U.S. Tax Policy and International Flows of Goods and Capital

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ABSTRACT

We integrate trade modeling and tax modeling, by evaluating the international spillover effects of changes in U.S. tax policy. The model is based primarily on Rutherford's GTAPinGAMS, which is a static computational general-equilibrium model, using data from the Global Trade Analysis Project. Our model incorporates a labor/leisure choice and international cross-ownership of assets. Our simulations suggest that unilateral elimination of U.S. capital-income taxation generates capital inflows, and that they encourage more efficient use of the capital stock, but they will also generate negative effects on the terms of trade. Overall, the policy change generates welfare gains for the United States.

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1. Introduction

The current tax-reform debate in the United States has focused attention on proposals that would lead to capital deepening.[1] Although they differ in some important details, many of the proposals point toward reduced taxation of capital income generally (and corporate capital income in particular), and toward increased consumption taxation. Much of the discussion has focused on the effect of tax reforms on labor supply and capital accumulation within the domestic economy.[2] International issues have been given relatively little attention. However, as the world economy becomes increasingly integrated, it becomes increasingly appropriate to focus on international issues, and some papers have used open-economy models to analyze the effects of tax-policy changes.

Whalley (1980) evaluates the effects of removing distortions in domestic factor taxes, using a static trade model in which goods are mobile, but factors are immobile across regions. He suggests that significant welfare *losses* could occur as a result of the elimination of domestic factor taxes. This result contrasts with the results of conventional closed-economy analysis. Whalley's result is explained by the fact that national terms-of-trade losses outweigh the gains from removal of domestic distortions.

Goulder, Shoven, and Whalley (GSW, 1983) modify the GEMTAP model of the U.S. economy and tax system, to include international capital flows.[3] In some simulations, GSW find that the domestic economy can reap substantial *gains* from unilateral adoption of capital-deepening policies. The welfare gains are driven partly by international capital flows, which were ruled out by assumption in Whalley (1980). In addition, the GSW model is dynamic, and this allows another avenue by which capital-deepening policy changes can lead to welfare gains.

Thalmann, Goulder, and DeLorme (1996) assess the effects on the U.S. economy of tax-policy changes in foreign countries. They use an infinite-horizon model that displays a larger degree of intertemporal sensitivity than does the model of GSW. As suggested in Ballard (1990, 2001), infinite-horizon models may overstate the degree of intertemporal responsiveness of the economy, and thus

[1] See the papers in Mieszkowski and Zodrow (forthcoming), which discuss the effects of various proposals that would move in the direction of greater reliance on consumption taxation. These include proposals to replace the current income tax with a national retail sales tax, or a value-added tax. They also include proposals for unlimited saving allowances within the framework of the current income tax.

[2] A number of authors have simulated the effects of moving toward consumption taxation in closed-economy models, and have generally found that heavier reliance on consumption taxation will lead to welfare gains in the long run. For example, see Fullerton, King, Shoven, and Whalley (1981), Fullerton, Shoven, and Whalley (1983), and Jorgenson and Wilcoxen (1997).

[3] A detailed description of the GEMTAP model can be found in Ballard, Fullerton, Shoven, and Whalley (1985).

may overstate the benefits of capital-deepening policy changes. Nevertheless, the results of Thalmann, *et al*., are of some interest. For one thing, they explicitly incorporate imperfect substitutability between foreign and domestic assets, which is consistent with the econometric evidence on international capital mobility. Even for a fairly modest policy change (an increase in depreciation allowances in the rest of the world), the model of Thalmann, *et al*., calculates a welfare improvement of 0.3 percent of GDP for the rest of the world.

Mendoza and Tesar (1998) use a simulation model to assess the difference between the effects of fundamental tax reform in a closed economy and in an open economy. They employ some extreme assumptions. First, they use a model with an infinitely lived consumer. As mentioned above, a model of this type is likely to produce simulated consumer behavior that is unrealistically responsive to changes in rates of return.[4] The second extreme assumption is that they consider a world in which international capital markets are "fully integrated"; that is, capital is assumed to be perfectly mobile, in spite of the evidence of substantial international capital immobility. Thus, their simulations are likely to overstate the extent of the international capital flow that would be caused by fundamental tax reform in the United States. Mendoza and Tesar suggest that the simulated welfare gains from replacing the U.S. capital income tax with a consumption tax are greater when the simulations are carried out in an open-economy model than in a closed-economy model. In the open-economy model, the U.S. gains by 2.89 percent, which is about one-third larger than in the closed-economy model.

Although these earlier studies shed some light, they can be improved upon in several dimensions: (1) The papers mentioned above are based on models with only two regions. (2) The model of Mendoza and Tesar has a fully integrated world capital market, which greatly overstates the degree of international capital mobility. (3) The models of Thalmann *et al.*, and Mendoza and Tesar employ infinite-horizon formulations, which tend to overstate the intertemporal effects of tax-policy changes. Therefore, the model described in this paper is a static model with four regions, in which capital is internationally mobile, but with incomplete adjustment in the world capital market.

2. Description of the Simulation Model

2.1. Overview

The basic framework for our research originates with the Global Trade Analysis Project (GTAP), which is described by Hertel and Tsigas (1996). The standard version of the GTAP model is

[4] Indeed, when Mendoza and Tesar (1998) simulate the effects of replacing the U.S. capital income tax with a consumption tax in a *closed-economy* setting, they find that the impact effect is for consumption to decline by 8.3 percent, which seems quite large.

a static, multi-sectoral, multi-regional model, in which each region's final demand is determined by a representative agent, who allocates expenditure across goods so as to maximize welfare. The model described here is based primarily on Rutherford's (1998) GTAP-data-based CGE model.[5] We aggregate the GTAP database considerably. In this paper, we use a data set with five commodities and four regions (the United States, the European Union, Japan, and the Rest of the World).

