change in capital income taxation abroad will affect the domestic economy through capital flows, commodity flows, and tax revenue effects. Thus, the model considers the spillovers associated with changes in commodity flows in addition to the usual spillovers generated by capital movements. The model derives from optimising principles the saving and portfolio behaviour of domestic and foreign households. Similarly, investment decisions of firms stem from the objective of each firm to maximise its equity value. The behaviour of households and firms is forward-looking: today's decisions depend not only on current prices and interest rates but also on the prices and interest rates that are expected to occur in the future. A change in tax policy will alter such behaviour and lead to a new equilibrium with a different system of prices and distribution of income.

The GT model is simulated to assess the importance of the capital flight and tax exportation effects consecutive to a change in capital income taxation. The relative importance of the two effects depend upon two key factors:

- whether taxes are residence- or source-based. These characteristics determine whose returns, among investors and savers, are affected by a given change in capital taxation.

- the response of saving, investment and portfolio composition to changes in after-tax returns implied by tax policy changes.

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In view of these considerations, the analysis attempts to shed light on the following questions:

1) What are the potential short- and long-term impacts on the various macroeconomic variables of, on the one hand, a unilateral reduction in the foreign personal income taxation and, on the other hand, an equivalent reduction in the corporate income taxation?

2) What are the dynamic effects arising from induced changes in investment and saving patterns?

3) What is the importance of the degree of international capital mobility on the magnitude of spillover effects?

The workings of the GT model can be illustrated with the help of a simple example. Consider a reduction in the domestic rate of tax on interest income. This will have an impact on the allocation of resources in the domestic and the foreign country mainly through the following effects:

-- **international effects:** A reduction in the taxation of personal capital income will change the relative rates of return offered on capital located in the home and foreign countries. Changes in relative rates of return affect the prices of the existing stocks of assets so that, despite the changes in rates of return, the supply of existing assets is consistent with its demand. In addition, the changes in relative rates of return influence the rates of accumulation of new assets. In general, capital (new savings) will flow toward the country whose assets offer the higher after-tax return. These capital flows influence exchange rates and interest rates, if the home country is large enough.

-- **intertemporal effects:** Domestic firms will also invest more. Thus, reductions in the domestic tax rate on interest income will affect interest rates and capital accumulation. The transition path of the economy to the long run is critically influenced by changes over time in the industrial and global allocation of capital stocks.

The magnitude and, sometimes, the direction of these results are sensitive to the specification of the model, to the values of certain key parameters as well as to the modelling of expectations. For this

reason, it is critical to perform sensitivity analyses in order to determine the robustness of the simulation results. Such an analysis is presented in Section V.

III. Model specification

This section describes briefly the intertemporal open-economy model. Complete documentation of the model, including a list of variables and equations, is presented in Goulder and Eichengreen (1989b).

A.   Overview

The Goulder-Thalmann model covers two regions. One region is a specific country and the other represents the rest of the world. In this paper, the model has been calibrated for the United States and rest of the world. The United States was selected because the existing model is already calibrated for this country based on 1983 data.

There are six distinct U.S. industries and one foreign industry. At each point in time, domestic and foreign producers combine cost-minimising levels of labour and intermediate inputs with the existing capital stock. Intermediate inputs can be obtained both at home and abroad, and firms choose the mix of imperfectly substitutable domestic and foreign inputs in accordance with cost-minimisation.

Both consumers and producers are forward-looking and form model-consistent expectations. Firms follow capital accumulation strategies aimed at maximising the value of the firm. Optimal investment involves balancing the costs of new capital against the benefits in terms of the higher future profits made possible by a larger capital stock. The cost of new capital includes the costs of installing capital which is imperfectly mobile across uses.[3]

Domestic and foreign households make labour, consumption and portfolio decisions in accordance with intertemporal utility maximisation. Overall consumption at each point in time is a composite of specific consumption good types which in turn are composites of domestically-produced and foreign goods of each type. When relative prices change, households alter the proportions of domestic and foreign consumer goods making up each composite in accordance with utility maximisation. As on the production side, domestic and foreign consumer goods are treated as imperfect substitutes. Households' portfolio

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decisions include choosing the shares of domestic and foreign assets in financial wealth. An increase in the relative rate of return offered by a given asset induces households to hold a larger fraction of their wealth in that asset.

Finally, the model incorporates a government sector in both the domestic and foreign economies. Each government collects taxes, distributes transfers, purchases goods and services, and faces a budget constraint according to which revenues and borrowing on one side and expenditures on the other must balance in each year.

B.   Production

a. Domestic industries

i) Production technologies.

Each industry produces a single output (X) using labour (L), structures (K_s) and equipments (K_e), and domestic and foreign intermediate inputs (M), according to the function:

$$X = f \left\{ g[h(K_s, K_e), L], M \right\} - AC \tag{1}$$

where AC represents capital adjustment costs; f(.) is a Leontief matrix and g(.) and h(.) are CES functions. Firms choose the quantity of labour that maximises profits, given the composite capital stock. Labour and capital combine to produce a value-added composite, which then combines with intermediate inputs in fixed proportions to generate output. Adjustment costs are treated as internal to the firm: to add capital, currently available resources (labour, existing capital, and intermediate goods) must be devoted to installation. They are a convex function of the rate of investment.