The core model used here is essentially identical to the standard GTAP model in some ways. First, the model is static.[6] There is no capital accumulation in the model. Consequently, in this version of the model, we may understate the distorting effects of domestic tax policy, since the effects on savings decisions are not captured.[7] Second, perfect competition is assumed in all sectors and all regions. The production technology is characterized by constant returns to scale (CRTS).[8] Third, trade is based on the Armington assumption: Commodities are distinguished by their place of origin.[9] The assumption of national product differentiation is particularly convenient, because it allows us to use a very simple formulation to incorporate crosshauling (*i.e.*, the simultaneous export and import of goods in the same commodity category), which is an important empirical feature of international trade. However, it should be noted that the Armington assumption has weaknesses. Brown (1987) criticizes this approach to product differentiation. She suggests that strong terms-of-trade effects can arise from the monopoly power implicit in national product differentiation. Therefore, she suggests that the Armington-type model may be fundamentally flawed for commercial policy analysis. An alternative approach is firm-level product differentiation, in which products are differentiated by firm, rather than by country of origin. Firm-level product differentiation implies imperfect competition. See footnote 8.

However, our model does not have precisely the same structure as the standard GTAP or GTAPinGAMS model. The model is modified in the following ways:

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[5] The standard programming language for GTAP data and modeling work has been GEMPACK. In the GEMPACK framework, the model is solved as a system of linearized equations. Rutherford (1998) develops a GTAP-data-based model that is implemented as a nonlinear complementarity problem in the GAMS programming language, and calls it the "GTAPinGAMS" model. The database represents global production and trade for 45 countries, 50 commodities, and 5 primary factors. This database characterizes all transactions in 1995, and measures them in 1995 dollars.

[6] The model described here has the same time frame as the well-known model of Harberger (1962), which is sometimes called a "medium-run" model. Since there is no capital accumulation, our model is not a long-run model. However, our model allows reallocation of the existing world capital stock among all sectors in the world. Thus, it is not a short-run model, either.

[7] The model will be extended later to a dynamic setting, along lines of the model of Ballard *et al.* (1985).

[8] The assumptions of perfect competition and constant returns to scale have been criticized on grounds that they tend to underestimate the welfare gains of trade liberalization. Recent work in international trade has focused on imperfect competition and scale economies. Imperfect competition and scale economies are an important subject for our future work.

[9] See Armington (1969).

(1) The model incorporates a labor-leisure choice, by having leisure as an argument of one nest of the utility function. It is not possible to capture the distortionary effects of the income tax in a model with exogenous labor supply (such as the standard GTAP model or the GTAPinGAMS model). Since our model incorporates an endogenous labor-supply decision, the results reflect the fact that the income tax is distortionary.

(2) The model incorporates a new method for calibrating the international capital flows. In our model, investors hold internationally diversified portfolios.[10] Consumers choose the portfolio shares of domestic and foreign assets, which are assumed to be imperfect substitutes in portfolios. As a result of changes in the relative rates of return, consumers are induced to alter the fractions of their financial wealth held in assets from different countries.

2.2. Utility Structure

A representative agent determines final demand in each region. Figure 1 shows the structure of the decision-making process of the representative agent in region *r*.

As in Thalmann, Goulder, and DeLorme (1996), the consumer's asset-holding decisions are based on the maximization of a Cobb-Douglas utility function, where the utility is defined over current expenditure and asset holdings. On the first level, the consumer decides on portfolio holdings (A^r) as well as on current expenditure (H^r): The consumer holds an internationally diversified portfolio, and chooses the shares of domestic and foreign assets, which are assumed to be imperfect substitutes in financial wealth.[11] The utility levels in region *r*, U^r, are represented by a Cobb-Douglas function:

$$U^r\left(H^r, A^r\right) = H^{r\,\beta^H} A^{r\,\left(1-\beta^H\right)} . \tag{1}$$

The consumer's asset holdings are represented by a CES function over domestic assets, K^{rr}, and foreign assets, K^{rs}:

$$A^r\left(K^{rr}, K^{rs}\right) = \left\{\alpha^{rA} K^{rr\,\frac{\sigma_{rs}^A - 1}{\sigma_{rs}^A}} + \left(1-\alpha^{rA}\right) K^{rs\,\frac{\sigma_{rs}^A - 1}{\sigma_{rs}^A}}\right\}^{\frac{\sigma_{rs}^A}{\sigma_{rs}^A - 1}} , \tag{2}$$

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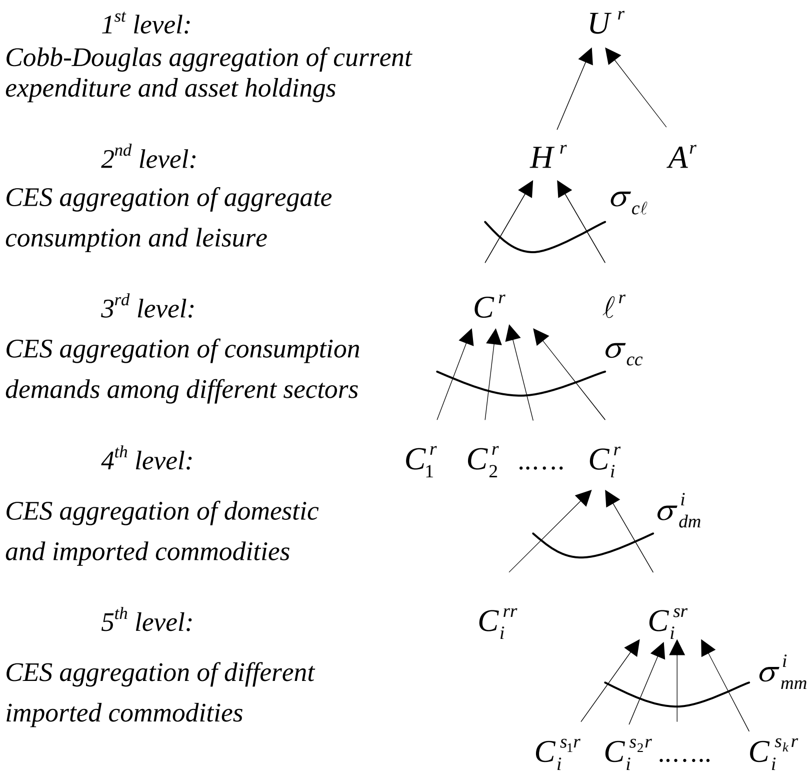
[10] The standard GTAP model assumes that international capital flows are allocated in response to changes in regional rates of return. The GTAPinGAMS model assumes that international capital flows are exogenous.

[11] The assumption that domestic and foreign assets are imperfect substitutes in the consumer's portfolio is consistent with observed home-country preference; home-country assets typically make up the bulk of portfolios, even when rates of return on foreign assets are comparable or higher. See Thalmann, Goulder, and DeLorme (1996). French and Poterba (1991) examine international asset-ownership patterns empirically, and find that most investors hold nearly all of their wealth in domestic assets.

Figure 1. The Structure of Utility



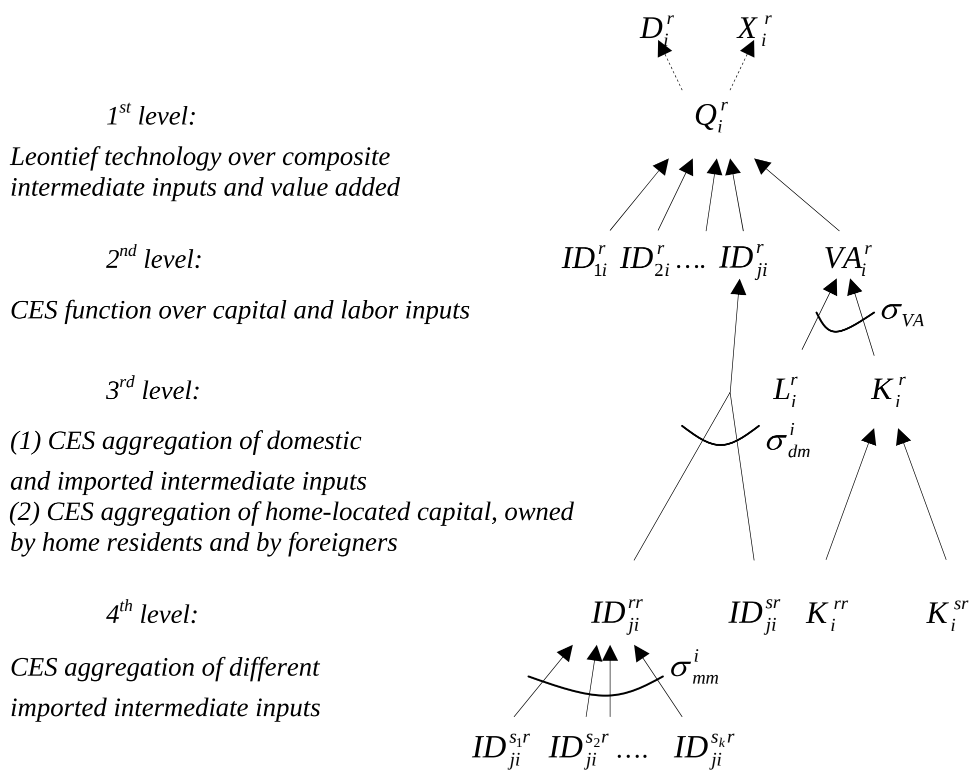
where the σ_{rs}^A are the elasticities of substitution between domestic and foreign capital assets. The σ_{rs}^A parameters are calibrated to match with desired levels of the elasticity of demand for domestic capital with respect to rate-of-return differentials. If there is an increase in domestic rates of return relative to foreign rates, investors will want to hold a greater proportion of their portfolios in domestic assets. (The relevant algebra can be found in the Appendix.)

On the second level, the consumer decides on aggregate consumption (C^r) and leisure (ℓ^r), where the $\sigma_{c\ell}$ are the elasticities of substitution between consumption and leisure. The $\sigma_{c\ell}$ parameters are calibrated to match with desired levels of the labor-supply elasticities. On the third level, the consumer maximizes utility from aggregate consumption, which is represented by a CES aggregation of consumption demands among the sectors (C_i^r), where the σ_{cc} are the elasticities of substitution among commodities. On the fourth level, the consumer decides whether to buy a commodity at home (C_i^{rr}) or abroad (C_i^{sr}), where the σ_{dm}^i are the Armington elasticities of substitution between domestic and imported goods in sector *i*. On the fifth level, the consumer maximizes aggregate consumption of imported goods, which are an aggregation of different imported commodities ($C_i^{s_k r}$), where the σ_{mm}^i are the Armington elasticities of substitution among imported goods in sector *i* from different regions.

2.3. Production Structure

Figure 2 represents the production side of the model. There are two types of produced commodities: domestic outputs and exports. We assume that the production process is characterized by perfect substitution between domestic output and exports. The primary factors, labor and capital, are combined according to a value-added function. Labor inputs are assumed to be mobile between production sectors, but not internationally. Capital inputs are assumed to be mobile across sectors *and* regions. Cross-ownership of capital is allowed in the model: both home residents and foreigners may

Figure 2. The Structure of Production



own domestic capital. We assume that producers are indifferent regarding whether their capital is owned by domestic residents or by foreigners.

3. Parameter Selection and Model Calibration

We employ the technique of calibration to impose a desired set of elasticities upon the model. The most important demand-side parameters are summarized in Table 1.

Table 1. Parameter Values

	U.S.	*E.U., Japan, ROW*
Time-Endowment Ratio (Φ)	1.40	1.40~1.49
Elasticities of Substitution:		
Consumption and Leisure $(\sigma_{c\ell})$	1.09	0.78~1.12
Domestic and Foreign Assets (σ_{rs}^{A})	1.79~1.90	1.23~1.47
Domestic and Imported Goods (σ_{dm}^{i})	0.50~3.10	0.50~3.10
Different Imported Goods (σ_{mm}^{i}) [a]	1.00~6.20	1.00~6.20

a. These values are arbitrarily chosen, based on the calibrated σ_{dm}^{i}.

The elasticity of substitution between consumption and leisure, $\sigma_{c\ell}$, depends on the uncompensated labor-supply elasticity, η_L, and the time-endowment ratio, Φ.[12] This ratio is directly related to the total-income elasticity of labor supply, η_I. Our strategy is to specify values of η_L and η_I, and to solve for the values of Φ and $\sigma_{c\ell}$ that are consistent with those elasticities.[13] Based on the econometric literature, our central-case values are -0.1 for η_I and 0.15 for η_L.