Industry outputs serve both as intermediate inputs and as final goods for purchase by the government. These outputs also combine in fixed proportions (using a so-called transition matrix) to create 17 different consumer goods as well as the new capital goods used in production.[4] Intermediate inputs are composites of foreign- and domestically-supplied intermediate goods. Each type of intermediate input is a CES composite of foreign- and domestically-supplied intermediate goods of that type. To minimise costs, firms alter the mix of domestic and foreign inputs that make up each composite.

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ii) Producer behaviour.

The representative firm in each sector behaves as a price-taker on the markets for its output and inputs. It chooses levels of employment, intermediate inputs, and investment to maximise the equity value of the firm (V). This equity value can be expressed as the discounted value of net payments to shareholders:

$$V_t = \sum_{s=t}^{\infty} \left[\frac{1-\theta}{1-\kappa} DV_s - VN_s \right] \mu_t(s) \tag{2}$$

$$\mu_t(s) = \prod_{u=t}^{s} \left[1 + \frac{r_u}{1-\kappa} \right]^{-1} \tag{3}$$

where DV are dividends and VN are share issues. The parameter θ is the marginal personal income tax rate,

κ is the effective capital gains tax rate, and r is the risk-adjusted rate of return that the firm must offer to stockholders. Equation (2) derives from the arbitrage condition requiring risk-adjusted rates of return to be equal across financial assets.

Dividends and share issues in each period are related to after-tax profits and investment through a cash-flow identity equating sources and uses of funds. By substitution, the value of the firm can be expressed as a function of two types of variables: (1) the choice variables, namely current and future uses of labour and materials, and investment; (2) the exogenous variables, namely the initial capital stock, technology and financial behaviour parameters, and current and future tax parameters.

Optimal levels of labour and intermediate inputs in any single year can be chosen with a view to maximising the current value of net output. The same is not true for investment because it adds to durable capital and thereby affects returns in all future periods. Investment will be optimal when the total cost of the last unit is equal to the present value of the total benefits that the marginal increment of the capital stock makes possible. The marginal cost of investment includes the purchase price of the investment good reduced possibly by an investment tax credit, and the marginal adjustment cost. The benefits of an

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additional unit of capital include its marginal product net of corporate and personal taxes, depreciation allowances, and the reduction in the marginal adjustment cost for future investment.[5]

b. Foreign Industry

The structure of foreign production is identical to that of domestic production, except for aggregation. A single representative foreign firm produces output using inputs of capital, labour, and domestic and foreign intermediate inputs. Input levels as well as levels of investment are chosen to maximise the value of the firm.

C. Consumption

Households are forward-looking and endowed with perfect foresight. In each region, a representative, infinitely-lived household solves a multi-level decision problem, choosing a path of labour, consumption and portfolio holdings. Its preferences are represented by a nested utility function of the following form:

$$U_t = \sum_{s=t}^{\infty} (1 + \omega)^{t-s} \frac{\sigma}{1-\sigma} u_s \frac{\sigma-1}{\sigma} \tag{4}$$

$$u_s = u[Z(C_s, l_s), A_s] \tag{5}$$

$$C = C(\bar{c}_{1s}, \bar{c}_{2s}, ..., \bar{c}_{ms}) \tag{6}$$

$$\bar{c}_{is} = \bar{c}_i(c_{is}, c_{is}^*) \tag{7}$$

$$A_s = k \left[\alpha_0^{1-\rho} \alpha^\rho + (1-\alpha_0)^{1-\rho} (1-\alpha)^\rho \right]^{1/\rho} \tag{8}$$

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In equation (4), ω is the rate of time preference and σ is the intertemporal elasticity of substitution. Equation (5) defines annual utility, a Cobb-Douglas composite of full consumption (Z) and portfolio satisfaction (A). Full consumption is a CES composite of the consumption of goods and services (C) and leisure (l). The consumption of goods and services is a Cobb-Douglas composite of the 17 consumer goods, as shown in equation (6). The consumer goods themselves are a (CES) aggregation of domestic and foreign consumer goods with a constant elasticity of substitution (equation (7)). Equation (8) finally shows that portfolio satisfaction is a CES function of the shares of the portfolio held in domestic assets (α) and foreign assets; k, α_0 and ρ are parameters.

The specification of each household portfolio preference index and its inclusion in the utility function derives from the observation that households exhibit home-country preference: assets from their own country typically make up the bulk of their portfolios, even when rates of return on other-country assets are comparable or higher. The domestic household maximises intertemporal utility subject to the wealth accumulation condition:

$$W_{t+1} = \left[1 + \alpha_t r_{DD,t} + (1-\alpha) r_{DF,t}\right] W_t + w_t (L_t, l_t) - \bar{P}_t C_t - T_t \qquad (9)$$

where W is the total financial wealth owned by the household, r_{DD} and r_{DF} are the annual after-tax returns offered to the domestic household on its holdings of domestic and foreign assets, w is the after-tax wage rate, L is the household's total time endowment, $\bar{p}$ is the price index for overall consumption, and T is the sum of lump-sum taxes minus transfers. The aggregate endowment of time is exogenous: it grows at a constant rate, g, which determines the long-run (steady-state) real growth rate of the economy. This growth represents Harrod-neutral technical progress in producing labour or leisure services per unit of actual time. Labour is perfectly mobile across sectors.