Second, we calibrate the portfolio elasticity of substitution, which may play a relatively large role in an open-economy model. The consumer's share of domestic assets is expected to increase when domestic rental rates are relatively higher. The responsiveness of the decision is controlled by the elasticity of substitution between domestic and foreign assets, σ_{rs}^{A}. Previous papers have employed fairly arbitrary assumptions regarding the value of this parameter. Gravelle and Smetters (1998) take the portfolio elasticity of substitution as 3.0. Thalmann, Goulder, and DeLorme (1996) calibrate it as 4.0. Our goal is to calibrate this parameter more precisely, based on the econometric evidence.

The equation for the elasticity of demand for domestic capital with respect to the rate-of-return differentials, η_{KD}, was derived from the consumer's utility maximization. (See Appendix.) As shown in equation (A5), the elasticity of demand for domestic capital depends on the amount of domestic capital, K^{rr}, and the portfolio elasticity of substitution, σ_{rs}^{A}. Therefore, the elasticity of substitution between domestic and foreign assets can be calibrated, using the value of η_{KD}, which is calculated based on the value of the elasticity of demand for capital abroad, η_{KA}, which, in turn, is taken from the

[12] The "time-endowment ratio" is defined as $\Phi = E / L$, where E is the consumer's endowment of time, and L is the amount of labor supplied in the base case.
[13] See Ballard (1999) for discussion.

econometric literature. As shown in Table 2, if we use the value of the elasticity of capital abroad provided by Altshuler, Grubert, and Newlon (1998), we calibrate the portfolio elasticity of substitution for the U.S. to be 1.79. If we use the elasticity estimated by Grubert and Mutti (2000), the calibrated value of the portfolio elasticity of substitution is 1.90. Similarly, the portfolio elasticities of substitution in other regions of the world are calibrated as 1.23 and 1.47, based on the values of the elasticity of capital abroad, provided by Boskin and Gale (1987) and Slemrod (1990). Therefore, in this analysis, we take the central values of the portfolio elasticity of substitution in the U.S. and other regions as 1.8 and 1.4, respectively, although we will also perform sensitivity analysis.

Table 2. Elasticity of Capital Abroad and Calibrated Elasticity of Substitution between Domestic and Foreign Assets

Elasticity of Capital Abroad (η_{KA}) [a]		*Elasticity of Domestic Capital* (η_{KD}) [b]	*Calibrated* σ_{rs}^{A}
(U.S.)			
Altshuler, Grubert, and Newlon (1998)	2.80	0.24	1.79
Grubert and Mutti (2000)	3.23	0.28	1.90
(E.U., Japan, ROW)			
Boskin and Gale (1987)	1.91	0.12	1.47
Slemrod (1990)	0.77	0.05	1.23

a. The η_{KA} in the U.S. and in other regions represent the U.S. DIA (direct investment abroad) elasticity, and the U.S. FDI (foreign direct investment) elasticity, respectively, from the U.S. point of view.

b. The elasticities are calculated, using $\eta_{KD} = \eta_{KA} \times \left(1-\alpha^{A}\right)/\alpha^{A}$, where α^{A} is the share of domestic assets in portfolio.

Finally, we consider the trade elasticities of substitution. The σ_{dm}^{i} parameters represent the higher-level Armington elasticity between domestic and imported goods, and the σ_{mm}^{i} parameters represent the lower-level Armington elasticity among imported goods from different regions. These elasticity values are very important because the magnitude of the terms-of-trade effects varies substantially with these trade elasticities. As shown by Brown (1987), lower trade elasticities tend to produce strong terms-of-trade effects. Shiells and Reinert (1993) suggest that higher values of Armington elasticities must be considered, in order to avoid large terms-of-trade effects.

It would be possible to calibrate the trade elasticities on the basis of econometric evidence, as we have just done for the asset-substitution elasticities. However, the econometric literature has an extremely wide range of estimates, and it is difficult to find a consensus. Consequently, we defer to the judgment of Jomini, *et al.* (1991), and use the SALTER elasticities of substitution as our central values. In the SALTER setting, the values of σ_{dm}^{i} are based on preferred estimates from the econometric literature, with some upward adjustment, and the values of σ^i_{mm} are set at twice the values of σ^i_{dm}. The sector-specific SALTER trade elasticities are shown in Table 3.

Table 3. The SALTER Trade Elasticities [a]

Sectors	σ^i_{dm}	σ^i_{mm}
Agriculture	2.43	4.86
Primary Materials	2.60	5.20
Durable Manufactures	3.40	6.80
Non-durable Manufactures	2.75	5.50
Services	2.05	4.10

a. The SALTER values, which are provided by Jomini, *et al*. (1991), are modified to fit in the model, using a weight parameter.

4. Interpretation of Simulation Results

We analyze the international spillover effects of U.S. tax reform.[14] Since many of the proposals for tax reform point toward reduced taxation of capital income, and toward increased consumption taxation, we consider here the extreme case of complete elimination of capital income taxes. The lost revenues are replaced with higher rates of consumption tax, so that tax revenue remains unchanged.

In the analysis of elimination of the sector-specific capital income taxes in the U.S., a negative terms-of-trade effect is expected for the United States. If the U.S. eliminates capital income taxes, there will be a decrease in the gross-of-capital-tax prices of U.S. output. Thus, there will be a decline in the prices of U.S. exports and in the prices of U.S. output produced for the domestic market (the first-order effect). Since the prices of domestic goods decrease, domestic consumers will consume more domestic goods and fewer imports. The reduction in demand for imports leads to a decrease in import prices (the second-order effect). Since the first-order effect dominates the second-order effect, a negative terms-of-trade effect will be expected. This negative effect can reduce the U.S. welfare gains that come from the elimination of domestic distortions.

4.1. Effects on Capital Flows and Terms of Trade

Table 4 shows the result of two of the mechanisms that determine the overall welfare effects. First, we consider the spillovers that occur as a result of international capital flows. The reduction in U.S. capital income taxes raises the after-tax returns on U.S.-located capital relative to the rate of return on foreign capital. Under this circumstance, the U.S. tax policy will tend to be accompanied by a reallocation of global capital, with a greater share of the world's capital stock being located in the United States. The overall U.S. capital stock is increased by 12.8 percent.

International spillovers also occur through changes in terms-of-trade effects. As a result of the policy change, there are decreases in both export prices and import prices. However, the reduction in U.S. export prices is larger than the reduction in U.S. import prices, and this causes a 2.3-percent deterioration in the terms of trade for the United States. After the changes in U.S. tax policy, the other regions of the world experience an improvement in the terms of trade.

Table 4. Effects on Capital Flows and Terms of Trade

(Unit: % Changes [a])

	USA	*E.U.*	*JAPAN*	*ROW*
Rental Price of Capital	25.74	-7.70	-7.75	-8.83
Capital Flows by Sector				
Agriculture	-0.18	-1.51	-1.47	-1.11
Primary Materials	3.50	-3.07	-3.24	-2.03
Durable Manufactures	54.36	-5.50	-5.04	-4.97
Non-durable Manufactures	19.05	-3.25	-3.06	-2.53
Services	9.16	-3.29	-3.00	-2.31
Overall	12.76	-3.35	-3.18	-2.29
Terms of Trade	-2.25	0.25	0.76	0.45

a. The figures are deviations from the benchmark values, in percent.

4.2. Aggregate Effects on the U.S. Economy

Table 5 reports the results for the United States, which is the policy-initiating economy. Under the complete elimination of capital income taxes, higher rates of consumption tax are used to achieve equal tax-revenue yield for the government. We consider a multiplicative increase in tax rates, as well as an additive increase. The first column of Table 5 shows the results of the case where consumption tax rates are increased multiplicatively. The results show that the tax-policy changes lead to a 7.6-percent increase in the overall U.S. output level. The largest size price decreases are in the durable-manufactures sector. As a result, that sector has the largest output increases. Overall, U.S. imports are increased by 1.6 percent. The tax-policy changes cause U.S. consumption to rise by 1.3 percent, and they lead to an increase in U.S. welfare by 2.9 percent. These welfare gains are around $270 billion per year in 1995 dollars.

[14] For the analysis, we aggregate 45 regions into 4 regions (the United States, the European Union, Japan, and the Rest of the World (ROW)), and we aggregate 50 sectors into 5 sectors (agriculture, primary materials, durable manufactures, non-durable manufactures, and services).

The "multiplicative" change in consumption-tax rates may exacerbate consumption distortions, and thus may lead to smaller welfare effects than those that would occur under a different set of replacement taxes. Therefore, we also consider an "additive" tax-rate change. The second column of Table 5 has the results of the case where consumption tax rates are increased additively. With the "additive" tax-rate changes, consumption in the U.S. increases by 1.5 percent (vs. 1.3 percent with multiplicative scaling), and welfare in the U.S. increases by 3.2 percent (vs. 2.9 percent with multiplicative scaling). These welfare gains are around $290 billion per year.

The positive U.S. welfare gains can be explained through three channels. First, the equalization of capital tax rates leads to a more efficient allocation of the U.S. capital stock. In this paper, however, our emphasis is on international issues. The tax-policy change also has a positive effect on capital flows, but it has a negative effect on the terms of trade. The positive welfare gains are due to the fact that the positive effects dominate the negative terms-of-trade effect.

Table 5. Domestic Effects of the Tax-Policy Change on the U.S. Economy

	Changes in Consumption Tax	
	Multiplicative	*Additive*
Output by Sector (% changes) [a]		
Agriculture	5.22	-0.53
Primary Materials	7.53	3.00
Durable Manufactures	22.58	12.72
Non-durable Manufactures	10.27	4.16
Services	0.06	2.41
Overall	7.64	3.63
Imports by Sector (% changes)		
Agriculture	13.01	6.61
Primary Materials	6.54	4.46
Durable Manufactures	-0.85	-7.82
Non-durable Manufactures	-1.72	-5.72
Services	-7.58	-3.27
Overall	1.56	-0.97
Consumption (% changes)	1.26	1.53
Utility (% changes)	2.94	3.20
Equivalent Variation ($ billion)	269.7	294.0
Compensating Variation ($ billion)	262.0	284.9

a. Units are in parentheses.

4.3. Aggregate Effects on the Foreign Economies

The policy initiated by one country affects the allocation of resources across regions. The effects of the policy change in the U.S. on the foreign economies are reported in Table 6.

Table 6. Spillover Effects of the U.S. Tax-Policy Change on Foreign Economies

	Foreign Economy					
	European Union		*Japan*		*Rest of the World*	
	(1) [b]	*(2)* [c]	*(1)*	*(2)*	*(1)*	*(2)*
Output by Sector (% changes) [a]						
Agriculture	0.39	0.30	0.22	0.40	0.22	0.21
Primary Materials	-0.18	-0.32	-0.85	-0.84	-0.34	-0.35
Durable Manufactures	-2.06	-2.16	-2.06	-2.27	-2.54	-3.06
Non-durable Manufactures	-0.11	-0.20	-0.24	-0.23	-0.58	-0.65
Services	-0.17	-0.14	-0.15	-0.15	-0.27	-0.21
Overall	-0.35	-0.42	-0.52	-0.52	-0.59	-0.68
Imports by Sector (% changes)						
Agriculture	-0.38	-0.43	-2.30	-3.30	-1.68	-2.38
Primary Materials	-0.45	-0.52	-0.09	-0.49	-0.29	-0.67
Durable Manufactures	1.19	0.98	7.85	6.25	2.25	1.51
Non-durable Manufactures	0.31	0.32	2.47	1.88	1.27	0.79
Services	1.38	1.06	1.68	1.11	1.52	0.93
Overall	0.34	0.24	1.61	0.91	0.51	0.03
Consumption (% changes)	0.42	0.41	0.33	0.29	0.48	0.40
Utility (% changes)	0.43	0.43	0.35	0.31	0.48	0.41
Equivalent Variation ($ billion)	43.8	42.9	25.2	22.8	53.3	45.8
Compensating Variation ($ billion)	39.4	38.1	22.8	20.3	48.0	40.6

a. Units are in parentheses.
b. Each column (1) shows the results from a simulation with "multiplicative" changes in consumption-tax rates in the United States.
c. Each column (2) shows the results from a simulation with "additive" changes in consumption-tax rates in the United States.