Condition (9), together with the transversality condition that imposes a zero lower bound on terminal wealth, determines the household's intertemporal budget constraint:

$$\sum_{s=t}^{\infty} P_{z,s} v_t(s) = W_t + \sum_{s=t}^{\infty} [\omega_s L_s - T_s] v_s(s) \qquad (10)$$

$$v(s) = \prod_{u=t}^{s} \left[1 + \alpha_u r_{DD,u} + (1 - \alpha_u) \, r_{DF,u}\right]^{-1} \qquad (11)$$

The first term of equation (10) is the present value of full consumption; p_z is the composite price of full consumption. The present value of full consumption must not exceed the sum of initial financial wealth and total human wealth, which is the present value of the infinite stream of after-tax earnings minus net lump-sum taxes.

The portfolio trade-off for the household now becomes apparent. When $r_{DD} = r_{DF}$, it maximises utility by optimising portfolio satisfaction (A), that is, by choosing $\alpha = \alpha_0$ in equation (8). When rates of return differ, however, maintaining the same portfolio shares has a cost in terms of a lower overall return than that which could be obtained if the household held more of the asset with the higher return. The household chooses the path of α that balances the rewards of approaching preferred shares against the costs in terms of lower consumption as a result of a lower overall return on the portfolio.

The parameter ρ in the portfolio preference function is related to σ_A, the elasticity of substitution between asset shares ($\rho = 1 - 1/\sigma_A$). When $\sigma_A = 0$, households maintain shares α_0 and $1 - \alpha_0$ of domestic and foreign assets, irrespective of differences in rates of return, as assets are not substitutable. As σ_A approaches infinity, household behaviour approaches the limiting case of perfect substitutability, where the slightest difference in return leads households to hold only the asset offering the higher return.

Similarly, optimal full consumption involves balancing the marginal utility of consumption and leisure against the "cost" of reduced wealth, i.e. reduced future consumption. The trade-off depends on the discount rate (and thereby on portfolio choices) and on the prices of the consumption baskets. The latter depend on the composition of the baskets. In other words, the household will select for every year the mix of consumer goods of domestic and foreign origin that produces the preferred consumption bundle at the lowest cost. It combines, in turn, consumption of goods and services with leisure with the objective of maximising full consumption at the lowest cost. Finally, it trades full consumption today against full consumption in later periods.[6]

Current consumption and saving depend on total wealth and the expected interest rates. Higher future interest rates diminish wealth and thereby reduce consumption and raise savings. Changes in the relative returns offered by home and foreign assets induce households to raise the portfolio share of the

asset whose relative return has increased. The treatment of the foreign household is the same as that of the domestic household.

D.   Government Behaviour

The model incorporates very specific elements of the U.S. tax system. Overall, real government spending (transfers plus purchases) is exogenous and increases at the steady-state growth rate, g. The model is parameterised so that, in the base case, government expenditures exceed revenues in each period by the amount of a deficit that grows at the nominal steady-state growth rate of the economy; the ratios of the deficit to government debt and to GNP remain constant along the base case path. In policy change simulations, real government spending is the same as in the base case, and the same deficit is maintained through lump-sum adjustments to personal income taxes.[7] The foreign government performs the same functions and has the same tax instruments as the domestic government.

The set of capital tax instruments applying to firms and investors includes the corporate income tax, depreciation allowances, investment tax credits, the effective tax on capital gains, property taxes, and the tax on capital income at the individual level.

E.   Equilibrium conditions

The model is calibrated to exhibit steady-state growth in the base case (or benchmark) equilibrium. Following a policy shock, temporary equilibria (in the sense employed in Grandmont (1977)) with market-clearing conditions are generated in every period. These temporary equilibria form a transition path on which the economy gradually approaches a new long-run, steady-state equilibrium.

The requirements of temporary equilibrium are that in each country and in each period: (1) the demand for labour equal its supply; (2) the demand for output from each industry equal its supply; (3) total external borrowing by firms equals total saving by residents of the given country plus the net capital inflow; and (4) government revenues plus borrowing equal government spending. Equilibrium is established by adjusting the nominal exchange rate, domestic and foreign output prices, domestic and foreign interest rates, and lump-sum domestic and foreign personal taxes.[8]

In the short run, shocks give rise to divergences in marginal products of capital across industries and in average portfolio returns to domestic and foreign residents. Over time, long-run equilibrium is re-established as savings and investment decisions equalize marginal products of capital across industries (adjusted for taxes and risk) and bring overall portfolio returns back to equality.

Since households and firms are forward-looking with perfect foresight, solution of the model requires that expectations conform to the actual future values. To derive perfect foresight expectations, the model is repeatedly solved forward, each time generating a path of equilibria under a given set of expectations. After each path of equilibria is obtained, expectations are revised and a new equilibrium path is generated. Using an approach similar to that of Fair and Taylor (1983), the model obtains perfect foresight expectations and the consistent intertemporal equilibrium path.

F.   Data and parameters

A detailed documentation of the model's data sources and parameterisation procedure is contained in Goulder (1991). Econometric estimates provide many important parameters for the model. Remaining parameters are obtained through a calibration method in which the requirements of utility maximisation, cost minimisation, and balanced growth serve as identifying restrictions. Calibrating the model consists of adjusting certain parameters to make it fit the data for the benchmark year, given its specification and exogenous values for certain key parameters. In the GT model, it includes the restriction that, in the base case, the current and capital accounts of the balance of payments are both zero.

The fully parameterised data set generates a base case simulation in which the domestic and foreign economies exhibit balanced growth at the rate g, the rate of growth of effective labour services. Policy shocks cause growth rates to differ from g during transition periods but to return asymptotically to that rate in the steady state.

IV.   Simulation results

To illustrate the main channels by which international spillovers operate, as well as to indicate their order of magnitude, two simulations are performed. In the first simulation, the (enforced) personal tax rate on capital income on dividends and interest income in the foreign country is assumed to be unilaterally lowered by 10 percentage points. In the second simulation, it is assumed that there is an

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increase in the investment tax credit in the foreign country. To permit comparison of the two policy simulations, the budgetary impact of each policy is assumed to be the same. In the following section, both simulations are assessed under alternative hypotheses regarding international mobility of capital.

The results of the simulations are applied to the case of the United States: the tax policy changes originate from the foreign economy and impact on the United States. This enables to analyze more reliably the impacts of the spillovers on the United States. The results of a unilateral reduction of the personal income tax rate are discussed first. The results are presented in the following order: their impacts on the foreign economy, the channels by which international spillovers operate and finally, the effects on the U.S. economy. The results of the investment tax credit policy are then described. As noted, the simulation entails that both the United States and the rest of the world neutralise the effects on the budget by adjusting non-distortionary taxes. Both simulation results are reported in Table 1.

The model has also been applied to examine the impact of the 1986 Tax reform Act by Bovenberg and Goulder (1990). A summary of their results is also given in this section. These results contribute to validate the use of the model in a concrete situation, thus lending credibility to results obtained in the illustrative simulations, in particular, to the impact of tax competition upon the U.S. net foreign asset position.

A.   Unilateral reduction in foreign personal income taxation

   i)   Aggregate effects outside the U.S. economy

The short-term impact of reduction of 10 percentage points of the foreign personal capital income tax rate is to increase the after-tax returns to foreign investors. This leads to an initial increase in foreign saving of almost 12 per cent. As most foreign assets are owned by foreigners, and the rest of the world is large compared with the U.S. economy, the rise in saving leads to a fall in the real before-tax rate of interest of 0.8 percentage points (from 9 to 7.2 per cent). This reduction has a positive impact on foreign investment, which increases by about 5 per cent in the short run and by almost 10 per cent in the long run. Real GDP in the rest of the world rises as a result of increased investment and exports. At the end of the transition period, higher saving and the improved terms of trade result in a welfare gain for foreign households of 3.2 per cent.[9] Production in the United States and in the foreign economy, as measured by GDP rises by 0.7 and 4.4 per cent, respectively.

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ii) International spillovers: capital flight effects and the U.S. economy

The transfer of capital to the United States from abroad (i.e. capital flight effect) induced by the reduction of the foreign personal capital income tax rate works mainly through i) (before-tax) interest rate movements, which affect the geographic relocation of savings; and ii) changes in the real exchange rate, which influence import and export flows. Following the policy change, foreigners change their allocation of the savings across domestic and foreign assets. Much of the increased saving by foreign households is directed toward the foreign economy, causing the foreign interest rate to fall. At the same time, the flow of additional saving to the United States is substantial enough to cause the before-tax interest rate in the United States to fall as well. The drop in the U.S. rate from 9 to 8.8 per cent is part of the spillover effect, and it is associated with a decline in the personal saving of U.S. residents by 11 per cent.

Since the foreign tax was imposed on a residence basis, the tax burden faced by U.S. residents does not change. Hence, the fall in before-tax interest rates at home and abroad implies a drop in the after-tax returns enjoyed by U.S. savers. Thus, although the tax cut benefits foreign savers, it hurts U.S. savers in terms of the after-tax returns they can enjoy on assets located in the United States and abroad. Overall, interest income, both from U.S. and foreign assets, falls and, as a result, personal saving of U.S. residents declines by 11 per cent in the short run. Part of the reduced interest income is reflected in lower tax revenues for the U.S. government, which has to increase other taxes in order to restore the initial position of the budget deficit.

The change of relative (before-tax) interest rates between the U.S and the rest of the world also has important consequences on the balance of payments. The policy encourages foreigners to save more, and the increase in their saving includes additional purchases of U.S. assets by foreigners (the initial share is, however, less than 10 per cent). In contrast, U.S. residents, whose saving is discouraged by the lower after-tax interest rates they face, reduce their accumulation of foreign assets over the transition period. This shift in the composition of world saving represents a direct spillover effect following the policy change in the rest of the world.

Both the level and the composition of savings imply an improvement of the U.S. capital account following the reduction in the foreign personal tax rate on capital income. But the emerging surplus of the U.S. capital account must be financed by a deficit in the current account balance. The lowering of the foreign personal capital income tax rate increases the value of net interest payments paid to foreign residents. Thus, net interest receipts in the U.S. become substantially negative, but, as shown in Chart 1,

not sufficiently to finance entirely the surplus in the capital account in the short run. Hence, the real exchange rate rises in order to achieve a trade deficit over the transition period. However, as the U.S. capital account remains in surplus over the simulation's time horizon, net interest payments become increasingly negative as a per cent of GNP, pushing the trade balance into surplus. As can be expected, these patterns in the components of the balance of payments reflect the change in the net foreign asset position of the United States (i.e. the difference between U.S. asset holdings abroad and foreign-owned assets located in the U.S.). As shown in Table 1, this variable rapidly deteriorates into a large deficit because of lower interest income received by U.S. residents as foreign returns fall. The resulting evolution of the trade balance from a deficit to a surplus is a clear example of the potential importance of the spillover effects on the U.S. economy.