The results show that the U.S. tax policy, which replaces a capital income tax with a consumption tax, leads to lower outputs in the foreign regions. The overall outputs in the foreign economies are decreased by 0.4~0.7 percent. The reduction of output is primarily attributable to international capital outflows. (See Table 4.) As Thalmann, Goulder, and DeLorme (1996) point out, the mechanisms that determine the overall welfare impacts can be complex. On the one hand, the U.S. tax policy raises after-tax returns on U.S.-located capital, which benefits foreigners who own such capital. By raising these foreigners' capital income, the tax policy generates revenues to the foreign government. On the other hand, the higher returns in the United States tend to increase the attractiveness of investment in U.S.-located capital. So there will be reallocation of capital from the foreign economies to the United States. The reduction in foreign-located capital leads to a negative impact on the welfare of the foreign economies. The latter negative effects are partly offset by the former positive effects. Therefore, if we focus only on the capital market, the foreign economies suffer small welfare losses.

However, the negative capital-flow effects for the foreign economies are dominated by positive terms-of-trade effects. Due to the elimination of the U.S. capital income tax, the terms of trade for foreign economies are relatively improved, by from 0.3~0.8 percent. As a result, there is higher consumption and higher welfare outside the United States, but to a lesser extent than in the United States. The levels of consumption in the European Union, Japan, and the ROW are increased by 0.4 percent, 0.3 percent, and 0.4 percent, respectively. The levels of welfare rise by from 0.3~0.5 percent.

4.4. Sensitivity Analyses

In this section, we conduct sensitivity analyses for the key parameters. We start with a sensitivity analysis for the trade elasticities of substitution, in which four possible cases are considered. These are: (a) changes in $\sigma_{dm}(usa)$, (b) changes in $\sigma_{dm}(others)$, (c) changes in $\sigma_{mm}(usa)$, and (d) changes in $\sigma_{mm}(others)$. The results are briefly summarized in Table 7.

Table 7. Sensitivity Analysis with Respect to the Different Combinations of Trade Elasticities of Substitution

(Unit: % Changes [a])

Elasticities of Substitution	*Changes*		
$\sigma^i_{dm}(usa)$	*central*	*+50%*	*+100%*
U.S. Terms of Trade	-2.254	-1.642	-1.192
	(0.00)	(27.15)	(47.12)
U.S. Utility Level	2.94	2.99	3.03
	(0.00)	(1.70)	(3.06)
$\sigma^i_{dm}(teu) = \sigma^i_{dm}(jpn) = \sigma^i_{dm}(row)$	*central*	*+50%*	*+100%*
U.S. Terms of Trade	-2.254	-2.134	-2.023
	(0.00)	(5.32)	(10.25)
U.S. Utility Level	2.94	2.95	2.96
	(0.00)	(0.34)	(1.02)
$\sigma^i_{mm}(usa)$	*central*	*+50%*	*+100%*
U.S. Terms of Trade	-2.254	-2.256	-2.258
	(0.00)	(-0.09)	(-0.18)
U.S. Utility Level	2.94	2.94	2.94
	(0.00)	(0.00)	(0.00)
$\sigma^i_{mm}(teu) = \sigma^i_{mm}(jpn) = \sigma^i_{mm}(row)$	*central*	*+50%*	*+100%*
U.S. Terms of Trade	-2.254	-1.271	-0.642
	(0.00)	(43.61)	(71.52)
U.S. utility level	2.94	3.03	3.08
	(0.00)	(3.06)	(4.76)

a. The figures in the table are deviations from the benchmark values, in percent. Numbers in parentheses represent percentage changes with respect to the values in the central case.

(a) *As the* $\sigma_{dm}(usa)$ *become larger, the terms-of-trade effects become smaller.*[15] In other words, as imports become closer substitutes with domestically produced goods in the U.S., the terms-of-trade loss in the U.S. becomes smaller. The more sensitive domestic consumers are, the greater is the shift into domestically produced goods, and hence the greater will be the decreases in import prices. The results show that lower elasticities tend to produce stronger terms-of-trade effects.

(b) *As the* $\sigma_{dm}(other)$ *become larger, the terms-of-trade effects become smaller.* In other words, as the domestically produced goods in the foreign regions become closer substitutes with imports (i.e., with exports from the U.S.), the U.S. terms-of-trade loss becomes smaller. After changes in U.S tax policy, foreign consumers will consume more import goods and fewer of their domestically produced goods, due to the relative decline in the price of import goods. The more sensitive foreign consumers are, the greater is the shift out of their domestically produced goods and into imported goods. This leads to decreases in U.S. import prices, and increases in U.S export prices, when compared with a situation in which the elasticities are smaller. Both the reduction of U.S. import prices and the rise in U.S. export prices will reduce the U.S. terms-of-trade loss.

(c) *As the* $\sigma_{mm}(usa)$ *become larger, there are no substantial changes in the terms-of-trade effects.* The magnitudes of the elasticity of substitution among different imported goods in the U.S. don't have a significant effect on U.S. import and export prices.

(d) *As the* $\sigma_{mm}(others)$ *become larger, the terms-of-trade effects become smaller.* In the model, the elasticity of substitution among different imported goods in other regions plays the same role as the elasticity of substitution between domestic and imported goods in the United States.

Next, we conduct a sensitivity analysis with respect to the portfolio elasticity of substitution. The elasticity of substitution between domestic and foreign assets in portfolios, σ_{rs}^{A}, determines the ease of substitution between two assets, and thus the degree of international capital mobility. Altering the elasticities of substitution changes the results of replacing the U.S. capital income tax. Table 8 reports the results. We take the central values of the portfolio elasticity of substitution as 1.8 for the U.S. and 1.4 for other regions. For sensitivity analysis, the values of these elasticities of substitution

[15] This differs from the result in Brown (1987). She evaluates how national product differentiation relates to the terms-of-trade effects of a tariff, and shows that the terms-of-trade effects would increase in magnitude, as the elasticity of substitution between domestic and imported goods becomes larger. However, we find that the terms-of-trade effects are smaller when the elasticity of substitution is larger. This difference comes from the fact that imposing a tariff drives the export price up, whereas eliminating capital-income taxation drives it down. Imposing a tariff leads to an increase in export prices and a decrease in import prices, and thus generates terms-of-trade gains. On the other hand, eliminating capital-income taxation leads to a decrease in export prices, and thus generates terms-of-trade losses.

are increased by 100 percent, to 3.6 and 2.8, to represent a greater degree of international capital mobility, and they are decreased by 25 percent, to1.35 and 1.05, to represent a smaller degree of international capital mobility.