Tax competition from the rest of the world contributes to the erosion of the tax base in the United States.[10] When the foreign country lowers its capital income tax rate by 10 percentage points, the U.S. government has to levy lump-sum taxes on income to make up for the revenue loss due to lower interest income tax receipts to prevent tax revenues from falling. Table 1 shows that in the unilateral simulation, the discounted value of revenue loss amounts to about 1.2 per cent of total revenues.

iii) Aggregate impact on the U.S. economy

U.S. residents experience a permanent real income loss of 1.8 per cent of GDP following the change in policy abroad, because of the fall in personal saving and the real exchange rate depreciation consequent to the increased net interest payments to foreigners. However, despite the fall in U.S. income (or GNP), production as measured by the GDP rises, as the increase in foreign saving stimulates investment and production in the United States. The additional production generates income to foreigners, not to U.S. residents.

B.   Unilateral increase of the foreign investment tax credit

In this simulation, the investment tax credit abroad is increased such that its impact on the foreign budget is equivalent to that of the personal tax reduction in the previous subsection[11]. A rise of 11 percentage points was necessary in order to achieve the objective.[12] The results of this simulation are presented in the right panel of Table 1.

The initial impact of the 11 percentage point increase in the investment tax credit is to stimulate investment in the rest of the world by 9 per cent, as the policy lowers the effective cost of capital. This additional investment puts upward short-run pressure on the (before-tax) interest rate in the foreign economy, which increases by about 0.5 percentage points. However, as the policy applies to new capital only, it triggers a fall of 3 per cent in real equity values of foreign firms, because the higher discount rate reduces the value of existing capital.[13] This factor is the main reason behind the fall of both total financial wealth and personal saving of foreigners, despite higher asset returns.

The investment tax credit, as opposed to the personal income taxation policy, represents a source-based policy, which may be expected to have large spillover effects. Yet, spillovers, whether measured by the real income effects or by the balance of payments, are small compared with the personal income taxation simulation presented above. It is interesting to note that tax policies with the same budgetary consequences can have very different spillover effects.

The reason for such difference in spillovers is clear. The initial impact of the foreign tax policy is to stimulate investment and to attract U.S. capital flows. As the foreign economy grows over the transition period, capital accumulation continues, and investment rises by 15 per cent compared with the benchmark value. Total personal saving rises by about 7 per cent in the long run as foreigners increase their total wealth and, notably, the share devoted to U.S. assets. The accumulation of U.S. assets by foreigners more than offsets the demand for foreign assets by U.S. residents, leading to a deterioration of the U.S. net foreign asset position and a small U.S. capital account surplus in the long run. The impact on capital accumulation is mainly concentrated in the foreign economy rather than spread among the two regions.

The offsetting movements in cross-border flows and the concentration of the investment impacts in the foreign economy imply that spillovers from the policy are relatively small. As a result, the overall real income consequences of the foreign country investment tax credit policy on the U.S. economy are rather marginal. The real income gain of foreigners amounts to almost 4 per cent of GDP, with a significant lump-sum tax effect as the public consumption effect amounts to about 1 per cent of GDP.

C.   Reduction in the investment tax credit in the United States

In a recent paper, Bovenberg and Goulder (1990) analysed the welfare consequences of a number of changes initiated under the U.S. Tax Reform Act of 1986. The 1986 reform was not limited to

repealing the investment tax credit.[14] It also reduced corporate statutory rates and tightened depreciation allowances. The main objective of their paper is to assess the different impacts of two investment promoting policies. Both simulations are inspired from the 1986 tax reform: 1) the re-introduction of the investment tax credit of 8 per cent, which was the rate prevailing prior to the 1986 reform and 2) a reduction of corporate tax rates from 34 to 30 per cent.

The results show that the investment tax credit stimulates U.S. investment by more than 5 per cent in the long run. Domestic welfare rises by 0.6 per cent of GDP whereas real income of foreigners barely increases. International spillover effects caused by the investment tax credit are also quite small. The capital account moves from a small surplus (0.1 per cent of GDP) to a small deficit. When the two policies are compared, the investment tax credit produces larger welfare gain that the reduction in corporate tax rate of equal revenue cost. This result is enhanced when capital is more mobile internationally. The two policies have different impacts on the balance of payments. The investment tax credit generates a trade deficit and consequently, and appreciation of the real exchange rate while the reduction in corporate tax rates yields a trade surplus.

V. Sensitivity analysis

Sensitivity analysis is usually performed to assess the robustness of the simulation results with respect to key parameters. Given the illustrative nature of the simulations presented above, the main objective of the sensitivity analysis in this context is to see to what extent the magnitude of the spillover effects is sensitive to three key parameters: 1) the value for the elasticity of substitution between assets located in the United States and in the foreign economy; 2) the intertemporal elasticity of substitution, which governs consumption-saving households' decisions; and 3) the importance of the share of foreign ownership of domestic assets. The results of the sensitivity analysis are presented in Table 3.