Table 8. Sensitivity Analysis with Respect to the Elasticities of Substitution between Domestic and Foreign Assets

(Unit: % Changes [a])

Variables	σ_{rs}^{A}				
	-25%	*central* [b]	*+25%*	*+50%*	*+100%*
Capital Flows					
U.S.	11.597	12.756	13.868	14.937	16.960
	(-9.086)	(0.000)	(8.717)	(17.098)	(32.957)
E.U.	-3.051	-3.351	-3.635	-3.903	-4.399
	(8.953)	(0.000)	(-8.475)	(-16.473)	(-31.274)
JAPAN	-2.847	-3.179	-3.482	-3.760	-4.254
	(10.444)	(0.000)	(-9.531)	(-18.276)	(-33.816)
ROW	-1.992	-2.287	-2.570	-2.842	-3.353
	(12.899)	(0.000)	(-12.374)	(-24.268)	(-46.611)
Utility					
U.S.	3.010	2.940	2.880	2.820	2.710
	(2.381)	(0.000)	(-2.041)	(-4.082)	(-7.823)
E.U.	0.410	0.430	0.460	0.480	0.530
	(-4.651)	(0.000)	(6.977)	(11.628)	(23.256)
JAPAN	0.330	0.350	0.360	0.380	0.410
	(-5.714)	(0.000)	(2.857)	(8.571)	(17.143)
ROW	0.460	0.480	0.490	0.510	0.550
	(-4.167)	(0.000)	(2.083)	(6.250)	(14.583)

a. The figures in the table are deviations from the benchmark values, in percent. Numbers in parentheses represent percentage changes with respect to the values in the central case.

b. The central values of σ_{rs}^{A} are 1.8 for U.S., and 1.4 for other regions.

Under the U.S. tax-policy changes, as σ_{rs}^{A} becomes larger, there are more capital inflows into the United States. In other words, as domestic and foreign assets become closer substitutes, the amount of capital inflows into the U.S. becomes larger. The more sensitive investors are, the more domestic capital is demanded, due to the higher after-tax returns in the United States. If σ_{rs}^{A} is increased by 100 percent, the capital stock located in the U.S. will increase by 17.0 percent, relative to the base case. This compares with an increase of 12.8 percent when the central-case parameters are used. Consequently, the amount of capital outflow from the other regions will be substantially greater when the elasticity of substitution is larger than in the central case. Therefore, the positive welfare gains for the U.S. are expected to increase when the portfolio elasticities of substitution are higher. However, the results show that the welfare gains in the U.S. are *decreased* with higher elasticities of substitution: As σ_{rs}^{A} is increased by 100%, the U.S. welfare gains decrease by 7.8 percent, relative to the revised case with central-case parameters. We attribute the reduction in welfare gains to the fact that the larger portfolio elasticity of substitution causes larger terms-of-trade effects.[16] The terms-of-trade effects through the changes in portfolio elasticity of substitution are shown in Table 9, which reports the sensitivity analysis for different combinations of portfolio and trade elasticities of substitution.

We compare row (a) and row (e) in Table 9. Row (a) represents the results with lower trade elasticities of substitution, and row (e) represents the results with higher trade elasticities of substitution. Given a lower elasticity of substitution between domestic and imported goods (such as in row (a)), as σ_{rs}^{A} is increased by 100 percent, the amount of capital inflows increases (from 12.7 to 16.8 percent), and the terms-of-trade losses become larger (from -2.7 to -4.7 percent). As a result, the welfare gains decrease (from 1.2 to 1.1 percent). This is due to the fact that the increase in the terms-of-trade effects outweighs the increase in the capital-inflow effects.

Table 9. Sensitivity Analysis with Respect to the Different Combinations of Portfolio and Trade Elasticities of Substitution

(Unit: % Changes [a])

		σ_{rs}^{A}				
		-25%	*central* [b]	*+25%*	*+50%*	*+100%*
σ_{dm}^{i}	*(a) -25%*	(1) -2.16 (2) 11.56 (3) 1.25	(1) -2.73 (2) 12.69 (3) 1.20	(1) -3.26 (2) 13.78 (3) 1.17	(1) -3.76 (2) 14.81 (3) 1.13	(1) -4.70 (2) 16.76 (3) 1.07
	(b) central [c]	(1) -1.73 (2) 11.60 (3) 1.30	(1) -2.25 (2) 12.76 (3) 1.26	(1) -2.75 (2) 13.87 (3) 1.23	(1) -3.22 (2) 14.94 (3) 1.20	(1) -4.08 (2) 16.96 (3) 1.16
	(c) +25%	(1) -1.38 (2) 11.62 (3) 1.34	(1) -1.87 (2) 12.81 (3) 1.31	(1) -2.34 (2) 13.94 (3) 1.29	(1) -2.78 (2) 15.04 (3) 1.26	(1) -3.60 (2) 17.13 (3) 1.22
	(d) +50%	(1) -1.10 (2) 11.65 (3) 1.38	(1) -1.56 (2) 12.84 (3) 1.35	(1) -1.99 (2) 14.00 (3) 1.33	(1) -2.41 (2) 15.12 (3) 1.31	(1) -3.19 (2) 17.26 (3) 1.27
	(e) +100%	(1) -0.66 (2) 11.67 (3) 1.43	(1) -1.07 (2) 12.90 (3) 1.41	(1) -1.46 (2) 14.09 (3) 1.40	(1) -1.83 (2) 15.25 (3) 1.38	(1) -2.55 (2) 17.48 (3) 1.36

a. The figures are deviations from the benchmark values, in percent.
(1) = % changes in terms of trade
(2) = % changes in capital inflow
(3) = % changes in consumption level

b. The central values of σ_{rs}^{A} are 1.8 for U.S., and 1.4 for other regions.

c. The central values of σ_{dm}^{i} are 2.43 for agriculture, 2.60 for primary materials, 3.40 for durable manufactures, 2.75 for non-durable manufactures, and 2.05 for services. These are assumed to be the same across regions.