The first sensitivity test consists of changing the elasticity of substitution between domestic and foreign assets. Higher values for this elasticity corresponds to higher international mobility of capital. The base case scenario presented in Table 1 assumes that capital was relatively mobile internationally. The international mobility of capital is characterised by the elasticity of substitution between domestic and foreign assets in the portfolios of individual investors. A higher value for this elasticity implies that it is easier to move investor's demands from domestic to foreign assets (or vice versa). Hence, this situation also proxies increased international capital mobility on world financial markets. In the base case scenario (Table 1), the "high" mobility is proxied by value of the substitution elasticity equals 4 whereas this value

is equal to 0.9 for the lower capital mobility scenario (Table 2). It is often argued that increased mobility of capital flows among countries has increased the potential importance of international spillovers. These observations are confirmed by Table 2.

Assuming lower international capital mobility significantly alters the general pattern of the results. In both policy shocks, reduced substitutability of domestic for foreign assets lowers the impact on the capital account as foreigners' portfolio responses are less important, devoting a smaller share of their additional savings to new assets located in the United States. Consequently, the capital account surplus is smaller and the real exchange rate appreciation less pronounced. It results that, in the personal taxation shock for instance, the welfare loss in the United States is halved compared with the situation where capital is assumed to be highly mobile across countries. The results barely changes in the investment tax credit scenario. The order of magnitudes being already rather small, the spillover effects on the U.S. economy do not change with different assumptions relative to international capital mobility. With low capital mobility, the spillover effects of changes in personal income taxation are still the more important ones.

The second key parameter concerns the initial share of domestic assets owned by U.S. residents. Simulation results from the corporate simulation are relatively insensitive to the choice of the parameter value because of the weak spillover effects. In the personal taxation scenario, the magnitude of the results appear to be sensitive to this initial value. In the base case, this parameter value is chosen such that U.S residents and foreigners have strong preferences for home-country assets. A lower domestic share implies that, following the reduction in personal taxation on interest income, foreigners enjoy higher than U.S. residents and, as a result, foreigners' income and saving grow faster than that of domestic residents. With a lower home-country preference, much of the increased saving takes place in the U.S, which explain the relatively important impact on the capital account. Thus the foreigners increased saving cause both domestic and foreign returns to fall considerably. This causes the average return enjoyed by domestic households to fall by 3.5 per cent of GDP.

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Table 1: Impact of lowering the foreign personal and corporate capital income taxation with high international capital mobility (1)

	Personal income taxation reduction				Corporate income taxation reduction			
	United States		Foreign economy		United States		Foreign economy	
	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run
Real income (2)	-0.4	-1.8	0.9	3.2	0.2	0.1	0.8	3.7
Public consumption effect (2)	-0.3	-0.4	-1.1	-0.8	0.0	0.0	-1.2	-0.8
Private consumption effect (2)	-0.2	-1.4	2.0	4.1	0.1	0.1	2.0	3.6
Real exchange rate	3.5	-2.8	—	—	-0.5	1.1	—	—
Real interest rate (4)	-0.2	0.1	-0.8	-1.3	0.1	0.0	0.5	0.0
Real equity values of firms	2.6	0.0	11.2	16.2	-0.8	0.1	-2.7	-2.4
US household returns on assets located in (4):	-0.1	0.1	0.1	-0.8	0.1	0.0	0.0	0.0
Foreigners returns on assets located in (4):	0.0	0.9	0.2	-0.1	0.1	0.0	0.0	0.0
Wealth owned by U.S. residents located in:	0.0	-10.4	—	—	0.0	-0.5	—	—
	0.2	-8.4	-2.4	-30.1	-0.1	-0.5	1.3	-0.4
Wealth owned by foreigners located in:	—	—	6.7	17.2	—	—	-0.6	4.4
	11.6	72.8	6.0	14.2	-2.0	4.3	-0.6	4.4
Real Investment	0.9	0.4	5.5	9.8	-0.3	0.1	9.3	15.4
Real consumption	1.1	-1.6	-1.7	4.3	-0.2	0.1	-1.4	4.2
Real personal saving	-10.7	-11.0	12.2	21.6	1.6	-0.4	-6.7	7.4
Equal yield taxes required (5)	0.4	1.2	5.0	2.8	0.0	-0.1	5.5	2.5
Trade balance (3)	-1.3	1.7	—	—	0.3	0.1	—	—
Net capital income flow (3)	-0.3	-2.8	—	—	0.0	-0.1	—	—
Current account (3)	-1.6	-1.1	—	—	0.3	-0.1	—	—
Capital account (3)	1.6	1.3	—	—	-0.3	0.1	—	—
Net foreign asset position (3)	-2.7	-31.8	—	—	0.8	-1.9	—	—
Real GDP	-0.3	0.7	0.5	4.4	0.1	0.2	1.0	6.1

(1) The personal income tax reduction consists of a reduction of 10 percentage points of the foreign personal tax rate on capital income. The corporate income tax shock simulates the impacts of a reduction of the foreign investment tax credit of 11 percentage points. Both policies have an identical impact on the budget of the foreign country.

(2) Welfare Hicks dynamic equivalent income variation as a percentage of GDP.
(3) Expressed as a percentage of GNP.
(4) Level differences.
(5) As a percentage of total revenues.

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Table 2: Impact of lowering the foreign personal and corporate capital income taxation with low international capital mobility (1)

	Personal income taxation reduction				Corporate income tax reduction			
	United States		Rest of the world		United States		Rest of the world	
	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run
Real income (2)	-0.3	-0.9	0.8	2.7	0.1	0.1	0.8	3.0
Public consumption effect (2)	-0.1	-0.2	-1.2	-0.9	0.0	0.0	-1.3	-0.8
Private consumption effect (2)	-0.1	-0.7	2.0	3.6	0.1	0.1	2.1	3.8
Real exchange rate	2.3	-0.8	—	—	-0.2	1.2	—	—
Real interest rate (4)	-0.5	0.1	-0.6	-1.3	0.2	0.0	0.5	0.0
Real equity values of firms	2.0	-0.5	11.4	16.1	-0.6	0.1	-3.0	-2.7
US household returns on assets located in (4):	-0.3	0.1	0.7	-0.8	0.1	0.0	0.1	0.0
Foreigners returns on assets located in (4):	0.3	-0.1	-0.7	0.9	0.1	0.0	0.1	0.0
Wealth owned by U.S. residents	0.4	-3.9	—	—	-0.1	-0.6	—	-0.5
located in:	0.5	-3.3	-0.1	-9.4	-0.2	-0.6	0.0	-0.5
Wealth owned by foreigners	—	—	6.2	13.6	—	—	-0.9	4.7
located in:	6.6	23.8	6.2	13.1	-0.9	4.7	-1.0	4.7
Real Investment	0.6	-0.2	5.8	9.7	-0.2	0.1	9.8	16.6
Real consumption	0.7	-0.8	-1.5	3.7	-0.1	0.1	-1.6	4.5
Real personal saving	-6.4	-4.1	11.6	16.3	2.1	-0.5	-1.2	8.1
Equal yield taxes required (5)	0.0	0.6	5.2	3.0	0.0	-0.1	5.9	2.7
Trade balance (3)	-0.8	0.8	—	—	0.2	0.1	—	—
Net capital income flow (3)	-0.3	-1.1	—	—	0.1	-0.1	—	—
Current account (3)	-1.1	-0.3	—	—	0.3	0.0	—	—
Capital account (3)	1.1	0.3	—	—	-0.3	0.0	—	—
Net foreign asset position (3)	-0.8	-10.6	—	—	0.2	-2.1	—	—
Real GDP	-0.2	0.2	0.5	4.3	0.1	0.2	1.0	6.5

(1) The personal income tax reduction consists of a reduction of 10 percentage points of the foreign personal tax rate on capital income. The corporate income tax shock simulates the impacts of a reduction of the foreign investment tax credit of 11 percentage points. Both policies have an identical impact on the budget of the foreign country.

(2) Welfare Hicks dynamic equivalent income variation as a percentage of GDP.
(3) Expressed as a percentage of GNP.
(4) Level differences.
(5) As a percentage of total revenues.

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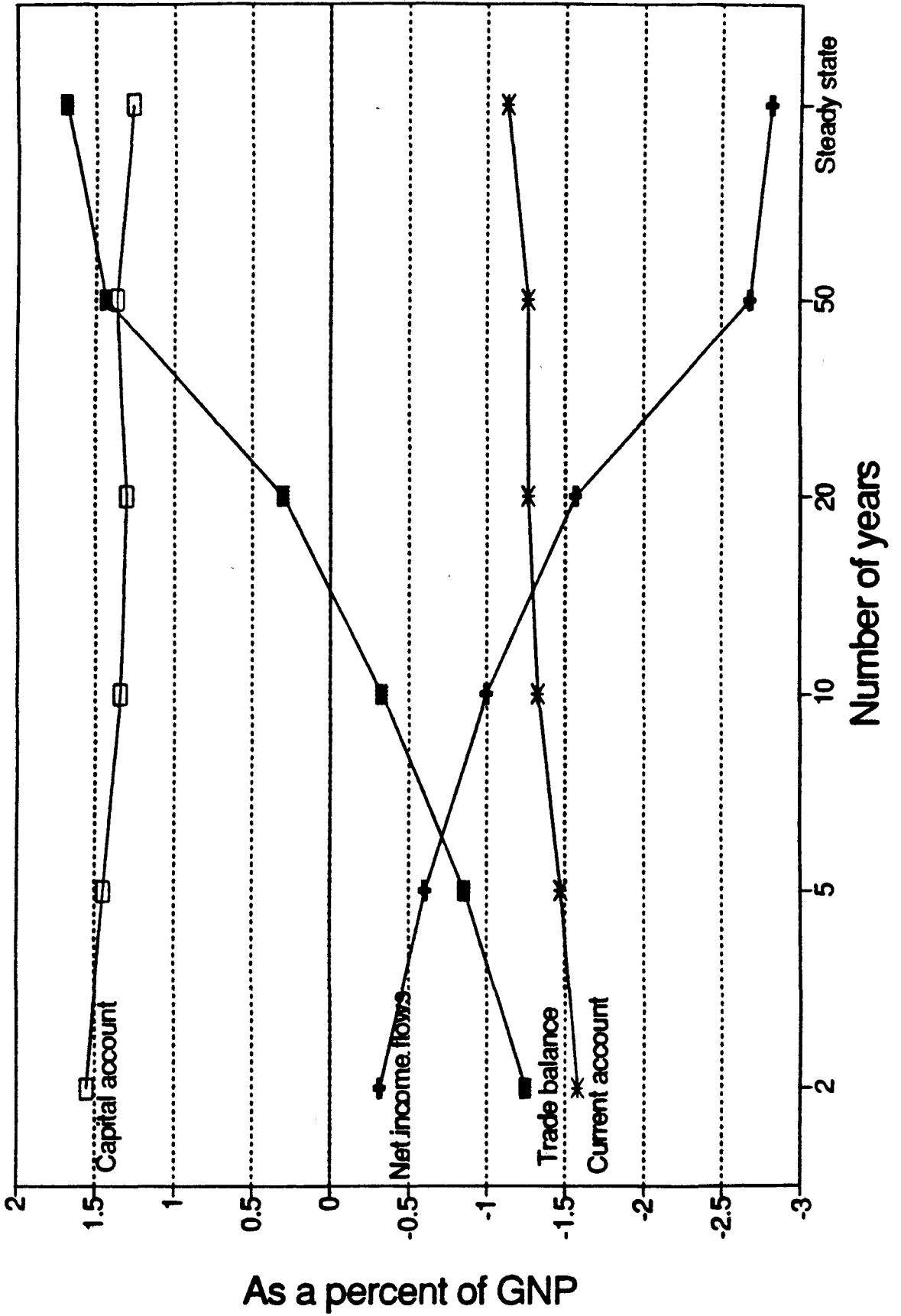# Table 3: Sensitivity analysis: Long-run impacts on the U.S. economy.