[16] As domestic assets and foreign assets become closer substitutes, the amount of capital inflows becomes larger, but the terms-of-trade loss in the U.S. also becomes larger: The more sensitive investors are, the more domestic

On the other hand, given a higher elasticity of substitution between domestic and imported goods (such as in row (e) of Table 9), as σ_{rs}^{A} is increased by 100 percent, the amount of capital inflows increases (from 12.9 to 17.5 percent), but the terms-of-trade losses become larger (from -1.1 to -2.5 percent). When the trade elasticity of substitution is large enough to avoid strong terms-of-trade effects, the increase in the terms-of-trade effects is almost canceled out by the increase in the capital-inflow effects. As a result, there are no substantial changes in the welfare gains, which remain in the vicinity of 1.4 percent.

5. Conclusion

This paper has described a global trade model in which international spillover effects can occur through changes in commodity flows and changes in capital flows. We report and interpret the results of simulations of changes in U.S. tax policy.

We find that unilateral elimination of U.S. capital-income taxation generates welfare gains for the United States. The tax-policy changes improve the allocation of the domestic capital stock, and they generate capital inflows, but they also generate negative effects on the terms of trade. The positive effects dominate the negative effect, so that U.S. welfare is improved. Conversely, foreign economies experience capital outflows, along with positive terms-of-trade effects. In this model, in which asset cross-ownership is incorporated, the U.S. tax-policy changes raise after-tax returns on U.S.-located capital. As a result, there is a benefit for foreigners who own such capital. This benefit is sufficiently large that the foreign economies have welfare gains.

As the elasticities of substitution between domestic and foreign goods become larger, the terms-of-trade effects become smaller. A larger elasticity of substitution between domestic and foreign assets causes larger capital-flow effects, and it also causes larger terms-of-trade effects.

Our research is based on a static model. In the static framework, the distorting effects of domestic tax policy are relatively small, since the effects on saving decisions are not captured. In this sense, we may underestimate the welfare gains from capital-tax reduction. In order to capture the intertemporal distortion, it is necessary to develop a dynamic version of the model, in which consumers make a saving decision in each period. The model will be extended later to the dynamic setting.

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capital is demanded, and hence the smaller are the increases in the net-of-tax price of capital. This leads to more decreases in the gross-of-capital-tax prices of the U.S. output, and hence more decreases in the export prices.

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Appendix

The *Lagrangean* for the consumer's constrained maximization of the utility functions, U^r, is given by:

$$L = H^{r\,\beta^H} A^{r\,1-\beta^H} + \lambda\left\{wE^r + r^*\overline{K} - vK^{rr} + TR^r - P_H{}^r H^r\right\} \quad , \qquad \text{(A1)}$$

where $\overline{K} = K^{rr} + K^{rs}$ and $v = r^* - r$. Differentiating with respect to the choice variables H^r and K^{rr} yields the first-order conditions:

$$P_H{}^r \lambda = \beta^H H^{r\,\beta^H - 1} A^{r\,1-\beta^H} \qquad \text{(A2)}$$

and $$v\lambda = \left(1-\beta^H\right) H^{r\,\beta^H} A^{r\,-\beta^H} A^{r\,\prime} \quad . \qquad \text{(A3)}$$

Dividing equation (A2) by equation (A3), and arranging for H^r gives the equation:

$$H^r = \frac{v}{P_H^r}\frac{\beta^H}{1-\beta^H}\frac{\left\{\alpha^{r\,A} K^{rr\,\frac{\sigma_{rs}^A-1}{\sigma_{rs}^A}} + \left(1-\alpha^{r\,A}\right)\left(\overline{K}-K^{rr}\right)^{\frac{\sigma_{rs}^A-1}{\sigma_{rs}^A}}\right\}}{\left\{\alpha^{r\,A} K^{rr\,\frac{-1}{\sigma_{rs}^A}} + \left(1-\alpha^{r\,A}\right)\left(\overline{K}-K^{rr}\right)^{\frac{-1}{\sigma_{rs}^A}}\right\}} \quad . \qquad \text{(A4)}$$

After putting equation (A4) into the budget constraint, totally differentiating it with respect to v and K^{rr}, and manipulating it, we get the elasticity of demand for domestic capital with respect to the rate-of-return differentials, η_{KD}:

$$\eta_{KD} \equiv \frac{\partial K^{rr}}{\partial v}\frac{v}{K^{rr}} = \frac{-\left(\frac{\beta^H}{1-\beta^H}\right)\frac{B}{D}\frac{1}{K^{rr}} - 1}{\left\{\left(\frac{\beta^H}{1-\beta^H}\right)\left[\frac{\left(\frac{\sigma_{rs}^A-1}{\sigma_{rs}^A}\right)D^2 + \left(\frac{1}{\sigma_{rs}^A}\right)B\cdot F}{D^2}\right] + 1\right\}} \quad , \qquad \text{(A5)}$$

where $$B \equiv \left\{\alpha^{r\,A} K^{rr\,\frac{\sigma_{rs}^A-1}{\sigma_{rs}^A}} + \left(1-\alpha^{r\,A}\right)\left(\overline{K}-K^{rr}\right)^{\frac{\sigma_{rs}^A-1}{\sigma_{rs}^A}}\right\} \; ,$$

$$D \equiv \left\{\alpha^{r\,A} K^{rr\,\frac{-1}{\sigma_{rs}^A}} - \left(1-\alpha^{r\,A}\right)\left(\overline{K}-K^{rr}\right)^{\frac{-1}{\sigma_{rs}^A}}\right\} \; ,$$

and $$F \equiv \left\{\alpha^{r\,A} K^{rr\,\frac{-1}{\sigma_{rs}^A}-1} + \left(1-\alpha^{r\,A}\right)\left(\overline{K}-K^{rr}\right)^{\frac{-1}{\sigma_{rs}^A}-1}\right\} \; .$$