	Real income	Real investment	Real saving	Capital account
1. Personal income taxation reduction				
Basecase (1)	-1.8	0.4	-11.0	1.3
International capital mobility (2)				
high	-3.6	1.5	-24.1	2.7
low	-0.9	-0.2	-4.4	0.5
Cross-holdings (3)				
low	-3.5	0.8	-21.1	2.4
high	-0.6	0.1	-4.1	0.5
2. Corporate income taxation reduction				
Basecase (1)	0.1	0.1	-0.4	0.1
International capital mobility (2)				
high	0.1	0.1	-0.3	0.1
low	0.1	0.1	-0.5	0.2
Cross-holdings (3)				
low	0.0	0.1	-0.8	0.3
high	0.1	0.0	-0.1	0.1

(1) The basecase results are taken from Table A.1. for personal taxation simulation results and from Table A.2 for the corporate taxation simulation.

(2) The basecase value for the elasticity of substitution between domestic and foreign assets is equal to 4. The lower bound in fixed at 0.9 and the higher value at 8.

(3) The basecase value for the cross holding share (i.e. the share of domsticly-owned assets by domestic residents) is equal to 0.91. The "low" value is set at 0.86 while the "high" value is equal to 0.96.

Chart 1: Effects of personal income taxation on the U.S balance of payments

Capital account

Net income flows

Trade balance

Current account

As a percent of GNP

Number of years

Steady state

Notes

1. The authors are grateful to Lans Bovenberg, David Carey, Jean-Claude Chouraqui, Robert Ford, Robert Hagemann, Constantino Lluch, John Martin, Jack Mintz and Vito Tanzi for helpful suggestions. This work was performed while François Delorme was working for the OECD; he is now at the Canadian Department of Finance. Lawrence Goulder and Philippe Thalmann are from Stanford University and the University of Geneva respectively.

2. See Goulder, Shoven and Whalley (1983), Bovenberg and Goulder (1989) and Goulder and Eichengreen (1989a). For a survey, see Borges (1986).

3. See for example Abel (1979) and Summers (1981b).

4. There are four types of capital goods: structures and equipments for non-residential and residential use. They are produced with specific combinations of sectoral contributions.

5. The present value of those benefits corresponds to tax-adjusted marginal Q. The model of the firm is exposed with much more detail in appendix A of Goulder and Thalmann (1990).

6. The solution to the household's decision problem is shown with more detail in Goulder and Eichengreen (1989a).

7. This facilitates welfare evaluations, since household utility functions do not incorporate welfare derived from government-provided goods and services.

8. The number of equilibrating "prices" is one less than the number of equilibrium conditions, as one of the equilibrium conditions is redundant form Walras's Law. Both domestic and foreign nominal wages are fixed in their respective currencies. The exchange rate variable permits the relative prices of domestic and foreign labour to vary. It may be noted that the balance of payments equilibrium does not require an additional equilibrium condition: Walras's Law assures that this equilibrium is established when the other markets clear. To solve for the temporary equilibrium of each period, the model employs the algorithm of Powell (1970), which is designed to solve systems of nonlinear equations.

9. Real income (i.e. the welfare gain) is measured as the Hicks equivalent variation as a percentage of GDP.

10. A number of authors favour the base-eroding effects of tax competition as this limits the size of the public sector. See, for instance, Salin (1990).

11. The investment tax credit has been preferred to the statutory corporate income tax rate as the tax instrument used in this simulation. This is because, as shown in Summers (1981a), a reduction of the statutory corporate rate has an ambiguous effect in an intertemporal context as the corporate tax cut reduces the value of depreciation deductions. Although the tax cut provides a windfall to firms, it does not necessarily make investment in new capital attractive.

12. This is achieved by assuming that the discounted government revenue loss over the whole transition period is equivalent between the two simulations.

13. See Summers (1981a).

14.   Several tax instruments were altered following the 1986 reform: 1) marginal tax rates on labour and capital income were lowered by about 12 per cent (3 percentage points);   2) the 60 per cent exclusion on long-term capital gains was abandoned;   3) the corporate income tax at all levels of government was lowered from 51 per cent to 39 per cent;   4) the present value of depreciation allowances was lowered by 46 per cent for structures and 4 per cent for equipment; and 5) the investment tax credit was repealed.

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